# Notices 

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## Opinion

## The Nominating Committee

An enduring American Mathematical Society urban legend holds that there is an inner circle of elite mathematicians who determine who will be president, vice president, and members at large of the Council. But in reality, it's hard to get anyone to stand for election for these positions, including many alleged to either belong to or be chosen by this legendary inner circle.

This spring, I completed a term on the AMS Nominating Committee, including a stint as its chair. Serving on the AMS Nominating Committee is at once a very fulfilling and a hugely disappointing experience. It is fulfilling because one is witness to the enthusiasm and excitement some members display when asked to serve the Society by standing for election to a position in the AMS. But it is also disappointing in many ways: many excellent mathematicians are not even members of the Society, and of those who are, they don't want to serve, or they are too busy.

The AMS has both volunteer officers and two bodies of volunteer members who are elected to their positions. These bodies determine the policies and direction of the Society. They are the AMS Council and the Board of Trustees (BT). Simply put, the Council determines policy, and the Board has fiduciary responsibility. The Board appoints the Executive Director and determines the budget. The Council determines scientific policy. Six of the eight members of the Board of Trustees are elected by the members (the two Board members not elected are the treasurer and associate treasurer). A majority of the Council are elected directly by the members (those not directly elected are the secretaries, the treasurers, and the representatives of the editorial boards).

Each year the nine members of the Nominating Committee $(\mathrm{NC})$ meet from $9 \mathrm{a} . \mathrm{m}$. to $5 \mathrm{p} . \mathrm{m}$. for the first two days of the annual meeting of the Society. These members, elected to three-year terms upon nomination by the president (so each president has put six members on the committee), meet in a small room. They are equipped with a charge, prepared by the secretary, that details the positions to be filled and how many nominees are required. This charge follows carefully the policies adopted by the Council. Among other resources, the NC has available the list of all candidates for the past twenty to thirty years-who has won and who has lost. The NC members are assisted by the AMS Secretary's Administrative Assistant. They have access to MathSciNet and the Combined Membership List. The NC is a committee of the Council, and it reports to the Council; it is the Council which does the nominating. So you will not find mention of the NC in the Society Bylaws.

The NC must identify ten (10) candidates for five vacant positions as member-at-large (MaL) of the AMS Council. (There are fifteen MaLs, five elected each year for three-year terms-re-election is not possible.) It must find two candidates for vice president (VP). (There are three VPs, one elected each year for a three-year term.) It must also find two candidates for trustee. (There are five elected trustees, one elected each year for a five-year term. Reelection one time is permitted by the Council.)

Before the meeting begins, the NC has communicated via email, and usually members come to the meeting with a list of potential candidates. For MaL, their combined list may contain fifty or more names. Each name is considered by the committee. Membership in the AMS is a must. Experience in AMS activities is not so important, because membership on the Council is considered by some to be an entry level position. The list is then rank ordered by secret ballot. Members of the NC take into account the diversity (meant in the broadest sense) of the Council. It tries to limit to less than three the number of members from any one institution. It attempts to ensure that there are candidates from the several different types of educational institutions-from doctoralgranting to four-year colleges. Usually at least twenty names are needed in order to come up with a list of ten to present to the Council.

Selecting VPs is not as difficult mainly because only two have to be found. Still the NC has had to use ten or more names on occasion to find two people willing to stand for election.

The BT often presents a different problem. A member of the Board can be reelected for one term. In fact, it may be desirable to have a BT member be reelected, as it takes somewhat longer for a trustee to learn the position. Having done so, they can then bring this valuable experience to the BT. Thus there is a conflict between the desire to let a standing trustee serve again by running unopposed and the desire by the Council to have contested elections. The Society has lost the services of some excellent trustees by adhering to the "contested election" policy-but democracy has been preserved. It is relatively easy to find a distinguished mathematician who is willing to stand for election to the BT.

Finally there is the problem, faced every other year by the NC , of finding two candidates to run for the president elect position. (We usually talk about "president" because the president elect becomes president after one year.) Finding two candidates for this position is complicated by the necessity of finding a "nominator" for each of the candidates. This nominator has to write an article for the election material extolling the mathematical and other virtues of the candidate. Finding serious mathematicians who have taken the affairs of the Society seriously to be president is becoming an increasingly difficult task. Even with expert arm twisting, the NC often has to conclude its meetings before a final list is ready.

After deciding on the slate, the NC reports to the April meeting of the Council-which really does the nominating. This year the report was completed just days before the Council met. One potential MaL candidate dropped out after the Council had nominated him-showing that the NC somehow failed, and leaving only nine candidates for the five open MaL positions.

A glance back at the history of the AMS shows that many of America's elite mathematicians served as elected volunteers. We need to convince current-day mathematicians that membership in and service to the AMS is vital for our discipline and profession. In particular, when the Nominating Committee calls, please say "Yes".
-Robert M. Fossum
University of Illinois at Urbana-Champaign

## Letters to the Editor

## Ralston Responds to Escobales

I find it intriguing that, when criticizing things I have written in the Notices, writers of letters to the Notices (Rich Escobales in the August 2004 issue, Wilfried Schmid in the March 2004 issue) focus not on what I have written in the Notices but rather on what I have written elsewhere.

My article ("Research Mathematicians and Mathematics Education: A Critique") was not, as Escobales claims, "an update of [my] ideas expressed in other writings on school mathematics" but rather an attempt at an objective evaluation of the activities in recent years of research mathematicians related to school mathematics education. I hardly expected that I could be entirely successful in keeping my well known "prejudices" on this subject out of my article. But I must have been more successful than I had anticipated since Escobales' letter criticizes quotes from two of my previous papers (one from 19 years ago!) but criticizes nothing at all from my Notices article.

In commenting on an article of mine about the high school mathematics curriculum, Escobales asks, "Where are the statistical studies supporting Ralston's more radical conclusions?" The answer, of course, is that there are none. But, equally, there are no such studies that validate the current content of school mathematics, most particularly, I might note, the emphasis on pencil-and-paper arithmetic in elementary school mathematics. Instead we have no more than what seems to be the gut feeling of many (most?-no one knows) college mathematicians that pencil-and-paper arithmetic is the only or, anyhow, clearly the best way to teach children what they need to know about arithmetic. In Escobales' case, we have the dogma, unsupported except by anecdote, that, without "mastery of addition and the other algorithms of basic arithmetic", children are "condemned to move about blindly in [the] intriguing world of numbers". And this despite considerable evidence that a curriculum that focuses on pencil-
and-paper arithmetic has never been even moderately successful in teaching arithmetic to large numbers of children.

> -Anthony Ralston
> Professor Emeritus of Computer Science and Mathematics SUNY at Buffalo arg@doc.ic.ac.uk (Received June 22, 2004)

## Is Wallace's Chicken Russell's Turkey?

While my letter carries no mathematical content whatsoever, I felt I had to write this to compliment Michael Harris for his review of David Foster Wallace's "Everything and More" (E \& M) (Notices, June/July 2004). Harris's review is one of the most enjoyable pieces I have seen in the Notices in recent times, and it shows how even an unfavourable review can be an elegant thing. However, I did wonder why Harris did not say more about the origins of Mr. Chicken, whose activities mark the narrative high point of E \& M. Unless I am mistaken, Mr. Chicken is not quite an original creation. Isn't that character merely Russell's inductivist turkeyreincarnated as a chicken?

> -Gautam Bharali
> University of Michigan
> Ann Arbor
(Received June 29, 2004)

## How Mathematics Can Be Political

"Mathematicians and mathematics educators must be political!" Johnny Lott declares (Notices, June/July 2004, page 607), warning that "All mathematical people...must come together politically if the mathematics discipline is to survive."

Although the former NCTM (National Council of Teachers of Mathematics) president does not specify the threats to our millennia-old discipline, he seems to imply that they are: first, the No Child Left Behind Act; and second, the potential failure of "mathematical people" to support NCTM's political advocacy program.

The No Child Left Behind Act does indeed compromise the quality of
mathematics education in America's high schools. This is a serious prob-lem-the type which NCTM should naturally be concerned with. But let us not slide with Dr. Lott down a slippery slope and imagine that NCLB ultimately represents a threat to the survival of mathematics. Though not politically correct, we should remember that the formal education of the masses, while of tremendous importance in its own right, is more or less irrelevant to the development of most intellectual disciplines-including mathematics. Universal, compulsory schooling of teenagers such as we have in the United States is a very recent phenomenon. Mathematics, in contrast, is an ancient discipline. Mathematics may indeed benefit from a vast system of high schools, but history shows quite clearly that it is not dependent on them. What percentage of high school students today take even a single course of philosophy? Even one percent? Probably not, yet philosophy continues to draw its adherents. Similarly, if math disappeared altogether from high schools, the discipline of mathematics would continue to thrive. The discipline of mathematics education, however, would not.

Dr. Lott is correct about one thing-we can, as "mathematical people", affect some much-needed change in the classroom by coming together politically. Lobbying for government support of math education research, however, is political action of a fairly ineffectual kind. Such grants certainly benefit those working in the field of mathematics education, but whether or not they actually benefit our students remains an open question. NCTM's political advocacy program, as outlined in Dr. Lott's opinion piece, is, alas, peppered with pleas for government grants. While funding need not be discontinued or even necessarily reduced, there is much that we can do for mathematics education without government money. Indeed, we should generally be seeking ways to take money out of the educational machine rather than throwing more into it. Persistent demands for money, especially when accompanied by patently fallacious stories that mathematics may not survive if it is not
granted, invite accusations of profiteering.

As one who is deeply concerned with mathematics education but only mildly concerned with the discipline of mathematics education, I would like to propose one example of a meaningful and realistic way in which we, as "mathematical people", can bring about a small but important change through political action which takes money out of the system.

By working together, we can pressure publishers to lower textbook prices. A boycott can work wonders. There is no excuse for $\$ 70$ paperbacks, other than the fact that we as educators passively condone them. We ourselves are largely to blame, and we should work to correct this deplorable situation. Organizing such a boycott would be a great triumph for NCTM or any other math education organization. Of course, no one would receive research grants for such work, but bringing the cost of textbooks down would be (for once!) an unquestionable boon which the mathematics education community could bestow upon our students. This should be reward enough.
$\quad-$ Reb Hastrev
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(Received June 29, 2004)

## Teaching Loads

In many universities the current teaching load is lowered, or its lowering is discussed. When I was a young professor in France, the teaching load of all professors was 3 hours per week. I certainly enjoyed it a lot, and I would not have come to the U.S. if it had still been so in 1986 when I came. However, I wonder whether we are not going to some sort of collective political suicide guided by what has to be called academic greed.

It first strikes me to have these reductions of the teaching load coming at a time when tuitions are steeply increased, when services to students are strongly diminished (despite the futile speeches on undergraduate education), and when public support is rather weak.

In addition to increasing the number of classes taught in big size lectures, savings will be done by exploiting cheap labor with many adjuncts (without secure jobs and probably without fringe benefits-as already done in many technical colleges) instead of professors. Is it a way we wish to go? Are we not digging a hole for the future? Moreover, after step 1 , where reduction of the teaching load is negotiated with administrations by agreeing with teaching more large lectures, are we sure that step 2 (for our followers) will not be teaching these large lectures with a teaching load back to the previous level?

Competition between universities is often mentioned for justifying the present trend. Is it a competition of sheep jumping over a cliff?

> -Jean-Pierre Rosay Department of Mathematics, Van Vleck Hall University of Wisconsin, Madison jrosay@math.wisc.edu
(Received July 7, 2004)

## More Recommendations for Minority Mathematicians

Duane A. Cooper hit a home run with "Recommendations for increasing the participation and success of Blacks in graduate mathematics study" (Notices, May 2003). His recommendations on the undergraduate courses to be done by prospective graduate mathematics students is the icing on the cake, knowing that the $\mathrm{Ph} . \mathrm{D}$ in mathematics involves research and in most cases ability to bring to birth a theorem in mathematics. But in many universities, be they predominantly White, Black or mixed, many mathematics students can graduate without being well grounded in those core courses of analysis and algebra. This should then be an eyeopener to those who prepare the mathematics curriculum in many of our universities.

On my own, I strongly recommend more Blacks attending predominantly White colleges for their undergraduate studies in mathematics, but for their graduate studies they have brighter chances of succeeding when
they attend predominantly Black universities which to an extent is in line with Cooper's recommendations. I say this because I have a feeling that if a statistics is taken today it will be seen that most Blacks/minorities who graduated from predominantly Black universities have more confidence in themselves and are more "successful" in life than their counterparts who went to predominantly White universities.

Who says self-confidence doesn't have to do with success in life?

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## About the Cover

The "Olympia" sculpture, located at the Promenade in Midtown at 14th Street and Peachtree Street, Altlanta, Georgia. Atlanta is the site of the 2005 Joint Mathematics Meetings, January 5-8, 2005.

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# Computing over the Reals:Where Turing Meets Newton 

Lenore Blum

TThe classical (Turing) theory of computation has been extraordinarily successful in providing the foundations and framework for theoretical computer science. Yet its dependence on 0 s and 1 s is fundamentally inadequate for providing such a foundation for modern scientific computation, in which most algorithms-with origins in Newton, Euler, Gauss, et al.-are real number algorithms.

In 1989, Mike Shub, Steve Smale, and I introduced a theory of computation and complexity over an arbitrary ring or field $R$ [BSS89]. If $R$ is $\mathbb{Z}_{2}=(\{0,1\},+, \cdot)$, the classical computer science theory is recovered. If $R$ is the field of real numbers $\mathbb{R}$, Newton's algorithm, the paradigm algorithm of numerical analysis, fits naturally into our model of computation.

Complexity classes $P, N P$ and the fundamental question "Does $P=N P$ ?" can be formulated naturally over an arbitrary ring $R$. The answer to the fundamental question depends in general on the complexity of deciding feasibility of polynomial systems over $R$. When $R$ is $\mathbb{Z}_{2}$, this becomes the classical satisfiability problem of Cook-Levin [Cook71, Levin73]. When $R$ is the field of complex numbers $\mathbb{C}$, the answer depends on the complexity of Hilbert's Nullstellensatz.

The notion of reduction between problems (e.g., between traveling salesman and satisfiability) has

[^0]been a powerful tool in classical complexity theory. But now, in addition, the transfer of complexity results from one domain to another becomes a real possibility. For example, we can ask: Suppose we can show $P=N P$ over $\mathbb{C}$ (using all the mathematics that is natural here). Then, can we conclude that $P=N P$ over another field, such as the algebraic numbers, or even over $\mathbb{Z}_{2}$ ? (Answer: Yes and essentially yes.)

In this article, I discuss these results and indicate how basic notions from numerical analysis such as condition, round-off, and approximation are being introduced into complexity theory, bringing together ideas germinating from the real calculus of Newton and the discrete computation of computer science. The canonical reference for this material is the book Complexity and Real Computation [BCSS98].

## Two Traditions of Computation

The two major traditions of the theory of computation have, for the most part, run a parallel nonintersecting course. On the one hand, we have numerical analysis and scientific computation; on the other hand, we have the tradition of computation theory arising from logic and computer science.

Fundamental to both traditions is the notion of algorithm. Newton's method is the paradigm example of an algorithm cited most often in numerical analysis texts. The Turing machine is the underlying model of computation given in most computer science texts on algorithms. Yet Newton's

[^1]method is not discussed in these computer science texts, nor are Turing machines mentioned in texts on numerical analysis.

More fundamental differences arise with the distinct underlying spaces, the mathematics employed, and the problems tackled by each tradition. In numerical analysis and scientific computation, algorithms are generally defined over the reals or complex numbers, and the relevant mathematics is that of the continuum. On the other hand, 0 s and 1 s are the basic bits of the theory of computation of computer science, and the mathematics employed is generally discrete. The problems of numerical analysts tend to come from the classical tradition of equation solving and the calculus. Those of the computer scientist tend to have more recent combinatorial origins. The highly developed theory of computation and complexity theory of computer science in general is unnatural for analyzing problems arising in numerical analysis, yet no comparable formal theory has emanated from the latter.

One aim of our work is to reconcile the dissonance between these two traditions, perhaps to unify, but most important, to see how perspectives and tools of each can inform the other.

We begin with some background and motivation, then we present our unifying model and main complexity results, and, finally, we see Turing meet Newton and fundamental links introduced.

## Background

The motivation for logicians to develop a theory of computation in the 1930s had little to do with computers (think of it, aside from historical artifacts, there were no computers around then). Rather, Gödel, Turing, et al. were groping with the question: "What does it mean for a problem or set $S$ ( $\subset$ universe $X$ ) to be decidable?" For example, how can one make precise Hilbert's Tenth Problem?

Example. Hilbert's Tenth Problem. Let $X=\left\{f \in \mathbb{Z}\left[x_{1}, \ldots, x_{n}\right] n>0\right\}$ and $S=\{f \in X \mid \exists \zeta$ $\left.\in \mathbb{Z}^{n}, f\left(\zeta_{1}, \ldots, \zeta_{n}\right)=0\right\}$. Is $S$ decidable? That is, can one decide by finite means, given a diophantine polynomial, whether or not it has an integer solution? (Actually, Hilbert's challenge was: Produce such a decision procedure.)

The logicians' subsequent formalization of the notion of decidability has had profound consequences.

Definition. A set $S(\subset X)$ is decidable if its characteristic function $\chi_{S}$ (with values 1 on $S, 0$ on $X-S$ ) is computable (in finite time) by a machine.

Such a 0-1 valued machine is called a decision procedure for $S$. On input $x \in X$ it answers the question "Is $x \in S$ ?" with output 1 if YES and 0 if NO. Here $X$ is $\Sigma^{*}$, the set of finite but unbounded sequences over a finite set $\Sigma$. We will also allow $X$

| Numerical Analysis/ Scientific <br> Computation | Logic/Computer Science |
| :--- | :--- |
| -Newton's Method, Paradigm <br> Example in Most Numerical <br> Analysis Texts | - Turing Machine, Underlying <br> Model in most Computer Science <br> Texts on Algorithms |
| - No Mention of Turing Machines* | - No Mention of Newton's Method |
| - Real \& Complex \#'s | - 0's \& 1's (bits)* |
| - Math is Continuous | - Math is discrete |

to be a decidable subset of $\Sigma^{*}$ (e.g., as would be the case for the set of all diophantine polynomials embedded in $\{0,1\}^{*}$ via some natural coding). N.B. $\Sigma^{*}$ is countable.

To complete the definition, many seemingly different machines were proposed. What has been striking is that all gave rise to the exact same class of "computable" functions. This gives rise to the belief, known as Church's Thesis, that the computable functions form a natural class and any informal notion of procedure or algorithm can be realized within any of the formal settings.

In 1970, Yuri Matijasevich answered Hilbert's Tenth Problem in the negative by showing the associated characteristic function $\chi_{s}$ is not Turing computable and hence, by Church's Thesis, no procedure exists for deciding the solvability in integers of diophantine equations. (Following the program mapped out earlier by Martin Davis, Hi-


The Turing Machine (with simple operations, finite number of states, finite program, and infinite tape) provides a mathematical foundation for the classical Theory of Computation (originated by logicians in the 1930s and 40s) and Complexity Theory (originated by computer scientists in the 1960s and 70s). The program of this 2 -state TM instructs the machine "if in state A with a 0 or 1 in the current scanned cell, then print a 1 , move $R$ (ight) and go into state B; if in state B, print 0 , move $R$ and go into state $A$." That the long-term behavior of this machine is discernible is not the norm. (TM picture, courtesy of Bryan Clair.)
lary Putnam, and Julia Robinson, Matijasevich needed only to show the existence of a diophantine relation of exponential growth [DavisMatijasevicRobinson76].)

Since the initial startling results of the 1930s of the undecidability of the true statements of arithmetic and the halting problem for Turing machines, logicians have focused attention on classifying problems as to their decidability or undecidability. Considerable attention was placed on studying the hierarchy of the undecidable. Decidable problems, particularly finite ones, held little interest. In the 1960s and 70 s, computer scientists started to realize that not all such decidable problems were alike; indeed, some seemed to defy feasible solution by machine.
Example. The SATisfiability Problem (SAT). Here,

$$
X=\left\{f \mid f: \mathbb{Z}_{2}^{n} \rightarrow \mathbb{Z}_{2}\right\}
$$

is the set of Boolean functions and

$$
S=\left\{f \in X \mid \exists \zeta \in \mathbb{Z}_{2}^{n}, f\left(\zeta_{1}, \ldots, \zeta_{n}\right)=0\right\}
$$

It is assumed $X$ is embedded in $\{0,1\}^{*}$ via some natural encoding. Systematically testing all possible $2^{n}$ arguments for a given Boolean function $f$ clearly yields a decision procedure for $S$. This procedure takes an exponential number of basic operations in the worst case. We do not know if SAT is tractable, i.e., if there is a polynomial time decision procedure for $S$.

Definition. The decision problem $(X, S)$ is in class $P$ if the characteristic function $\chi_{s}$ is polynomial time computable, i.e., computable by a polynomial time Turing machine. A polynomial time Turing machine is one that halts in $c(\text { size } x)^{k}$ Turing operations for some fixed $c, k \geq 0$ and all inputs $x \in X$. Here size $x$ is the length of the sequence $x$, i.e., the bit length if $\Sigma=\{0,1\}$.

As was the case for computable functions, the polynomial time functions, the class $P$, and subsequently defined complexity classes, form natural classes independent of machine. ${ }^{1}$ Thus again, computer scientists have confidence they are working with a very natural class of functions and feel justified employing their favorite model.

In the early 1970s Steve Cook and Leonid Levin [Cook71, Levin73] independently formulated and answered the question about the tractability of SAT with another question: Does $P=N P ?^{2}$

A decision problem $(X, S) \in$ classNP if for each $x \in S$ there is a polynomial time verification of this fact. Later we will formalize the definition of $N P$, but meantime we note that SAT $\in N P$ : If a Boolean function $f \in S$, then there is a witness

[^2]$\zeta \in \mathbb{Z}_{2}^{n}$ that provides, together with the computation of $f$ on argument $\zeta=\left(\zeta_{1}, \ldots, \zeta_{n}\right)$ producing value 0 , a polynomial time verification. If $f \notin S$, then no such witness will do.

The significance of the $P=N P$ ? question became clear when Dick Karp showed that the tractability of each of twenty-one seemingly unrelated problems was equivalent to the tractability of SAT [Karp72]. The number of such problems known today is legion.

As did the earlier questions about decidability, the $P=N P$ ? question has had profound consequence. The apparent dichotomy between the classes $P$ and NP has been the underpinning of some of the most important applications of complexity theory, such as to cryptography and secure communication. Particularly appealing here is the idea of using hard problems to our advantage.

Thus the classical Turing tradition has yielded a highly developed and rich (invariant) theory of computation and complexity with essential applications to computation-and deep interesting questions. Why do we want a new model of computation?

## Motivation for Model

## Decidability over the Continuum: Is the Mandelbrot Set Decidable?

Now we witnessed a certain extraordinarily complicated-looking set, namely the Mandelbrot set. Although the rules which provide its definition are surprisingly simple, ${ }^{3}$ the set itself exhibits an endless variety of highly elaborate structure. Could this be an example of a non-recursive [i.e. undecidable] set, truly exhibited before our mortal eyes? ${ }^{4}$ -Roger Penrose, The Emperor's New Mind [Penrose89].
Classically, decidability is defined only for countable sets. The Mandelbrot set is uncountable. So the Mandelbrot set is not decidable classically. But clearly this is not a satisfactory argument. So how do we reasonably address Penrose's question?

From time to time, logicians and computer scientists do look at problems over the reals or complex numbers. One approach has been through "recursive analysis," which has its origins in Turing's seminal 1936 paper [Turing36-37]. ${ }^{5}$ In the first paragraph, Turing defines "a number [to be] computable
${ }^{3}$ The Mandelbrot set $M$ is the set of all parameters $c \in \mathbb{C}$, such that the orbit of 0 under the quadratic map $p_{c}(z)=z^{2}+c$ remains bounded.
${ }^{4}$ Emphasis mine.
${ }^{5}$ Here Turing first defines automatic machines and shows the undecidability of the halting problem.
if its decimal can be written down by a machine." Turing later defines computable functions of computable real numbers. ${ }^{6}$ One can then imagine an oracle Turing machine that, when fed a real number by oracle, decimal by decimal, outputs a real number decimal by decimal. A refinement of this notion forms the basis of recursive analysis.


Another tack taken by computer scientists is what might be called the "rational number model" approach. The approach is not formalized, but its reasoning goes as follows:
A. Machines are finite.
B. Finite approximations of reals are rationals.
C. $\therefore$ We are really looking at problems over the rationals.

If we are totally naïve here, we quickly run into trouble. The rational skeleton of the curve $x^{3}+y^{3}=1$ on the positive quadrant is hardly informative. ${ }^{7}$

We have even more serious concerns when this approach is used in complexity theory. Computer scientists measure complexity as a function of input word size (in bits). But small perturbations (of input) can cause large differences in word size. For example, a small perturbation of an input 1 to $1+1 / 2^{n}$ causes the word size to grow from 1 to $n+1$. Thus an algorithm that is polynomial time according to the discrete model definition would be allowed to take considerably more time on a perturbed input than on a given input. If the problem instance were well conditioned, this clearly would not be acceptable. An issue here is that the Euclidean metric is very different from the bit metric. Another is condition.

Not paying attention to these issues has caused both incompleteness in the analysis and confusion in the comparison of different algorithms over the reals. The comparison of competing algorithms for the Linear Programming Problem provides a case in point. We shall return to this example again.

Penrose explores similar scenarios for posing his question but in the end "... is left with the strong

[^3]feeling that the correct viewpoint has not yet been arrived at."

The Mandelbrot example is perhaps too exotic to draw generalizations. We turn now to a decision problem ubiquitous in mathematics.

## The Hilbert Nullstellensatz/R

Given a system of polynomial equations over a ring $R, f_{1}\left(x_{1}, \ldots, x_{n}\right)=0, \ldots, f_{m}\left(x_{1}, \ldots, x_{n}\right)=0$. Is there $\zeta \in R^{n}$, such that $f_{1}(\zeta)=\ldots=f_{m}(\zeta)=0$ ?

We call the corresponding decision problem over $R, H N_{R}$. If $R$ is $\mathbb{Z}_{2}, \mathbb{Z}$, or the rational numbers $\mathbb{Q}, \mathrm{HN}_{R}$ fits naturally into the Turing formalism (via bit coding of integers and rationals). The corresponding decision problem over $\mathbb{Z}_{2}$ is essentially SAT (decidable but not known to be in $P$ ), over $\mathbb{Z}$ it is Hilbert's Tenth Problem (undecidable) and over $\mathbb{Q}$ it is not known to be decidable or undecidable. If $R$ is the real field $\mathbb{R}$ or complex numbers $\mathbb{C}$, then $\mathrm{HN}_{R}$ does not fit naturally into the Turing formalism.

An even simpler example is the high school algorithm for deciding whether or not a real polynomial $a x^{2}+b x+c$ has a real root. We just check if the discriminant $b^{2}-4 a c \geq 0$. We do not stipulate that $a, b$, and $c$ be rational or be fed to us bit by bit-or question if we can tell whether or not a real number equals 0 . We just work with the basic arithmetic operations and comparisons of an ordered ring or field.

More generally, we have perfectly good algorithms for deciding $\mathrm{HN}_{R}$ over $\mathbb{R}$ and $\mathbb{C}$. Recall:

## Hilbert's Nullstellensatz, HN [Hilbert 1893]

Given $f_{1}\left(x_{1}, \ldots, x_{n}\right), \ldots, f_{m}\left(x_{1}, \ldots, x_{n}\right) \in \mathbb{C}\left[x_{1}, \ldots\right.$, $\left.x_{n}\right]$. Then, $f_{1}=\ldots=f_{m}=0$ is not solvable over $\mathbb{C} \Leftrightarrow$

$$
1=\Sigma g_{i} f_{i},
$$

for some polynomials

$$
g_{i} \in \mathbb{C}\left[x_{1}, \ldots, x_{n}\right]
$$

This theorem provides a semidecision procedure for the complement of $\mathrm{HN}_{C}$ : Given $f_{1}, \ldots, f_{m} \in \mathbb{C}\left[x_{1}, \ldots, x_{n}\right]$, systematically search for $g_{i}$ 's to solve $\left(^{*}\right)$. If found, then $f_{1}=\ldots=f_{m}=0$ is not solvable over $\mathbb{C}$ and so output 0 . (The search can be done by considering, for each successive $D$, general polynomials $g_{i}$ of degree $D$ with indeterminate coefficients. Checking if there exist coefficients satisfying ${ }^{(*)}$ ) reduces to solving $\sim D^{n}$ linear equations over $\mathbb{C}$.)

However, if $f_{1}=\ldots=f_{m}=0$ is solvable, then no such $g_{i}$ 's will ever be found. Fortunately, we have stopping rules. In 1926, Grete Hermann, a student of Emmy Noether, gave an effective upper bound $D\left(=d \dagger\left(2^{n}\right)\right.$ where $\left.d=\max \left(3, \operatorname{deg} f_{i}\right)\right)$ on the degrees of the $g_{i}$ 's that one need consider [Hermann26]. 8 If no solution is found for generic $g_{i}$ 's

[^4]of degree $D$, then none exists, and so we can output 1.

This decision procedure, using arithmetic operations and comparisons on complex numbers, inspires us to take a different tack. Rather than forcing artificial coding of problems into bits, we propose a model of computation that computes over a ring (or field), using basic algebraic operations and comparisons on elements of the ring (or field). Thus we have our first motivation for proposing a new model.

## Algorithms of Numerical Analysis

Our next motivation comes directly from the tradition of numerical analysis. We start with the paper, "Rounding-off errors in matrix processes" in the Quarterly Journal of Mechanics and Applied Mathematics, vol. I, 1948, pp. 287-308 [Turing48]. Written by Alan Turing while he was preoccupied with solving large systems of equations, this paper is quite well known to numerical analysts but almost unknown by logicians and computer scientists. Its implicit model of computation is more closely related to the former than the latter.

In the first section of his paper, Turing considers the "measures of work in a process":

> It is convenient to have a measure of the amount of work involved in a computing process, even though it be a very crude one.... We might, for instance, count the number of additions, subtractions, multiplications, divisions, recordings of numbers...

From this point of view, it is again natural to start with a model of computation in which real numbers are viewed as entities, and algebraic operations and comparisons, as well as simple accessing, are each counted as a unit of work. We will return again to this paper to motivate refinements of these initial "measures of work."

We also want a model of computation that is more natural for describing algorithms of numerical analysis, such as Newton's method for finding zeros of polynomials. Here, given a polynomial $f(z)$ over $\mathbb{R}$ or $\mathbb{C}$, the basic operation is the Newton map, $N_{f}(z)=z-f(z) / f^{\prime}(z)$, which is iterated until the current value satisfies some proscribed stopping rule. Translating to bit operations would wipe out the natural structure of this algorithm.

## Does $P=N P$ ?

In order to gain new perspective and access additional tools, mathematicians often find it profitable to view problems in a broader framework

[^5]

## A "machine" for executing Newton's method.

than originally posed. We are thus motivated to follow this path for the $P=N P$ ? problem.

## The Model: Machines over a Ring or Field $\boldsymbol{R}$ [BSS89]

We suppose $R$ is a commutative ring or field (possibly ordered) with unit. A machine $M$ over $R$ has the following properties:

Associated with $M$ is an input space and an output space, both $R^{\infty}$ (the disjoint union of $R^{n}, n \geq 0$ ). At the top level, our machine $M$ is similar to a Turing machine. $M$ has a 2-way infinite tape divided into cells and a read-write head that can view a fixed number $k_{M}$ of contiguous cells at a time.

Internal to $M$ is its program, a finite directed graph with 5 types of nodes, each with associated operations and next node maps:

- The operation $g_{l}$ associated with the input node $\iota$ takes elements $x=\left(x_{1}, \ldots, x_{k}\right)$ from the input space $R^{\infty}$ and puts each $x_{i}(i=1, \ldots, k)$ in successive tape cells, starting with the leftmost one in $M$ 's view. There is a unique next node $\iota^{\prime} \neq \iota$.
- Each computation node $\eta$ has a built-in polynomial or rational map $g_{\eta}: R^{n} \rightarrow R^{m}$ with $n, m \leq k_{M} \cdot{ }^{10}$ Given elements $x_{1}, \ldots, x_{n}$ in the first $n$ cells of $M$ 's view, the associated operation, also called $g_{\eta}$, puts $g_{\eta}^{j}\left(x_{1}, \ldots, x_{n}\right)$ in the $j$ th cell in $M$ 's view $(j=1, \ldots, m)$. There is a unique next node $\eta^{\prime}$.
- For each branch node $\eta$, the associated operation is the identity. There are two possible next nodes $\eta_{L}^{\prime}$ and $\eta_{R}^{\prime}$ depending on the leftmost element $x_{1}$ in $M$ 's view. If $x_{1}=0(\geq 0$, if $R$ is ordered), then $\eta^{\prime}=\eta_{R}^{\prime}$. If $x_{1} \neq 0\left(x_{1}<0\right)$, then $\eta^{\prime}=\eta_{L}^{\prime}$.
- For each shift node $\sigma$, the associated map is the identity and there is a unique next node $\sigma^{\prime}$. Right shift nodes $\sigma_{R}$ shift $M$ 's view one cell to the right, left shift nodes $\sigma_{L}$ shift one cell to the left.
- The operation $g_{N}$ associated with the output node $N$ outputs (by projection) the contents of the tape into $R^{\infty} . N$ has no next node.
${ }^{10}$ Machines over $R$ can thus have a finite number of builtin constants from $R$.



## A machine over a ring or field $R$, top-level and internal views.

The computable functions over $R$ are the inputoutput maps $\phi_{M}$ of machines $M$ over $R$. Thus, for $x \in R^{\infty}, \phi_{M}(x)$ is defined if the output node $N$ is reachable by following $M$ 's program on input $x$. If so, $\phi_{M}(x)$ is the output $y \in R^{\infty}$.

Although the machine's view at any time is finite, the shift nodes enable the machine to read and operate on inputs from $R^{n}$ for all $n$, and thus we can model algorithms that are defined uniformly for inputs of any dimension. Noting this, we can also construct universal (programmable) machines over $R$. (We do not use Gödel coding. The machine program itself is (essentially) its own code.)

If $R$ is $\mathbb{Z}_{2}$, we recover the classical theory of computation (and complexity, as we shall see). We also note that Newton's method is naturally implemented by a machine over $\mathbb{R}$.

Let's return now to questions of decidability over $\mathbb{R}$ and $\mathbb{C}$, which were so problematic before.

Definition. A problem over $R$ is a pair, ( $X, X_{\text {yes }}$ ), where $X_{\text {yes }} \subseteq X \subseteq R^{\infty}$. $X$ consists of the problem instances, $X_{\text {yes }}$, the yes-instances.

For $\mathrm{HN}_{R}$,

$$
\begin{gathered}
X=\left\{f=\left(f_{1}, \ldots, f_{m}\right) \mid f_{i} \in R\left[x_{1}, \ldots, x_{n}\right]\right\}, m, n>0 \text { and } \\
X_{\text {yes }}=\left\{f \in X \mid \exists \zeta \in R^{n}, f_{i}\left(\zeta_{1}, \ldots, \zeta_{n}\right)=0, i=1, \ldots, m\right\} .
\end{gathered}
$$

Finite polynomial systems over $R$ can be coded as elements of $R^{\infty}$ (by systematically listing coefficients); thus $X$ can be viewed as a subspace of $R^{\infty}$.

Definition. A problem over $R,\left(X, X_{\text {yes }}\right)$, is decidable if the characteristic function of $X_{\text {yes }}$ in $X$ is computable over $R$.

Thus, in this framework, we can state problems over $\mathbb{R}$ and $\mathbb{C}$ (or any ring or field) and ask questions of decidability. The algorithm presented earlier, based on Hilbert's Nullstellensatz with effective
bounds, is easily converted to a decision machine over $\mathbb{C}$, and so $\mathrm{HN}_{\mathbb{C}}$ is decidable over $\mathbb{C}$. Similarly, $\mathrm{HN}_{\mathbb{R}}$ is decidable over $\mathbb{R}$ (by Seidenberg's elimination theory [Seid54]).

We can also now formally state, and answer, Penrose's question about the Mandelbrot set $M$. Here $X$ is $\mathbb{R}^{2}$ and $X_{\text {yes }}$ is $M$. (In order to allow algorithms that compare magnitudes, we are viewing $\mathbb{C}$ as $\mathbb{R}^{2}$.)

Theorem [BlumSmale93]. The Mandelbrot set $M$ is undecidable over $\mathbb{R}$.

The proof uses the fact that the boundary of a closed semidecidable set in $\mathbb{R}^{2}$ has Hausdorff dimension at most 1, whereas the Hausdorff dimension of the boundary of the Mandelbrot set is 2 [Shishikura91].

It turns out that the complement of the Mandelbrot set $M$ is semidecidable over $\mathbb{R}$. To see this, a little arithmetic shows that $M=\{c \in \mathbb{C}$ such that the sequence $c, c^{2}+c,\left(c^{2}+c\right)^{2}+c, \ldots$ stays within the circle of radius 2$\}$. Hence, if at some point the orbit of 0 under the map $z^{2}+c$ escapes the circle of radius 2 , we can be certain that $c$ is in the complement of $M$. One can use this fact to "draw" the Mandelbrot set.

## Complexity Classes and Theory over a Ring $R$

Following the classical tradition, we measure time (or cost) as a function of input word size. Suppose $x \in R^{\infty}$. We define $\operatorname{size}(x)$ to be the vector length of $x$, thus $\operatorname{size}(x)=n$ if $x \in R^{n}$. For machine $M$ over $R$ and input $x$, we define $T_{M}(x)$ to be the number of nodes traversed from input to output when $M$ is input $x . T_{M}$ is our measure of time or cost. So, if $R=\mathbb{Z}_{2} \operatorname{size}(x)$ is the bit size of $x$, and $T_{M}(x)$ is the bit cost of the computation.


Machine to "draw" the Mandelbrot set $M$ (Fact: $\boldsymbol{M}=\left\{\mathbf{c} \in \mathbb{C}| | p_{c}^{n}(0) \mid \geq 2\right.$, all $\left.\mathbf{n}>\mathbf{0}\right\}$ where

$$
\left.p_{c}(z)=z^{2}+c\right)
$$

Definition. $\left(X, X_{\text {yes }}\right) \in P_{R}($ class $P$ over $R)$ if there exists a decision machine $M$ and a polynomial $p \in \mathbb{Z}[x]$ such that for each $x \in X, T_{M}(x)$ $<p(\operatorname{size}(x)) . M$ is called a polynomial time (decision) machine.

Definition. $\left(X, X_{\text {yes }}\right) \in N P_{R}$ (class $N P$ over $R$ ) if there exists $\left(Y, Y_{\text {yes }}\right) \in P_{R}$ and a polynomial $p \in \mathbb{Z}[x]$ such that, for each $x \in X, x \in X_{\text {yes }} \Leftrightarrow \exists$ witness $w \in R^{p(\text { size( }(x))}$ such that $(x, w) \in Y_{\text {yes }}$.

In the above, we generally require that ( $\left.R^{\infty}, X\right) \in P_{R}$. Then, if $R=\mathbb{Z}_{2}$, we recover the classical complexity classes, that is, class $P$ over $\mathbb{Z}_{2}$ is the classical class $P$, and class $N P$ over $\mathbb{Z}_{2}$ is the classical class $N P$. Whenever we omit subscripts in the following, we are referring to the case when $R=\mathbb{Z}_{2}$, the classical case.

Example. $\mathrm{HN}_{R} \in \mathrm{NP}_{R}$. To see this let $Y=\left\{(f, \zeta) \mid f=\left(f_{1}, \ldots, f_{m}\right), f_{i} \in\right.$

$$
\left.R\left[x_{1}, \ldots, x_{n}\right], \zeta \in R^{n}, m, n>0\right\}
$$

and $Y_{\text {yes }}=\left\{(f, \zeta) \in Y \mid f_{i}\left(\zeta_{1}, \ldots, \zeta_{n}\right)=0\right.$,

$$
i=1, \ldots, m\} .
$$

Then, since polynomial evaluation is a polynomial time computation over $R, 11$ we have

[^6]$\left(Y, Y_{\text {yes }}\right) \in P_{R} \quad$ over $R$. Also, given $f \in X$, $f=\left(f_{1}, \ldots, f_{m}\right), f_{i} \in R\left[x_{1}, \ldots, x_{n}\right], f \in X_{\text {yes }} \Leftrightarrow$ $\exists \zeta \in R^{n}$ such that $f_{i}\left(\zeta_{1}, \ldots, \zeta_{n}\right)=0, i=1, \ldots, m$, that is, $(f, \zeta) \in Y_{\text {yes }}$.

We note that there is an exponential time decision machine for HN over $\mathbb{Z}_{2}$, but as mentioned earlier, we do not know if $\mathrm{HN} \in P$. On the other hand, since $\mathrm{HN}_{\mathbb{Z}}$ is not decidable (over $\mathbb{Z}$ ), it certainly is not in $P_{\mathbb{Z}}$, thus $P_{\mathbb{Z}} \neq N P_{\mathbb{Z}}$.

## Main Complexity Results

We recall that
Theorem [Cook71, Levin73].

$$
P=N P \Leftrightarrow \mathrm{SAT} \in P \text { and }
$$

Theorem [Karp72].

$$
P=N P \Leftrightarrow \mathrm{TSP}^{12} \in P \Leftrightarrow X \in P,
$$

where $X=$ Hamilton Circuit or any of nineteen other problems.

We prove
Theorem [BSS89].

$$
P_{R}=N P_{R} \Leftrightarrow \mathrm{HN}_{R} \in P_{R} \text { for } R=\mathbb{Z}_{2}, \mathbb{R}, \mathbb{C},
$$

or for any field $R$, unordered or ordered.
To prove this theorem, we show that given any problem $\left(X, X_{\text {yes }}\right) \in \mathrm{NP}_{R}$ and instance $x \in X$, we can code $x$ (in polynomial time) as a polynomial system $f_{x}$ over $R$ such that $x \in X_{\text {yes }} \Leftrightarrow f_{x}$ has a zero over $R$. In other words, we give a polynomial time reduction from any problem in class $N P_{R}$ into $\mathrm{HN}_{R}$. This is done by writing down the equations for the computing endomorphism of an $N P_{R}$ machine.

So, $\mathrm{HN}_{R}$ is a universal NP-complete problem. We know that $\mathrm{HN}_{R} \in E X P_{R}$ for $R=\mathbb{R}$ and $\mathbb{C}$. That is, there are exponential time algorithms for deciding the solvability of polynomial systems over $\mathbb{R}$ and $\mathbb{C}$ [Renegar92, BPR96]. But, again, no polynomial time algorithms are known.

So, in addition to the classical $P=N P$ ? question, we pose two new ones: Is $P_{\mathbb{R}}=N P_{\mathbb{R}}$ ? Is $P_{\mathbb{C}}=N P_{\mathbb{C}}$ ?

Understanding the complexity of the Hilbert Nullstellensatz thus plays a central role in complexity theory over R. ${ }^{13}$

## Transfer Principles

In the preface to Complexity and Real Computation [BCSS98], Dick Karp speculates about the transferability of complexity results from one domain to another:

[^7]It is interesting to speculate as to whether the questions of whether $P_{\mathbb{R}}=N P_{\mathbb{R}}$ and whether $P_{\mathbb{C}}=N P_{\mathbb{C}}$ are related to each other and to the classical $P$ versus $N P$ question. ...I am inclined to think that the three questions are very different and need to be attacked independently.... ${ }^{14}$

One reason for the skepticism is that over $\mathbb{R}$ or $\mathbb{C}$ one can quickly build numbers of large magnitude, for example by successive squaring. And over $\mathbb{R}$ or $\mathbb{C}$, arithmetic operations on numbers of any magnitude can be done in one step. Hence, polynomial time machines over $\mathbb{R}$ or $\mathbb{C}$ might be able to decide inherently hard discrete problems by "cheating", e.g., by quickly coding up an exponential amount of information within large numbers and subsequently getting an exponential amount of essential bit operations accomplished quickly.

In our book we present a number of transfer results for complexity theory, one of which transfers the $P_{R}=N P_{R}$ ? question across algebraically closed fields of characteristic 0 .

Theorem [BCSS96/98]. $P_{\mathrm{C}}=N P_{\mathbb{C}} \Leftrightarrow P_{K}=N P_{K}$, where $K$ is any algebraically closed field of characteristic 0 , for example the field of algebraic numbers.

The transfer of the $P_{R}=N P_{R}$ ? problem from the algebraic numbers to the complexes had been proved earlier by Christian Michaux, using model theoretic techniques [Michaux94]. The other direction uses number theory. Here we show how a machine over $\mathbb{C}$ with built in algebraically independent constants can be simulated by a machine that has no such constants and that takes the same amount of time (up to a polynomial factor) to compute. We call this result the elimination of constants. The constants in a machine come into play at branch nodes where a decision is to be made as to whether or not the current $x_{1}$, which is a polynomial in the machine constants, is equal to 0 . This polynomial is not presented to us in the standard form, but rather by a composition of the polynomials along the computation path, so we cannot in general tell quickly enough if the coefficients are all zero. Instead, we use the Witness Theorem to quickly generate algebraic witnesses with the property that, if the original constants are replaced by these witnesses, and the resulting evaluation is 0 , then the original polynomial is 0 . (The theory of heights comes into play here.)

Shortly after our book went to press, Steve Smale realized (after talking to Manuel Blum) that standard computer science arguments could yield a transfer result from $\mathbb{C}$ to the classical setting [Smale2000].

[^8]
## ROUNDING-OFF ERRORS IN MATRIX PROCESSES

(National Physical Laboratory, Teddington, Middlesex)

[Received 4 November 1947]
SUMMARX
A number of mothods of solving gets of linear equations and inverting matricus arc diseussed. The, theory of the counding-off errors involved is investigated' for some of tbe methods. In all cascs examined, including the well-known 'Gauss elimination process', it is found that the errors sre normally quite moderate: no exponential build-up need occur.
Included amongst the mothods considered is a generalizatiou of Choleski's method which appears to bave advantages over other known methods both as regards socuracy and convenience. This method may also bo regarded as a roarrangement of the climination proecsa.
THIs paper contains descriptions of a number of mothods, for solving sets of linear simultaneous equations and for inverting matrices, but its main concern is with the theoretical limits of accuracy that may be obtained in the application of these methods, due to rounding-off errors.
The best known method for the solution of linear equations is Gauss's elimination method. This is the mether almost universally taught in thools. It has, unfortunately, recently come into disrepute on the ground that rounding off will give rise to very large errors. It has, for instance,

## From the Quarterly Journal of Mechanics and Applied Mathematics, vol. I, 1948, p. 287.

Let $B P P$ be the class of problems over $\mathbb{Z}_{2}$ that can be solved in bounded error ( $<1 / 2$ ) probabilistic polynomial time. Class BPP is a practical modification of class $P$. Repeating a $B P P$ algorithm $k$ times produces a polynomial time algorithm with probability of error $<1 / 2^{k}$. For example, BPP algorithms for Primality (testing) were known and used well before it was known that Primality was in class $P$.

Theorem. $P_{\mathrm{C}}=N P_{\mathrm{C}} \Rightarrow B P P \supseteq N P$.
The idea of the proof goes as follows. First we note that by adding polynomials of the form $x(x-1)$ to an instance $f \in \mathrm{HN}$ we get an equivalent instance $f^{*} \in H N_{\mathrm{C}}$. Then, any polynomial decision machine $M$ over $\mathbb{C}$ for $\mathrm{HN}_{\mathbb{C}}$ will decide the solvability of $f^{*}$ and hence the solvability of $f$ over $\mathbb{Z}_{2}$. The trouble is, $M$ might have a finite number of built-in complex constants. As before, they come into play at branch nodes where a decision is to be made as to whether or not a polynomial in these constants, presented by composition, is equal to 0 . Rather than generate witnesses as before to eliminate constants, the decision is now made by probabilistically replacing these constants by a small number (by Schwartz's Lemma) of small numbers (by the Prime Number Theorem). Thus, given a polynomial time machine $M$ over $\mathbb{C}$ for $\mathrm{HN}_{\mathrm{C}}$, we could construct a probabilistic polynomial time machine for HN .

Transfer results provide important connections between the two approaches to computing. ${ }^{15}$ Underlying connections derive from the uniform distribution of rational data of bounded input length
${ }^{15}$ Transfer results are also known for questions regarding other complexity classes such as PSPACE [Koiran02].
with respect to the probability distribution of condition numbers of numerical analysis [CMPS02].

## Introducing Condition, Accuracy, and Round-off into Complexity Theory: Where Turing Meets Newton

We now return to the Turing paper on roundingoff errors referred to earlier [Turing48].

It is here that the notion of condition (of a linear system) was originally introduced. An illustrative example is presented on page 297:

$$
\begin{align*}
1.4 x+0.9 y & =2.7  \tag{8.1}\\
0.8 x+1.7 y & =-1.2 \\
-0.786 x+1.709 y & =-1.173  \tag{8.2}\\
-0.8 x+1.7 y & =-1.2
\end{align*}
$$

The set of equations (8.2) is fully equivalent to (8.1) ${ }^{16}$, but clearly if we attempt to solve (8.2) by numerical methods involving rounding-off errors we are almost certain to get much less accuracy than if we worked with equations (8.1)...

We should describe the equations (8.2) as an ill-conditioned set, or, at any rate, as ill-conditioned compared with (8.1). ${ }^{17}$ It is characteristic of ill-conditioned sets of equations that small percentage errors in the coefficients given may lead to large percentage errors in the solution.

Turing's notion of condition, clearly inspired by Newton's derivative, links both traditions, particularly when considering questions of complexity.

## Condition Numbers and Complexity

The condition of a problem (instance) measures how small perturbations of the input will alter the output. Introducing the notion of condition provides an important link between the two traditions of computing.

Definition (Turing). Suppose $A$ is an $n \times n$ real matrix and $b \in \mathbb{R}^{n}$. The condition number of the linear system, $A x=b$, is given by $\kappa(A)=$ $\|A\|\left\|A_{1}\right\|$. Here $\|A\|=\max \{|A y| / \mid y \| y \neq 0\}$ is the operator norm with respect to the Euclidean norm ||.

We note that $\kappa(A)$ is the worst-case relative condition for solving the system $A x=b$ for $x$. Thus $\log ^{+} \kappa(A)$ provides a worst-case lower bound for the loss of precision in solving the system. ${ }^{18}$ For

[^9]

With appropriate norm, the ratio $\|\varphi(x+\Delta x)-\varphi(x)\| /\|\Delta x\|$, or relative ratio $(\|\varphi(x+\Delta x)-\varphi(x)\| /\|\varphi(x)\|) /(\|\Delta x\| /\|x\|)$
indicates the condition of an instance. If the quotient is large, the instance is ill-conditioned and so requires more accuracy, and hence more resources, to compute with small error.
computational purposes, ill-conditioned problem instances will generally require more input precision than well-conditioned instances.

During the 1980s a number of people gave estimates on the average loss of precision for (solving) linear systems over $\mathbb{R}$.

Theorem [Edelman 88]. Average $\log ^{+} \kappa(A)$ $\sim \log n$.

The log of condition provides an intrinsic parameter to replace arbitrarily chosen bit input word sizes for problem instances where the underlying mathematical spaces are $\mathbb{R}$ or $\mathbb{C}$. And so a focus for complexity theory is to formulate and understand measures of condition.

My favorite example for illustrating the issues raised and the resolutions proposed is the Linear Programming Problem over $R\left(L_{P P}\right)$ alluded to earlier, where $R$ is $\mathbb{Q}$ or $\mathbb{R}$. An instance of the LPP $_{R}$ is to maximize a linear function $c \cdot x$ subject to the constraints $A x \leq b, x \geq 0$, or to conclude no such maximum exists. The data here is ( $A, b, c$ ), where $A$ is an $m \times n$ matrix over $R, b \in R^{m}$ and $c \in R^{n}$.

Competing algorithms for solving the $L_{P P}$ are often posed and analyzed using distinct models of computation. (Also, there are various equivalent


The simplex method for the LPP optimizes by traversing vertices. The newer interior point methods follow a trajectory of centers.
mathematical formulations of the $\operatorname{LPP}_{R}$, not necessarily equivalent with respect to complexity theory.)

The simplex algorithm [Dantzig47/90], a longtime method of choice, is an algebraic algorithm that in the worst case takes exponential (in $n$ and $m$ ) number of steps [KleeMinty72] given exact arithmetic. For rational inputs, simplex also is exponential in the input word size (given in bits) in the bit model.

On the other hand, for rational inputs, the ellipsoid algorithm [Khachiyan79] is polynomial time in the input word size in the bit model. But, as an algorithm over $\mathbb{R}$, i.e., allowing exact arithmetic, it is not finite in general. The same is true of the newer interior point algorithms. ${ }^{19}$

It would seem more natural, and appropriate, to analyze the complexity of algorithms for the $\mathrm{LPP}_{R}$ with respect to an intrinsic input word size. Hence we are motivated to define a measure of the condition of a linear program [Blum90]. Jim Renegar [Renegar95] was the first to propose such a condition number in this context. His definition is inspired by the 1936 theorem of Eckart and Young.

Theorem [EckartYoung36]. For a real matrix $A$, $\kappa(A) \sim 1 / d_{F}(A, \Sigma)$ where $\Sigma$ is space of ill-posed problem instances, i.e., $\Sigma$ is the space of noninvertible matrices. (Here the relative distance $d_{F}$ is with respect to the Frobenius norm $\|A\|_{F}=\sqrt{\Sigma a_{i j}^{2}}$.)


We now consider the linear programming problem over $\mathbb{R}$ in the form: Given $A x=b, x \geq 0$, find a feasible solution or declare there is none.

Definition [Renegar95]. The condition number of a linear program over $\mathbb{R}$ with data $(A, b)$ is given by $C(A, b)=\|(A, b)\| / d\left((A, b), \Sigma_{m, n}\right)$. (Here, $\Sigma_{m, n}$ is the boundary of the feasible pairs $(A, b)$, and both the operator norm \|| \| and the distance $d$ are with respect to the respective Euclidean norms.)

Renegar proposes an interior point algorithm and analyzes it with respect to parameters: $n, m$, the loss of precision, and the desired accuracy of solution.
${ }^{19}$ We emphasize this distinction. Simplex is a finite algorithm over $\mathbb{R}$ and over the rationals in both the exact arithmetic model and the bit model. The newer interior point algorithms are finite only over the rationals in the bit

Theorem [Renegar Interior Point Algorithm]. 20 If the linear program is feasible, the number of iterations to produce an $\varepsilon$-approximation to a feasible point is polynomial in $n, m, \log ^{+} C(A, b)$ and $|\log \varepsilon|$.

Felipe Cucker and Javier Peña propose an algorithm and add round-off error as a parameter for the complexity analysis [CuckerPena02].

Theorem [Cucker-Peña Algorithm with RoundOff]. If the linear program is feasible, the bit cost to produce an $\varepsilon$-approximation to a feasible point is $O\left((m+n)^{3.5}\left(\log (m+n)+\log ^{+} C(A, b)+\right.\right.$ $\left.|\log \varepsilon|)^{3}\right)$. The finest precision required is a roundoff unit of $1 / c(m+n)^{12} C(A, b)^{2}$.

While condition, approximation and round-off help bridge the combinatorial and continuous approaches to the design and analyses of linear programming algorithms, basic connections and complexity questions remain open.

In particular: Is $L_{P} P_{\mathbb{R}} \in P_{\mathbb{R}}$ ? Even more, is LPP strongly polynomial? That is, is there a polynomial time algorithm over $\mathbb{R}$ for $\operatorname{LPP}_{\mathbb{R}}$ that is also polynomial time with respect to bit cost on rational input data? ${ }^{21}$

In conclusion, I have endeavored to give an idea of how machines over the reals-tempered with condition, approximation, round-off, and probability ${ }^{22}$-enable us to combine tools and traditions of theoretical computer science with tools and traditions of numerical analysis to help better understand the nature and complexity of computation.

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# Comme Appelédu NéantAs If Summoned from the Void: The Life of Alexandre Grothendieck 

This is the first part of a two-part article about the life of Alexandre Grothendieck. The second part of the article will appear in the next issue of the Notices.

Et toute science, quand nous l'entendons non comme un instrument de pouvoir et de domination, mais comme aventure de connaissance de notre espèce à travers les âges, n'est autre chose que cette harmonie, plus ou moins vaste et plus ou moins riche d'une époque à l'autre, qui se déploie au cours des générations et des siècles, par le délicat contrepoint de tous les thèmes apparus tour à tour, comme appelés du néant.

And every science, when we understand it not as an instrument of power and domination but as an adventure in knowledge pursued by our species across the ages, is nothing but this harmony, more or less vast, more or less rich from one epoch to another, which unfurls over the course of generations and centuries, by the delicate counterpoint of all the themes appearing in turn, as if summoned from the void.
-Récoltes et Semailles, page P20
Alexandre Grothendieck is a mathematician of immense sensitivity to things mathematical, of profound perception of the intricate and elegant lines of their architecture. A couple of high points from his biography-he was a founding member of

[^11]the Institut des Hautes Études Scientifiques (IHÉS) and received the Fields Medal in 1966-suffice to secure his place in the pantheon of twentieth century mathematics. But such details cannot capture the essence of his work, which is rooted in something far more organic and humble. As he wrote in his long memoir, Récoltes et Semailles (Reapings and Sowings, R\&S), "What makes the quality of a researcher's inventiveness and imagination is the quality of his attention to hearing the voices of things" (emphasis in the original, page P27). Today Grothendieck's own voice, embodied in his written works, reaches us as if through a void: now seventysix years old, he has for more than a decade lived in seclusion in a remote hamlet in the south of France.

Grothendieck changed the landscape of mathematics with a viewpoint that is "cosmically general", in the words of Hyman Bass of the University of Michigan. This viewpoint has been so thoroughly absorbed into mathematics that nowadays it is difficult for newcomers to imagine that the field was not always this way. Grothendieck left his deepest mark on algebraic geometry, where he placed emphasis on discovering relationships among mathematical objects as a way of understanding the objects themselves. He had an extremely powerful, almost other-worldly ability of abstraction that allowed him to see problems in a highly general context, and he used this ability with exquisite precision. Indeed, the trend toward increasing generality and abstraction, which can be seen across the whole field since the middle of the twentieth
century, is due in no small part to Grothendieck's influence. At the same time, generality for its own sake, which can lead to sterile and uninteresting mathematics, is something he never engaged in.

Grothendieck's early life during World War II had a good deal of chaos and trauma, and his educational background was not the best. How he emerged from these deprived beginnings and forged a life for himself as one of the leading mathematicians in the world is a story of high dramaas is his decision in 1970 to abruptly leave the mathematical milieu in which his greatest achievements blossomed and which was so deeply influenced by his extraordinary personality.

## Early Life

Ce qui me satisfaisait le moins, dans nos livres de maths [au lycée], c'était l'absence de toute définition sérieuse de la notion de longueur (d'une courbe), d'aire (d'une surface), de volume (d'un solide). Je me suis promis de combler cette lacune, dès que j'en aurais le loisir.

What was least satisfying to me in our [high school] math books was the absence of any serious definition of the notion of length (of a curve), of area (of a surface), of volume (of a solid). I promised myself I would fill this gap when I had the chance.

## -Récoltes et Semailles, page P3

Armand Borel of the Institute for Advanced Study in Princeton, who died in August 2003 at the age of 80 , remembered the first time he met Grothendieck, at a Bourbaki seminar in Paris in November 1949. During a break between lectures, Borel, then in his mid-twenties, was chatting with Charles Ehresmann, who at forty-five years of age was a leading figure in French mathematics. As Borel recalled, a young man strode up to Ehresmann and, without any preamble, demanded, "Are you an expert on topological groups?" Ehresmann, not wanting to seem immodest, replied that yes, he knew something about topological groups. The young man insisted, "But I need a real expert!" This was Alexandre Grothendieck, age twenty-one-brash, intense, not exactly impolite but having little sense of social niceties. Borel remembered the question Grothendieck asked: Is every local topological group the germ of a global topological group? As it turned out, Borel knew a counterexample. It was a question that showed Grothendieck was already thinking in very general terms.

Grothendieck's time in Paris in the late 1940s was his first real contact with the world of mathematical research. Up to that time, his life story-


Grothendieck's mother, Hanka, 1917.
at least what is known of it-contains few clues that he was destined to become a dominant figure in that world. Many of the details about Grothendieck's family background and early life are sketchy or unknown. Winfried Scharlau of the Universität Münster is writing a biography of Grothendieck and has studied carefully this part of his life. Much of the information in the following biographical sketch comes from an interview with Scharlau and from biographical materials he has assembled about Grothendieck [Scharlau].

Grothendieck's father, whose name may have been Alexander Shapiro, was born into a Jewish family in Novozybkov in Ukraine on October 11, 1889. Shapiro was an anarchist and took part in various uprisings in czarist Russia in the early twentieth century. Arrested at the age of seventeen, he managed to elude a death sentence, but, after escaping and being recaptured a few times, he spent a total of about ten years in prison. Grothendieck's father has sometimes been confused with another more famous activist also named Alexander Shapiro, who participated in some of the same political movements. This other Shapiro, who was portrayed in


Grothendieck's father, Sascha, ca. 1922. John Reed's book Ten Days that Shook the World, emigrated to New York and died there in 1946, by which time Grothendieck's father had already been dead for four years. Another distinguishing detail is that Grothendieck's father had only one arm. According to Justine Bumby, who lived with Grothendieck for a period in the 1970s and had a son by him, his father lost his arm in a suicide attempt while trying to avoid being captured by the police. Grothendieck himself may unwittingly have contributed to the confusion between the two Shapiros; for example, Pierre Cartier of the Institut des Hautes Études Scientifiques mentioned in [Cartier2] Grothendieck's
maintaining that one of the figures in Reed's book was his father.

In 1921 Shapiro left Russia and was stateless for the rest of his life. To hide his political past, he obtained identity papers with the name Alexander Tanaroff, and for the rest of his life he lived under this name. He spent time in France, Germany, and Belgium, where he associated with anarchist and other revolutionary groups. In the radical circles of Berlin in the mid-1920s, he met Grothendieck's mother, Johanna (Hanka) Grothendieck. She had been born on August 21, 1900, into a bourgeois family of Lutherans in Hamburg. Rebelling against her traditional upbringing, she was drawn to Berlin, which was then a hotbed of avant-garde culture and revolutionary social movements.

A. Grothendieck as a child. Both she and Shapiro yearned to be writers. He never published anything, but she published some newspaper articles; in particular, between 1920 and 1922, she wrote for a leftist weekly newspaper called Der Pranger, which had taken up the cause of prostitutes living on the fringe of Hamburg society. Much later, in the late 1940 s, she wrote an autobiographical novel called Eine Frau, which was never published.

For most of his life, Tanaroff was a street photographer, an occupation that allowed him to earn an independent living without being in an employer-employee relationship that would have run counter to his anarchist principles. He and Hanka had each been married before, and each had a child from the previous marriage, she a daughter and he a son. Alexandre Grothendieck was born in Berlin on March 28, 1928, into a family consisting of Hanka, Tanaroff, and Hanka's daughter from her first marriage, Maidi, who was four years older than Alexandre. He was known in the family, and to his close friends later on, as Shurik; his father's nickname was Sascha. Although he never met his half-brother, Grothendieck dedicated to him the manuscript A La Poursuite des Champs (Pursuing Stacks), written in the 1980 s.

In 1933, when the Nazis came to power, Shapiro fled Berlin for Paris. In December that year, Hanka decided to follow her husband, so she put her son in the care of a foster family in Blankenese, near Hamburg; Maidi was left in an institution for handicapped children in Berlin, although she was not handicapped (R\&S, pages 472-473). The foster family was headed by Wilhelm Heydorn, whose remarkable life is outlined in his biography, Nur Mensch Sein! [Heydorn]; the book contains a photograph of Alexandre Grothendieck from 1934,
and he is mentioned briefly. Heydorn had been a Lutheran priest and army officer, then left the church and worked as an elementary school teacher and a Heilpraktiker (which nowadays might be translated roughly as "practitioner of alternative medicine"). In 1930 he founded an idealistic political party called the "Menschheitspartei" ("Humanity Party"), which was outlawed by the Nazis. Heydorn had four children of his own, and he and his wife Dagmar, following their sense of Christian duty, took in several foster children who were separated from their families in the tumultuous period leading up to World War II.

Grothendieck remained with the Heydorn family for five years, between the ages of five and eleven, and attended school. A memoir by Dagmar Heydorn recalled the young Alexandre as being very free, completely honest, and lacking in inhibitions. During his time with the Heydorns, Grothendieck received only a few letters from his mother and no word at all from his father. Although Hanka still had relatives in Hamburg, no one ever came to visit her son. The sudden separation from his parents was highly traumatic for Grothendieck, as he indicated in Récoltes et Semailles (page 473). Scharlau speculated that the young Alexandre was probably not especially happy with the Heydorns. Having started life in a liberal home headed by a couple of anarchists, the stricter atmosphere of the Heydorn household probably chafed. He was actually closer to some other families who lived near the Heydorns, and as an adult he continued to write to them for many years. He also wrote to the Heydorns and visited Hamburg several times, the last time in the mid-1980s.

By 1939, with war imminent, political pressure increased on the Heydorns, and they could no longer keep the foster children. Grothendieck was an especially difficult case, because he looked Jewish. The exact whereabouts of his parents were unknown, but Dagmar Heydorn wrote to the French consulate in Hamburg and managed to get a message to Shapiro in Paris and to Hanka in Nîmes. Once contact with his parents was made, Grothendieck, then 11 years old, was put on a train from Hamburg to Paris. He was reunited with his parents in May 1939, and they spent a brief time together before the war began.

It is not clear exactly what Grothendieck's parents were doing while he was in Hamburg, but they remained politically active. They went to Spain to fight in the Spanish Civil War and were among the many who fled to France when Franco triumphed. Because of their political activities, Hanka and her husband were viewed in France as dangerous foreigners. Some time after Grothendieck joined them there, Shapiro was put into the internment camp Le Vernet, the worst of all the French camps. It is probable that he never again saw his wife and son.

In August 1942 he was deported by the French authorities to Auschwitz, where he was killed. What happened to Maidi at this time is unclear, but eventually she married an American soldier and emigrated to the United States; she passed away a couple of years ago.

In 1940 Hanka and her son were put into an internment camp in Rieucros, near Mende. As internment camps went, the one at Rieucros was one of the better ones, and Grothendieck was permitted to go to the lycée (high school) in Mende. Nevertheless, it was a life of deprivation and uncertainty. He told Bumby that he and his mother were sometimes shunned by French people who did not know of Hanka's opposition to the Nazis. Once he ran away from the camp with the intention of assassinating Hitler, but he was quickly caught and returned. "This could easily have cost him his life", Bumby noted. He had always been strong and a good boxer, attributes that were useful at this time, as he was sometimes the target of bullying.

After two years, mother and son were separated; Hanka was sent to another internment camp, and her son ended up in the town of Chambon-surLignon. André Trocmé, a Protestant pastor, had transformed the mountain resort town of Chambon into a stronghold of resistance against the Nazis and a haven for protecting Jews and others endangered during the war [Hallie]. There Grothendieck was taken into a children's home supported by a Swiss organization. He attended the Collège Cévenol, set up in Chambon to provide an education for the young people, and earned a baccalauréat. The heroic efforts of the Chambonnais kept the refugees safe, but life was nevertheless precarious. In Récoltes et Semailles Grothendieck mentioned the periodic roundups of Jews that would send him and his fellow students scattering to hide in the woods for a few days (page P2).

He also related some of his memories of his schooling in Mende and Chambon. It is clear that, despite the difficulties and dislocation of his youth, he had a strong internal compass from an early age. In his mathematics classes, he did not depend on his teachers to distinguish what was deep from what was inconsequential, what was right from what was wrong. He found the mathematics problems in the texts to be repetitive and presented in isolation from anything that would give them meaning. "These were the book's problems, and not $m y$ problems," he wrote. When a problem did seize him, he lost himself in it completely, without regard to how much time he spent on it (page P3).

## From Montpellier to Paris to Nancy

Monsieur Soula [mon professeur de calcul] m'assurait...que les derniers problèmes qui s'étaient encore posés en
maths avaient été résolus, il y avait vingt ou trente ans, par un dénommé Lebesgue. Il aurait développé justement (drôle de coïncidence, décidement!) une théorie de la mesure et de l'intégration, laquelle mettait un point final à la mathématique.

Mr. Soula [my calculus teacher] assured me that the final problems posed in mathematics had been resolved, twenty or thirty years before, by a certain Lebesgue. He had exactly developed (an amusing coincidence, certainly!) a theory of measure and integration, which was the endpoint of mathematics.

## -Récoltes et Semailles, page P4

By the time the war ended in Europe, in May 1945, Alexandre Grothendieck was seventeen years old. He and his mother went to live in Maisargues, a village in a wine-growing region outside of Montpellier. He enrolled at the Université de Montpellier, and the two survived on his student scholarship and by doing seasonal work in the grape harvest; his mother also worked at housecleaning. Over time he attended the university courses less and less, as he found that the teachers were mostly repeating what was in the textbooks. At the time, Montpellier "was among the most backward of French universities in the teaching of mathematics," wrote Jean Dieudonné [D1].

In this uninspiring environment, Grothendieck devoted most of his three years at Montpellier to filling the gap that he had felt in his high school textbooks about how to provide a satisfactory definition of length, area, and volume. On his own, he essentially rediscovered measure theory and the notion of the Lebesgue integral. This episode is one of several parallels between the life of Grothendieck and that of Albert Einstein; as a young man Einstein developed on his own ideas in statistical physics that he later found out had already been discovered by Josiah Willard Gibbs.

In 1948, having finished his Licenceès Sciences at Montpellier, Grothendieck went to Paris, the main center for mathematics in France. In an article about Grothendieck that appeared in a French magazine in 1995 [Ikonicoff], a French education official, André Magnier, recalled Grothendieck's application for a scholarship to go to Paris. Magnier asked him to describe the project he had been working on at Montpellier. "I was astounded," the article quoted Magnier as saying. "Instead of a meeting of twenty minutes, he went on for two hours explaining to me how he had reconstructed, 'with the tools available', theories that had taken decades to construct. He showed an extraordinary
sagacity." Magnier also added: "Grothendieck gave the impression of being an extraordinary young man, but imbalanced by suffering and deprivation." Magnier immediately recommended Grothendieck for the scholarship.

Grothendieck's calculus teacher at Montpellier, Monsieur Soula, recommended he go to Paris and make contact with Cartan, who had been Soula's teacher. Whether the name Cartan referred to the father, Élie Cartan, who was then close to eighty years old, or his son, Henri Cartan, then in his midforties, Grothendieck did not know (R\&S, page 19). When he arrived in Paris, in the autumn of 1948, he showed to mathematicians there the work he had done in Montpellier. Just as Soula had told him, the results were already known. But Grothendieck was not disappointed. In fact, this early solitary effort was probably critical to his development as a mathematician. In Récoltes et Semailles, he said of this time: "Without knowing it, I learned in solitude what is essential to the metier of a mathemati-cian-something that no master can truly teach. Without having been told, I nevertheless knew 'in my gut' that I was a mathematician: someone who 'does' math, in the fullest sense of the word-like one 'makes' love" (page P5).

He began attending the legendary seminar run by Henri Cartan at the École Normale Supérieure. This seminar followed a pattern that Grothendieck was to take up with great vigor later in his career, in which a theme is investigated in lectures over the course of the year and the lectures are systematically written up and published. The theme for the Cartan seminar for 1948-1949 was simplicial algebraic topology and sheaf theory-then cut-ting-edge topics that were not being taught anywhere else in France [D1]. Indeed, this was not long after the notion of sheaves had been formulated by Jean Leray. In the Cartan seminar, Grothendieck encountered for the first time many of the outstanding mathematicians of the day, including Claude Chevalley, Jean Delsarte, Jean Dieudonné, Roger Godement, Laurent Schwartz, and André Weil. Among Cartan's students at this time was Jean-Pierre Serre. In addition to attending the Cartan seminar, Grothendieck went to a course on the then-new notion of locally convex spaces, given by Leray at the Collège de France.

As the son of the geometer Élie Cartan, as an outstanding mathematician in his own right, and as a professor at the École Normale Supérieure, Henri Cartan was in many ways the center of the Parisian mathematical elite. Also, he was one of the few French mathematicians who made efforts to reach out to German colleagues after the war. This was despite his intimate knowledge of the war's horrors: his brother, who had joined the Résistance, had been captured by the Germans and beheaded. Cartan and many of the top mathematicians of the
time-such as Ehresmann, Leray, Chevalley, Delsarte, Dieudonné, and Weil-shared the common background of having been normaliens, meaning that they were graduates of the École Normale Supérieure, the most prestigious institution of higher education in France.

When Grothendieck joined Cartan's seminar, he was an outsider: not only was he a German speaker living in postwar France, but his meager educational background contrasted sharply with that of the group he found himself in. And yet in Récoltes et Semailles, Grothendieck said he did not feel like a stranger in this milieu and related warm memories of the "benevolent welcome" he received (pages 19-20). His outspokenness drew notice: in a tribute to Cartan for his 100th birthday, Jean Cerf recalled seeing in the Cartan seminar around this time "a stranger (it was Grothendieck) who took the liberty of speaking to Cartan, as if to his equal, from the back of the room" [Cerf]. Grothendieck felt free to ask questions, and yet, he wrote, he also found himself struggling to learn things that those around him seemed to grasp instantly and play with "like they had known them from the cradle." (R\&S, page P6). This may have been one reason why, in October 1949, on the advice of Cartan and Weil, he left the rarefied atmosphere of Paris for the slower-paced Nancy. Also, as Dieudonné wrote [D1], Grothendieck was at this time showing more interest in topological vector spaces than in algebraic geometry, so Nancy was the natural place for him to go.

## Apprenticeship in Nancy

...l'affection circulait...depuis ce premier moment où j'ai été reçu avec affection à Nancy, en 1949, dans la maison de Laurent et Hélène Schwartz (où je faisais un peu partie de la famille), celle de Dieudonné, celle de Godement (qu'en un temps je hantais également régulièrement). Cette chaleur affectueuse qui a entouré mes premiers pas dans le monde mathématique, et que j'ai eu tendance un peu à oublier, a été importante pour toute ma vie de mathématicien.
...the affection circulated...from that first moment when I was received with affection in Nancy in 1949, in the house of Laurent and Hélène Schwartz (where I was somewhat a member of the family), in that of Dieudonné, in that of Godement (which at that time also became one of my regular haunts). This affectionate warmth that surrounded my first steps in the mathematical
world, and that I have had some tendency to forget, was important in my entire life as a mathematician.

## -Récoltes et Semailles, page 42

In the late 1940s, Nancy was one of the strongest mathematical centers in France; indeed, the fictitious Nicolas Bourbaki was said to have come from the "University of Nancago", a name that makes reference to Weil's time at the University of Chicago as well as to his fellow Bourbakists in Nancy. The Nancy faculty included Delsarte, Godement, Dieudonné, and Schwartz. Among Grothendieck's fellow students at Nancy were Jacques-Louis Lions and Bernard Malgrange, who like Grothendieck were students of Schwartz, as well as Paulo Ribenboim, a Brazilian who at twenty-two years of age arrived in Nancy about the same time as Grothendieck.

According to Ribenboim, who is today a professor emeritus at Queen's University in Ontario, the pace in Nancy was less hectic than in Paris, and professors had more time for the students. Ribenboim said he had the impression that Grothendieck had come to Nancy because his lack of background had made it hard for him to follow Cartan's high-powered seminar. Not that Grothendieck came out and said this: "He was not the guy who would admit he didn't understand!" Ribenboim remarked. Nevertheless, Grothendieck's extraordinary talents were apparent, and Ribenboim remembered looking up to him as an ideal. Grothendieck could be extremely intense, sometimes expressing himself in a brazen way, Ribenboim recalled: "He was not mean, but very demanding of himself and everyone else." Grothendieck had very few books; rather than learning things by reading, he would try to reconstruct them on his own. And he worked very hard. Ribenboim remembered Schwartz telling him: You seem to be a nice, well-balanced young man; you should make friends with Grothendieck and do something so that he is not only working.

Dieudonné and Schwartz were running a seminar in Nancy on topological vector spaces. As Dieudonné explained in [D1], by this time Banach spaces and their duality were well understood, but locally convex spaces had only recently been introduced, and a general theory for their duality had not yet been worked out. In working in this area, he and Schwartz had run into a series of problems, which they decided to turn over to Grothendieck. They were astonished when, some months later, he had solved every one of them and gone on to work on other questions in functional analysis. "When, in 1953, it was time to grant him a doctor's degree, it was necessary to choose from among six papers he had written, any one of which was at the level of a good dissertation," Dieudonné wrote. The
paper chosen for his thesis was "Produits tensoriels topologiques et espaces nucléaires," which shows the first signs of the generality of thinking that would come to characterize Grothendieck's entire oeuvre. The notion of nuclear spaces, which has had wide applications, was first proposed in this paper. Schwartz popularized Grothendieck's results in a Paris seminar, "Les produits tensoriels d'après Grothendieck," published in 1954 [Schwartz]. In addition, Grothendieck's thesis appeared as a monograph in 1955 in the Memoirs of the AMS series; it was reprinted for the seventh time in 1990 [Gthesis].

Grothendieck's work in functional analysis "was quite remarkable," commented Edward G. Effros of the University of California at Los Angeles. "He was arguably the first to realize that the algebraic/categorical methods that flourished after the Second World War could be used in this highly analytic branch of functional analysis." In some ways, Grothendieck was ahead of his time. Effros noted that it took at least fifteen years before Grothendieck's work was fully incorporated into mainstream Banach space theory, partly because of a reluctance to adopt his more algebraic perspective. The influence of his work has grown in recent years, Effros said, with the "quantization" of Banach space theory, for which Grothendieck's categorical approach is especially well suited.

Although Grothendieck's mathematical work had gotten off to a promising start, his personal life was unsettled. He lived in Nancy with his mother, who as Ribenboim recalled was occasionally bedridden because of tuberculosis. She had contracted the disease in the internment camps. It was around this time that she was writing her autobiographical novel Eine Frau. A liaison between Grothendieck and an older woman who ran the boarding house where

he and his mother rented rooms resulted in the birth of his first child, a son named Serge; Serge was raised mostly by his mother. After he finished his Ph.D., Grothendieck's prospects for per-


Top: Paris, with Karin
Tate, 1964.
Bottom: with E. Luft, an excursion on the Rhine, manent employment were bleak: he was stateless, and at that time it was difficult for noncitizens to get permanent jobs in France. Becoming a French citizen would have entailed military service, which Grothendieck refused to do. Since 1950 he had had a position through the Centre National de la Recherche Scientifique (CNRS), but this was more like a fellowship than a permanent job. At some point he considered learning carpentry as a way to earn money (R\&S, page 1246(*)).

Laurent Schwartz visited Brazil in 1952 and told people there about his brilliant young student who was having trouble finding a job in France. As a result Grothendieck received an offer of a visiting professor position at the Universidade de São Paulo, which he held during 1953 and 1954. According to José Barros-Neto, who was then a student in São Paulo and is now a professor emeritus at Rutgers University, Grothendieck made a special arrangement so that he would be able to return to Paris to attend seminars that took place in the fall. The second language for the Brazilian mathematical community was French, so it was easy for Grothendieck to teach and converse with his colleagues. In going to São Paulo, Grothendieck was carrying on a tradition of scientific exchange between Brazil and France: in addition to Schwartz, Weil, Dieudonné, and Delsarte had all visited Brazil in the 1940s and 1950s. Weil came to São Paulo in January 1945 and stayed until the fall of 1947, when he went to the University of Chicago. The mathematical ties between France and Brazil continue to this day. The Instituto de Matemática Pura e Aplicada in Rio de Janeiro has a BrazilFrance cooperative agreement that brings many French mathematicians to IMPA.

In Récoltes et Semailles, Grothendieck referred to 1954 as "the wearisome year" ("l'année pénible") (page 163). For the whole year he tried without success to make headway on the problem of approximation in topological vector spaces, a problem that was resolved only some twenty years later
by methods different from those Grothendieck was attempting to use. This was "the only time in my life when doing mathematics became burdensome for me!" he wrote. This frustration taught him a lesson: always have several mathematical "irons in the fire," so that if one problem proves too stubborn, there is something else to work on.

Chaim Honig, a professor at the Universidade de São Paulo, was an assistant in the mathematics department when Grothendieck was there, and they became good friends. Honig said Grothendieck led a somewhat spartan and lonely existence, living off of milk and bananas and completely immersing himself in mathematics. Honig once asked Grothendieck why he had gone into mathematics. Grothendieck replied that he had two special passions, mathematics and piano, but he chose mathematics because he thought it would be easier to earn a living that way. His gift for mathematics was so abundantly clear, said Honig, "I was astonished that at any moment he could hesitate between mathematics and music."

Grothendieck planned to write a book on topological vector spaces with Leopoldo Nachbin, who was in Rio de Janeiro, but the book never materialized. However, Grothendieck taught a course in São Paulo on topological vector spaces and wrote up the notes, which were subsequently published by the university. Barros-Neto was a student in the course and wrote an introductory chapter for the notes, giving some basic prerequisites. Barros-Neto recalled that at the time he was in Brazil Grothendieck was talking about changing fields. He was "very, very ambitious," Barros-Neto said. "You could sense that drive-he had to do something fundamental, important, basic."

## A Rising Star

La chose essentielle, c'était que Serre à chaque fois sentait fortement la riche substance derrière un énoncé qui, de but en blanc, ne m'aurait sans doute fait ni chaud ni froid-et qu'il arrivait à "faire passer" cette perception d'une substance riche, tangible, mystérieusecette perception qui est en même temps désir de connaître cette substance, d'y pénétrer.

The essential thing was that Serre each time strongly sensed the rich meaning behind a statement that, on the page, would doubtless have left me neither hot nor cold-and that he could "transmit" this perception of a rich, tangible, and mysterious substance-this perception that is at the same time the
desire to understand this substance, to penetrate it.

## -Récoltes et Semailles, page 556

Bernard Malgrange of the Université de Grenoble recalled that after Grothendieck wrote his thesis he asserted that he was no longer interested in topological vector spaces. "He told me, 'There is nothing more to do, the subject is dead'," Malgrange recalled. At that time, students were required to prepare a "second thesis", which did not contain original work but which was intended to demonstrate depth of understanding of another area of mathematics far removed from the thesis topic. Grothendieck's second thesis was on sheaf theory, and this work may have planted the seeds for his interest in algebraic geometry, where he was to do his greatest work. After Grothendieck's thesis defense, which took place in Paris, Malgrange recalled that he, Grothendieck, and Henri Cartan piled into a taxicab to go to lunch at the home of Laurent Schwartz. They took a cab because Malgrange had broken his leg skiing. "In the taxi Cartan explained to Grothendieck some wrong things Grothendieck had said about sheaf theory," Malgrange recalled.

After leaving Brazil Grothendieck spent the year of 1955 at the University of Kansas, probably at the invitation of N. Aronszajn [Corr]. There Grothendieck began to immerse himself in homological algebra. It was while he was at Kansas that he wrote "Sur quelques points d'algèbre homologique," which came to be known informally among specialists as the "Tôhoku paper" after the name of the journal in which it appeared, the Tôhoku Mathematical Journal [To]. This paper, which became a classic in homological algebra, extended the work of Cartan and Eilenberg on modules. Also while he was in Kansas, Grothendieck wrote "A general theory of fiber spaces with structure sheaf," which appeared as a report of the National Science Foundation. This report developed his initial ideas on nonabelian cohomology, a subject to which he later returned in the context of algebraic geometry.

Around this time, Grothendieck began corresponding with Jean-Pierre Serre of the Collège de France, whom he had met in Paris and later encountered in Nancy; a selection of their letters was published in the original French in 2001 and in a dual French-English version in 2003 [Corr]. This was the beginning of a long and fruitful interaction. The letters display a deep and vibrant mathematical bond between two very different mathematicians. Grothendieck shows a high-flying imagination that is frequently brought back to earth by Serre's incisive understanding and wider knowledge. Sometimes in the letters Grothendieck displays a surprising level of ignorance: for example, at one
point, he asks Serre if the Riemann zeta function has infinitely many zeros ([Corr], page 204). "His knowledge of classical algebraic geometry was practically zero," recalled Serre. "My own knowledge of classical algebraic geometry was a little bit better, but not very much, but I tried to help him with that. But...there were so many open questions that it didn't matter." Grothendieck


During an Arbeitstagung in 1961, an evening at the Hirzebruch home in Bonn. was not one for keeping up on the latest literature, and to a large degree he depended on Serre to tell him what was going on. In Récoltes et Semailles Grothendieck wrote that most of what he learned in geometry, apart from what he taught himself, he learned from Serre (pages 555-556). But Serre did not simply teach Grothendieck things; he was able to digest ideas and to discuss them in a way that Grothendieck found especially compelling. Grothendieck called Serre a "detonator," one who provided a spark that set the fuse burning for an explosion of ideas.

Indeed, Grothendieck traced many of the central themes of his work back to Serre. For example, it was Serre who around 1955 described the Weil conjectures to Grothendieck in a cohomological context-a context that was not made explicit in Weil's original formulation of the conjectures and was the one that could hook Grothendieck (R\&S, page 840). Through his idea of a "Kählerian" analogue of the Weil conjectures, Serre also inspired Grothendieck's conception of the so-called "standard conjectures," which are more general and would imply the Weil conjectures as a corollary (R\&S, page 210).

When Grothendieck returned to France in 1956 after his year in Kansas, he held a CNRS position and spent most of his time in Paris. He and Serre continued to correspond by letter and to talk regularly by telephone. This was when Grothendieck began to work more deeply in topology and algebraic geometry. He "was bubbling with ideas," recalled Armand Borel. "I was sure something firstrate would come out of him. But then what came out was even much higher than I had expected. It was his version of Riemann-Roch, and that's a fantastic theorem. This is really a masterpiece of mathematics."

The Riemann-Roch theorem was proved in its classical form in the mid-nineteenth century. The
question it addresses is, What is the dimension of the space of meromorphic functions on a compact Riemann surface having poles of at most given orders at a specified finite set of points? The answer is the Riemann-Roch formula, which expresses the dimension in terms of invariants of the surfacethereby providing a profound link between the analytic and topological properties of the surface. Friedrich Hirzebruch made a big advance in 1953, when he generalized the Riemann-Roch theorem to apply not just to Riemann surfaces but to projective nonsingular varieties over the complex numbers. The mathematical world cheered at this tour de force, which might have seemed to be the final word on the matter.
"Grothendieck came along and said, 'No, the Riemann-Roch theorem is not a theorem about varieties, it's a theorem about morphisms between varieties'," said Nicholas Katz of Princeton University. "This was a fundamentally new point of view...the very statement of the theorem completely changed." The basic philosophy of category theory, that one should pay more attention to the arrows between objects than to the objects themselves, was just then beginning to have an influence. "What [Grothendieck] did is he applied this philosophy on a very hard piece of mathematics," Borel said. "This was really in the spirit of categories and functors, but no one had ever thought about doing this in such a hard topic.... If people had been given that statement and had understood it, there might have been others who would have been able to prove it. But the statement itself was ten years ahead of anybody else."

This theorem, which was also proved independently by Gerard Washnitzer in 1959 [Washnitzer], applies not just to a complex algebraic variety-the case where the ground field has characteristic zero-but to any proper smooth algebraic variety regardless of the ground field. The Hirzebruch-Riemann-Roch theorem then follows as a special case. A far-reaching generalization of the RiemannRoch theorem came in 1963, with the proof by Michael Atiyah and Isadore Singer of the AtiyahSinger Index Theorem. In the course of his proof, Grothendieck introduced what are now called Grothendieck groups, which essentially provide a


Bonn, around 1965.
new kind of topological invariant. Grothendieck himself called them K-groups, and they provided the starting point for the development of topological K-theory by Atiyah and Hirzebruch. Topological K-theory then provided the inspiration for algebraic K-theory, and both have been active fields of research ever since.

The Arbeitstagung, which means literally "working meeting," was begun by Hirzebruch at the Universität Bonn and has been a forum for cutting-edge mathematics research for more than forty years. It was at the very first Arbeitstagung in July 1957 that Grothendieck spoke about his work on Rie-mann-Roch. But in a curious twist, the result was not published under his name; it appears in a paper by Borel and Serre [BS] (the proof also appeared later as an exposé in volume 6 of Séminaire de Géometrie Algébrique du Bois Marie from 196667). While visiting the IAS in the fall of 1957, Serre received a letter from Grothendieck containing an outline of the proof (November 1, 1957, letter in [Corr]). He and Borel organized a seminar to try to understand it. As Grothendieck was busy with many other things, he suggested to his colleagues that they write up and publish their seminar notes. But Borel speculated that there may have been another reason Grothendieck was not interested in writing up the result himself. "The main philosophy of Grothendieck was that mathematics should be reduced to a succession of small, natural steps," Borel said. "As long as you have not been able to do this, you have not understood what is going on.... And his proof of Riemann-Roch used a trick, une astuce. So he didn't like it, so he didn't want to publish it.... He had many other things to do, and he was not interested in writing up this trick."

This was not the last time Grothendieck would revolutionize the viewpoint on a subject. "This just kept happening over and over again, where he would come upon some problem that people had thought about for, in some cases, a hundred years...and just completely transformed what people thought the subject was about," Katz remarked. Grothendieck was not only solving outstanding problems but reworking the very questions they posed.

## A New World Opens

[J'ai fini] par me rendre compte que cette idéologie du "nous, les grands et nobles esprits...", sous une forme particulièrement extrême et virulente, avait sévi en ma mère depuis son enfance, et dominé sa relation aux autres, qu'elle se plaisait à regarder du haut de sa grandeur avec une commisération souvent dédaigneuse, voire méprisante.
[I eventually] realized that this ideology of "we, the grand and noble spirits...", in a particularly extreme and virulent form, raged in my mother since her childhood and dominated her relations to others, whom she liked to view from the height of her grandeur with a pity that was frequently disdainful, even contemptuous.
-Récoltes et Semailles, page 30
According to Honig, Grothendieck's mother was with him at least part of the time that he was in Brazil, though Honig says he never met her. Whether she was with him in Kansas is not clear. When Grothendieck returned to France in 1956, they may not have continued living together. In a letter to Serre written in Paris in November 1957, Grothendieck asked whether he might be able to rent a Paris apartment that Serre was planning to vacate. "I am interested in it for my mother, who is not doing so well in Bois-Colombes, and is terribly isolated," Grothendieck explained [Corr]. In fact, his mother died before the year's end.

Friends and colleagues say that Grothendieck spoke with great admiration, almost adulation, of both of his parents. And in Récoltes et Semailles Grothendieck expressed a deep and elemental love for them. For years he had in his office a striking portrait of his father, painted by a fellow detainee in the Le Vernet camp. As Pierre Cartier described it, the portrait showed a man with his head shaved and a "fiery expression" in the eyes [Cartier1]; for many years Grothendieck also shaved his head. According to Ribenboim, Hanka Grothendieck was very proud of her brilliant son, and he in turn had an extremely deep attachment to his mother.

After her death, Grothendieck went through a period of soul-searching, during which he stopped all mathematical activity and thought about becoming a writer. After several months, he decided to return to mathematics, to finish work on some of the ideas he had begun developing. This was 1958, the year that, as Grothendieck put it, was "probably the most fecund of all my mathematical life." (R\&S, page P24) By this time he was living with a woman named Mireille, whom he was to
marry a few years later and with whom he had three children, Johanna, Mathieu, and Alexandre. Mireille had been close to Grothendieck's mother and, according to several people who knew them, was quite a bit older than he was.

John Tate of the University of Texas at Austin and his wife at


With Mireille and baby Mathieu, Paris, May 1965. the time, Karin Tate, spent the academic year 1957-58 in Paris, where they met Grothendieck for the first time. Grothendieck displayed none of the arrogance he attributed to his mother. "He was just friendly, and at the same time rather naive and childlike," John Tate recalled. "Many mathematicians are rather childlike, unworldly in some sense, but Grothendieck more than most. He just seemed like an innocent-not very sophisticated, no pretense, no sham. He thought very clearly and explained things very patiently, without any sense of superiority. He wasn't contaminated by civilization or power or one-upmanship." Karin Tate recalled that Grothendieck had a great capacity for enjoyment, he was charming, and he loved to laugh. But he could also be extremely intense, seeing things in black-and-white with no shades of gray. And he was honest: "You always knew where you stood with him," she said. "He didn't pretend anything. He was direct." Both she and her brother, Michael Artin of the Massachusetts Institute of Technology, saw similarities between Grothendieck's personality and that of their father, Emil Artin.

Grothendieck had "an incredible idealistic streak," Karin Tate remembered. For example, he refused to have any rugs in his house because he believed that rugs were merely a decorative luxury. She also remembered him wearing sandals made out of tires. "He thought these were fantastic," she said. "They were a symbol of the kind of thing he respected-you take what you have, and you make do." In his idealism, he could also be wildly impractical. Before Grothendieck and Mireille visited Harvard for the first time in 1958, he gave her one of his favorite novels so that she could improve her rather weak knowledge of English. The novel was Moby Dick.

## The Birth of the New Geometry

Avec un recul de près de trente ans, je peux dire maintenant que c'est l'année [1958] vraiment où est née la vision de la géometrie nouvelle, dans le sillage
des deux maître-outils de cette géometrie: les schémas (qui représentent une métamorphose de l'ancienne notion de "variété algébrique"), et les topos (qui représentent une métamorphose, plus profonde encore, de la notion d'espace).

With hindsight of thirty years, I can now say that [1958] is the year where the vision of the new geometry was really born, in the wake of two mastertools of this geometry: schemes (which represent a metamorphosis of the old notion of "algebraic variety"), and toposes (which represent a metamorphosis, yet more profound, of the notion of space).

- Récoltes et Semailles, page P23

In August 1958, Grothendieck gave a plenary lecture at the International Congress of Mathematicians in Edinburgh [Edin]. The talk outlined, with a remarkable prescience, many of the main themes that he was to work on for the next dozen years. It was clear by this time that he was aiming to prove the famous conjectures of André Weil, which hinted at a profound unity between the discrete world of algebraic varieties and the continuous world of topology.

At this time, algebraic geometry was evolving rapidly, with many open questions that did not require a great deal of background. Originally the main objects of study were varieties over the complex numbers. During the early part of the twentieth century, this area was a specialty of Italian mathematicians, such as Guido Castelnuovo, Federigo Enriques, and Francesco Severi. Although they developed many ingenious ideas, not all of their results were proved rigorously. In the 1930s and 1940s, other mathematicians, among them B. L. van der Waerden, André Weil, and Oscar Zariski, wanted to work with varieties over arbitrary fields, particularly varieties over fields of characteristic $p$, which are important in number theory. But, because of the lack of rigor of the Italian school of algebraic geometry, it was necessary to build new foundations for the field. This is what Weil did in his 1946 book Foundations of Algebraic Geometry [Weil1].

Weil's conjectures appeared in his 1949 paper [Weil2]. Motivated by problems in number theory, Weil studied a certain zeta function that had been introduced in special cases by Emil Artin; it is called a zeta function because it was defined in analogy to the Riemann zeta function. Given an algebraic variety $V$ defined over a finite field of characteristic $p$, one can count the number of points of $V$ that are rational over this field, as well as the
corresponding numbers for each finite extension field. These numbers are then incorporated into a generating function, which is the zeta function of $V$. Weil proved for both curves and abelian varieties three facts about this zeta function: it is rational, it satisfies a functional equation, and its zeros and poles have a certain specific form. This form, once a change of variables is made, corresponds exactly to the Riemann hypothesis. Moreover, Weil observed that, if $V$ arose from reduction modulo $p$ of a variety $W$ in characteristic zero, then the Betti numbers of $W$ can be read off the zeta function of $V$, when the zeta function is expressed as a rational function. The Weil conjectures ask whether these same facts hold true if one defines such a zeta function for a projective nonsingular algebraic variety. In particular, would topological data such as the Betti numbers emerge in the zeta function? This conjectured link between algebraic geometry and topology hinted that some of the new tools, such as cohomology theory, that were then being developed for topological spaces, could be adapted for use with algebraic varieties. Because of its similarity to the classical Riemann hypothesis, the third of the Weil conjectures is sometimes called the "congruence Riemann hypothesis"; this one turned out to be the most difficult of the three to prove.
"As soon as [the Weil] conjectures were made, it was clear that they were somehow going to play a central role," Katz said, "both because they were fabulous just as 'black-box' statements, but also because it seemed obvious that solving them required developing incredible new tools that would somehow have to be incredibly valuable in their own way-which turned out to be completely correct." Pierre Deligne of the Institute for Advanced Study said that it was the conjectured link between algebraic geometry and topology that attracted Grothendieck. He liked the idea of "turning this dream of Weil into powerful machinery," Deligne remarked.

Grothendieck was not interested in the Weil conjectures because they were famous or because other people considered them to be difficult. Indeed, he was not motivated by the challenge of hard problems. What interested him were problems that seemed to point to larger, hidden structures. "He would aim at finding and creating the home which was the problem's natural habitat," Deligne noted. "That was the part that interested him, more than solving the problem." This approach contrasts with that of another great mathematician of the time, John Nash. In his mathematical prime, Nash searched out specific problems considered by his colleagues to be the most important and challenging [Nasar]. "Nash was like an Olympian athlete," remarked Hyman Bass of the University of Michigan. "He was interested in enormous
personal challenges." If Nash is an ideal example of a problem-solver, then Grothendieck is an ideal example of a theory-builder. Grothendieck, said Bass, "had a sweeping vision of what mathematics could be."

In the fall of 1958, Grothendieck made the first of his several visits to the mathematics department at Harvard University. Tate was a professor there, and the chairman was Oscar Zariski. By this time Grothendieck had reproved, by recently developed cohomological methods, the connectedness theorem that was one of Zariski's biggest results, proved in the 1940s. According to David Mumford of Brown University, who was Zariski's student at the time, Zariski never took up the new methods himself, but he understood their power and wanted his students to be exposed to them, and this was why he invited Grothendieck to Harvard.

Zariski and Grothendieck got along well, Mumford noted, though as mathematicians they were very different. It was said that Zariski, when he got stuck, would go to the blackboard and draw a picture of a self-intersecting curve, which would allow him to refresh his understanding of various ideas. "The rumor was that he would draw this in the corner of the blackboard, and then he would erase it and then he would do his algebra," explained Mumford. "He had to clear his mind by creating a geometric picture and reconstructing the link from the geometry to the algebra." According to Mumford, this is something Grothendieck would never do; he seemed never to work from examples, except for ones that were extremely simple, almost trivial. He also rarely drew pictures, apart from homological diagrams.

When Grothendieck was first invited to Harvard, Mumford recalled, he had some correspondence with Zariski before the visit. This was not long after the era of the House Un-American Activities Committee, and one requirement for getting a visa was swearing that one would not work to overthrow the government of the United States. Grothendieck told Zariski he would refuse to take such a pledge. When told he might end up in jail, Grothendieck said jail would be acceptable as long as students could visit and he could have as many books as he wanted.

In Grothendieck's lectures at Harvard, Mumford found the leaps into abstraction to be breathtaking. Once he asked Grothendieck how to prove a certain lemma and got in reply a highly abstract argument. Mumford did not at first believe that such an abstract argument could prove so concrete a lemma. "Then I went away and thought about it for a couple of days, and I realized it was exactly right," Mumford recalled. "He had more than anybody else I've ever met this ability to make an absolutely startling leap into something an order of magnitude more abstract.... He would always look for
some way of formulating a problem, stripping apparently everything away from it, so you don't think anything is left. And yet something is left, and he could find real structure in this seeming vacuum."

## The Heroic Years

Pendant les années héroiques de l'IHÉS, Dieudonné et moi en avons été les seuls membres, et les seuls aussi à lui donner crédibilité et audience dans le monde scientifique. ...Je me sentais un peu comme un cofondateur "scientifique", avec Dieudonné, de mon institution d'attache, et je comptais bien y finir mes jours! J'avais fini par m'identifier fortement à l'IHÉS....

During the heroic years of the IHÉS, Dieudonné and I were the only members, and the only ones also giving it credibility and an audience in the scientific world. ...I felt myself a bit like a "scientific" co-founder, with Dieudonné, of the institution where I was on the faculty, and I counted on ending my days there! I ended up strongly identifying with the IHÉS....
-Récoltes et Semailles, page 169
In June 1958, the Institut des Hautes Études Scientifiques (IHÉS) was formally established in a meeting of its sponsors at the Sorbonne in Paris. The founder, Léon Motchane, a businessman with a doctoral degree in physics, had a vision of establishing in France an independent research institution akin to the Institute for Advanced Study in Princeton. The original plan for the IHÉS was to focus on fundamental research in three areas: mathematics, theoretical physics, and the methodology of human sciences. While the third area never gained a foothold, within a decade the IHÉS had established itself as one of the world's top centers for mathematics and theoretical physics, with a small but stellar faculty and an active visitor program.

According to the doctoral thesis of historian of science David Aubin [Aubin], it was at the Edinburgh Congress in 1958, or possibly before, that Motchane persuaded Dieudonné and Grothendieck to accept professorships at the newly established IHÉS. Cartier wrote in [Cartier2] that Motchane originally wanted to hire Dieudonné, who made it a condition of his taking the position that an offer also be made to Grothendieck. Because the IHÉS has been from the start independent of the state, there was no problem in hiring Grothendieck despite his
being stateless. The two professors formally took up their positions in March 1959, and Grothendieck started his seminar on algebraic geometry in May of that year. René Thom, who had received a Fields Medal at the 1958 Congress, joined the faculty in October 1963, and the IHÉS section on theoretical physics was launched with the appointments of Louis Michel in 1962 and of David Ruelle in 1964. Thus by the mid-1960s, Motchane had assembled an outstanding group of researchers for his new institute.

Up to 1962, the IHÉS had no permanent quarters. Office space was rented from the Fondation Thiers, and seminars were given there or at universities in Paris. Aubin reported that an early visitor to the IHES, Arthur Wightman, was expected to work from his hotel room. It is said that, when a visitor noted the inadequate library, Grothendieck replied, "We don't read books, we write them!" Indeed, in the early years, much of the institute's activity centered on the "Publications mathématiques de l'IHÉS," which began with the initial volumes of the foundational work Éléments de Géométrie Algébrique, universally known by its acronym EGA. In fact, the writing of EGA had begun half a year before Dieudonné and Grothendieck formally took their positions at the IHÉS; a reference in [Corr] dates the beginning of the writing to the autumn of 1958.

The authorship of EGA is attributed to Grothendieck, "with the collaboration of Jean Dieudonné." Grothendieck wrote notes and drafts, which were fleshed out and polished by Dieudonné. As Armand Borel explained it, Grothendieck was the one who had the global vision for EGA, whereas Dieudonné had only a line-by-line understanding. "Dieudonné put this in a rather heavy style," Borel remarked. At the same time, "Dieudonné was of course fantastically efficient. No one else could have done it without ruining his own work." For some wanting to enter the field at that time, learning from EGA could be a daunting challenge. Nowadays it is seldom used as an introduction to the field, as there are many other, more approachable texts to choose from. But those texts do not do what EGA aims to do, which is to explain fully and systematically some of the tools needed to investigate schemes. When he was at Princeton University, Gerd Faltings, now at the Max-Planck-Institut für Mathematik in Bonn, encouraged his doctoral stu-


Around 1965.
dents to read EGA. And for many mathematicians today, EGA remains a useful and comprehensive reference. The current IHÉS director, Jean-Pierre Bourguignon, says that the institute still sells over 100 copies of EGA every year.

Grothendieck's plans for what EGA would cover were enormous. In a letter to Serre from August 1959, he gave a brief outline, which included the fundamental group, category theory, residues, duality, intersections, Weil cohomology, and "God willing, a little homotopy." "Unless there are unexpected difficulties or I get bogged down, the multiplodocus should be ready in 3 years' time, or 4 at the outside," Grothendieck optimistically wrote, using his and Serre's joking term "multiplodocus," meaning a very long paper. "We will be able to start doing algebraic geometry!" he crowed. As it turned out, EGA ran out of steam after almost exponential growth: chapters one and two are each one volume, chapter three is two volumes, and the last, chapter four, runs four volumes. Altogether, they comprise 1,800 pages. Despite its falling short of Grothendieck's plans, EGA is a monumental work.

It is no coincidence that the title of EGA echoes the title of the series by Nicolas Bourbaki, Éléments de Mathématique, which in turn echoes Euclid's Elements: Grothendieck was a member of Bourbaki for several years, starting in the late 1950s and was close to many of the other members. Bourbaki was the pseudonym for a group of mathematicians, most of them French, who collaborated on writing a series of foundational treatises on mathematics. Dieudonné was a founder of the Bourbaki group, together with Henri Cartan, Claude Chevalley, Jean Delsarte, and André Weil. Usually there were about ten members, and the group's composition evolved over the years. The first Bourbaki book appeared in 1939, and the group's influence was at its height during the 1950s and 1960s. The purpose of the books was to provide axiomatic treatments of central areas of mathematics at a level of generality that would make the books useful to the largest number of mathematicians. The books were born in a crucible of animated and sometimes heated discussions among the group's members, many of whom had strong personalities and highly individual points of view. Borel, who was a member of Bourbaki for 25 years, wrote that this collaboration
may have been "a unique occurrence in the history of mathematics" [Borel]. Bourbaki pooled the efforts of some of the top mathematicians of the day, who unselfishly and anonymously devoted a good deal of time and energy to writing texts that would make a wide swath of the field accessible. The texts had a large impact, and by the 1970s and 1980s, there were grumblings that Bourbaki had too much influence. Also, some criticized the style of the books as being excessively abstract and general.

The work of Bourbaki and that of Grothendieck bear some similarities in the level of generality and abstraction and also in the aim of being foundational, thorough, and systematic. The main difference is that Bourbaki covered a range of mathematical areas, while Grothendieck focused on developing new ideas in algebraic geometry, with the Weil conjectures as a primary goal. In addition, Grothendieck's work was very much centered on his own internal vision, whereas Bourbaki was a collaborative effort that forged a synthesis of the viewpoints of its members.

Borel described in [Borel] the March 1957 meeting of Bourbaki, dubbed the "Congress of the inflexible functor" because of Grothendieck's proposal that a Bourbaki draft on sheaf theory be redone from a more categorical viewpoint. Bourbaki abandoned this idea, believing it could lead to an endless cycle of foundation-building. Grothendieck "could not really collaborate with Bourbaki because he had his big machine, and Bourbaki was not general enough for him," Serre recalled. In addition, Serre remarked, "I don't think he liked very much the system of Bourbaki, where we would really discuss drafts in detail and criticize them. ...That was not his way of doing mathematics. He wanted to do it himself." Grothendieck left Bourbaki in 1960, though he remained close to many of its members.

Stories have circulated that Grothendieck left Bourbaki because of clashes with Weil, but in fact the two had only a brief overlap: following the edict that members must retire at age 50, Weil left the group in 1956. Nevertheless, it is true that Grothendieck and Weil were very different as mathematicians. As Deligne put it, "Weil felt somewhat that Grothendieck was too ignorant of what the Italian geometers had done and what all the classical literature was, and Weil did not like the style of building a big machine. ...Their styles were quite different."

Apart from EGA, the other major part of Grothendieck's oeuvre in algebraic geometry is Séminaire de Géométrie Algébrique du Bois Marie, known as SGA, which contains written versions of lectures presented in his IHÉS seminar. They were originally distributed by the IHÉS. SGA 2 was copublished by North-Holland and Masson, while the
remaining volumes were published by SpringerVerlag. SGA 1 dates from the seminars of 1960-1961, and the last in the series, SGA 7, dates from 1967-1969. In contrast to EGA, which is intended to set foundations, SGA describes ongoing research as it unfolded in Grothendieck's seminar. He presented many of his results in the Bourbaki Seminar in Paris, and they were collected in FGA, Fondements de la Géométrie Algébrique, which appeared in 1962. Together, EGA, SGA, and FGA total around 7,500 pages.

## The Magic Fan

[S]'il y a une chose en mathématique qui (depuis toujours sans doute) me fascine plus que toute autre, ce n'est ni "le nombre", ni "la grandeur", mais toujours la forme. Et parmi les mille-et-un visages que choisit la forme pour se révéler à nous, celui qui m'a fasciné plus que tout autre et continue à me fasciner, c'est la structure cachée dans les choses mathématiques.
[I]f there is one thing in mathematics that fascinates me more than anything else (and doubtless always has), it is neither "number" nor "size", but always form. And among the thousand-andone faces whereby form chooses to reveal itself to us, the one that fascinates me more than any other and continues to fascinate me, is the structure hidden in mathematical things.

- Récoltes et Semailles, page P27

In the first volume of Récoltes et Semailles, Grothendieck presents an expository overview of his work intended to be accessible to nonmathematicians (pages P25-48). There he writes that, at its most fundamental level, this work seeks a unification of two worlds: "the arithmetic world, in which live the (so-called) 'spaces' having no notion of continuity, and the world of continuous size, in which live the 'spaces' in the proper sense of the term, accessible to the methods of the analyst". The reason the Weil conjectures were so tantalizing is exactly that they provided clues about this unity. Rather than trying to solve the Weil conjectures directly, Grothendieck greatly generalized their entire context. Doing so allowed him to perceive the larger structures in which the conjectures lived and of which they provided only a fleeting glimpse. In this section of Récoltes et Semailles, Grothendieck explained some of the key ideas in his work, including scheme, sheaf, and topos.

Basically, a scheme is a generalization of the notion of an algebraic variety. Given the array of
finite fields of prime characteristic, a scheme produces in turn an array of varieties, each with its distinct geometry. "The array of these different varieties of different characteristics can be visualized as a sort of 'infinite fan of varieties' (one for each characteristic)," Grothendieck wrote. "The 'scheme' is this magic fan, which links, like so many different 'branches', the 'avatars' or 'incarnations' of all the possible characteristics." The generalization to a scheme allows one to study in a unified way all the different "incarnations" of a variety. Before Grothendieck, "I don't think people really believed you could do that," commented Michael Artin. "It was too radical. No one had had the courage to even think this may be the way to work, to work in complete generality. That was very remarkable."

Starting with the insight of the nineteenthcentury Italian mathematician Enrico Betti, homology and its dual cohomology were developed as tools for studying topological spaces. Basically, cohomology theories provide invariants, which can be thought of as "yardsticks" for measuring this or that aspect of a space. The great hope, sparked by the insight implicit in the Weil conjectures, was that cohomological methods for topological spaces could be adapted for use with varieties and schemes. This hope was realized to a great extent in the work of Grothendieck and his collaborators. "It was like night and day to [bring] these cohomological techniques" into algebraic geometry, Mumford noted. "It completely turned the field upside down. It's like analysis before and after Fourier analysis. Once you get Fourier techniques, suddenly you have this whole deep insight into a way of looking at a function. It was similar with cohomology."

The notion of a sheaf was conceived by Jean Leray and further developed by Henri Cartan and Jean-Pierre Serre. In his groundbreaking paper known as FAC ("Faisceaux algébriques cohérents", [FAC]), Serre showed how sheaves could be used in algebraic geometry. Without saying exactly what a sheaf is, Grothendieck described in Récoltes et Semailles how this notion changed the landscape: When the idea of a sheaf came along, it was as if the good old standard cohomology "yardstick" suddenly multiplied into an infinite array of new "yardsticks", in all sizes and forms, each perfectly suited to its own unique measuring task. What is more, the category of all sheaves over a space carries so much information that one can essentially "forget" what the space is. All the information is in the sheaf-what Grothendieck called the "silent and sure guide" that led him on the path to his discoveries.

The notion of topos, Grothendieck wrote, is "a metamorphosis of the notion of a space." The concept of a sheaf provides a way of translating from the topological setting, where the space lives, to the
categorical setting, where the category of sheaves lives. A topos, then, can be described as a category that, without necessarily arising from an ordinary space, nevertheless has all of the "nice" properties of a category of sheaves. The notion of topos, Grothendieck wrote, highlights the fact that "what really counts in a topological space is not at all its 'points' or its subsets of points and their proximity relations and so forth, but rather the sheaves on the space and the category that they form."

To come up with the idea of topos, Grothendieck "thought very deeply about the notion of space," Deligne commented. "The theory he created to understand those conjectures of Weil was first to create the concept of topos, a generalization of the notion of space, then to define a topos adapted to the problem," he explained. Grothendieck also showed that "one can really work with it, that the intuition we have about ordinary space works [on a topos] also. ...This was a very deep idea."

In Récoltes et Semailles Grothendieck commented that from a technical point of view much of his work in mathematics consisted in developing the cohomology theories that were lacking. Étale cohomology was one such theory, developed by Grothendieck, Michael Artin, and others, specifically to apply to the Weil conjectures, and indeed it was one of the key ingredients in their proof. But Grothendieck went yet further, developing the concept of a motive, which he described as the "ultimate cohomological invariant" of which all others are different realizations or incarnations. A full theory of motives has remained out of grasp, but the concept has generated a good deal of mathematics. For example, in the 1970s Deligne and Robert Langlands of the IAS conjectured precise relationships between motives and automorphic representations. This conjecture, now part of the socalled Langlands Program, first appeared in print in [Langlands]. James Arthur of the University of Toronto said that proving this conjecture in full generality is decades away. But, he pointed out, what Andrew Wiles did in the proof of Fermat's Last Theorem was essentially to prove this conjecture in the case of two-dimensional motives that come from elliptic curves. Another example is the work of Vladimir Voevodsky of the IAS on motivic cohomology, for which he received the Fields Medal in 2002. This work builds on some of Grothendieck's original ideas about motives.

In looking back on this brief retrospective of his mathematical work, Grothendieck wrote that what makes up its essence and power is not results or big theorems, but "ideas, even dreams" (page P51).

## The Grothendieck School

Jusqu'au moment du premier "réveil," en 1970, les relations à mes élèves, tout
comme ma relation à mon propre travail, était une source de satisfaction et de joie, un des fondements tangibles, irrécusables, d'un sentiment d'harmonie dans ma vie, qui continuait à lui donner un sens....

Until the moment of the first "awakening", in 1970, the relations with my students, just like my relation to my own work, was a source of satisfaction and joy, one of the tangible, unimpeachable bases of a sense of harmony in my life, which continued to give it meaning....
-Récoltes et Semailles, page 63
During a visit to Harvard in the fall of 1961, Grothendieck wrote to Serre: "The mathematical atmosphere at Harvard is ravishing, a real breath of fresh air compared with Paris, which is getting more gloomy every year. Here, there are a fair number of intelligent students who are beginning to be familiar with the language of schemes and ask for nothing more than to work on interesting problems, which obviously are not in short supply" [Corr]. Michael Artin was at Harvard at that time as a Benjamin Peirce instructor, after having finished his thesis with Zariski in 1960. Immediately after his thesis, Artin set about learning the new language of schemes, and he also became interested in the idea of étale cohomology. When Grothendieck came to Harvard in 1961, "I asked him to tell me the definition of étale cohomology," Artin recalled with a laugh. The definition had not yet been formulated precisely. Said Artin, "Actually we argued about the definition for the whole fall."

After moving to the Massachusetts Institute of Technology in 1962, Artin gave a seminar on étale cohomology. He spent much of the following two years at the IHÉS working with Grothendieck. Once the definition of étale cohomology was in hand, there was still a lot of work to be done to tame the theory and make it into a tool that could really be used. "The definition looked marvelous, but it came with no guarantees that anything was finite, or could ever be computed, or anything," Mumford commented. This was the work that Artin and Grothendieck plunged into; one product was the Artin representability theorem. Together with JeanLouis Verdier, they directed the 1963-64 seminar, which focused on étale cohomology. That seminar was written up in the three volumes of SGA 4, which total nearly 1,600 pages.

There might be disagreement with Grothendieck's "gloomy" assessment of the Parisian mathematical scene of the early 1960s, but there is no question that it got an enormous boost when he returned to the IHÉS in 1961 and restarted his
seminar. The atmosphere was "fantastic", Artin recalled. The seminar was well populated by the leading lights of Parisian mathematics, as well as mathematicians visiting from other places. A group of brilliant and eager students began to collect around Grothendieck and to write their theses under his direction (the IHÉS does not give degrees, so formally they were students at universities in and around Paris). By 1962 the IHÉS had moved to its permanent home in the middle of a serene, tree-filled park called the Bois-Marie, in the Paris suburb of Bures-sur-Yvette. The gazebolike building where the seminar was held, with its large picture windows and open, airy feel, provided an unusual and dramatic setting. Grothendieck was the dynamic center of the activities. "The seminars were highly interactive," recalled Hyman Bass, who visited the IHÉS in the 1960s, "but Grothendieck dominated whether he was the speaker or not." He was extremely rigorous and could be rather tough on people. "He was not unkind, but also not coddling," Bass said.

Grothendieck developed a certain pattern of working with students. A typical example is that of Luc Illusie of the Université de Paris-Sud, who became a student of Grothendieck's in 1964. Illusie had been participating in the Paris seminar of Henri Cartan and Laurent Schwartz, and it was Cartan who suggested that Illusie might do a thesis with Grothendieck. Illusie, who had until that time worked only in topology, was apprehensive about meeting this "god" of algebraic geometry. As it turned out, Grothendieck was quite kind and friendly and asked Illusie to explain what he had been working on. After Illusie had spoken for a short time, Grothendieck went to the board and launched into a discussion of sheaves, finiteness conditions, pseudo-coherence, and the like. "It was like a sea, like a continuous stream of mathematics on the board," Illusie recalled. At the end of it Grothendieck said that the next year he would devote his seminar to $L$-functions and $l$-adic cohomology and that Illusie should help to write up the notes. When Illusie protested that he knew nothing about algebraic geometry, Grothendieck said it didn't matter: "You will learn quickly."

And Illusie did. "His lectures were so clear, and he made so many efforts to recall what was necessary, all the prerequisites," Illusie remarked. Grothendieck was an excellent teacher, very patient and adept at explaining things clearly. "He took time to explain very simple examples showing how the machinery works," Illusie said. Grothendieck discussed formal properties that are often glossed over as being "trivial" and therefore too obvious to require explanation. Usually "you don't specify them, you don't spend time," Illusie said, but such things are pedagogically very useful. "Sometimes
it was a bit lengthy, but it was very good for understanding."

Grothendieck gave Illusie the assignment of writing up notes for some exposés of the semi-nars-namely, exposés I, II, and III of SGA 5. The notes done, "I was shivering when I handed them to him," Illusie recalled. A few weeks later, Grothendieck asked Illusie to come to his home to discuss the notes; he often worked at home with colleagues and students. When Grothendieck took the notes out and set them on the table, Illusie saw that they were blackened with penciled comments. The two sat there for several hours as Grothendieck went over each comment. "He could criticize for a comma, for a period, he could criticize for an accent, he could criticize also on the substance of the thing very deeply and propose another organiza-tion-it was all kinds of comments," Illusie said. "But all his comments were very up to the point." This kind of line-by-line critique of written notes was typical of Grothendieck's way of working with students. Illusie recalled that a couple of students could not bear this kind of close criticism and ended up writing their theses with someone else. One was nearly reduced to tears after an encounter with Grothendieck. Illusie said, "Some people I remember didn't like it so much. You had to comply with that. ...[But] they were not petty criticisms."

Nicholas Katz was also given an assignment when he visited the IHÉS as a postdoc in 1968. Grothendieck suggested that Katz could give a lecture in the seminar about Lefschetz pencils. "I had heard of Lefschetz pencils but really knew as little as is possible to know about them except for having heard of them," Katz recalled. "But by the end of the year I had given a few talks in the seminar, which now exist as part of SGA 7. I learned a tremendous amount from it, and it had a big effect on my future." Katz said that Grothendieck would come to the IHÉS perhaps one day a week to talk to the visitors. "What was completely amazing is he would then somehow get them interested in something, give them something to do," Katz explained. "But with, it seemed to me, a kind of amazing insight into what was a good problem to give to that particular person to think about. And he was somehow mathematically incredibly charismatic, so that it seemed like people felt it was almost a privilege to be asked to do something that was part of Grothendieck's long range vision of the future."

Barry Mazur of Harvard University still remembers today the question that Grothendieck posed to him in one of their first conversations at the IHÉS in the early 1960s, a question that Gerard Washnitzer had originally asked Grothendieck. The question: Can an algebraic variety defined over a field give topologically different manifolds by two different embeddings of the field into the complex numbers? Serre had given some early examples
showing that the two manifolds could be different, and Mazur went on to do some work in homotopy theory with Artin that was inspired by this question. But at the time Grothendieck posed it, Mazur was a dedicated differential topologist, and such a question would not have occurred to him. "For [Grothendieck], it was a natural question," Mazur said. "But for me, it was precisely the right kind of motivation to get me to begin to think about algebra." Grothendieck had a real talent for "matching people with open problems. He would size you up and pose a problem that would be just the thing to illuminate the world for you. It's a mode of perceptiveness that's quite wonderful, and rare."

In addition to work with students and colleagues at the IHÉS, Grothendieck maintained correspondence with a large number of mathematicians outside Paris, some of whom were working on parts of his program in other places. For example, Robin Hartshorne of the University of California at Berkeley was at Harvard in 1961 and got the idea for his thesis topic, concerning Hilbert schemes, from Grothendieck's lectures there. Once the thesis was done, Hartshorne sent a copy to Grothendieck, who was by then back in Paris. In a reply dated September 17, 1962, Grothendieck made some brief positive remarks about the thesis. "The next three or four pages [of the letter] are all of his ideas about further theorems that I might be able to develop and other things that one might like to know about the subject," Hartshorne said. Some of the things the letter suggested are "impossibly difficult," he noted; others show a remarkable prescience. After this outpouring of ideas, Grothendieck returned to the thesis and offered three pages of detailed comments.

In his 1958 talk at the Edinburgh Congress, Grothendieck had outlined his ideas for a theory of duality, but because he was busy with other topics in his IHÉS seminar, it did not get treated there. So Hartshorne offered to give a seminar on duality at Harvard and write up the notes. Over the summer of 1963, Grothendieck fed Hartshorne about 250 pages of "pre-notes" that formed the basis for the seminar, which Hartshorne began in the fall of 1963. Questions from the audience helped Hartshorne to develop and refine the theory, which he began to write up in a systematic fashion. He would send each chapter to Grothendieck to critique. "It would come back covered with red ink all over," Hartshorne recalled. "So I'd fix everything he said, and then I would send him the new version. And it would come back again covered with more red ink." After realizing that this was a potentially endless process, Hartshorne decided one day to send the manuscript off to be published; it appeared in the Springer Lecture Notes series in 1966 [Hartshorne].

Grothendieck "had so many ideas that he kept basically all the serious people working in algebraic geometry in the world busy during that time," Hartshorne observed. How did he keep such an enterprise going? "I don't think there is a simple answer," Artin replied. But certainly Grothendieck's energy and breadth were factors. "He was very dynamic, and he did cover a lot of territory," Artin said. "One thing that was remarkable was that he had complete control of the field, which was not inhabited by slouches, for a period of 12 years or so."

During his IHÉS years, Grothendieck's devotion to mathematics was total. His tremendous energy and capacity for work, combined with a tenacious fidelity to his internal vision, produced a flood of ideas that swept many into its currents. He did not shrink from the daunting program he had set for himself, but plunged straight in, taking on tasks great and small. "His mathematical agenda was much more than any single human being could do," Bass commented. He parceled out much of the work to his students and collaborators, while also taking on a great deal himself. What motivated him, as he explained in Récoltes et Semailles, was simply the desire to understand, and indeed those who knew him then confirm that he was not propelled by any sense of competition. "At the time, there was never a thought of proving something before somebody else," Serre explained. And in any case, "he could not be in competition with anybody, in a sense, because he wanted to do things his own way, and essentially nobody else wanted to do the same. It was too much work."

The dominance of the Grothendieck school had some detrimental effects. Even Grothendieck's distinguished IHÉS colleague, René Thom, felt the pressure. In [Fields], Thom wrote that his relations with Grothendieck were "less agreeable" than with his other IHÉS colleagues. "His technical superiority was crushing," Thom wrote. "His seminar attracted the whole of Parisian mathematics, whereas I had nothing new to offer. That made me leave the strictly mathematical world and tackle more general notions, like morphogenesis, a subject which interested me more and led me towards a very general form of 'philosophical' biology."

In the historical remarks that appear at the end of his 1988 textbook Undergraduate Algebraic Geometry, Miles Reid wrote: "[T]he Grothendieck personality cult had serious side effects: many people who had devoted a large part of their lives to mastering Weil foundations suffered rejection and humiliation. ...[A] whole generation of students (mainly French) got themselves brainwashed into the foolish belief that a problem that can't be dressed up in high-powered abstract formalism is unworthy of study." Such "brainwashing" was perhaps an inevitable by-product of the fashions of the
times, though Grothendieck himself never pursued abstraction for abstraction's sake. Reid also noted that, apart from the small number of students of Grothendieck who could "take the pace and survive," the people who benefited most from his ideas were those influenced at a distance, particularly American, Japanese, and Russian mathematicians. Pierre Cartier sees Grothendieck's heritage in the work of such Russian mathematicians as Vladimir Drinfeld, Maxim Kontsevich, Yuri Manin, and Vladimir Voevodsky. Said Cartier, "They capture the true spirit of Grothendieck, but they are able to combine it with other things."

Photographs used in this article are courtesy of Friedrich Hirzebruch, Karin Tate, and the website of the Grothendieck Circle (http://www. grothendieck-circle.org).

The second part of this article will appear in the next issue of the Notices.

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# Math through the Ages: A Gentle History for Teachers and Others 

Reviewed by Philip C. Curtis Jr.

## Math through the Ages: A Gentle History for Teachers and Others <br> William Berlinghoff and Fernando Gouvêa <br> Oxton House Publishers, 2002 <br> Paperback, 224 pages, $\$ 19.95$ <br> ISBN 188-1929-213

The state of school mathematics education in the United States and the training of school mathematics teachers both have been of constant interest to the professional mathematics community in recent years. The content of school mathematics has changed dramatically. An emphasis on discrete mathematics, probability, and statistics has emerged that was completely absent not long ago. Beginning algebra has often been moved to the eighth grade, and single variable calculus is the acknowledged goal in the 12th grade. Computers and sophisticated handheld graphing calculators have greatly enlarged the scope and type of problems that can be considered.

This change in content and emphasis has great implications for the training of elementary and high school teachers. It has been long acknowledged that prospective elementary school teachers need much more than just the mathematics they learned in school to be effective teachers. A mathematics major or the equivalent is recommended, and in many cases required, for high school teachers. However, recent studies have shown that more

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than advanced course work is necessary if the teaching is to be effective.

The report of the Conference Board of the Mathematical Sciences, The Mathematical Education of Teachers, published in 2001, makes this quite explicit: "Prospective teachers need mathematics courses that develop a deep understanding of the mathematics they will teach." At the high school level, the report recommends "Prospective high school teachers of mathematics should be required to complete the equivalent of an undergraduate major in mathematics that includes a 6-hour capstone course connecting their college mathematics courses with high school mathematics." This course should bring together all the strands of school mathematics, algebra, number theory, geometry, analysis, and probability and statistics, considering the basic ideas involved from an advanced standpoint, and "explicitly tracing the historical development of key ideas, identifying questions that were challenging for mathematicians and will be difficult for students."

The book under review, Math through the Ages, by William Berlinghoff and Fernando Gouvêa, satisfies this objective brilliantly. The authors first give
a gentle history or, as they put it, a "History of Mathematics in a Large Nutshell," which covers the development of mathematics from its earliest days to the present, emphasizing the development of fundamental ideas that are central to school mathematics.

This account begins with a discussion of the type of measurement problems considered in ancient Egypt and the Near East. This is followed by a brief discussion of Greek, Indian, and Arabic contributions that then stimulated development in medieval Europe. Progress in algebra and geometry during the fifteenth and sixteenth centuries leads to the development of the calculus and applications during the seventeenth and eighteenth centuries. A rigorous foundation for analysis was developed in the nineteenth century. The history concludes with a brief discussion of modern mathematics and the role played by technology. The discussion is low key, and the mathematical demands on the reader are minimal. It provides an appropriate overview of mathematics that ideally should be in the background of mathematics teachers at all levels.

This is followed by twenty-five detailed historical sketches of how various mathematical ideas developed, each with examples and problems to illustrate how the ideas emerged. These begin with a discussion of arithmetic, the writing of numbers and the various symbols used, fractions, negative numbers, the decimal system, and the concept of zero. It may come as a surprise to the reader that the standard technique of solving polynomial equations by factoring and setting each factor equal to zero was a revolutionary step when it was first proposed by Thomas Harriot in the seventeenth century. An important thread in the discussion is the simplification of notation and the emergence of the Hindu-Arabic number system based on powers of ten.

Following a discussion of plane and coordinate geometry, there are projects devoted to the development of probability and statistics. The discussion ends with projects devoted to computers and the concept of infinity. Each sketch contains wellchosen suggestions for further reading. The bibliography at the end is a marvel, containing a very extensive selection of historical references both recent and older.

Each of the sketches is designed to illuminate the historical development of the ideas in such a way as to deepen the reader's understanding of the mathematics involved. The exercises accomplish this objective admirably both from the point of view of a prospective or practicing teacher and, in many cases, from the point of view of a student struggling to understand the material for the first time.

As an example, young students often have difficulty with the concept of negative numbers when
they first meet them. I remember conversations with my granddaughter, then in the sixth grade, who was convinced that negative numbers just did not exist. It is important for the teacher to be aware that mathematicians in the fifteenth and sixteenth centuries had the same problem. As the authors point out in the sketch on negative numbers, mathematicians could manipulate with negative numbers well before they were clear about the concept. It was not until the middle of the nineteenth century that negative numbers were completely accepted. It also took a long time for mathematicians to be comfortable with the statement that Cardano's solution to the cubic equation

$$
x^{3}-15 x-4=0
$$

was

$$
x=\sqrt[3]{2+\sqrt{-121}}+\sqrt[3]{2-\sqrt{-121}}
$$

and that this was indeed $x=4$. It wasn't until Gauss, Argand, and Hamilton in the nineteenth century showed how complex numbers could be represented as points in the plane and how the arithmetic operations could be interpreted that mathematicians completely accepted complex numbers. For teachers to have a deep understanding of complex numbers, this historical background would seem to be essential.

Another example concerns the discussion of the quadratic formula. In many introductory textbooks, this formula is introduced directly following a discussion of factoring of quadratic polynomials. Such an approach often leaves students completely at sea and encourages them just to memorize the formula and not to understand why it works. Historically, a geometric illustration of the process of completing the square always accompanied a verbal description of the technique of solving the equation. This began with Al-Khwarizmi in the ninth century and was standard in the discussion of quadratic equations for hundreds of years. It should also be well known to all algebra teachers today.

Probability and statistics and dealing with data is another area in which knowledge of the historical development of the subject can be very useful. Elementary probability is now introduced in the middle grades, and students are encouraged to conduct experiments with real data and draw conclusions. None of this was in the curriculum a generation ago. What were the problems that gave rise to the study of probability? The discussion of the Chevalier de Méré's problem of points by Pascal and Fermat is no doubt unfamiliar to most teachers. However, it provides an illuminating introduction to the study of games of chance. Statistics had its origins in the analysis by John Graunt of weekly burial records in London in the beginning of the
seventeenth century. What questions did he ask, and how reliable were his answers?

That mathematics is a vital and growing creative enterprise is important for all teachers to know. The discussion of Andrew Wiles's solution to Fermat's Last Theorem is especially pertinent. What are some other elementary problems that are easy to state but seem to be very difficult to solve? The direction of modern mathematics, the development of computer technology, and its impact on mathematics are all made accessible to the teacher via the historical discussion and associated sketches and problems contained in Math through the Ages.

This book has a role to play in the mathematics education of prospective teachers at all levels. For teachers in the elementary and middle grades, the sketches dealing with arithmetic and the introduction to algebra and geometry should be part of the course offerings provided by mathematics departments for these students. For mathematics majors contemplating high school teaching, this book would form an ideal base for the recommended capstone course at the senior level. The standard major designed to prepare students for graduate school or careers using mathematics does not in general provide an in-depth look at these more elementary ideas. In fact, such a course would be useful for all math majors.

Practicing teachers, just as much as new teachers, need an in-depth understanding and historical perspective of the mathematics they teach. Thus this book has an important role to play in the in-service courses provided to practicing teachers. Even if the training of new teachers were ideal, the rate of replacement of retiring teachers by fully trained new teachers is painfully slow. In California, for example, in 2002 it was projected that 2,131 new mathematics teachers were to be hired for 2003-2004. However, the number of mathematics teaching credentials awarded to holders of undergraduate degrees in mathematics was only 422. That year there were 1,389 bachelor's degrees in mathematics awarded in California. The need for the insight provided by Math through the Ages and similar books will be with us for a long time.

The authors invite readers to make suggestions for additional sketches to be added to later editions. I would like to see a sketch devoted to a discussion of the well-ordering principle of the positive integers and the principle of mathematical induction. The applications of induction are of course well known. That every nonempty collection of positive integers has a smallest member is the fundamental assumption implying that every positive integer is either prime or has a prime divisor, and therefore there are infinitely many primes. It is implicit in the geometric proof of the irrationality of the square root of 2 . In the essay, "Irrational
numbers", Dedekind uses it explicitly in his short proof of the irrationality of square roots of integers that are not perfect squares (c.f. James R. Newman, The World of Mathematics, vol. 1, p. 531).

Math through the Ages is both clearly and accurately written and is a joy to read. The exercises, an important tool in developing the ideas, are well chosen and often quite thought-provoking. The only historical inaccuracy that I uncovered was the listing of Niels Henrik Abel as Danish rather than Norwegian (p. 50). This book should have considerable impact on the mathematical education of teachers. I hope that it does.

# a Topos? 

Luc Illusie

## Basic Examples

In the early 1960s Grothendieck chose the Greek word topos (which means "place") to denote a mathematical object that would provide a general framework for his theory of étale cohomology and other variants related to his philosophy of descent. Even if you do not know what a topos is, you have surely come across some of them. Here are two examples:
(a) The category of sheaves of sets on a topological space is a topos. In particular, the category of sets is a topos, for it is the category of sheaves of sets on the one point space. This topos, denoted $\{p t\}$, is called the punctual topos.
(b) Let $G$ be a group. The category $B G$ of $G$-sets, i. e., sets equipped with a left action of $G$, is a topos. For $G=\{1\}, B G=\{p t\}$.

What these categories have in common is that (i) they behave very much like the category of sets, and (ii) they possess a good notion of localization. In order to formalize (ii), Grothendieck conceived the idea of sheaf on a site, which generalizes the notion of sheaf on a topological space. That led him to the notion of topos, which encompasses (i) and (ii).

## Sites and Toposes

Consider the category $C$ of open subsets of a topological space $X$ (the morphisms being the inclusions of open subsets). A sheaf of sets $E$ on $X$ is a contravariant functor $U \mapsto E(U)$ on $C$ (with values in the category of sets) having the property that for any open cover $\left(U_{i}\right)_{i \in I}$ of $U$, a section $s$ of $E$ on $U$, i. e., an element of $E(U)$, can be identified via the

[^12]restriction maps with a family of sections $s_{i}$ of $E$ on the $U_{i}$ 's which coincide on the intersections $U_{i} \cap U_{j}$. Now, let $C$ be a category having finite projective limits. To give a topology (sometimes called a Grothendieck topology) on $C$ means to specify, for each object $U$ of $C$, families of maps $\left(U_{i} \rightarrow U\right)_{i \in I}$, called covering families, enjoying properties analogous to those of open covers of an open subset of a topological space, such as stability under base change and composition (see [SGA 4 II 1.3] for a precise definition). Once a topology has been chosen on $C, C$ is called a site, and one can define a sheaf of sets on $C$ in the same way as in the case in which $C$ is the category of open subsets of a topological space: a sheaf of sets $E$ on $C$ is a contravariant functor $U \mapsto E(U)$ on $C$ (with values in the category of sets) having the property that for any covering family $\left(U_{i} \rightarrow U\right)_{i \in I}$, a section $s$ of $E$ on $U$, i. e., an element of $E(U)$, can be identified via the "restriction" maps with a family of sections $s_{i}$ of $E$ on the $U_{i}$ 's that coincide on the "intersections" $U_{i} \times_{U} U_{j}$.

A topos $T$ is a category equivalent to the category of sheaves of sets on a site $C$ (which is then called a defining site for $T$ ). Here are some properties of toposes :
(1) A topos $T$ admits finite projective limits: in particular, it has a final object, and it admits fibered products.
(2) If $\left(U_{i}\right)_{i \in I}$ is a family of objects of $T$, the sum $\coprod_{i \in I} U_{i}$ exists, is "disjoint", and commutes with base change.
(3) Quotients by equivalence relations exist and have the same good properties as in the category of sets.

A theorem of Giraud [SGA 4 IV 1.2] asserts that the converse is essentially true. Namely, if $T$ is a category satisfying (1), (2), (3), and if moreover $T$
satisfies a certain technical "smallness" condition, then $T$ is a topos.

Several unequivalent sites may give rise to the same topos, as the case of $\{p t\}$ already shows : both the one point space and the category of sets, equipped with the topology defined by surjective families, are defining sites. Grothendieck liked to compare this with the fact that a group can be defined by generators and relations in many different ways. The site is some kind of system of generators and relations for the topos. And in the same way in which a group $G$ can be defined by a set of generators that is $G$ itself, a topos $T$ can be defined by a site whose underlying category is $T$ itself. Covering families are just epimorphic families. This topology is called the canonical topology. In the case of $B G$, the canonical topology is the topology defined by surjective families of $G$-maps.

## Morphisms, Points, Cohomology

A continuous map of topological spaces $f: X \rightarrow Y$ defines a pair of adjoint functors $\left(f^{*}, f_{*}\right)$ between the categories of sheaves of sets on $X$ and $Y$. The inverse image functor $f^{*}$ commutes (as a left adjoint) with inductive limits. It also commutes with finite projective limits. Now, if $X, Y$ are toposes, one defines a morphismf: $X \rightarrow Y$ as a pair of adjoint functors ( $f^{*}: Y \rightarrow X, f_{*}: X \rightarrow Y$ ) such that $f^{*}$ commutes with finite projective limits. If $T$ is a topos, up to a unique isomorphism of functors, there is only one morphism from $T$ to the punctual topos $\{p t\}$. On the other hand, a point of $T$ is by definition a morphism from $\{p t\}$ to $T$. If $T$ is defined by a topological space $X$, a (usual) point $x$ of $X$ defines a point of $T$, whose inverse image functor is the stalk functor $E \rightarrow E_{x}$. But new phenomena occur. Deligne has constructed examples of toposes without points (he has also given criteria for the existence of "enough points") [SGA 4 IV 7, VI 9]. Moreover, if $x$ and $y$ are points of a topos $T$, there may exist nontrivial morphisms (of functors) from $x$ to $y$. In the case of $B G$, for example, the forgetful functor from $B G$ to $\{p t\}$ is the inverse image functor by a point of $B G$, whose group of automorphisms is $G$ itself! This observation is at the root of Grothendieck's theory of the fundamental group in algebraic geometry. If $X$ is a topological space and $P$ is a $G$-torsor on $X$ (i. e., a principal $G$-cover of $X$ ), then twisting a $G$-set $E$ by $P$ (i. e., forming the corresponding fiber space with fiber $E$ over $X$ ) is the inverse image functor by a morphism $f_{P}: X \rightarrow B G$, and $P \mapsto f_{P}$ establishes a bijective correspondence between isomorphism classes of $G$-torsors on $X$ and morphisms from $X$ to $B G$. Thus $B G$ plays the role of a classifying space.

If $T$ is a topos, the direct image functor for the unique morphism $T \rightarrow\{p t\}$ associates to an object $E$ of $T$ the set of its "global sections" $\Gamma(T, E)=\operatorname{Hom}(e, E)$, where $e$ is the final object of $T$. The category of abelian group objects of $T$
admits enough injectives, and one can consider the derived functor of $\Gamma(T,-)$. This yields a common generalization of sheaf cohomology on topological spaces and group cohomology (the functor $\Gamma(B G,-)$ is "taking the invariants under $G$ ").
Toposes Arising from Algebraic Geometry
The most important example, which was the main motivation for Grothendieck and which is also the closest to geometric intuition, is the étale topos of a scheme $X$. It is the topos of sheaves on the étale site $X_{e t}$ of $X$. The underlying category of $X_{e t}$ is the category of schemes $Y$ étale over $X$ (i. e., étale morphisms $Y \rightarrow X$ ). Étale morphisms are the analogs, in algebraic geometry, of morphisms of complex analytic spaces that are analytically local isomorphisms. Covering families of $X_{\text {et }}$ are surjective families $\left(Y_{i} \rightarrow Y\right)_{i \in I}$ of (étale) $X$-schemes. When $X$ is the spectrum of a field $k$ with absolute Galois group $G$, the étale topos of $X$ is a variant of $B G$, namely the category of (discrete) sets endowed with a continuous action of $G$; cohomology in this case is the Galois cohomology of $k$. It is a miracle that the consideration of the cohomology of étale toposes with values in $\mathbb{Z} / n$, with $n$ prime to the characteristics, has given rise to a Weil cohomology and, eventually, to the proof of the Weil conjectures, by Grothendieck and Deligne [D]. Variants of the étale topology, such as the so-called fppf topology, play an important role in certain moduli problems (Hilbert and Picard schemes, etc.) and also in the theory of group schemes and arithmetic applications.

Another interesting example is the crystalline topos, constructed by Grothendieck and Berthelot, which is crucial in differential calculus and the study of de Rham cohomology in positive or mixed characteristic. The comparison between crystalline cohomology and $p$-adic étale cohomology, sometimes called $p$-adic Hodge theory [P], is closely related to deep problems in arithmetic geometry.

Finally, let me mention that, in the wake of pioneering work of Lawvere in the late 1960s, a variant of the notion of topos, called elementary topos, has been extensively used in logic for the past thirty years.

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# The BKPS Letter of 1962: The History of a "New Math" Episode 

David Lindsay Roberts

In 1999, a group of research mathematicians organized an open letter to then Secretary of Education Richard Riley, which was published in the Washington Post that November. In recalling this event in his article "Research mathematicians and mathematics education: A critique" [1], Anthony Ralston makes favorable mention of a letter on mathematics education published by a group of mathematicians in 1962.

However, it is doubtful that this letter proves something positive about the educational acumen of mathematicians or even demonstrates that the signers, aside from a small minority, knew what they were writing about. I base this statement primarily on my historical research in the records of the School Mathematics Study Group, held in the Archives of American Mathematics (AAM) at the University of Texas at Austin, supplemented by oral history interviews I have been conducting, also held at the AAM. I describe this evidence below, with the thought that reviewing this earlier foray of research mathematicians into the public discussion of school mathematics may be useful background for similar events, such as the Riley letter, of our own time.

The 1962 letter, titled "On the mathematics curriculum of the high school", was published in both The Mathematics Teacher (March 1962, pp. 191-195) and the American Mathematical Monthly (May 1962, pp. 189-193). This was at a time when there was considerable debate surrounding the

[^13]introduction of new school curriculum programs, often referred to as the "New Math." The largest of these programs was the School Mathematics Study Group (SMSG), founded in 1958 under the leadership of Edward Begle of the Yale University mathematics department. In 1961 Begle and SMSG moved to the School of Education at Stanford University.

The records of SMSG contain correspondence suggesting that the original letter was being circulated among mathematicians by the fall of 1961. (The letter as eventually published asserted that it was "sent to 75 mathematicians in the United States and Canada", but the number of signers listed was in fact 64.) Begle obtained a copy from the editor of the Monthly and began asking SMSG members and others for advice on how to respond. Almost all of this correspondence referred to the "Bers, Kline, Pólya, Schiffer" article or letter, strongly suggesting that the primary authors were Lipman Bers and Morris Kline of New York University and George Pólya and Max Schiffer of Stanford. (Hereafter I will refer to the BKPS letter.) This attribution of authorship is confirmed by a letter from Pólya to his former student Paul Rosenbloom, an SMSG stalwart then at the University of Minnesota. Begle himself asserted the BKPS authorship in his published reply "Some remarks on 'On the mathematics curriculum of the high school"' (The Mathematics Teacher, March 1962, pp. 195-196; American Mathematical Monthly, May 1962, pp. 425-426). Most of Begle's correspondents attributed the primary authorship to Morris Kline, hiding behind an alphabetic smokescreen. There seems little reason to doubt that

Kline was the main instigator. He had been vocal on education matters since the mid-1950s and by 1961 was publicly criticizing SMSG and other new programs. Kline later reprinted the BKPS letter in his book of 1973, Why Johnny Can't Add: The Failure of the New Math.

The BKPS letter, in between prefatory and concluding remarks, described guidelines for judging mathematics curricula. It warned against focusing the curriculum too exclusively on future mathematicians, urged that abstract concepts be built on concrete examples, and recommended greater attention to connecting mathematics with science. Begle and his allies were in full agreement with all of this. One correspondent reported that University of Wisconsin mathematician R. Creighton Buck (occasional SMSG contributor and signer of the BKPS letter) "hoped that lots of SMSG people would climb on the bandwagon and sign the manifesto in hopes of pulling Kline's teeth." At least one other SMSG participant, Henry Pollak of the Bell Telephone Laboratories, did sign the BKPS letter precisely in order to assert his belief that SMSG was developing its materials in accordance with the letter's guidelines (1998 interview with me). The only recommendation of the BKPS letter about which Begle quibbled in his response was the "genetic principle", by which BKPS suggested that "The best way to guide the mental development of the individual is to let him retrace the mental development of the race." This would, noted Begle, seemingly "deny to our students the efficiency of using algebra in the first course in geometry."

It was not primarily the substance of the BKPS letter that bothered Begle and many SMSG supporters but rather some of the rhetorical scaffolding, especially one sentence near the end: "We cannot enter here into detailed analysis of the proposed new curricula, but we cannot leave unsaid that, in judging them on the basis of the guidelines stated above (Sections 1-5), we find points with which we cannot agree." Neither SMSG nor any other program was mentioned by name in the BKPS letter, but in view of Kline's previous writings and speeches, Begle felt that his program was being subjected to invidious, and highly nonconstructive, criticism.

Begle's response was to endeavor to elicit constructive comments from the BKPS signers. To this end he prepared a form letter and brief questionnaire, which he apparently sent to most if not all these individuals. He asked them to comment specifically on the strengths and weaknesses of SMSG materials with regard to the BKPS guidelines and also asked if they might be willing to devote some time to helping SMSG prepare a course "closely articulating mathematics and science at about the ninth grade level." In accordance with
good survey practices, he enclosed a return envelope.

The SMSG collection in Austin contains replies by twenty-four of the BKPS signers. A representative response was that of Harvard's Lars Ahlfors (who, by alphabetic accident, is often listed as author of BKPS): "The presence of my signature under the article which appeared in the Monthly does not mean that I am ready to make further comments which I fear would be rather amateurish."

Exactly one response evinced substantial knowledge of SMSG materials. This was from Harold Bacon of the Stanford University mathematics department, a man who had been devoting his professional attention for many years primarily to teaching issues. Another five responders claimed to have some knowledge of SMSG but provided minimal specific commentary, while expressing generally positive views of SMSG. For example, Richard Brauer of Harvard commented that "I never connected the trends which I do not like with SMSG." He was vague about these undesirable trends, as were the rest of this group, although one responder accused Max Beberman of the University of Illinois of advocating "dangerous extremes." The remaining eighteen responders either explicitly admitted having little or no knowledge of SMSG or strongly implied lack of such knowledge by failure to respond to any of Begle's questions, although several expressed a willingness to look over the materials at some future date. Eight of the responders said they were too busy with research to make any further contribution, and this seems implied by several of the others. Only one cited teaching responsibilities as preventing him from responding more fully.

Begle's files also contain critical comments on SMSG by four BKPS signers who were not included among the respondents to the questionnaire. Of these, only the critique by Kline's NYU colleague Peter Lax provides unequivocal evidence of conscientious close reading of SMSG materials.

It may be that a large proportion of the remaining signers of the BKPS letter who did not respond to Begle's questionnaire held well-formulated views on SMSG that they nevertheless failed to convey to Begle, but I know of no evidence to support this supposition.

I conclude that the BKPS letter was instigated by a small group of mathematicians with strong views on mathematics education who enlisted the aid of a larger group of mathematicians, many of whom had little if any knowledge of the issues under discussion, nor any inclination to become more deeply involved.

## References

[1] Anthony Ralston, Research mathematics and mathematics education: A critique, Notices 51 (2004), 403-411.

# Oberwolfach Celebrates Its Sixtieth Anniversary 

On the intermittently sunny and rainy afternoon of July 2, 2004, before an audience of about seventy people, Mozart's quintet for clarinet, two violins, viola, and cello (K. 581) floated through the lecture room of the Mathematisches Forschungsin-


Musicians at Oberwolfach celebration, left to right: Wolfgang Soergerl (violin, with back to camera), Volker Puppe (violin), A. Conrad (viola), and D. Müllner (clarinet). stitut Oberwolfach. The tune, at once celestial and bucolic, seemed to capture the spirit of this institute nestled in the Black Forest of Germany and to provide a fitting opening for its sixtieth anniversary celebration. The musicians knew well what they were celebrating: four out of the quintet are mathematicians, and one of them, Matthias Kreck of the Universität Heidelberg, is a former director of Oberwolfach. It was a warm and festive occasion, but not entirely lighthearted, as many at the event discussed the serious business of Oberwolfach's recent decision to change the basis on which it has been funded for its sixty years of existence.

Founded in 1944 in the final days of World War II, the institute was originally intended to
support the Nazi war effort, but it never played such a role. In fact, in the years immediately following the war, Oberwolfach became a place where German mathematicians and colleagues from other countries could reestablish ties broken during the war. Since then, the institute's rise as one of the world's major meeting points for mathematics has made the
 tiny, placid, Black Forest village of Oberwolfach a household word among mathematicians. Within Germany, Oberwolfach plays a critical role in providing many young German mathematicians with their first taste of international collaboration.

A large part of the


Martin Barner, above, and Günther Wildenhain, below. success of Oberwolfach can be attributed to the vision of Martin Barner, who served as director from 1963 to 1994 and built the institute into a world center for mathematics. Barner also kept up the Oberwolfach tradition of reaching across national barriers: one of the speakers during the celebration, Günther Wildenhain of the

Universität Rostock, president of the Deutsche Mathematiker Vereinigung (German Mathematical Society), noted that in the years of the "iron curtain" Barner made efforts to bring mathematicians from East Germany to Oberwolfach. Now eightythree years old and retired, Barner attended the anniversary celebration. His successor, Matthias Kreck, who played the cello in the quintet, served as di-


David Eisenbud, left, and Manuel Castellet, right.
rector from 1994 until 2002, when the current director, Gert-Martin Greuel of the Universität Kaiserslautern, took up the reins.

The basic idea of Oberwolfach is simple: to hold meetings in a wide range of mathematical areas in a peaceful setting with minimal distractions. Each year the institute holds about fifty week-long meetings that attract a total of around twenty-five hundred mathematicians. There are also activities for smaller groups, such as "Research in Pairs" and the longstanding Arbeitsgemeinschaft (work team), in which nonexperts work together to become familiar with a particular mathematical topic. Once a year Oberwolfach hosts a small program for mathematics teachers, but otherwise it trains its sights exclusively on fostering mathematical research.

Among the speakers at the anniversary celebration were three other directors of mathematics institutes: Jean-Pierre Bourguignon of the Institut des Hautes Études Scientifiques outside Paris, AMS president David Eisenbud of the Mathematical Sciences Research Institute in Berkeley, and Manuel Castellet of the Centre de Recerca Matemàtica in Barcelona. As the main speaker at the anniversary event, Bourguignon presented a lecture, in German, about some of the highlights of Oberwolfach's history and its place among institutes in the world. He delivered greetings from Henri Cartan, who celebrated his one-hundredth birthday one week after the Oberwolfach anniversary. Cartan, who first visited Oberwolfach in 1946, did a great deal to rebuild links between French and German
mathematicians after the war. Castellet spoke on behalf of the European Mathematical Society (EMS) and read a message from the EMS president, Sir John Kingman, who noted the role that Oberwolfach plays as "a symbol of European mathematics and a potent force for the development of mathematical research."

Among the other speakers at the anniversary celebration were representatives of funders of Oberwolfach, including the state of Baden-Württemberg, which provides most of


Oberwolfach Prize winner Paul Biràn. the money, and the Volkswagen Foundation, which paid for the construction of the Oberwolfach buildings in the 1960s and 1970s and has been an important source of funding ever since. Heinz Gumin, director of the Carl Friedrich von Siemens Stiftung, spoke on behalf of this foundation, which has supported the Oberwolfach library, as well as on behalf of the Oberwolfach Stiftung, which is building an endowment specifically to support the institute. The Oberwolfach Stiftung provides the 5,000-euro (about US $\$ 6,000$ ) award for the Oberwolfach Prize, which was presented during the celebration to Paul Biràn of Tel Aviv University. In a brief lecture, Mina Teicher of Bar-Ilan University described some of Biràn's work, which is in symplectic geometry, particularly symplectic packing and decomposition


## Left to right: Jean-Pierre Bourguignon, Heinz Gumin, Paul Biràn, Mina Teicher, and GertMartin Greuel.

of symplectic manifolds. Teicher mentioned that, just a few days before, Biran had also received an EMS Prize at the European Congress of Mathematicians.

Amid the celebratory music, the congratulations, and the laudatory words about the success
of Oberwolfach, a more equivocal note was struck concerning its long-term funding. Oberwolfach had recently finalized negotiations to enter the Leibniz Gemeinschaft, also known as the "blue list" of institutes in Germany. The Leibniz Gemeinschaft is an association of approximately eighty non-university-based institutes that receive funding from the federal government and from the states in which the institutes are located. Apart from Oberwolfach, there is only one other mathematics institute in the Leibniz Gemeinschaft, the Weierstrass Institute for Applied Analysis and Stochastics in Berlin, which is quite different from Oberwolfach. In fact, Oberwolfach does not really resemble any of the Leibniz institutes, most of


Guests enjoying dinner at the anniversary celebration. On the left is Friedrich Hirzebruch. which have permanent research staffs and are much larger.

Since its founding, Oberwolfach has received most of its funding from its home state of Baden-Württemberg. The institute is run not by the state but by a private organization of mathematicians called the Gesellschaft für Mathematische Forschung (Society for Mathematical Research). The state funds have never dried up, but neither have they been secure from year to year. Baden-Württemberg funds Oberwolfach out of a sense of tradition; the state has no law stipulating that these funds must be paid nor does it have an established funding program to which the institute applies for support. States in Germany have been under increasing financial strain for some years now, so it could be risky to continue to rely on Baden-Württemberg's sense of obligation toward the institute.

The advantage of becoming a Leibniz institute is that doing so would provide Oberwolfach with a more stable funding base. The disadvantage is that Oberwolfach may have to give up some of the autonomy and freedom it now enjoys as a private institute in order to adhere to the rules of the Leibniz Gemeinschaft. Entering the Leibniz Gemeinschaft entails more bureaucracy, of which Oberwolfach has already gotten a taste. Not knowing quite how Oberwolfach would fit in, the Leibniz Gemeinschaft initially wanted to categorize it as a "service institute". The Leibniz service institutes are typically libraries or other archives, or facilities that provide access to specimens or instrumentation for research. According to Greuel, it took some doing to convince the Leibniz Gemeinschaft that

Oberwolfach is not a service institute, because research is actually conducted at Oberwolfach. In the end this point was resolved, and Oberwolfach will enter the Leibniz Gemeinschaft next year, with funding to start in 2006. Greuel was optimistic that the change would improve the stability of Oberwolfach's funding but noted that vigilance would be needed to ensure that the institute preserves its unique character.

In his remarks during the celebration, Gumin pointed to a bright spot in Oberwolfach's finances: since its founding in 1997, the Oberwolfach Stiftung has raised 1 million euros (about US $\$ 1.2$ million) for its endowment, called the Horst Tietz Fund. This is no small feat, as Germany has not developed the tradition of individual charitable donations that one finds, for example, in the United States, where such donations bring greater tax breaks. In addition to individual contributions, the endowment also received donations from the insurance company allianz and the publisher Springer-Verlag. In addition, the U.S.-based Preuss Foundation provides one-toone matching of individual contributions to the endowment. The Preuss Foundation was established by Peter Preuss, a German mathematician who founded a profitable software company in the United States. The Oberwolfach Förderverein (Friends of Oberwolfach) also raises money for the institute through annual membership dues from its approximately 650 members.

The anniversary celebration was an occasion for many of the attendees to look back on what Oberwolfach meant to them personally. In his remarks during the celebration, Eisenbud remembered that he first came to Oberwolfach in 1971 as a fresh Ph.D. He encountered leaders in the field whom he had heard of but never met and established ties with people who later became close colleagues and collaborators. Since then he has returned to Oberwolfach about once a year and now considers himself an "old-timer". Behind the calm appearance of Oberwolfach run the strong dynamics of mathematical research, he noted, and the simplicity and serenity of the place gives mathematicians the security they need to pursue their passion. One time when he arrived for a visit at Oberwolfach, a colleague greeted him with the words, "Welcome to heaven." As Eisenbud put it, "This is a feeling many mathematicians share of this charmed place."
-Allyn Jackson

# ChernReceives Shaw Prize 

Shiing-Shen Chern of Nankai University has received the first Shaw Prize in Mathematical Sciences. Awarded by the Shaw Foundation, the prize carries a monetary award of $\$ 1$ million. The prize ceremony took place on September 7, 2004. Chern is honored "for his initiation of the field of global differential geometry and his continued leadership of the field, resulting in beautiful developments that are at the center of contemporary mathematics, with deep connections to topology, algebra, and analysis, in short, to all major branches of mathematics of the last sixty years."

## An Essay on Shiing-shen Chern

The members of the selection committee for the 2004 Shaw Prize in Mathematical Sciences are: Jean-Pierre Bourguignon, Institut des Hautes Études Scientifiques; Phillip A. Griffiths, Institute for Advanced Study, Princeton; Chang-shou Lin, Taiwan National Chung Cheng University; Wentsun Wu, Chinese Academy of Sciences (chairman); and Le Yang, Chinese Academy of Sciences. What follows is an essay about Chern, written by the selection committee.

Shiing-shen Chern is the foremost geometer of our time. His mathematical work, centering on geometry and spanning almost seven decades, has shaped large areas of modern mathematics. More than any other mathematician, he defined the subject of global differential geometry, one of the central areas in contemporary mathematics. The depth and originality of his mathematical insight is seen in the many basic concepts of modern mathematics to which his name is attached: Chern classes, the Chern-Weil map, the Chern connection, the Bott-Chern forms, Chern-Moser invariants, and the Chern-Simons invariants.

Chern's talent became apparent early. He completed his undergraduate work at Nankai University and his M.Sc degree work at Tsinghua University. In the 1930s he was sent to Europe, where he studied with Wilhelm Blaschke in Hamburg and Élie

Cartan in Paris. Guided by their influence he wrote, in effect, two theses: one on web geometry and one on the differential invariants of a third-order ordinary differential equation. Both works were published and remain of interest today.

Chern then returned to China to teach at Tsinghua University which during the war had moved to Kunming in southwestern China. After several years in Kunming he made his way out of wartime


Shiing-Shen Chern China and, by a circuitous route via Africa, managed to reach the United States. There Chern began a highly productive stay at the Institute for Advanced Study in Princeton at the invitation of Oswald Veblen and H. Weyl. It was during this period that he gave the first intrinsic proof of the general Gauss-Bonnet formula. In hindsight, one may say that from this proof evolved many fundamental concepts in topology, such as transgression in sphere bundles introduced from a differential geometric perspective. In addition, he began the monumental work that introduced Chern classes and, as a by-product, initiated the subject of Hermitian differential geometry. This work brought to the fore the relationship between differential geometry and topology; it also opened fertile new areas for other mathematicians and remains of central importance to this day.

He completed his work on the Chern classes during a brief return to China after the war. Then he moved to the University of Chicago, where together with Weil and others he helped to establish one of the leading mathematics departments in the world. During this period his work arrived at the center of mathematical life. Through it and his influence on colleagues, Chern guided the field of
differential geometry and led it into interaction with essentially all aspects of geometry, including topology, algebraic geometry, integral geometry, complex geometry, exterior differential systems, global analysis, and partial differential equations.

Chern's contributions typically begin when he engages a specific problem; then, through his geometric insight and computational mastery, he brings it to resolution; eventually his work has been seen to open up productive new areas for other mathematicians to develop. This pattern, which continues to this day, is an extension of the classic tradition of Cartan, supplemented by a deep and far-reaching global perspective.

Two examples, one specific and one general, may serve to illustrate the continuing influence of Chern's mathematical work in the scientific community. One that is of great current interest derives from the Chern-Simons invariants, which inform both theoretical physics and three-dimensional topology. Another is Chern's recognition of the special role that a complex structure plays in differential geometry. Examples of this are evident throughout his work, including the introduction of the Chern classes of holomorphic vector bundles via curvature forms, the study of minimal surfaces and harmonic maps using the conformal structure, Chern's geometrization of complex function theory, and the geometry of CR-structures. Reflecting the pervasive role of the complex structures, the differential geometric properties of complex algebraic varieties are of central importance in modern theoretical physics and in number theory.

At the end of the 1950s Chern moved to the University of California at Berkeley, where he was a professor of mathematics and, in 1980, became founding director of the Mathematical Sciences Research Institute (MSRI). A few years later, he also established a mathematics institute at Nankai University where he had earlier received his undergraduate education. He continued his professional life in Berkeley until five years ago, when he moved to reside at Nankai. Throughout these times he has remained mathematically active, most recently initiating a revitalization of the subject of Finsler geometry.

At Berkeley, as in all his positions of leadership, the influence of Chern as a practitioner of mathematics was matched by his warmth and skill as a teacher and leader. He was always an attentive and generous mentor to younger people. When one of us (Griffiths) first went to Princeton as a graduate student, his advisor sent him to Berkeley in the summer of 1961. Upon his arrival Chern immediately invited him to lunch, initiating a friendship and professional collaboration that continues through the present.

As a welcoming and collaborative friend, Chern likes nothing better than to gather people of all ages
and perspectives to talk about mathematics. He has taken special pleasure in advancing the professional lives of those who have had the opportunity to work with him. He has always been among the first to understand the importance of the work of his colleagues and to bring it to the attention of the wider mathematical community. Chern's former students now populate the mathematics departments of major universities across the US, and his influence is, and has always been, widely felt in China.

The first Shaw Prize is awarded to Professor Chern in recognition of his singular contributions to, and influence on, the mathematical life of our time.

## About the Prize

The Shaw Prize was established under the auspices of Run Run Shaw in November 2002. Shaw was born in China in 1907 and is a native of Ningbo county, Zhejiang province. He joined his brother's film company in China in the 1920s. In the 1950s he founded the film company Shaw Brothers (Hong Kong) Limited in Hong Kong. He has been Executive Chairman of Television Broadcasts Limited in Hong Kong since the 1970s.

The Shaw Prize is an international prize managed and administered by the Shaw Prize Foundation. There are three annual prizes in astronomy, life science and medicine, and mathematical sciences, each bearing a monetary award of US $\$ 1$ million. The purpose of the prize is to honor scientists, regardless of race, nationality, or religious belief, who have achieved significant breakthroughs in academic and scientific research or applications and whose work has resulted in a positive and profound impact on mankind.

Run Run Shaw has also founded two charities, the Sir Run Run Shaw Charitable Trust and the Shaw Foundation Hong Kong, both dedicated to the promotion of education, scientific, and technological research, medical and welfare services, and culture and art.
-From news releases of the Shaw Foundation

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equations (ref: driff2) and (ref: diff2):

$$
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$$

$$
\hat{\sigma}\left(z_{i}\right)=\sqrt{\frac{\sum_{i=1}^{T-1}\left(x_{i+1}^{\Delta}-x_{i}^{\Delta}\right)^{2} K\left(\frac{z_{i}-x_{i}^{\hat{L}}}{h}\right)}{\sum_{t=1}^{T-1} K\left(\frac{z_{i}-x_{i}^{\hat{A}}}{h}\right)} \frac{1}{\Delta}} .
$$

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# Mathematics People 

## Prizes Presented at the European Congress of Mathematicians

The European Mathematical Society (EMS) awarded a number of prizes at the 2004 European Congress of Mathematicians, held in Stockholm, Sweden, 27 June-2 July, 2004. The EMS prizes are awarded every four years in conjunction with the congress in recognition of distinguished contributions in mathematics by young researchers not older than 35 years. The prize carries a cash value of 5,000 euros (about US $\$ 6,000$ ). The names of the awardees, their institutions, and brief descriptions of their work follow.

Franck Barthe, the Institut de Mathématiques Laboratoire de Statistique et Probabilités, Toulouse, France: Barthe pioneered the use of measure-transportation techniques (due to Kantorovich, Brenier, Caffarelli, McCann, and others) in geometric inequalities of harmonic and functional analysis with striking applications to geometry of convex bodies. His major achievement is an inverse form of classical Brascamp-Lieb inequalities. Further contributions include discovery of a functional form of isoperimetric inequalities and a recent solution (with Artstein, Ball, and Naor) of a long-standing Shannon's problem on entropy production in random systems.

Stefano Bianchini, the Instituto per le Applicazioni del Calcolo "M. Picone", Rome, Italy: Stefano Bianchini has introduced an entirely new perspective to the theory of discontinuous solutions of one-dimensional hyperbolic conservation laws, representing solutions as local superposition of traveling waves and introducing innovative Glimm functionals. His ideas have led to the solution of the long-standing problem of stability and convergence of vanishing viscosity approximations. In his best individual achievement, published in 2003 in Arch. Rational Mech. Anal., he shows convergence of semidiscrete upwind schemes for general hyperbolic systems. In the technically demanding proof the traveling waves are constructed as solutions of a functional equation, applying center manifold theory in an infinite-dimensional space.

Paul Biràn, Tel-Aviv University, Israel: Paul Biràn has made fundamental and influential contributions to symplectic topology as well as to algebraic geometry and Hamiltonian systems. His work is characterized by new depths in the interactions between complex algebraic geometry and symplectic topology. One of the earlier
contributions is his surprising solution of the symplectic packing problem, completing work of Gromov, McDuff, and Polterovich, showing that compact symplectic manifolds can be packed by symplectic images of equally sized Euclidean balls without wasting volume if the number of balls is not too small. Among the corollaries of his proof, Biràn obtains new estimates in the Nagata problem. A powerful tool in symplectic topology is Biràn's decomposition of symplectic manifolds into a disc bundle over a symplectic submanifold and a Lagrangian skeleton. Applications of this discovery range from the phenomenon of Lagrangian barriers to surprising novel results on topology of Lagrangian submanifolds. Paul Biràn not only proves deep results, he also discovers new phenomena and invents powerful techniques important for the future development of the field of symplectic geometry.

Elon Lindenstrauss, Clay Mathematics Institute and Courant Institute of Mathematical Sciences, USA: Elon Lindestrauss has done deep and highly original work at the interface of ergodic theory and number theory. Although he has worked widely in ergodic theory, his recent proof of the quantum unique ergodicity conjecture for arithmetic hyperbolic surfaces breaks fertile new ground, with great promise for future applications to number theory. Already, in joint work with Katok and Einsiedler, he has used some of the ideas in this work to prove the celebrated conjecture of Littlewood on simultaneous diophantine approximation for all pairs of real numbers lying outside a set of Hausdorff dimension zero. This goes far beyond what was known earlier about Littlewood's conjecture and spectacularly confirms the high promise of the methods of ergodic theory in studying previously intractable problems of diophantine approximation.

Andrei Okounkov, Princeton University, USA: Andrei Okounkov contributed greatly to the field of asymptotic combinatorics. An extremely versatile mathematician, he found a wide array of applications of his methods. His early results include a proof of a conjecture of Olshanski on the representation theory of groups with infinite-dimensional duals. Okounkov gave the first proof of the celebrated Baik-Deift-Johansson conjecture, which states that the asymptotics of random partitions distributed according to the Plancherel measure coincides with that of the eigenvalues of large Hermitian matrices. An important and influential result of Okounkov is a formula he found in joint work with Borodin, which expresses a general Toeplitz determinant as the Fredholm determinant of the product of two associated Hankel operators. The new techniques of working
with random partitions invented and successfully developed by Okounkov lead to a striking array of applications in a wide variety of fields: topology of moduli spaces, ergodic theory, the theory of random surfaces, and algebraic geometry.

Sylvia Serfaty, the Courant Institute of Mathematical Sciences, USA: Sylvia Serfaty was the first to make a systematic and impressive asymptotic analysis for the case of large parameters in theory of the Ginzburg-Landau equation. She established precisely the values of the first, second, and third (with E. Sandier) critical fields for nucleation of one stable vortex, vortex fluids, and surface superconductivity. In micromagnetics, her work with F. Alouges and T. Rivière breaks new ground on singularly perturbed variational problems and provides the first explanation for the internal structure of cross-tie walls.

Stanislav Smirnov, Royal Institute of Technology, Sweden, and University of Geneva, Switzerland: Stanislav Smirnov's most striking result is the proof of existence and conformal invariance of the scaling limit of crossing probabilities for critical percolation on the triangular lattice. This gives a formula for the limiting values of crossing probabilities, a breakthrough in the field, which has allowed for the verification of many conjectures of physicists concerning power laws and critical values of exponents. Stanislav Smirnov also made several essential contributions to complex dynamics around the geometry of Julia sets and the thermodynamic formalism.

Xavier Tolsa, ICREA and the Universitat Autònoma de Barcelona, Spain: Xavier Tolsa has made fundamental contributions to harmonic and complex analysis. His most outstanding work solves Vitushkin's problem about semiadditivity of analytic capacity. The problem was raised in 1967 by Vitushkin in his famous paper on rational approximation in the plane. Tolsa's result has important consequences for a classical (100 years old) problem of Painlevé about a geometric characterization of planar compact sets that are removable in the class of bounded analytic functions. Answering affirmatively Melnikov's conjecture, Tolsa provides a solution of the Painlevé problem in terms of the Menger curvature. Xavier Tolsa has also published many important and influential results related to CalderónZygmund theory and rational approximation in the plane.

Warwick Tucker, Uppsala University, Sweden: Warwick Tucker has given a rigorous proof that the Lorenz attractor exists for the parameter values provided by Lorenz. This was a long-standing challenge to the dynamical system community and was included by Smale in his list of problems for the new millennium. The proof uses computer estimates with rigorous bounds based on higherdimensional interval arithmetics. In later work, Warwick Tucker made further significant contributions to the development and application of this area.

Otmar Venjakob, Universität Heidelberg, Germany: Otmar Venjakob has made a number of important discoveries in both the algebraic and arithmetic aspects of noncommutative Iwasawa theory, especially on problems which appeared intractable from the point of view of the classical commutative theory. In arithmetic geometry, Iwasawa theory is the only general technique known for studying the
mysterious relations between exact arithmetic formulae and special values of $L$-functions, as typified by the conjecture of Birch and Swinnerton-Dyer. Venjakob's work applies quite generally to towers of number fields whose Galois group is an arbitrary compact $p$-adic Lie group (which is not, in general, commutative) and has done much to show that a rich theory is waiting to be developed. His most important results include the proof of a good dimension theory for modules over Iwasawa algebras and the proof of the first case of a structure theory for modules over these algebras. With Hachimori he discovered the first examples of arithmetic Iwasawa modules which are completely faithful, as well as proving a remarkable asymptotic upper bound for the rank of the Mordell Weil group of elliptic curves in certain towers of number fields over $Q$ whose Galois group is a $p$-adic Lie group of dimension 2. Very recently, he found the key to the problem of defining, in noncommutative Iwasawa theory, the analogue of the characteristic series of modules over Iwasawa algebras.

The Carl-Erik Fröberg Prize was also awarded at the ECM. The prize is awarded in even-numbered years to a young Nordic author of an article published in the journal BIT Numerical Mathematics. The prize was awarded to AnnaKarin Tornberg of the Courant Institute of Mathematical Sciences for her article "Multidimensional quadrature of singular and discontinuous functions". The prize carries a cash award of SEK 30,000 (about US $\$ 4,000$ ).

## -From an ECM announcement

## Serguei Denissov Awarded Popov Prize

Serguei Denissov of the California Institute of Technology was awarded the fourth Vasil Popov Prize at the International Conference in Approximation Theory held in Gatlinburg, Tennessee, in May 2004. The Popov Prize is awarded every third year to a young mathematician (within six years of receipt of the Ph.D.) who has made outstanding research contributions to approximation theory and related areas. This year the prize consisted of a cash award of \$1,000.

Denissov received his Ph.D. in mathematics from Moscow State University in 1999. He was awarded the Popov Prize for his contributions to spectral theory and orthogonal polynomials. He has introduced new ideas and powerful new techniques in spectral theory that have enabled him to solve deep problems. In particular, he was the first to show that there exist Schrödinger operators with square integrable potentials for which absolutely continuous and singular spectra coexist on the same spectral interval. Previous winners of the Popov Prize are Albert Cohen (1995), Arno Kuijlaars (1998), and Emmanuel Candes (2001).
-From a Popov Prize announcement

## George Ellis Wins 2004 Templeton Prize

The 2004 Templeton Prize has been awarded to George F. R. Elus, professor of applied mathematics at the University of Cape Town. Ellis is a theoretical cosmologist who has made important contributions to the dialogue between science and religion. The prize has a cash value of 795,000 pounds (about US $\$ 1.4$ million).

Ellis was born in Johannesburg, South Africa, and received his Ph.D. in applied mathematics and theoretical physics in 1964 from Cambridge University. He specializes in general relativity theory and is considered to be among a handful of the world's leading relativistic cosmologists. His most recent investigations question whether or not there was ever a start to the universe and if there is only one universe or many.

Ellis has advocated balancing the rationality of evi-dence-based science with faith and hope, a view shaped in part by his firsthand experiences in South Africa. He has promoted using religious and theological perspectives to view the universe in terms of "kenosis", or self-sacrificing love.

More than one hundred of Ellis's publications appear in MathSciNet. His works include The Large Scale Structure of Space-Time (1973), coauthored with Stephen Hawking.

He has devoted much of his energies to developing the social, political, cultural, and educational future of South Africa, particularly in making mathematics and science education more broadly available to his fellow citizens. He plans to use a portion of the Templeton Prize money to provide tutorial and monetary assistance for black youths in Cape Town.

The Templeton Prize for Progress toward Research or Discoveries about Spiritual Realities was founded by Sir John Templeton and is the world's largest annual monetary prize given to an individual. It is given each year to a living person who has contributed to spiritual matters and to understanding the relationship between theology and science.

## LMS Prizes Awarded

The London Mathematical Society (LMS) has awarded a number of prizes for 2004.

Sir Roger Penrose of the University of Oxford was awarded the De Morgan Medal for his wide and original contributions to mathematical physics.

Boris Zilber of the University of Oxford was awarded the Senior Berwick Prize for a paper titled "Exponential sums equations and the Schanuel conjecture", published in the Journal of the London Mathematical Society, which discussed the long-neglected subject of the model theory of the complex exponential and revealed many fascinating possibilities.

Richard Jozsa of the University of Bristol received the Naylor Prize for his fundamental contributions to the new field of quantum information science, which encompass such theoretical areas as quantum computation, communication and coding, and the role of quantum resources in quantum information processing.

Ian Grojnowski of the University of Cambridge was awarded the first Fröhlich Prize in recognition of his originality and influence across a wide range of problems in representation theory and algebraic geometry.

Four Whitehead Prizes were awarded. Mark Ainsworth of Strathclyde University was honored for his contributions to the analysis and application of high-order (hp) finite element methods to the numerical approximation of partial differential equations in continuum mechanics. Vladimir Markovic of the University of Warwick was chosen for his work on infinite-dimensional Teichmüller spaces. Richard Thomas of Imperial College, London, was recognized for his contributions to algebraic and differential geometry. Ulrike Tillmann of the University of Oxford was honored for her work in the study of the moduli spaces of algebraic curves (or Riemann surfaces).
-From an LMS announcement

## 2004 d'Alembert Prize Awarded

Every two years the Société Mathématique de France presents the d'Alembert Prize. Established in 1984, the prize is intended to encourage mathematical works in the French language and the exposition of mathematics for the general public. The prize recognizes an article, book, radio or television broadcast, film, or other project that is designed to improve understanding of mathematics and its recent developments.

The d'Alembert Prize for 2004 has been awarded to Ex Nihilo "for a series of six films distributed by Arte in 2003: 'Carré Magique', '20 février 2002 (Jour Palindromique)', 'Signe', 'Jonglage', 'Le Coeur Net', and 'Incertitudes'."
-Société Mathématique de France

## Paul Erdös Award Recipients Announced

The 2004 recipients of the Paul Erdös Award have been announced. They are Warren Atkins, Australia; André Deledico, France; and Patricia Fauring, Argentina.

The Paul Erdös National Award is given by the World Federation of National Mathematics Competitions in recognition of mathematicians who have contributed to the development of mathematical challenges at the national level and to the enrichment of mathematics learning.
-From an Australian Mathematics Trust announcement

## International Mathematical Olympiad, Athens 2004

The 45th International Mathematical Olympiad (IMO) was held July 4-18, 2004, in Athens, Greece. The IMO is the preeminent mathematical competition for high-school age students from around the world. More than 480 students from 85 countries competed in the 2004 IMO. The IMO awarded 45 gold medals for correctly and elegantly solving six extremely challenging mathematical problems in a 9 -hour competition administered over two days. More information about the 45th International Mathematical Olympiad is at http: //www.imo2004.gr.

The USA team did very well at the competition, winning 5 gold medals and 1 silver medal and finishing second overall among the 85 participating countries. The final team standings had China first, the USA second, followed by Russia in third place. This is the best medal count and highest placing for the USA team since 1994.

Oleg Goldberg of Bedford, Massachusetts, distinguished himself by accumulating 40 out of 42 possible points to have the best overall score on the USA team. TianKai Liu of Saratoga, California, had 38 points for another of the USA's gold medals. Aaron Pixton of Vestal, New York, had 37 points, and Alison Miller of Niskayuna, New York, and Tony Zhang of Arcadia, California, each had 33 points, all for gold medals. Matt Ince of Arnold, Missouri, gained a silver medal with a score of 31 points. Alison Miller is the first female gold medal winner for a team from the USA.

The sponsor of the USA team to the IMO is the Mathematical Association of America through its America Mathematics Competitions program, with travel support provided by a grant from the Army Research Office. Training for the team at the University of Nebraska-Lincoln is aided by a grant from the Akamai Foundation. Additional support for the team is provided by the National Council of Teachers of Mathematics.
-Steven R. Dunbar, MAA American Mathematics Competitions, University of Nebraska-Lincoln

## Royal Society of Canada Elections

Two scholars who work in the mathematical sciences have been elected fellows of the Royal Society of Canada for 2004. They are Stephen E. Fienberg of Carnegie Mellon University and Jacques Hurtubise of McGill University.
-From a Royal Society announcement

## Correction

The June/July 2004 Notices, page 664, carried an announcement about the mathematicians selected in the

2004 fellowship competition of the John Simon Guggenheim Memorial Foundation. Inadvertently omitted from this list was Curtis T. McMullen, Maria Moors Cabot Professor of Natural Science at Harvard University, whose area of research is dynamics over moduli space.

- Allyn Jackson


# Mathematics Opportunities 

## Call for Applications: AMS Epsilon Fund

The AMS Epsilon Fund awards grants to summer mathematics programs that support and nurture mathematically talented high school students in the United States. The deadline for application for funding for summer 2005 programs is December 15, 2004. Application materials are available at http://www.ams.org/outreach/ epsilon.htm1 or by mail: Membership and Programs Department, AMS, 201 Charles Street, Providence, RI 029042294; telephone 800-321-4267, ext. 4058; email: profserv@ams.org.
$-A M S$ announcement

## Enhancing the Mathematical Sciences Workforce in the 21st Century

The Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) sponsors a program entitled Enhancing the Mathematical Sciences Workforce in the 21st Century (EMSW21). This program includes Grants for Vertical Integration of Research and Education (VIGRE), Research Training Groups in the Mathematical Sciences (RTG), and Mentoring through Critical Transition Points in the Mathematical Sciences (MCTP).

An updated program announcement is now available. Please see http://www.nsf.gov/pubsys/ods/ getpub.cfm?nsf04600. The deadline for proposals is October 12, 2004.
-From an NSF announcement

## Humboldt Foundation Offers Fellowships

The Alexander von Humboldt Foundation awards annual fellowships to foreign scholars holding doctorates to support research projects of their own choosing in Germany. The fellowships are offered for research visits of between six and twelve months. Scholars in the United States may also apply for two-year postdoctoral fellowships or summer research fellowships.

Applicants from all countries and in all academic disciplines may apply. Approximately 500 research fellowships are available each year. Decisions are based primarily on the quality and feasibility of the proposed research projects and on the applicants' international publications. For more information on application requirements and procedure, consult the foundation's website at http://www.avh.de/en/programme/stip_aus/index. htm.
-From a Humboldt Foundation announcement

## Call for Nominations for Clay Research Fellows

The Clay Mathematics Institute (CMI) is currently accepting nominations for the position of Clay Research Fellow. Fellows are employed for a period of two to five years and may conduct their research at whatever location or combination of locations best suits their research. In addition to a generous salary, the fellows receive support for travel and research expenses, as well as provisions for collaboration.

The primary selection criteria are the exceptional quality of the candidate's research and the candidate's promise to become a mathematical leader. At the time of their selection, most recent appointees were graduating Ph.D.
students. However, mathematicians under age thirty have sometimes been appointed. Selection decisions are made by CMI's Scientific Advisory Board.

To nominate a candidate, please send the following items by October 30, 2004: (1) letter of nomination, (2) names and contact information of two other references, (3) curriculum vitae, and (4) publication list for the nominee. Nominations should be sent to Clay Mathematics Institute, One Bow Street, Cambridge, MA 02138. Electronic submissions are also accepted at nominations@ claymath.org.

Information about Clay Research Fellows is also available on the CMI website at www.claymath.org/fas/ research_fellows/. Additional information may be obtained by calling 617-995-2600 or emailing nominations@ claymath.org.
-From a CMI announcement

## AMS-AAAS Mass Media Summer Fellowships

The American Association for the Advancement of Science (AAAS) sponsors the Mass Media Science and Engineering Summer Fellows Program through which graduate students work during the summer in major media outlets. The AMS provides support each year for one or two graduate students in the mathematical sciences to participate in the program. In past years the AMS-sponsored fellows have held positions at Scientific American, Business Week, Voice of America, Discovery Channel Online, National Geographic Television, Popular Science, The Chicago Tribune, and Time magazine.

Fellows receive a weekly stipend of $\$ 450$ plus travel expenses to work for ten weeks during the summer as reporters, researchers, and production assistants in media organizations. They observe and participate in the process by which events and ideas become news, improve their ability to communicate about complex technical subjects in a manner understandable to the public, and increase their understanding of editorial decision making and of how information is effectively disseminated. Each fellow attends an orientation and evaluation session in Washington, DC, and begins the internship in mid-June. Fellows submit interim and final reports to the AAAS. A wrap-up session is held at the end of the summer.

Mathematical sciences faculty are urged to make their graduate students aware of this program. The deadline to apply for fellowships for the summer of 2005 is January 15, 2005. Further information about the fellowship program and application procedures is available online at http://ehrweb.aaas.org/massmedia.htm or contact: Stacey Pasco, Manager, Mass Media Program, AAAS Mass Media Science and Engineering Fellows Program, 1200 New York Avenue, NW, Washington, DC 20005; telephone: 202-326-6441; fax: 202-371-9849; or the AMS Washington Office, 1527 Eighteenth Street, NW, Washington, DC

20036; telephone: 202-588-1100; fax: 202-588-1853; email: amsdc@ams.org.
-Elaine Kehoe

## Call for Nominations for the 2005 Fermat Prize

The Fermat Prize for Mathematics Research is awarded every two years by the Université Paul Sabatier. The 2005 Fermat Prize will carry a cash award of 20,000 euros (about US $\$ 24,000$ ). The prize is intended to recognize research in fields in which Pierre Fermat made significant contributions, particularly statements of variational principles, foundations of probability and analytical geometry, and number theory. Candidates should be under the age of forty-five, and the work should have been done within the past five years.

The deadline for nominations is June 30, 2005. For more information, see http://www.ups-tlse.fr/ ACTUALITES/Sciences/Prix_Fermat_2004/ Areglement.htm7.
-From a Université Paul Sabatier announcement

## AWM Essay Contest

To increase awareness of women's ongoing contributions to the mathematical sciences, the Association for Women in Mathematics (AWM) is holding an essay contest for biographies of contemporary women mathematicians and statisticians in academic, industrial, and government careers. The 2004 contest is sponsored by Sandia National Laboratories.

The essays will be based primarily on interviews with women who are currently working in mathematical sciences careers. The contest is open to students in the following categories: 6th-8th grades, 9 th-12th grades, and college undergraduates. At least one winning submission will be chosen from each category. Winners will receive a prize, and their essays will be published on the AWM website. A grand prize winner will have his or her submission published in the AWM Newsletter as well. The deadline for entries is October 29, 2004.

In addition to student entries, organizers are currently seeking women mathematicians to volunteer as the subjects of these essays.

For more information, go to http://www. awm-math.org/biographies/contest.htm1 or contact Victoria Howle, the contest organizer, by email at vehow1e@sandia.gov or by postal mail at Sandia National Labs, MS 9159, P.O. Box 969, Livermore, CA 94551.
-From an AWM announcement

## Inside the AMS

## Updated AMSRefs Package Available

In June 2004 the AMS made available an update of the AMSRefs package. This is an extension package for $\mathrm{ET}_{\mathrm{E}} \mathrm{X}$ that facilitates the creation of bibliographies and citations in ETEX documents. Use of AMSRefs allows for the retention of rich markup that makes references easier to reuse in other publishing environments, such as on the Web, in other book or journal formats, or with citation services. The package is available for free on the AMS website.

The purpose of AMSRefs is to provide a simpler, more flexible way to use many of the convenient bibliography and citation features that users of $\mathrm{ET}_{\mathrm{E}} \mathrm{X}$ and BibTeX have come to expect. AMSRefs has been carefully designed to encourage the preservation of structured markup of the bibliography throughout the entire lifetime of a document, from rough draft to final archival version. It does this by replacing the unstructured .bbl file format of $1 T_{\mathrm{E}} \mathrm{X}$ by a new, fully structured format. The package is compatible with the "showkeys", "hyperref", and "backrefs" packages and implements the functionality of the popular "cite" package. One of the advantages of AMSRefs is that the bibliography style is controlled completely through ETEX instead of being determined partly by a BibTeX style file and partly through ETEX. Another advantage is that the same data format is used in the database file and in the ETE E document. Thus an AMSRefs-format database is a valid EATEX document that can be printed directly. Also, an author can send an article with embedded references to a publisher without any loss of internal structural information about the entries. It is possible to use the AMSRefs package without abandoning one's existing BibTeX database files.

For more information on AMSRefs and to download the package, visit the website http://www. ams.org/tex/ amsrefs.htm1. Further information can be obtained by writing to the AMS technical support group, tech-support@ams.org.
-David M. Jones, AMS

## AMS Participates in Capitol Hill Exhibition

Lisa Fauci and Nick Cogan of Tulane University represented the AMS at the 10th annual exhibition of the Coalition for National Science Funding (CNSF), held June 22,

2004, on Capitol Hill in Washington, DC. Fauci and Cogan highlighted their work on "Mathematical Modeling of Swimming Organisms" and discussed the use of modern methods in computational fluid dynamics to create a controlled environment where the dynamics of organisms can be measured and visualized. Their presentation at this exhibition reached many congressional staff and members of


Lisa Fauci and Nick Cogan (Tulane University) discuss mathematical modeling with Dr. Arden Bement, acting director of the National Science Foundation.

Congress, as well as other interested parties. In fact, this year's exhibition drew its largest crowd ever, with over 370 in attendance.

The CNSF is an alliance of over ninety scientific and professional societies and universities that are united by a concern for the future vitality of the national science, mathematics, and engineering enterprise. This coalition, chaired by Samuel M. Rankin III, associate executive director of the AMS and the director of its Washington office, works to increase the federal investment in the National Science Foundation (NSF).

The annual CNSF exhibition showcases research made possible by the NSF through exhibits displaying a wide range of scientific research and education projects. The 2004 exhibition included thirty-three exhibit booths and provided an informal setting for university researchers and educators to describe their work to leaders on Capitol Hill.

# Reference and Book List 

## 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.ou.edu in the case of the editor and notices@ams.org in the case of the managing editor. The fax numbers are 405-325-7484 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

## Upcoming Deadlines

September 15, 2004: Full proposals for REU sites. See http://www.nsf. gov/pubsys/ods/getpub. cfm?nsf02136.

September 15, 2004: Nominations for Alfred P. Sloan Foundation fellowships. Seehttp://umw.sloan.org/programs/ fellowship_brochure.shtm7 or write to Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, NY 10111.

September 16, 2004: Proposals for NSF Enhancing the Mathematical Sciences Workforce in the 21st Century program (including VIGRE). See the website http://www.nsf.gov/pubs/ 2003/nsf03575/nsf03575.htm.

September 30, 2004: Nominations for Information-Based Complexity Young Researcher Award. Contact Joseph F. Traub at traub@cs. columbia.edu.

October 1, 2004: Applications for AWM Travel Grants. See http://www. awm-math.org/travelgrants.htm7; tel. 301-405-7892; email: awm@math. umd. edu.

October 1, 2004: Nominations for the Louise Hay Award and the Alice T. Schafer Mathematics Prize. Contact Hay Award Selection Committee or Alice T. Schafer Award Selection Committee, Association for Women in Mathematics, 4114 Computer \& Space Sciences Building, University of Maryland, College Park, MD 20742-2461; telephone 301-4057892; email to awm@math. umd.edu.

October 1, 2004: Nominations for CRM-Fields Prize. See http://www. fields.utoronto.ca/proposals/ crm-fields_prize.htm1, or contact the Director, The Fields Institute, 222 College Street, Toronto, Ontario M5T 3J1, Canada.

October 12, 2004: Enhancing the Mathematical Sciences Workforce in the 21st Century. See http://www.
nsf.gov/pubsys/ods/getpub.cfm? ns04600.

October 13, 2004: Full proposals for NSF Distinguished International Postdoctoral Research Fellowships. See http://www.nsf.gov/pubs/ 2001/nsf01154/nsf01154.txt.

October 15, 2004: Applications for support for activities at the Pacific Institute for the Mathematical Sciences. See http://www.pims. math.ca/opportunities/ proposals.htm7.

October 15, 2004: Proposals for workshops and summer schools at Banff International Research Station for Mathematical Innovation and Discovery. See http://www.pims.math. ca/birs/.

October 15, 2004: Proposals for NSA Grant and Sabbatical Programs. See http://www.nsa.gov/msp/ index.cfm or telephone 301-6880400.

October 15, 2004: Applications for NSF Postdoctoral Research Fellow-

## Where to Find It

A brief index to information that appears in this and previous issues of the Notices.
AMS Bylaws-November 2003, p. 1283
AMS E-mail Addresses-November 2003, p. 1266
AMS Ethical Guidelines-June/July 2004, p. 673
AMS Officers 2002 and 2003 (Council, Executive Committee, Publications Committees, Board of Trustees)-May 2004, p. 566
AMS Officers and Committee Members-October 2004, p. 1082
Conference Board of the Mathematical Sciences-September 2004, p. 921

Information for Notices Authors-June/July 2004, p. 668
Mathematics Research Institutes Contact Information-August 2004, p. 810

National Science Board-January 2004, p. 54
New Journals for 2003-June/July 2004, p. 670
NRC Board on Mathematical Sciences and Their Applications-March 2004, p. 350
NRC Mathematical Sciences Education Board-April 2004, p. 446
NSF Mathematical and Physical Sciences Advisory Committee-February 2004, p. 242
Program Officers for Federal Funding Agencies-October 2004, p. 1083 (DoD, DoE); December 2003, p. 1429 (NSF)
ships. See http://www.nsf.gov/ pubs/2001/nsf01126/nsf01126. htm.

October 29, 2004: Entries for AWM essay contest. See "Mathematics Opportunities" in this issue.

October 30, 2004: Nominations for Clay Research Fellowships. See "Mathematics Opportunities" in this issue.

November 1, 2004: Applications for NSF International Research Fellow Awards. Contact the program officer, Susan Parris, 703-292-8711, sparris@nsf.gov; or visit http:// www.nsf.gov/sbe/int/fellows/ start.htm.

December 1, 2004: Applications for AMS Centennial Research Fellowships. See http://www.ams.org/ employment/centflyer.htm1 or write to Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; telephone 401-455-4107; email: prof-serv@ams. org.

December 1, 2004: Nominations for the Ferran Sunyer i Balaguer Prize. See http://www.crm.es/ FerranSunyerBalaguer/ffsb.htm.

December 15, 2004: AMS Epsilon Program. See "Mathematics Opportunities" in this issue.

January 1, 2005: Entries for Cryptologia undergraduate paper competitions. See http://www. dean. usma.edu/math/pubs/ cryptologia/ or contact Cryptologia, Department of Mathematical Sciences, United States Military Academy, West Point, NY 10996; email: Cryptologia@usma.edu.

January 15, 2005: Applications for AMS-AAAS Mass Media Summer Fellowships. See "Mathematics Opportunities" in this issue.

February 1, 2005: Applications for AWM Travel Grants and AWM Mentoring Travel Grants. See http:// www. a w m - math.org / travelgrants.htm7; tel. 301-4057892.

May 1, 2005: Applications for AWM Travel Grants. See http://www. awm-math.org/travelgrants.htm7; tel. 301-405-7892.

June 30, 2005: Nominations for the 2005 Fermat Prize. See "Mathematics Opportunities" in this issue.

## Mathematics Staff at DoD Funding Agencies

Five agencies of the Department of Defense fund research in the mathematical sciences. The names, addresses, and telephone numbers of the pertinent staff members are listed below.
Defense Advanced Research Projects Agency
Applied and Computational Mathematics Program
ARPA Defense Sciences Office
3701 North Fairfax Drive
Arlington, VA 22203-1714
703-526-6630
fax 703-696-2207
http://www.darpa.mi1/
Anthony J. Tether, Director
Robert F. Leheny, Deputy Director 703-696-2400

Air Force Office of Scientific Research
Directorate of Mathematics and Space Sciences
AFOSR/NM
4015 Wilson Boulevard, Room 713
Arlington, VA 22203-1954
fax: 703-696-8450
http://www.afosr.af.mi1/
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Physical Mathematics and Applied
Analysis
Arje Nachman
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arje.nachman@afosr.af.mi1.

## Computational Mathematics

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## Army Research Office

Mathematical and Information Sciences Directorate
4300 South Miami Blvd.
Durham, NC 27703-9142
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Fax: 919-549-4310
http://www.aro.ncren.net/
people/misdir.htm
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Discrete Mathematics and Computer
Science
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Probability and Statistics
Mou-Hsiung Chang, Program Manager

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Modeling of Complex Systems John Lavery, Program Manager 919-549-4253
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sander@aro.ar1.army.mi $\rceil$

Communication and Networks
Robert Ulman, Program Manager 919-549-4330
ulmanrj@aro.ar1.army.mi1

## Information Assurance

Cliff Wang, Program Manager
919-549-4207
cliff.wang@aro.ar1.army.mi1

## National Security Agency

Mathematical Sciences Program
Attn: R51A, Suite 6557
Ft. George G. Meade, MD 20755-
6557
http://www.nsa.gov:8080/ programs/msp/

Charles F. Osgood, Director
301-688-0400
msp@math13.math.umbc.edu

## Office of Naval Research

Mathematical, Computer, and Information Sciences Division Office of Naval Research 800 N. Quincy St. Arlington, VA 22217-5660
http://www.onr.navy.mi 1

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Visualization and Computer Graphics
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Autonomous Systems
Behzad Kamgar-Parsi
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behzad_kamgar-parsi@onr.navy. mi 1

## DoE Mathematics Program

Mathematical, Information, and Computational Sciences Division (MICS)
Office of Advanced Scientific Computing Research

Office of Science
U.S. Department of Energy

19901 Germantown Road
Germantown, MD 20874-1290
http://www.osti.gov/ascrtest/
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Program Manager
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Computer Science
John R. van Rosendale
301-903-3127
johnvr@er.doe.gov

## 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.

Abel's Proof: An Essay on the Sources and Meaning of Mathematical Unsolvability, by Peter Pesic. MIT Press, May 2003. ISBN 0-262-16216-4. (Reviewed March 2004.)

Across the Board: The Mathematics of Chessboard Problems, by John J. Watkins. Princeton University Press, April 2004. ISBN 0-691-11503-6.

Adam Spencer's Book of Numbers, by Adam Spencer. Four Walls Eight Windows, January 2004. ISBN 1-568-58289-7.

Alan Turing: Life and Legacy of a Great Thinker, edited by Christof Teuscher. Springer, 2004. ISBN 3-540-20020-7.

Alpha \& Omega: The Search for the Beginning and End of the Universe, by Charles Seife. Viking, July 2003. ISBN 0-670-03179-8.

Automated Reasoning and the Discovery of Missing and Elegant Proofs, by Larry Wos and Gail Pieper. Rinton Press, December 2003. ISBN 1-58949-023-1.

Beyond Coincidence, by Martin Plimmer and Brian King. Icon Books, March 2004. ISBN 1-840-46534-4.

Beyond the Limit: The Dream of Sofya Kovalevskaya, by Joan Spicci. Forge, August 2002. ISBN 0-765-30233-0. (Reviewed January 2004.)

The Book of My Life, by Girolamo Cardano. New York Review of Books Classics Series/Granta. ISBN 1-590-17016-4.

Calculated Risks: How to Know When Numbers Deceive You, by Gerd Gigerenzer. Simon \& Schuster, March 2003. ISBN 0-743-25423-6.

California Dreaming: Reforming Mathematics Education, by Suzanne M. Wilson. Yale University Press, January
2003. ISBN 0-300-09432-9. (Reviewed November 2003.)

The Changing Shape of Geometry: Celebrating a Century of Geometry and Geometry Teaching, edited by Chris Pritchard. Cambridge University Press, January 2003. ISBN 0-521-53162-4.

Cogwheels of the Mind: The Story of Venn Diagrams, by A. W. F. Edwards. Johns Hopkins University Press, April 2004. ISBN 0-801-87434-3.

* Constantin Carathéodory: Mathematics and Politics in Turbulent Times, by M. Georgiadou. Springer, September 2004. ISBN 3-540-44258-8.

The Constants of Nature: From Alpha to Omega. The Numbers That Encode the Deepest Secrets of the Universe, by John D. Barrow. Jonathan Cape, September 2002. Pantheon Books; January 2003. ISBN 0-375-42221-8.

Count Down: Six Kids Vie for Glory at the World's Toughest Math Competition, by Steve Olson. Houghton Mifflin, April 2004. ISBN 0-618-25141-3. (Reviewed August 2004.)

The Curious Life of Robert Hooke, the Man Who Measured London, by Lisa Jardine. HarperCollins, February 2004. ISBN 0-060-53897-X.

Einstein's Clocks, Poincarés Maps: Empires of Time, by Peter Galison. W. W. Norton, August 2003. ISBN 0 -393-02001-0.

Everything and More: A Compact History of Infinity, by David Foster Wallace. W. W. Norton, October 2003. ISBN 0-393-00338-8. (Reviewed June/July 2004.)

The Fabric of the Cosmos, by Brian Greene. Knopf, February 2004. ISBN 0-375-41288- 3.

Fields Medalists' Lectures, edited by Sir Michael Atiyah and Daniel Iagolnitzer. 2nd edition, World Scientific, December 2003. ISBN 9-812-38259-3.

Four Colors Suffice: How the Map Problem Was Solved, by Robin Wilson. Princeton University Press, March 2003. ISBN 0-691-11533-8. (Reviewed February 2004.)

From Newton to Hawking: A History of Cambridge University's Lucasian Professors of Mathematics, edited by Kevin C. Knox and Richard Noakes.

Cambridge University Press, November 2003. ISBN 0-521-66310-5.

Galois' Theory of Algebraic Equations, by Jean-Pierre Tignol. World Scientific, 2001. ISBN 981-02-4541-6.

Gamma: Exploring Euler's Constant, by Julian Havil. Princeton University Press, May 2003. ISBN 0-691-09983-9. (Reviewed August 2004.)

Geometry: Our Cultural Heritage, by Audun Holme. Springer, April 2002. ISBN 3-540- 41949-7. (Reviewed May 2004.)

Gödel's Proof, by Ernest Nagel and James R. Newman. New York University Press, revised edition, February 2002. ISBN 0-8147-5816-9. (Reviewed March 2004.)

The Golden Ratio: The Story of Phi, the World's Most Astonishing Number, by Mario Livio. Broadway Books, October 2002. ISBN 0-767-90815-5.

A Handbook of Mathematical Discourse, by Charles Wells. Infinity Publishing Company, 2003. ISBN 0-7414-1685-9. (Reviewed September 2004.)

How Economics Became a Mathematical Science, by E. Roy Weintraub. Duke University Press, June 2002. ISBN 0-822-32856-9.

Imagining Numbers (particularly the square root of minus fifteen), by Barry Mazur. Farrar, Straus and Giroux, February 2003. ISBN 0-374-17469-5. (Reviewed November 2003.)

Infinity: The Quest to Think the Unthinkable, by Brian Clegg. Carroll \& Graf, December 2003. ISBN 0-786-71285-6.

Information: The New Language of Science, by Hans Christian von Baeyer. Weidenfeld \& Nicolson, October 2003. ISBN 0-297-60725-1 (hardcover); 0-753-81782-9 (paperback).

Isaac Newton, by James Gleick. Pantheon Books, May 2003. ISBN 0-375-42233-1. (Reviewed December 2003.)

* Karl Pearson: The Scientific Life in a Statistical Age, by Theodore M. Porter. Princeton University Press, February 2004. ISBN 0-691-11445-5.

Kepler's Conjecture: How Some of the Greatest Minds in History Helped Solve One of the Oldest Math Problems in the World, by George G. Szpiro. John Wiley \& Sons, January 2003. ISBN 0-471-08601-0.

Linked: The New Science of Networks, by Albert-László Barabási.

Perseus Publishing, May 2002. ISBN 0-738-20667-9. (Reviewed February 2004.)

Masters of Theory: Cambridge and the Rise of Mathematical Physics, by Andrew Warwick. University of Chicago Press, July 2003. ISBN 0-226-87375-7.

Math through the Ages: A Gentle History for Teachers and Others, by William P. Berlinghoff and Fernando Q. Gouvêa. Oxton House, 2002. ISBN 1-881929-21-3. (Reviewed in this issue.)

The Mathematical Century: The 30 Greatest Problems of the Last 100 Years, by Piergiorgio Odifreddi. Translated by Arturo Sangalli. Princeton University Press, May 2004. ISBN 0-691-09294-X.

Mathematical Constants, by Steven R. Finch. Cambridge University Press, August 2003. ISBN 0-521-81805-2.

Mathematical Journeys, by Peter D. Schumer. Wiley-Interscience, February 2004. ISBN 0-471-22066-3.

A Mathematician's Survival Guide: Graduate School and Early Career Development, by Steven G. Krantz. AMS, August 2003. ISBN 0-8218-3455-X. (Reviewed April 2004.)

Mathematicians as Enquirers: Learning about Learning Mathematics, edited by Leone Burton. Kluwer, April 2004. Hardbound, ISBN 1-4020-7853-6; paperback, ISBN 1-4020-7859-5; eBook, ISBN 1-4020-7908-7.

Mathematics and Culture I, edited by Michele Emmer. Springer, January 2004. ISBN 3-540-01770-4.

Mathematics and War, edited by Bernhelm Booss-Bavnbek and Jens Høyrup. Birkhäuser, December 2003. ISBN 3-764-31634-9.

Mathematics, Art, Technology, and Cinema, edited by Michele Emmer and Mirella Manaresi. Springer, 2003. ISBN 3-540-00601-X.

Mathematics for the Imagination, by Peter M. Higgins. Oxford University Press, November 2002. ISBN 0-198-60460-2.

Mathematics in Nature: Modeling Patterns in the Natural World, by John Adam. Princeton University Press, November 2003. ISBN 0-691-11429-3.

The Mathematics of Juggling, by Burkard Polster. Springer, November
2002. ISBN 0-387-95513-5. (Reviewed January 2004.)

Memoirs of a Proof Theorist: Gödel and Other Logicians, by Gaisi Takeuti; translated by Mariko Yasugi and Nicholas Passell. World Scientific, February 2003. ISBN 981-238-279-8.

Meta Math! The Quest for Omega, by Gregory J. Chaitin. April 2004. Available at http://www.cs. umaine.edu/~chaitin/omega.htm1.

More Mathematical Astronomy Morsels, by Jean Meeus. Willmann-Bell Inc., 2002. ISBN 0-943396-743.

The Music of the Primes: Searching to Solve the Greatest Mystery in Mathematics, by Marcus du Sautoy. HarperCollins, April 2003. ISBN 0-066-21070-4.

Newton's Apple: Isaac Newton and the English Scientific Renaissance, by Peter Aughton. Weidenfeld \& Nicolson, October 2003. ISBN 0-297-84321-4.

The Number $\pi$, by Pierre Eymard and Jean-Pierre Lafon. AMS, 2004. ISBN 0-8218-3246-8.

On the Nature of Human Romantic Interaction, by Karl Iagnemma. Dial Press, April 2003. ISBN 0-385-33593-8.

Phase Change: The Computer Revolution in Science and Mathematics, by Douglas S. Robertson. Oxford University Press, March 2003. ISBN 0-195-15748-6.

Portraits of the Earth: A Mathematician Looks at Maps, by Timothy G. Freeman. AMS, September 2002. ISBN 0-8218-3255-7.

Predicting Presidential Elections and Other Things, by Ray C. Fair. Stanford University Press, August 2002. ISBN 0-804-74509-9.

Prime Obsession: Bernhard Riemann and the Greatest Unsolved Problem, by John Derbyshire. Joseph Henry Press, March 2003. ISBN 0-309-08549-7.

Probability Theory: The Logic of Science, by E. T. Jaynes; edited by G. Larry Bretthorst. Cambridge University Press, April 2003. ISBN 0-521-59271-2.

Proofs from The Book, by Martin Aigner and Günter M. Ziegler. Springer Verlag, third edition, December 2003. ISBN 3-540-40460-0.

* The Reader of Gentlemen's Mail: Herbert O. Yardley and the Birth of

American Codebreaking, by David Kahn. Yale University Press, March 2004. ISBN 0-300-09846-4.

The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics, by Karl Sabbagh. Farrar Straus \& Giroux, April 2003. ISBN 0-374-25007-3.

The Saga of Mathematics: A Brief History, by Marty Lewinter and William Widulski. Prentice Hall, January 2002. ISBN 0-130-34079-0.

Science in the Looking Glass, by E. Brian Davies. Oxford University Press, August 2003. ISBN 0-19-852543-5.

Shooting the Sun, by Max Byrd. Bantam, December 2003. ISBN 0-553-80208-9.

Signs of the Inka Khipu: Binary Coding in the Andean Knotted-String Records, by Gary Urton. University of Texas Press, August 2003. ISBN 0-292-78540-2.

Six Degrees: The Science of a Connected Age, by Duncan J. Watts. W. W. Norton, February 2003. ISBN 0-393-04142-5. (Reviewed February 2004.)

Strange Curves, Counting Rabbits, and Other Mathematical Explorations, by Keith Ball. Princeton University Press, November 2003. ISBN 0-691-11321-1.

Sync: The Emerging Science of Spontaneous Order, by Steven Strogatz. Hyperion, February 2003. ISBN 0-786-86844-9. (Reviewed March 2004.)

Turing (A Novel about Computation), by Christos H. Papadimitriou. MIT Press, November 2003. ISBN 0-262-16218-0.

What Is Thought?, by Eric B. Baum. MIT Press, January 2004. ISBN 0-262-02548-5.

What the Numbers Say: A Field Guide to Mastering Our Numerical World, by Derrick Niederman and David Boyum. Broadway Books, April 2003. ISBN 0-767-90998-4.

When Least Is Best: How Mathematicians Discovered Many Clever Ways to Make Things As Small (or As Large) As Possible, by Paul J. Nahin. Princeton University Press, November 2003. ISBN 0-691-07078-4.

## Officers and Committee Members

Numbers to the left of headings are used as points of reference in an index to AMS committees which follows this listing. Primary and secondary headings are:

1. Officers
1.1. Liaison Committee
2. Council
2.1. Executive Committee of the Council
3. Board of Trustees
4. Committees
4.1. Committees of the Council
4.2. Editorial Committees
4.3. Committees of the Board of Trustees
4.4. Committees of the Executive Committee and Board of Trustees
4.5. Internal Organization of the AMS
4.6. Program and Meetings
4.7. Status of the Profession
4.8. Prizes and Awards
4.9. Institutes and Symposia
4.10. Joint Committees
5. Representatives
6. Index

Terms of members expire on January 31 following the year given unless otherwise specified.

## 1. Officers

| President | David Eisenbud | 2004 |
| :--- | :--- | :--- |
| President-elect | James G. Arthur | 2004 |
| Vice Presidents | Vaughn F. R. Jones | 2006 |
|  | Hugo Rossi | 204 |
|  | Karen Vogtmann | 2005 |
| Secretary | Robert J. Daverman | 2006 |
| Associate Secretaries | John L. Bryant | 2004 |
|  | Susan J. Friedlander | 2005 |
|  | Michel L. Lapidus | 2005 |
|  | Lesley M. Sibner | 2006 |
| Treasurer | John M. Franks | 2006 |
| Associate Treasurer | Donald E. McClure | 2006 |

### 1.1. Liaison Committee

All members of this committee serve ex officio.

Chair

John B. Conway
Robert J. Daverman
David Eisenbud
John M. Franks

## 2. Council

### 2.0.1. Officers of the AMS

| President | David Eisenbud | 2004 |
| :--- | :--- | :--- |
| President-elect | James G. Arthur | 2004 |
| Vice Presidents | Vaughn F. R. Jones | 2006 |
|  | Hugo Rossi | 2004 |
|  | Karen Vogtmann | 2005 |
| Secretary | Robert J. Daverman | 2006 |
| Associate Secretaries** | John L. Bryant | 2004 |
|  | Susan J. Friedlander | 2005 |
|  | Michel L. Lapidus | 2005 |
|  | Lesley M. Sibner | 2006 |
| Treasurer | John M. Franks | 2006 |
| Associate Treasurer | Donald E. McClure | 2006 |


| 2.0.2. $\quad$ Representatives of Committees |  |  |
| :--- | :--- | :--- |
| Bulletin | Donald G. Saari | 2004 |
| Colloquium | Susan J. Friedlander | 2004 |
| Executive Committee | Walter L. Craig | 2006 |
| Journal of the AMS | Ingrid Daubechies | 2006 |
| Mathematical Reviews B. A. Taylor <br> Mathematical Surveys <br> and Monographs Peter S. Landweber | 2004 |  |
| Mathematics of <br> Computation | Chi-Wang Shu | 2004 |
| Proceedings <br> Transactions and <br> Memoirs | Eric D. Bedford | 2004 |
|  | William Beckner | 2004 |
|  |  | 2004 |

### 2.0.3. Members at Large

| Colin C. Adams | 2004 | Susan M. Hermiller | 2005 |
| :--- | :--- | :--- | :--- |
| Sylvia T. Bozeman | 2004 | Brian Marcus | 2005 |
| James W. Cannon | 2006 | John E. McCarthy | 2005 |
| Sylvain E. Cappell | 2006 | David R. Morrison | 2004 |
| Beverly E. J. Diamond | 2006 | Paul J. Sally, Jr. | 2005 |
| Irene Martinez Gamba | 2004 | Alejandro Uribe | 2006 |
| Henri A. Gillet | 2004 | Paul Zorn | 2005 |
| Mark Goresky | 2006 |  |  |

[^14]
### 2.1. Executive Committee of the Council

| James G. Arthur | ex officio |
| :--- | ---: |
| Walter L. Craig | 2006 |
| Robert J. Daverman | ex officio |
| David Eisenbud | ex officio |
| David R. Morrison | 2004 |
| Hugo Rossi | 2005 |
| Paul J. Sally | 2007 |

## 3. Board of Tru

### 4.1. Committees of the Council

## Standing Committees

| 4.1.1. | Editorial Boards |  |
| :---: | :---: | :---: |
| Chair | Richard A. Brualdi | 2005 |
|  | Clifford J. Earle | 2004 |
|  | Svetlana Y. Jitomirskaya | 2004 |
|  | Emma Previato | 2006 |
|  | Karl Rubin | 2006 |
|  | Leonard L. Scott, Jr. | 2005 |

### 4.1.2. Nominating Committee

Terms begin on January 1 and end on December 31 of the year listed.

|  | Sheldon Axler | 2004 |
| :--- | :--- | :--- |
| Chair | Annalisa Crannell | 2006 |
|  | Nathaniel Dean | 2005 |
|  | Robert M. Fossum | 2004 |
|  | Richard M. Hain | 2005 |
|  | Jane M. Hawkins | 2004 |
|  | Arthur M. Jaffe | 2006 |
|  | Krystyna Kuperberg | 2005 |
|  | Joel H. Spencer | 2006 |

## Special Committee

### 4.1.3. AMS Fellows Program Subcommittee

Chair

| Henri A. Gillet | 2004 |
| :--- | :--- |
| Curtis Greene | 2004 |
| William H. Jaco | 2004 |
| Sheldon H. Katz | 2004 |
| John Lowengrub | 2004 |
| Carolyn R. Mahoney | 2004 |
| David W. McLaughlin | 2004 |
| Ronald J. Stern | 2004 |
| Karen Vogtmann | 2004 |

### 4.2. Editorial Committees

### 4.2.1. Abstracts Editorial Committee <br> All members of this committee serve ex officio.

John L. Bryant
Chair Robert J. Daverman Susan J. Friedlander Michel L. Lapidus Lesley M. Sibner

### 4.2.2. Bulletin (New Series)

| Chief Editor | $\begin{array}{l}\text { Donald G. Saari } \\ \text { Robert L. Devaney }\end{array}$ |  | 2004 |
| :--- | :--- | :--- | :--- |
| Book Reviews Editor | 2006 |  |  |
| Associate Editors for Bulletin Articles |  |  |  |$]$| John C. Baez | 2004 | Paul H. Rabinowitz |
| :--- | :--- | :--- |$\quad 2004$

### 4.2.3. Collected Works

| Chair | Jonathan L. Alperin | 2003 |
| :--- | :--- | :--- |
|  | Elliott H. Lieb | 2003 |
|  | Cathleen S. Miorawetz | 2003 |

4.2.4. Colloquium

| Chair | Susan J. Friedlander | 2004 |
| :--- | :--- | :--- |
|  | Yuri Manin | 2006 |
|  | Peter Sarnak | 2005 |

4.2.5. Contemporary Mathematics

Andreas R. Blas

| Dennis DeTurck | 2004 |
| :--- | :--- |
| Andy R. Magid | 2004 |

Michael S. Vogelius 2004
4.2.6. Electronic Research Announcements

| Stuart Antman | 2005 |
| :--- | :--- |
| David J. Benson | 2004 |
| Dimitri Burago | 2006 |
| Tobias Colding | 2004 |
| Brian Conrey | 2006 |
| Sergey Fomin | 2006 |
| Mark Freidlin | 2005 |
| Timothy Gowers | 2006 |
| Boris Hasselblatt | 2006 |
| Svetlana R. Katok | 2004 |
| Yitzhak Katznelson | 2004 |
| David Kazhdan | 2005 |
| Alexander S. Kechris | 2005 |
| Alexandre A. Kirillov | 2005 |
| Frances C. Kirwan | 2005 |
| Krystyna M. Kuperberg | 2004 |
| Robert K. Lazarsfeld | 2005 |
| Grigorii A. Margulis | 2006 |
| Walter David Neumann | 2006 |
| Klaus Schmidt | 2004 |
| Michael E. Taylor | 2006 |
| Guido L. Weiss | 2004 |
| Don B. Zagier | 2006 |
| Efim I. Zelmanov |  |



| 4.2.15. | Transactions and Memoirs |  |
| :---: | :---: | :---: |
| Chair | Dan Abramovich |  |
|  | Peter W. Bates | 2006 |
|  | Patricia E. Bauman | 2004 |
|  | William Beckner | 2005 |
|  | Mladen Bestvina | 2004 |
|  | Krzysztof Burdzy | 2007 |
|  | Tobias Colding | 2007 |
|  | Marius Dadarlat | 2006 |
|  | Harold G. Diamond | 2007 |
|  | Sergey Fomin | 2005 |
|  | Robert Guralnick | 2004 |
|  | Lisa Claire Jeffrey | 2007 |
|  | Steffan Lempp | 2004 |
|  | V. Kumar Murty | 2007 |
|  | Alexander Nagel | 2006 |
|  | D. H. Phong | 2006 |
|  | Robert J. Stanton | 2004 |
|  | Daniel I. Tartaru | 2005 |
|  | Robert F. Williams | 2006 |
|  | Rerin | 2005 |

4.2.16. Translation from Chinese

Sun-Yung Alice Chang S.-Y. Cheng

Chair
Tsit-Yuen Lam
Tai-Ping Liu
Chung-Chun Yang
4.2.17. Translation from Japanese

Chair Shoshichi Kobayashi
Masamichi Takesaki
1999
1999

## Standing Committees

4.2.18. Conformal Geometry and Dynamics

| Chair | Mario Bonk | 2006 |
| :---: | :--- | :--- |
|  | Linda Keen | 2004 |
|  | Gaven J. Martin | 2006 |
|  | Howard Masur | 2004 |
|  | Yair N. Minsky | 2005 |
|  | Lei Tan | 2005 |

4.2.19. History of Mathematics

Joseph W. Dauben 2007
Peter L. Duren 2007
Chair
Karen H. Parshall
Michael I. Rosen
2004
2004
4.2.20. Representation Theory

James I. Lepowsky 2004
George Lusztig 2005
Chair
Dragan Milicic 2005
Henrik Schlichtkrull 2006
Birgit Speh 2005
David A. Vogan 2005
4.2.21. Student Mathematics Library

David P. Cervone 2006
Robin Forman 2007
Daniel L. Goroff 2005
Brad Osgood 2007
Chair
Carl Pomerance
2005

### 4.2.22. University Lecture Series Chair <br> Jerry L. Bona <br> 2004

Ranee Brylinski 2006
Eric M. Friedlander 2005
Nigel Higson 2006
Peter S. Landweber 2004

### 4.3. Committees of the Board of Trustees

### 4.3.1. Agenda and Budget

All members of this committee serve ex officio.

> John B. Conway Robert J. Daverman David Eisenbud John M. Franks Donald E. McClure

Chair David Eisenbud

### 4.3.2. Audit

All members of this committee serve ex officio. AMS staff contact: Connie Pass.

John B. Conway
Chair John M. Franks
Donald E. McClure
Carol S. Wood

### 4.3.3. Investment

AMS staff contact: Connie Pass.

| Chair | John M. Franks | ex officio |
| :--- | :--- | ---: |
|  | Linda Keen | ex officio |
|  | Donald E. McClure | ex officio |
|  | Peter J. Weinberger | 2006 |

### 4.3.4. Salary

All members of this committee serve ex officio. AMS staff contact: Gary Brownell.

|  | John B. Conway |
| :--- | :--- |
| Chair | John M. Franks |
|  | Donald E. McClure |

### 4.4. Committees of the Executive Committee and Board of Trustees

### 4.4.1. Long Range Planning

All members of this committee serve ex officio. AMS staff contact: Ellen H. Heiser.

John B. Conway
Walter L. Craig
Robert J. Daverman
Chair David Eisenbud
John H. Ewing
John M. Franks
Hugo Rossi
4.4.2. Nominating

All members of this committee serve ex officio.
Nathaniel Dean Hugo Rossi
Chair Carol S. Wood

### 4.5. Internal Organization of the American Mathematical Society

Standing Committees
4.5.1. Archives

Chair Steven L. Batterson 2004
Keith Dennis 2006
Judy Green 2005

| 4.5.2. | Books and Journal Donations Steering Committee |  |
| :---: | :---: | :---: |
|  | M. Salah Baouendi | 2004 |
|  | Peter W. K. Li | 2003 |
| Chair | James L. Rovnyak | 2003 |
| 4.5.3. | Committee on Committees |  |
|  | Dan Abramovich | 2004 |
|  | James G. Arthur | ex officio |
|  | Rodrigo Banuelos | 2004 |
|  | Joe P. Buhler | 2004 |
|  | Kevin David Corlette | 2004 |
|  | Walter L. Craig | 2004 |
|  | Robert J. Daverman | ex officio |
|  | David Eisenbud | ex officio |
|  | Robert Eugene Megginson | 2004 |
|  | Hugo Rossi | 2004 |
| Chair | Ronald J. Stern | 2004 |
|  | Chuu-Lian Terng | 2004 |
|  | Rekha R. Thomas | 2004 |
|  | Margaret H. Wright | 2004 |
| 4.5.4. Library Committee |  |  |
|  | Carol Hutchins | 2006 |
| Co-chair | Reinhard Laubenbacher | 2004 |
|  | Silvio Levy | 2005 |
|  | Karen H. Parshall | 2005 |
|  | V. Frederick Rickey | 2005 |
|  | Steve Rockey | 2006 |
|  | C. Edward Sandifer | 2006 |
| Co-chair | Molly T. White | 2004 |
| 4.5.5. Publications |  |  |
| AMS staff contact: Raquel E. Storti. |  |  |
|  | Krzysztof Burdzy | 2004 |
|  | Robert J. Daverman | ex officio |
|  | Beverly E. J. Diamond | 2006 |
|  | Emmanuele DiBenedetto | 2005 |
|  | David Eisenbud | ex officio |
|  | John H. Ewing | ex officio |
|  | Vaughan F. R. Jones | 2006 |
|  | Linda Keen | 2004 |
|  | John E. McCarthy | 2005 |
|  | David R. Morrison | 2004 |
|  | Leonard L. Scott, Jr. | 2004 |
|  | Alexandre Turull | 2005 |
| Chair | Jonathan M. Wahl | 2004 |
|  | Steven Weintraub | 2006 |

### 4.6. Program and Meetings

## Standing Committees

### 4.6.1. Meetings and Conferences

AMS staff contact: Diane Saxe

|  | Colin C. Adams |
| :--- | :--- |
|  | Edward J. Barbeau, Jr. |
|  | Robert J. Daverman |
|  | David Eisenbud |
|  | John H. Ewing |
|  | Tepper L. Gill |
|  | Craig L. Huneke |
| Chair | Irena Peeva |
|  | Richard Randell |
|  | Gregory G. Smith |
|  | Jean E. Taylor |
|  | Paul Zorn |

2005
2006
2004
2005
2004
2004
ex officio ex officio ex officio

2004
2004
2005 04

### 4.6.2. Program Committee for National Meetings

| Chair | Lenore C. Blum | 2004 |
| :---: | :---: | :---: |
|  | Robert J. Daverman | ex officio |
|  | Richard M. Hain | 2005 |
|  | John H. Hubbard | 2006 |
|  | Nicholas Katz | 2005 |
|  | Hans G. Othmer | 2006 |
|  | Lesley M. Sibner | ex officio |
|  | Maciej Zworski | 2006 |
| 4.6.3. | Short Course Subcommittee |  |
|  | Christian Constanda | 2005 |
|  | Susan M. Hermiller | 2004 |
|  | Trachette Levon Jackson | 2006 |
|  | Christopher King | 2006 |
|  | David I. Lieberman | 2006 |
| Chair | Kenneth C. Millett | 2005 |
|  | Neils O. Nygaard | 2004 |
| 4.6.4. | Central Section Program Committee |  |
|  | Benson S. Farb | 2005 |
|  | Susan J. Friedlander | ex officio |
| Chair | Berit Stensones | 2004 |
|  | Roldolfo H. Torres | 2005 |
|  | Jose Felipe Voloch | 2004 |
| 4.6.5. | Eastern Section Program Committee |  |
| Chair | Robert Calderbank | 2004 |
|  | Nigel Higson | 2004 |
|  | William P. Minicozzi II | 2005 |
|  | Lesley M. Sibner | ex officio |
|  | Wolfgang Ziller | 2005 |

4.6.6. Southeastern Section Program Committee

| John L. Bryant | ex officio |
| :--- | ---: |
| Jerome Goldstein | 2004 |
| Ellen E. Kirkman | 2005 |
| Michael P. Loss | 2005 |
| Gordana Matic | 2004 |

4.6.7. Western Section Program Committee

| Frank R. DeMeyer | 2004 |
| :--- | ---: |
| Svetlana Y. Jitomirskaya | 2005 |
| Michel L. Lapidus | ex officio |
| Linda Preiss Rothschild | 2004 |
| Martin G. Scharlemann | 2005 |
| Business Meetings |  |
| Robert J. Daverman | ex officio |
| D. J. Lewis | 2003 |
| Calvin C. Moore | 2003 |


| 4.6.9. Arnold Ross | Lecture Series Committee |  |
| :--- | :--- | :--- |
|  | Susan F. Parker | 2006 |
| Chair | Victoria A. Powers | 2005 |
|  | Zvezdelina Stankova | 2006 |
|  | Glenn H. Stevens | 2006 |

4.6.10. Colloquium Lecture

| David Kazhdan | 2005 |
| :--- | :--- |
| Janos Kollar | 2006 |
| Dusa McDuff | 2004 |

Chair Dusa McDuff 2004
4.6.11. Gibbs Lecturer for 2005 and 2006, Committee to Select

| Standing Committees |  |  |
| :---: | :---: | :---: |
| 4.7.1. | Academic Freedom, Tenure, and Employment Security |  |
|  | Duane Broline | 2005 |
|  | James H. Curry | 2004 |
| Chair | Murray Gerstenhaber | 2004 |
|  | Rhonda J. Hughes | 2006 |
|  | Robert Eugene Megginson | 2004 |
|  | Brooke E. Shipley | 2006 |
|  | Jay A. Wood | 2005 |
| 4.7.2. Education |  |  |
| AMS staff contact: Samuel M. Rankin III. |  |  |
|  | Arthur T. Benjamin | 2006 |
|  | Sylvia T. Bozeman | 2004 |
|  | John B. Conway | 2004 |
|  | Robert J. Daverman | ex officio |
|  | David Eisenbud | ex officio |
|  | John H. Ewing | ex officio |
|  | Robert Greene | 2006 |
|  | Jane Hawkins | 2004 |
|  | Roger E. Howe | 2005 |
|  | Carole B. Lacampagne | 2005 |
|  | William James Lewis | 2006 |
| Chair | William McCallum | 2004 |
|  | Paul J. Sally, Jr. | 2005 |
|  | Michael Starbird | 2005 |
|  | Alejandro Uribe | 2006 |
|  | Karen Vogtmann | 2005 |
|  | Hung-Hsi Wu | 2004 |
| 4.7.3. Fan Fund |  |  |
|  | Min Chen | 2006 |
| Chair | Song-Ying Li | 2005 |
|  | Gang Tian | 2004 |
| 4.7.4. | Human Rights of Mathematicians |  |
|  | Selman Akbulut | 2005 |
|  | Charles Herbert Clemens | 2004 |
|  | Paul M. Gauthier | 2006 |
|  | Lourdes Juan | 2005 |
| Chair | Tsit-Yuen Lam | 2004 |
|  | Peter W. K. Li | 2004 |
|  | Dino Lorenzini | 2006 |
|  | Emma Previato | 2005 |
|  | Edriss Saleh Titi | 2006 |
| 4.7.5. Profession |  |  |
| AMS staff contact: James W. Maxwell. |  |  |
|  | Charles Akemann | 2004 |
|  | James Cannon | 2006 |
|  | Ruth Charney | 2005 |
|  | Robert J. Daverman | ex officio |
|  | David Eisenbud | ex officio |
|  | John H. Ewing | ex officio |
|  | Henri A. Gillet | 2004 |
|  | Anne Greenbaum | 2006 |
|  | Brian Marcus | 2005 |
|  | Ellen Maycock Parker | 2004 |
|  | Kenneth R. Meyer | 2004 |
|  | Helen Moore | 2005 |
|  | Douglas C. Ravenel | 2004 |
|  | Claude L. Schochet | 2005 |
| Chair | Carol S. Wood | 2004 |

### 4.7.6. Professional Ethics

| Bruce C. Berndt | 2004 |
| :--- | :--- |
| Lisa Fastenberg | 2004 |
| Helen G. Grundman | 2006 |
| Peter G. Hinman | 2006 |
| Anne Leggett | 2004 |
| Warren R. Wogen | 2006 |

4.7.7. Science Policy

AMS staff contact: Samuel M. Rankin III.

| James G. Arthur | ex officio |
| :--- | ---: |
| Marco Avellaneda | 2004 |
| Felix E. Browder | 2004 |
| Robert J. Daverman | ex officio |
| David Eisenbud | ex officio |
| John H. Ewing | ex officio |
| Eric M. Friedlander | 2004 |
| Irene Martinez Gamba | 2004 |
| Mark Goresky | 2006 |
| Jane M. Hawkins | 2004 |
| Susan M. Hermiller | 2005 |
| William E. Kirwan | 2005 |
| William McCallum | 2004 |
| Calvin C. Moore | 2004 |
| Robert F. Olin | 2006 |
| Alvany Rocha | 2005 |
| Hugo Rossi | 2004 |
| Daniel W. Stroock | 2004 |

4.7.8. Young Scholars Awards

Terms expire on June 30.

| Manuel P. Berriozábal | 2006 |
| :--- | :--- |
| Leonore J. Cowen | 2005 |
| Joseph A. Gallian | 2005 |
| Paul Zeitz | 2006 |

### 4.8. Prizes and Awards

## Standing Committees

| 4.8.1. AMS Book Prize |  |  |
| :--- | :--- | :--- |
|  | Rodrigo Banuelos | 2004 |
| Chair | Steven G. Krantz | 2007 |
|  | H. W. Lenstra | 2004 |
|  | Dale P. O. Rolfsen | 2007 |
|  | Bhama Srinivasan | 2007 |

### 4.8.2. Award for Distinguished Public Service, Committee to Select the Winner of the

D. J. Lewis 2003

William James Lewis 2007
Calvin C. Moore 2004
William Yslas Velez 2005
Margaret Wright 2007
4.8.3. The Stefan Bergman Trust
F. Michael Christ 2006

John D'Angelo 2005
John Erik Fornaess 2004
Chair John Erik Fornaess 2004
4.8.4. Bôcher Prize

| Chair | Charles Fefferman | 2004 |
| :--- | :--- | :--- |
|  | Leon Simon | 2004 |
|  | Daniel Tataru | 2004 |


| 4.8.5. | Centennial Fellowships <br> Terms expire on June 30. |  |
| :---: | :---: | :---: |
|  | W. Dale Brownawell | 2004 |
|  | Dennis DeTurck | 2004 |
| Chair | Rebecca A. Herb | 2005 |
|  | Robert Lazarsfeld | 2005 |
|  | Richard Lyons | 2004 |
|  | Yuriko Y. Renardy | 2004 |
|  | Abigail Thompson | 2004 |
|  | Richard A. Wentworth | 2005 |
| 4.8.6. | Conant Prize, Committee to Select the Winner of the |  |
|  | Anthony W. Knapp | 2005 |
| Chair | Carl Pomerance | 2004 |
|  | M. Beth Ruskai | 2006 |
| 4.8.7. | Math in Moscow Progam-Travel Support Terms expire on June 30. |  |
| Chair | Rafe R. Mazzeo | 2004 |
|  | Nicolai Reshetikhin | 2004 |
|  | Mikhail Shubin | 2006 |
| 4.8.8. | Menger Prize Committee |  |
|  | Terms expire on May 31. |  |
|  | Elwyn Berlekamp | 2004 |
| Chair | Gisele Goldstein | 2006 |
|  | Hugh Montgomery | 2004 |
| 4.8.9. | E. H. Moore Research Article Prize, Committee to Select the Winner of the |  |
|  | Béla Bollobás | 2003 |
|  | Lawrence Craig Evans | 2006 |
|  | Grigorii A. Margulis | 2006 |
|  | George C. Papanicolaou | 2006 |
|  | Andrew Wiles | 2003 |

4.8.10. National Awards and Public Representation

|  | James G. Arthur | ex officio |
| :--- | :--- | ---: |
|  | Peter J. Bickel | 2004 |
|  | Robert J. Daverman | ex officio |
| Chair | David Eisenbud | ex officio |
|  | Philippe M. Tondeur | 2005 |

4.8.1 1. Satter Prize, Committee to Select the Winner of the

| Karen E. Smith | 2007 |
| :--- | :--- |
| Jean E. Taylor | 2004 |
| Chuu-Lian Terng | 2007 |

### 4.8.12. Steele Prizes

| Chair | Andreas R. Blass | 2004 |
| :--- | :--- | :--- |
|  | Daniel S. Freed | 2006 |
|  | John B. Garnett | 2006 |
|  | Victor W. Guilleman | 2006 |
|  | Craig L. Huneke | 2005 |
|  | Tsit-Yuen Lam | 2005 |
|  | Robert D. MacPherson | 2005 |
|  | Linda P. Rothschild | 2006 |
|  | Lou van den Dries | 2004 |

### 4.8.13. Whiteman Prize for 2005, Committee to Select the Winner of the

Chair
Thomas W. Hawkins
Victor Katz
Robert Osserman

## Special Committee

| 4.8.14. Cole Prize (in Number Theory) |  |
| :--- | :---: |
| Andrew J. Granville |  |
| Chair | Richard L. Taylor <br> Marie France Vigneras |
|  |  |

### 4.9. Institutes and Symposia

## Standing Committee

4.9.1. Liaison Committee with AAAS

| Gail A. Carpenter | 2005 |
| :--- | ---: |
| Jennifer Tour Chayes | ex officio |
| William H. Jaco | 2005 |
| Barbara Lee Keyfitz | ex officio |
| Robert Osserman | ex officio |
|  | 2005 |
| Warren Page | ex officio |
| Jean E. Taylor | ex officio |
| Alan Tucker | ex officio |

### 4.10. Joint Committees

| 4.10.1. | AMS-ASA-AWM-IMS-MAA-NCTM-SIAM Committee on Women in the Mathematical Sciences |  |
| :---: | :---: | :---: |
|  | Lisa Carbone (AMS) | 2004 |
|  | Sandra Clarkson (ASA) | 2004 |
|  | Susan J. Friedlander (AWM) | 2004 |
|  | Deanna B. Haunsperger (AMS) | 2004 |
|  | Abbe H. Herzig (AMS) | 2006 |
|  | Susan Holmes (IMS) | 2004 |
|  | Jennifer Hontz (MAA) | 2005 |
|  | Snehalata V. Huzurbazar (ASA) | 2005 |
|  | Janine E. Janosky (ASA) | 2006 |
|  | Tammy Kolda (SIAM) | 2006 |
|  | Jean LaDuke (MAA) | 2004 |
|  | Vlada Limic (IMS) | 2006 |
|  | Helen Moore (AWM) | 2004 |
|  | Dianne O'Leary (SIAM) | 2006 |
|  | Judith Olson (NCTM) | 2004 |
| Chair | C. Lanette Poteete-Young (MAA) | 2005 |
|  | Sanford Segal (MAA) | 2004 |

### 4.10.2. AMS-ASL-IMS-SIAM Committee on Translations from Russian and Other Slavic Languages

Chair
James D. Stasheff (AMS)
AMS Subcommittee Members

| Consultant | V. I. Arnol'd <br> Luchezar Avramov <br> Igor Dolgachev |
| :--- | :--- |
| Consultant | S. G. Gindikin <br> Consultant |
| Askol'd Georgievič Khovanskiï <br> Robert D. MacPherson <br> Grigorii A. Margulis |  |
| Consultant | N. K. Nikol'skiï <br> Chair |
| James D. Stasheff |  |

ASL Subcommittee Members

|  | Marat Arslanov |  |
| :---: | :---: | :---: |
|  | Sergei N. Artemov |  |
|  | Oleg Belegradek |  |
|  | Elisabeth Bouscaren |  |
|  | Wilfried Buchholz |  |
| Chair | Steffen Lempp |  |
|  | Mariko Yasugi |  |
| IMS Subcommittee Members |  |  |
| Chair | M. I. Freidlin |  |
|  | B. Pittel |  |
|  | A. Rukhin |  |
|  | W. J. Studden |  |
| 4.10.3. | AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences <br> Terms expire on June 30. |  |
|  |  |  |
|  |  |  |
|  | Bjorn Birnir (SIAM) | 2006 |
|  | Thomas DiCiccio (IMS) | 2004 |
|  | Ron Donagi (AMS) | 2004 |
|  | Michael Fried (AMS) | 2006 |
|  | William M. Goldman (AMS) | 2005 |
|  | Ilse Ipsen (SIAM) | 2006 |
|  | Tasso Kaper (SIAM) | 2006 |
|  | Ludmil Katzarkov (AMS) | 2007 |
|  | Charles Kooperberg (IMS) | 2006 |
|  | Steven Lalley (IMS) | 2005 |
|  | Hema Srinivasan (AMS) | 2004 |
|  | J. T. Stafford (AMS) | 2004 |
| Chair | Kenneth Stephenson (AMS) | 2004 |

4.10.4. AMS-IMS-SIAM Summer Research Conference Advisory Panel
Terms expire on June 30.

| James A. Carlson (AMS) | 2006 |
| :--- | :--- |
| Sun-Yung Alice Chang (AMS) | 2005 |
| Percy Alec Deift (SIAM) | 2004 |
| Persi Diaconis (IMS) | 2005 |
| Prem K. Goel (IMS) | 2004 |
| Bart Ng (SIAM) | 2006 |

4.10.5. AMS-MAA Committee on Cooperation

All members of this committee serve ex officio.
James G. Arthur (AMS)
Carl C. Cowen (MAA)
Robert J. Daverman (AMS)
David Eisenbud (AMS)
John H. Ewing (AMS)
Ronald L. Graham (MAA)
Martha J. Siegel (MAA)
Tina H. Straley (MAA)

### 4.10.6. AMS-MAA Committee on Mathematicians with Disabilities

|  | Curtis Bennett (MAA) | 2005 |
| :--- | :--- | :--- |
|  | John D. Fulton (MAA) | 2003 |
|  | Michael Klass (AMS) | 2005 |
| Chair | Eileen L. Poiani (MAA) | 2003 |
|  | Jack R. Porter (AMS) | 2004 |
|  | Gerard Walschap (AMS) | 2004 |

### 4.10.7. AMS-MAA Committee on Research in Undergraduate Mathematics Education (CRUME)

| Anne E. Brown (MAA) | 2004 |
| :--- | :--- |
| Julie M. Clark (MAA) | 2005 |
| Bruce N. Cooperstein (AMS) | 2004 |
| Ed Dubinsky (MAA) | 2006 |
| Karen King (AMS) | 2005 |
| Jay A. Malmstrom (AMATYC) | 2004 |
| John Ryan (AMS) | 2005 |
| Kirk Weller (AMS) | 2006 |
| Kay Wohlhuter (NCTM) | 2004 |

4.10.8. AMS-MAA Committee on Teaching Assistants and Part-time Instructors (TA/PTI)

| Judith M. Arms (AMS) | 2006 |
| :--- | :--- |
| Judith Lee Baxter (AMS) | 2005 |
| Kevin E. Charlwood (MAA) | 2004 |
| Robin J. Gottlieb (AMS) | 2006 |
| Lisa A. Mantini (MAA) | 2006 |
| Teri J. Murphy (MAA) | 2004 |
| Bruce Reznick (MAA) | 2004 |
| Pat Shure (AMS) | 2004 |
| Natasha Speer (AMS) | 2004 |


| 4.10.9. | AMS-MAA Joint Archives Committee |  |
| :--- | :--- | :--- |
| Chair | Steven L. Batterson (AMS) | 2004 |
|  | R. Keith Dennis (AMS) | 2006 |
|  | Mary W. Gray (MAA) | 2006 |
|  | Judy Green (AMS) | 2005 |
|  | Karen H. Parshall (MAA) | 2005 |
|  | James J. Tattersall (MAA) | 2004 |

### 4.10.10. AMS-MAA Joint Meetings Committee

All members of this committee serve ex officio.

| Chair | Robert J. Daverman |
| :--- | :--- |
| Consultant | John H. Ewing |
|  | Diane Saxe |
|  | Tina H. Straley |
|  | James J. Tattersall |

4.10.11. AMS-MAA Exhibits Advisory Subcommittee Terms begin on January 1 and end on December 31 of the year listed.

Cheryl Adams
Becky Anderson
Acasia Dalmau-Lopez
Robert J. Daverman
Joanne Foster
James Gandorf
Beth Huber
Patricia Kearney
Mary Kittell
Julie Lindstrom
Elaine Pedreira-Sullivan
Penny Pina
Diane M. Saxe
Sandi Lynn Scherer
Jackie Smith
James J. Tattersall
David Tranah
4.10.12. AMS-MAA Joint Program Committee for the

Atlanta Meeting January 5-8, 2005
Chair
Joseph A. Gallian (MAA)
Richard Hain (AMS)
Aparna W. Higgins (MAA)
Richard Randell (AMS)
4.10.13. AMS-MAA Arrangements Committee for the

Atlanta Meeting January 5-8, 2005
Sharon Ross Cutler
4.10.14. AMS-MAA-SIAM Joint Committee on Employment Opportunities
AMS staff contact: James W. Maxwell.

| Chair | Neil J. Calkin (AMS) | 2004 |
| :--- | :--- | ---: |
|  | Kevin E. Charlwood (AMS) | 2006 |
|  | Annalisa Crannell (MAA) | 2004 |
| Eli Donkar (MAA) | 2006 |  |
|  | David A. Field (SIAM) | 2006 |
|  | James W. Maxwell (AMS) | ex officio |
|  | Michael Pearson (MAA) | ex officio |
|  | Lee Seitelman (SIAM) | 2006 |
|  | Katherine St. John (AMS) | 2005 |
|  |  | 2006 |

4.10.15. AMS-MAA-SIAM Joint Policy Board for Mathematics
MAA and SIAM members' terms expire December 31 of the year given.

| James Crowley (SIAM) | 2007 |
| :--- | :--- |
| Robert J. Daverman (AMS) | 2006 |
| David Eisenbud (AMS) | 2004 |
| John H. Ewing (AMS) | 2004 |
| Ronald L. Graham (MAA) | 2004 |
| James M. Hyman (SIAM) | 2005 |
| David J. Lutzer (MAA) | 2005 |
| Thomas A. Manteuffel (SIAM) | 2003 |
| Tina H. Straley (MAA) | 2007 |


| 4.10.16. AMS-MAA-SIAM Frank and Brennie Morgan |  |  |
| :--- | :--- | ---: |
|  | Prize for Outstanding Research in |  |
|  | Mathematics by an Undergraduate Student |  |
|  |  | Kelly J. Black (SIAM) |

4.10.17. AMS-SIAM Committee on Applied Mathematics

James W. Demmel
Tai-Ping Liu
Juan C. Meza
Tamar Schlick
4.10.18. Annual Survey Data Committee

AMS staff contact: James W. Maxwell.

|  | Amy Cohen-Corwin (MAA) | 2005 |
| :--- | :--- | ---: |
|  | Donald M. Davis (AMS) | 2005 |
|  | Nicholas M. Ercolani (AMS) | 2006 |
|  | J. Douglas Faires (MAA) | 2005 |
|  | Alexander J. Hahn (AMS) | 2004 |
| Chair | Naresh Jain (IMS) | 2005 |
|  | Stephen F. Kennedy (AMS) | 2004 |
|  | Ellen E. Kirkman (AMS) | 2004 |
|  | David J. Lutzer (MAA) | 2005 |
|  | James W. Maxwell (AMS) | ex officio |
|  | Polly Phipps (ASA) | 2006 |

## Special Committees

### 4.10.19. AMS-Deutsche Mathematiker Verinigung (DMV)-Osterrichische Gesellschaft (OMG) Joint Program Committee, Mainz, Germany June 16-19, 2005

Volker Bach
Hans Werner Ballmann
Klaus D. Bierstedt
Susan J. Friedlander
Wilfried Schmid
Klaus Schmidt
B. A. Taylor
4.10.20. AMS-Taiwanese Mathematical Society (TMS) Joint Program Committee, December 14-18, 2005

Sun-Yung Alice Chang
Robert Lazarsfeld
Horng-Tzer Yau

## 5. Representatives

### 5.0.1. American Association for the Advancement of Science <br> Terms expire on February 21.

| Section A | Robert Osserman | 2006 |
| :--- | :--- | :--- |
| Section Q | Alan Tucker | 2006 |

5.0.2. Canadian Mathematical Society
Walter L. Craig ..... 2005

5.0.3. Commission on Professionals in Science and
Technology
Ellen E. Kirkman ..... 2004
5.0.4. Committee on the American Mathematics Competition (MAA)

Term expires on June 30.
Ravi Vakil2006
5.0.5. Conference Board of the Mathematical Sciences
David Eisenbud ..... 2004
5.0.6. Delbert Ray Fulkerson Prize Selection Committee ..... 2006
5.0.7. Joint Public Service Award Committee of the
AAS-AMS-APS

| James G. Arthur | 2006 |
| :--- | :--- |
| David Eisenbud | 2004 |

5.0.8. MAA Committee on Undergraduate Program in Mathematics (CUPM)

| Ramesh A. Gangolli | 2005 |
| :--- | :--- |
| Diane Herrmann | 2005 |

5.0.9. U.S. National Committee on Theoretical and Applied Mechanics
Term expires on October 31.
David Kinderlehrer

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# Mathematics Calendar 

The most comprehensive and up-to-date Mathematics Calendar information is available on e-MATH at
http://www.ams.org/mathcal/.

## October 2004

*5-10 Workshop on Geometric Tomography, Universidad de Alicante, Alicante, Spain.
Scope: Geometric Tomography is the branch of mathematics that deals with the retrieval of information about a geometric object from data about its sections, or projections, or both. The scope of this Workshop is to present the latest developments in this and in related topics and to facilitate the meeting between experts of the field and young researchers. Some of the lectures will have introductory level. There will be also communications on recent results.
Invited Speakers: Richard Gardner (Western Washington Univ.); Horst Martini (Technische Univ. Chemnitz); Wolfgang Weil (Univ. Karlsruhe); Apostolos Giannopoulos (Univ. of Crete); Markus Kiderlen (Univ. of Aarhus, Denmark); Artem Zvavitch (Univ. of Missouri-Columbia).
Information: http://www.ua.es/congreso/wgt/.

* 14-16 The p-Laplace equation, the infinity-Laplace equation and related topics, Linköping University, Linköping, Sweden.
Topics: Questions of regularity forp-Laplace and for infinity-Laplace equation absolutely minimizing functions (AMLE), role of viscosity solutions special situation in two dimensions; some relation to complex analysis eigenvalue problems for infinity Laplace structure of AMLE functions and other open problems; singular solutions obstacle problems for p-Laplace comparison principles excursion into more general metric spaces quasi-regular mappings numerical experiments AMLE and image interpolation/
Deadline: For registration: September 12, 2004.
Scientific committee: Gunnar Aronsson, Linköping; Peter Lindqvist, Trondheim; Petri Juutinen, Jyväskylä.

Organizing committee: Gunnar Aronsson, Brian Edgar, Ulf Janfalk Theresia Roth, Bengt Ove Turesson.
Confirmed speakers: Michael Crandall, Santa Barbara; Lawrence Craig Evans, Berkeley; Petri Juutinen, Jyväskylä; Bernd Kawohl, Köln; Peter Lindqvist, Trondheim; Juan Manfredi, Pittsburgh; Giorgio Talenti, Firenze.
Information: http://www.mai.liu.se/~uljan/conf/.

* 18-22 Time-reversal communications in richly scattering environments, AIM Research Conference Center, Palo Alto, California. Organizers: Robert Calderbank, George Papanicolaou, and Arogyaswami Paulraj.
Topics: This workshop, sponsored by AIM and the NSF, will bring together mathematicians and electrical engineers to explore the key issues underlying a new class of wireless communications systems that may have significant advantages over current approaches.
Deadline: September 1, 2004.
Information:http://aimath.org/ARCC/workshops/timerev.html.


## November 2004

* 9-10 DIMACS Working Group on Data De-Identification, Combinatorial Optimization, Graph Theory, and the Stat/OR Interface, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.
Description: In this meeting we will explore problems in combinatorial optimization, graph theory, and the interface between statistics and operations research that arise from issues of data privacy and, more specifically, data de-identification.
Organizer: Larry Cox, CDC, email: Icox@cdc.gov; Fred Roberts, DIMACS, email: froberts@dimacs.rutgers.edu.

This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found on the last page of each issue.
An announcement will be published in the Notices if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in every third issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.
In general, announcements of meetings and conferences held in North America carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with
respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the Notices in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.
In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the Notices prior to the meeting in question. To achieve this, listings should be received in Providence 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/.

Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.
Information: http://dimacs.rutgers.edu/Workshops/Stat/.
*26-28 Tame and Wild Workshop, Department of Mathematics, Uppsala University, Uppsala, Sweden.
Speakers: Igor Burban, Karin Erdmann, Gert-Martin Greuel, Steffen König, Helmut Lenzing, Serge Ovsienko, Claus Ringel, Leonid Vainerman, 2 more speakers to be confirmed.
Organizers: V. Mazorchuk and L. Turowska.
Information:http://www.math.uu.se/tww/; email: tww@math.uu. se.

## December 2004

*13-15 Pseudospectra and Structural Dynamics, University of Bristol, Bristol, UK.
Aim: The aim of this workshop is to bring together experts in pseudospectra and structural dynamics to assimilate ideas and methods from both communities.
Points: To be addressed include: Linear Algebra and Scientific Computation: Theory and Computation of Pseudospectra, StructurePreserving Analysis, Non-Normality and Transient Behaviour. Applications in Structural Dynamics: Analysis of Vibrating Systems, Reliability of Mechanical Systems, Vulnerability of Structures.
Confirmed Speakers: Yakov Ben-Haim, Matthew Cartmell, Jonathan Cooper, Mike Friswell, Seamus Garvey, Des Higham, Nick Higham, Tony Pritchard, Panos Psarrakos, Nick Trefethen, Marian Wiercigroch, and Keith Worden.
Information: Registration Information: If you are interested in attending the workshop please contact the organisers by sending an email to blade-pseudospectra@bristol.ac.uk; http://eis. bris.ac.uk/~enxtw/pseudo.html.

## January 2005

* 10-14 4th Symposium on Lévy Processes, University of Manchester, Manchester, England.
Topics: Lévy Processes, with breakout sessions on fractals and on finance. Also a special day in honour of the 75th birthday of S. James Taylor.
Organizers: Ron Doney (Manchester); Dave Applebaum (Nottingham Trent); Nick Bingham (Sheffield); Charles Goldie (Sussex) and René Schilling (Sussex).
Information:http://www.ma.man.ac.uk/4levy-conference.html or contact the organisers at email: rad@maths.man.ac.uk or $r$. schilling@sussex.ac.uk.
*31-February 1 DIMACS Workshop on Bounded Rationality, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.
Description: This workshop will bring together economists and game theorists interested in bounded rationality, as well as theoretical computer scientists with experience in limited computational models. It will explore previous interactions between computer scientists and economists concerning this topic.
Organizers: Lance Fortnow, Univ. of Chicago, email: fortnow@cs. uchicago.edu; Richard McLean, Rutgers Univ., email: rpmclean@ rci.rutgers.edu; Daijiro Okada, Rutgers Univ., email: okada@ econ.rutgers.edu.
Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.
Information: http://dimacs.rutgers.edu/Workshops/Bounded/


## February 2005

* 17-21 CERM. 4 (Fourth Congress of the European Society for Research in Mathematics Education), Sant Feliu de Guíxols, Spain

Aim: CERME is a congress designed to foster a communicative spirit. It deliberately and distinctively moves away from research presentations by individuals towards collaborative group work. Its main feature is a number of thematic groups whose members will work together in a common research area. Researchers wishing to present a paper at the congress should submit the paper to one of these groups. In addition to the thematic working groups, there will be plenary sessions, including plenary speakers and debates, poster sessions, and ERME policy sessions.
Programme Committee Members: Abraham Arcavi (II), Christer Bergsten (S), Rita Borromeo Ferri (G), Marianna Bosch (E), Jean-Luc Dorier (F), Núria Gorgorió (E), Barbara Jaworski (UK-N), Joao Pedro Ponte (P), Heinz Steinbring (G), Nada Stehlikova (Ch), Ewa Swoboda (Pl), Rosetta Zan (G).
Speakers: Yves Chevallard (F), Margaret Brown (UK), Juan D. Godino (E), Michèle Artigue (F), Paul Ernest (UK), Fulvia Furinghetti (I), Jose Matos (P), Costas Tzanakis (Gr).
Working Groups: The congress is organised around thematic groups working in parallel. Groups will have at least 12 hours over 4 days to meet and progress their work. Participants are encouraged to attend and contribute to the work of just one group.
Deadlines: For deadline and further information please check the web site of the congress: http://cerme4.crm.es.

## March 2005

*14-18 Deterministic and stochastic Navier-Stokes equations, AIM Research Conference Center, Palo Alto, California.
Topics: This workshop, sponsored by AIM and the NSF, will discuss global solutions to the Navier Stokes equation. The main goal of the workshop is improved understanding of the three dimensional initial problem. A number of other settings will be discussed which can inform the discussion including: stochastic and stationary solutions in two and three dimentions, the structure of invariant measures, and simplified model problems. Experts in numerical simulations will participate in the discussion to lend intuition and inform the analytic discussions with the wealth of numerical experiments which have been performed.
Organizers: Yakov Sinai and Jonathan Mattingly.
Application deadline: November 15, 2004.
Information:http://aimath.org/ARCC/workshops/navierstokes. html .
*19-20 Twenty-Eighth Annual Texas Partial Differential Equations Conference, University of Texas, Pan American, Edinburg, Texas.
Description: The Texas Partial Differential Equations Conference (Texas PDE) is an annual event that brings together researchers working on partial differential equations and related topics (ODEs, delay differential equations, numerical analysis of PDEs, etc). The Texas PDE was first organized by Professors Charles Radin and Ralph Showalter at the University of Texas at Austin in 1978.
Speakers: The Texas PDE has a strong democratic tradition: there are no principal speakers, all talks are allocated the same length of time, and there is no registration fee. The intent is to encourage participation by young faculty and graduate students.
Organizers: Andras Balogh (abalogh@panam.edu), Paul Bracken (bracken@panam.edu), Lokenath Debnath (debnathl@panam.edu), Bao-Feng Feng (feng@panam.edu), Roger Knobel (knobel@panam. edu), Vladimir Varlamov (varlamov@panam. edu).
Deadline: Those wishing to speak should submit title and short abstract by Friday, February 18, 2005 (preferably by email) to: email: abalogh@panam.edu.
Information: http://www.math.panam.edu/txpde05.html.
*22-26 Conference on Algebra and its Applications, Center of Ring Theory and Its Applications, Department of Mathematics, Ohio University, Athens, Ohio.
Aim: The aim of the Conference is to highlight the recent developments in theory of rings, representation theory, applications
of algebra to such fields as coding theory, cryptography, linear algebra.
Organizer: Center of Ring Theory and its Applications.
Invited Speakers: K. Fuller Fuchs J. L. Gomez-Pardo, K. Goodearl, B. Huisgen-Zimmermannn, C. R. Johnson, T. Y. Lam, T. Lenagan, A. Mikhalev, D. Mundici, A. Nechaev, H. Niederreiter, D. Passman, R. Plemmons, E. Puczylowski, C. M. Ringel, J. Rosenthal, D. Simson, A. Smoktunowicz, L. W. Small, J. Wolfmann, E. Zelmanov.
Deadlines: Those interested to participate and giving a talk may please submit their abstracts electronically by January 15, 2005. See instructions on webpage as to how to submit your abstract.
Information: http://www.math.ohiou.edu/~jain/conference. html; email: algebraconference@math.ohiou.edu.

## May 2005

:5-6 DIMACS Workshop on Security of Web Services and ECommerce, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.
Description: Apart from traditional aspects of web-enabled transactions such as authentication and digital signatures the workshop will explore such issues as: How do we build secure web services? How do we support commerce on the web? How do we securely handle web caches, which are an (authorized) "man in the middle"? What about content distribution security? How do we deal with the security issues raised by SOAP and XML, and how can they help improve security on the web? What types of auctions, electronic trading markets and electronic funds transfers can be implemented e.ciently and securely? The workshop will be focused on these and other current and future security and privacy challenges for web applications and e-commerce.
Organizer: Brian LaMacchia, Microsoft, email: bal@microsoft.com. Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.
Information:http://dimacs.rutgers.edu/Workshops/Commerce/
'13-14 Sixth Mississippi State-UAB Conference on Differential Equations \& Computational Simulations, Mississippi State University, Mississippi State, Mississippi
Description: This Interdisciplinary Conference will provide a joint forum where mathematicians, scientists, and engineers from academia and industry can exchange research ideas involving theoretical and applied developments in differential equations and computational simulations. In addition to the nine principal lectures, there will be sessions of contributed talks.
Conference Dedications: To Louis Nirenberg in celebration of his 80th birthday, Klaus Schmitt in celebration of his 65 th birthday, and their contributions in mathematics.
Organizers: Ratnasingham Shivaji Department of Mathematics \& Statistics, Mississippi State, MS, 39762; email: shivaji@math. msstate.edu, Phone: 662-325-3414/325-7136, Fax: 662-325-0005; Bharat Soni , Department of Mechanical Engineering, Birmingham, Alabama 35294; email: bsoni@uab.edu, Phone: 205-934-1820, Fax: 205-975-7217.
Co-Sponsors: Engineering Research Center, Mississippi State Univerisity, Electronic Journal of Differential Equations (EJDE), Institute of Mathematics and its Applications (IMA).
Principal Speakers: Margaret Cheney, Rensselaer Polytechnic Institute; Lawerence Delucas, University of Alabama at Birmingham; Weinan E, Princeton University; Thomas Yizhao Hou, Mark Lewis, California Institute of Technology, University of Alberta; FangHua Lin, U.S. Army, Nasa Ames Research Center; Robert Meakin, Courant Institute of Mathematical Sciences, Ames Research Center; Louis Nirenberg, Courant Institute of Mathematical Sciences; Klaus Schmitt, University of Utah.
Pre-registration deadline: May 1, 2005.
Information: http://www.msstate.edu/dept/math/de2005/.
*22-25 ICCS 2005: International Conference on Computational Science, Atlanta, Georgia.
Theme: The theme for ICCS 2005 in Atlanta, Georgia, is "Advancing Science through Computation".
Important dates: Proposals for Workshops: November 1, 2004. Full papers submission: December 1, 2004. Notification of acceptance of papers: January 31, 2005. Camera ready papers: February 14, 2005. Early registration: March 30, 2005.

Chairmen: Vaidy Sunderam, Scientific Chair; Dick van Albada, Workshop Chair; Jack Dongarra, Overall Co-chair; Peter M. A. Sloot, Overall Chair.
Contact: email: iccs2005@mathcs.emory.edu; http://www.iccsmeeting.org/.
*23-25 DIMACS Workshop on The Epidemiology and Evolution of Influenza, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.
Description: This workshop will explore the epidemiology and evolution of influenza. Among the issues to be explored are the causes and consequences of patterns of immunological crossreactivity, and the interactions with drug treatment and vaccination strategies. In addition, the applicability of SIR and agent based models to predict the spread of influenza, and the means of dealing with and planning for an influenza pandemic, will be discussed.
Organizers: Catherine Macken, Los Alamos National Labs, email: cam@t10.lanl.gov; Alan Perelson, Los Alamos National Labs, email: asp@lanl.gov.
Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.
Information: http://dimacs.rutgers.edu/Workshops/
Influenza/.

## June 2005

* 4-8 International Conference on Scientific Computing (ICSCO5), Nanjing, P. R. China.
Aim and Scope: This conference will provide a forum for applied mathematicians worldwide to present new and emerging research developments and future directions in computational mathematics and scientific computing and applications; to exchange research results and ideas; and to promote international and local research and educational cooperation and connections.
Sponsors: Nanjing Normal University, Nanjing University, Nanjing University of Aeronautics \& Astronautics, Peking University, Institute of Applied Physics and Computational Mathematics (IAPCM), Chinese Academy of Sciences (CAS), National Science Foundation of China (NSFC), Department of Mathematics, North Carolina State University, USA.
Organizing Committee: Yongzhong Song, Chair, Nanjing Normal University, Jinru Chen, Nanjing Normal University, Zhiming Chen, Chinese Academy of Sciences, Hua Dai, Nanjing University of Aeronautics \& Astronautics, Binsheng He, Nanjing University, Song Jiang, Institute of Applied Physics and Computational Mathematics, Zhilin Li, co-chair, North Carolina State University, USA Wenyu Sun, co-chair, Nanjing Normal University, China Pingwen Zhang, Peking University, China Ning Zhao, Nanjing University of Aeronautics \& Astronautics
*6-8 DIMACS Workshop on Polyhedral Combinatorics of Random Utility, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.
Description: Utility functions have a long history in economics and psychology but have recently caught the attention of computer scientists in various applications. Random utility approaches have been extensively used in the social sciences. The fundamental idea is that utilities of agents could be hard or even impossible to precisely assess or elicit, so one should model these utilities as random variables. This modeling approach could turn out to be useful in developing and solving optimization problems and algorithms for which there is no time to or where it is is impossible
to assess/obtain input data precisely. Such situations could be of interest in computing tasks with massive input data sets as well as tasks in which data corresponds to agent valuations that have to be elicited (such as pricing data like the willingness to buy/pay at a given price). Discrete choice models, i.e., situations in which utilities of only finitely many objects have to be elicited, are of special interest (and have been studied extensively, for example with regard to transportation systems, consumer choice in marketing, etc.
Workshop: On this topic will allow for exchange of ideas between researchers in random utility on the one side and polyhedral combinatorics on the other, with inclusion of computer scientists with expertise on algorithmic approaches to such problems as well as computer scientists with an interest in modern applications in IT. The aim is to define a program and general theory of developing random utility models that could be efficiently characterized and tested through experimental data.
Organizers: Jean-Paul Doignon, Univ. Libre de Bruxelles, email: doignon@ulb.ac.be; Aleksandar Pekec, Fuqua School of Business, Duke University, email: pekec@duke.edu.
Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.
Information: http://dimacs.rutgers.edu/Workshops/ RandomUtility/.
*19-24 Conference on Applied Mathematics and Scientific Computing 4: On the occasion of Professor Aganovic's 70th Birthday, Brijuni, Croatia.
Aim: The exchange of ideas, methods and problems between various disciplines of applied mathematics. Non mathematicians using mathematics as a tool are also encouraged to take part in the Conference.
Topics: Mathematical methods in fluid mechanics (main topic) -Splines and wavelets with applications to CAGD, CAD/CAM, computer graphics and differential equations -Ordinary and partial differential equations, integral equations, singular perturbation problems -Mathematics of Finance -Numerical Mathematics in general -Optimization -Scientific Computing -Engineering
Invited Speakers: Maria Rosaria Padula, University of Ferara, Italy, Sunèica Eaniæ, University of Houston, USA, Alain Bourgeat, University Lyon 1, France, Andro Mikeliæ, University Lyon 1, France, Kreúimir Veseliæ, Fernuniversitat, Hagen, Germany, Brahim Amaziane, University of Pau, France.
Organizer: Department of Mathematics, University of Zagreb; phone: 385-1-4605745; fax: 385-1-4680335; email: App1Math03@ math.hr.
Information: http://ApplMath05.math.hr.


## July 2005

*28-August 3 Logic Colloquium '05: ASL European Summer Meeting, Athens, Greece.
Short Courses: Computer Science Logic, Ph.-G. Kolaitis, I.B.M. Almaden Research Center \& U.C.S.C., U.S.A.; Model Theory, I. BenYaacov, Univ. of Wisconsin, U.S.A.; Philosophy of Logic, Speaker to be announced; Proof Theory and Constructivity, P. Aczel, Univ. of Manchester, U.K.
Plenary Lectures: Invited Speakers will include: J. Bergstra (Univ. of Amsterdam, Netherlands), D. Haskell (McMaster Univ., Canada), J. Moore (Boise State Univ., Idaho, U.S.A.), H. Schwichtenberg (Univ. of Munich, Germany), M. Sheard (Saint Lawrence Univ., New York), S. Tupailo (Tallinn univ. of Technology, Estonia), K. Weihrauch (Univ. of Hagen, Germany), J. Zapletal (Univ. of Florida, Gainesville, U.S.A.).

Address for Submission: Abstracts should be submitted to the address: Logic Colloquium 2005, Department of Mathematics, University of Athens, GR-157 84 Zografou, Greece; email: 1c2005® math.uoa.gr.
Information: http://www.math.uoa.gr/1c2005.

The following new announcements will not be repeated until the criteria in the next to the last paragraph at the bottom of the first page of this section are met.
July 2006
*30-August 24 Bayesian Nonparametric Regression: Theory, Methods and Applications, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom.
Organizers: Professor N. Hjort (Oslo), Dr C. Holmes (Oxford), Professor P. Mueller (Texas), Professor S. Walker (Bath).
Information: Isaac Newton Institute for Mathematical Sciences, 20 Clarkson Road, Cambridge, CB3 0EH, U.K., Tel.: +44 1223335999 , Fax.: +44 1223 330508; email: info@newton.cam.ac.uk ; http:// www.newton.cam.ac.uk/programmes/BNR/index.html.

# New Publications Offered by the AMS 

## Algebra and Algebraic Geometry



> Moduli of Riemann Surfaces, Real Algebraic Curves, and Their Superanalogs
S. M. Natanzon, Moscow State University, Russia, and Independent University of Moscow, Russia

The space of all Riemann surfaces (the so-called moduli space) plays an important role in algebraic geometry and its applications to quantum field theory. The present book is devoted to the study of topological properties of this space and of similar moduli spaces, such as the space of real algebraic curves, the space of mappings, and also superanalogs of all these spaces.
The book can be used by researchers and graduate students working in algebraic geometry, topology, and mathematical physics.
Contents: Introduction; Moduli of Riemann surfaces, Hurwitz type spaces and their superanalogs; Moduli of real algebraic curves and their superanalogs. Differentials, spinors, and Jacobians of real curves; Spaces of meromorphic functions on complex and real algebraic curves; Bibliography; Index.
Translations of Mathematical Monographs, Volume 225
September 2004, 160 pages, Hardcover, ISBN 0-8218-3594-7, LC 2004051990, 2000 Mathematics Subject Classification: 14H15, 32G15; 14H40, 14M30, 14P25, 30F35, 30F60, 32C11, 57M12, All AMS members \$47, List \$59, Order code MMONO/225N


## Exceptional Vector Bundles, Tilting Sheaves and Tilting Complexes for Weighted Projective Lines

Hagen Meltzer, Szczecin University, Poland

Contents: Background; Summary; Weighted projective lines; Mutations of exceptional sequences; Tubular mutations; Twisted mutations; On the number of exceptional vector bundles; Tilting sheaves; Tilting complexes; Hyperelliptic weighted projective lines; Bibliography; Index.
Memoirs of the American Mathematical Society, Volume 171, Number 808

July 2004, 139 pages, Softcover, ISBN 0-8218-3519-X, LC 2004049173, 2000 Mathematics Subject Classification: 14F05, 16G10; 16G70, 16G60, Individual member \$35, List \$58, Institutional member $\$ 46$, Order code MEMO/ $171 / 808 \mathrm{~N}$


## Group Theory, Statistics, and Cryptography

Alexei G. Myasnikov and Vladimir Shpilrain, City College of New York, NY, Editors

This volume consists of contributions by speakers at the AMS Special Session on Combinatorial and Statistical Group Theory held at New York University. Readers will find a variety of contributions, including survey papers on applications of group theory in cryptography, research papers on various aspects of statistical group theory, and papers on more traditional combinatorial group theory.
The book is suitable for graduate students and research mathematicians interested in group theory and its applications to cryptography.

This item will also be of interest to those working in applications.
Contents: P. Ackermann, V. große Rebel, and G. Rosenberger, On power- and commutation transitive, power commutative, and restricted Gromov groups; P. Dehornoy, Braid-based cryptography; B. Fine, A. M. Gaglione, and D. Spellman, Discriminating and squarelike groups I: Axiomatics; R. Z. Goldstein, The density of small words in a free group is 0; S. P. Humphries, Braid groups and $\operatorname{Aut}\left(\mathrm{F}_{2}\right)$ are not rigid; S. V. Ivanov and A. M. Storozhev, On varieties of groups in which all periodic groups are abelian; O. G. Kharlampovich, A. G. Myasnikov, V. N. Remeslennikov, and D. E. Serbin, Subgroups of fully residually free groups: Algorithmic problems; D. V. Osin, Weak hyperbolicity and free constructions; I. Rivin, Some properties of the conjugacy class growth function; E. C. Turner and C. F. Rocca, Boundary test elements; L. Sabalka, Geodesics in the braid group on three strands; L. M. Shneerson, Remarks on the growth of inverse semigroups; V. Shpilrain, Assessing security of some group based cryptosystems.
Contemporary Mathematics, Volume 360
November 2004, 177 pages, Softcover, ISBN 0-8218-3444-4, LC 2004050202, 2000 Mathematics Subject Classification: $20-\mathrm{XX}, 57 \mathrm{Mxx}, 68 \mathrm{P} 25,68 \mathrm{Qxx}, 94 \mathrm{~A} 60$, All AMS members $\$ 47$, List $\$ 59$, Order code CONM/360N

## Locally Finite Root Systems

Ottmar Loos, University of Innsbruck, Austria, and
 Erhard Neher, University of Ottawa, ON, Canada

Contents: Introduction; The category of sets in vector spaces; Finiteness conditions and bases; Locally finite root systems; Invariant inner products and the coroot system; Weyl groups; Integral bases, root bases and Dynkin diagrams; Weights and coweights; Classification; More on Weyl groups and automorphism groups; Parabolic subsets and positive systems for symmetric sets in vector spaces; Parabolic subsets of root systems and presentations of the root lattice and the Weyl group; Closed and full subsystems of finite and infinite classical root systems; Parabolic subsets of root systems: classification; Positive systems in root systems; Positive linear forms and facets; Dominant and fundamental weights; Gradings of root systems; Elementary relations and graphs in 3-graded root systems; Some standard results on finite root systems; Cones defined by totally preordered sets; Bibliography; Index of notations; Index.
Memoirs of the American Mathematical Society, Volume 171, Number 811

July 2004, 214 pages, Softcover, ISBN 0-8218-3546-7, LC 2004049174, 2000 Mathematics Subject Classification: 17B10, 17B20, 20F55, Individual member \$31, List \$51, Institutional member $\$ 41$, Order code MEMO/171/811N


A Course in Ring Theory<br>Donald S. Passman, University of Wisconsin, Madison<br>"There seems to be an emerging consensus as to what material should constitute the core of a first course in module-theoretic ring theory ... The book ... is definitely within the bounds of that consensus ... presentation is clear, the proofs are often quite inge- nious and the exercises are well chosen ... definitely suitable for use as a textbook."

-MathSciNet

First published in 1991, this book contains the core material for an undergraduate first course in ring theory. Using the underlying theme of projective and injective modules, the author touches upon various aspects of commutative and noncommutative ring theory. In particular, a number of major results are highlighted and proved.
The first part of the book, called "Projective Modules", begins with basic module theory and then proceeds to surveying various special classes of rings (Wedderburn, Artinian and Noetherian rings, hereditary rings, Dedekind domains, etc.). This part concludes with an introduction and discussion of the concepts of the projective dimension.
Part II, "Polynomial Rings", studies these rings in a mildly noncommutative setting. Some of the results proved include the Hilbert Syzygy Theorem (in the commutative case) and the Hilbert Nullstellensatz (for almost commutative rings).
Part III, "Injective Modules", includes, in particular, various notions of the ring of quotients, the Goldie Theorems, and the characterization of the injective modules over Noetherian rings.
The book contains numerous exercises and a list of suggested additional reading. It is suitable for graduate students and researchers interested in ring theory.
Contents: Projective modules: Modules and homomorphisms; Projective modules; Completely reducible modules; Wedderburn rings; Artinian rings; Hereditary rings; Dedekind domains; Projective dimension; Tensor products; Local rings; Polynomial rings: Skew polynomial rings; Grothendieck groups; Graded rings and modules; Induced modules; Syzygy theorem; Patching theorem; Serre conjecture; Big projectives; Generic flatness; Nullstellensatz; Injective modules: Injective modules; Injective dimension; Essential extensions; Maximal ring of quotients; Classical ring of quotients; Goldie rings; Uniform dimension; Uniform injective modules; Reduced rank; Index.
AMS Chelsea Publishing
September 2004, 306 pages, Hardcover, ISBN 0-8218-3680-3, LC 2004054403, 2000 Mathematics Subject Classification: 16-01; 16-02, 19-02, All AMS members \$41, List \$45, Order code CHEL/348.HN

## Differential Equations



## Partial Differential Equations and Inverse Problems

Carlos Conca, Raúl Manásevich, Gunther Uhlmann, and Michael S. Vogelius, Editors

This proceedings volume is a collection of articles from the Pan-American Advanced Studies Institute on partial differential equations, nonlinear analysis and inverse problems held in Santiago (Chile).
Interactions among partial differential equations, nonlinear analysis, and inverse problems have produced remarkable developments over the last couple of decades. This volume contains survey articles reflecting the work of leading experts who presented minicourses at the event. Contributors include J. Busca, Y. Capdeboscq, M.S. Vogelius, F. A. Grünbaum, L. F. Matusevich, M. de Hoop, and P. Kuchment.
The volume is suitable for graduate students and researchers interested in partial differential equations and their applications in nonlinear analysis and inverse problems.

This item will also be of interest to those working in applications.
Contents: T. Aktosun, Inverse scattering on the line with incomplete scattering data; M. S. Ashbaugh, On universal inequalities for the low eigenvalues of the buckling problem; J. Baras, C. Berenstein, and F. Gavilánez, Continuous and discrete inverse conductivity problems; R. D. Benguria and M. Loss, Connection between the Lieb-Thirring conjecture for Schrödinger operators and an isoperimetric problem for ovals on the plane; J. Busca, An introduction to PDE methods in finance; Y. Capdeboscq and M. S. Vogelius, A review of some recent work on impedance imaging for inhomogeneities of low volume fraction; F. A. C. C. Chalub and J. P. Zubelli, Matrix bispectrality and Huygens' principle for Dirac operators; A. J. Corcho and F. Linares, Well-posedness for the Schrödinger-Debye equation; A. Dall'Acqua and G. Sweers, On domains for which the clamped plate system is positivity preserving; M. Di Francesco and P. A. Markowich, Entropy dissipation and Wasserstein metric methods for the viscous Burgers' equation: convergence to diffusive waves;
J. Dolbeault, D. Kinderlehrer, and M. Kowalczyk, Remarks about the flashing rachet; N. Ghoussoub and R. J. McCann, A least action principle for steepest descent in a non-convex landscape; F. A. Grünbaum and L. F. Matusevich, A network tomography problem related to the hypercube; A. Hassell and J. Wunsch, On the structure of the Schrödinger propagator; M. V. de Hoop, The downward continuation approach to modeling and inverse scattering of seismic data in the Kirchhoff approximation; M. Kowalczyk, Approximate invariant manifold of the Allen-Cahn flow in two dimensions; P. Kuchment, On some spectral problems of mathematical physics; M. Lassas, L. Päivärinta, and E. Saksman, Inverse problem for a random potential; R. Mazzeo, Pseudodifferential analysis for the Laplacian on noncompact symmetric spaces;
G. A. Mendoza, Boundary structure and cohomology of $b$ complex manifolds; G. Nakamura, G. Uhlmann, and J.-N. Wang, Unique continuation property for elliptic systems and crack determination in anisotropic elasticity; M. del Pino, J. Dolbeault, and M. Musso, Duality in sub-supercritical bubbling in the Brezis-Nirenberg problem near the critical exponent; F. Reitich, High-order domain variations in boundary value and free boundary problems; A. S. Barreto, Radiation fields and inverse scattering on asymptotically Euclidean manifolds; C. Timofte and C. Conca, Interactive oscillation sources in Signorini's type problems; R. Weder, Inverse scattering with time-periodic potentials; R. Weikard, A local Borg-Marchenko theorem for difference equations with complex coefficients.
Contemporary Mathematics, Volume 362
October 2004, 410 pages, Softcover, ISBN 0-8218-3448-7, LC 2004051901, 2000 Mathematics Subject Classification: 05C40, 35B60, 35B65, 35P25, 35P99, 35Q40, 35Q53, 35Q55, 35Q60, 35R30, 58J05, 78A48, 81Q10, 81U40, All AMS members \$79, List \$99, Order code CONM/362N

## General and Interdisciplinary



## Assistantships and Graduate Fellowships 2004

From a review of a previous edition:
This directory is a tool for undergraduate mathematics majors seeking information about graduate programs in mathematics. Although most of the information can be gleaned from the Internet, the usefulness of this directory for the prospective graduate student is the consistent format for comparing different mathematics graduate programs without the hype. Published annually, the information is up-to-date, which is more than can be said of some Websites. Support for graduate students in mathematics is a high priority of the American Mathematical Society, which also provides information for fellowships and grants they offer as well as support from other societies and foundations. The book is highly recommended for academic and public libraries.
-American Reference Books Annual
This valuable reference source brings together a wealth of information about resources available for graduate study in mathematical sciences departments in the U. S. and Canada.
November 2004, approximately 128 pages, Softcover, ISBN 0-8218-3619-6, Individual member \$18, List \$23, Order code ASST/2004N


The

# Adventure of Numbers 

Gilles Godefroy, Institut de Mathématiques de Jussieu, Paris, France, and Directeur de Recherches at the C.N.R.S., Paris, France

Numbers are fascinating. The fascination begins in childhood, when we first learn to count, and continues as we learn arithmetic, algebra, geometry, and so on. Eventually, we find that numbers not only help us to measure the world, but also to understand it and, to some extent, to control it. In The Adventure of Numbers, Gilles Godefroy unfolds a great adventure of the mind by examining our expanding understanding of numbers throughout history.
The development of mathematics has been punctuated by a need to reconsider what we mean by "numbers". It is often during these times that major shifts occur, for example when the Pythagoreans discovered irrational numbers or when imaginary numbers were needed to solve the cubic. Each jump takes place in a context, where mathematics itself is forced to ponder fundamental questions, many of which led to famous controversies.
Godefroy's adventure starts in the very early days of mathematics in Mesopotamia and leads to the present day. The adventure does not end there. Important questions and controversies remain today that deal with consistency and complexity or with what constitutes a proof. And the future will hold even more questions.
The author, Gilles Godefroy, is a member of the Institut de Mathématiques de Jussieu and Directeur de Recherches at the C.N.R.S. The book is suitable for independent study and supplementary reading and is recommended for undergraduates, graduate students, and researchers interested in the history of mathematics.
Contents: Hands, sticks, and stones; By the waters of Babylon; Let none but geometers enter here; Algebra and algorithms; A new world; "Eppur, si muove!"; The century of revolutions; "From the paradise that Cantor has created for us"...; The present perplexity; And now?; Number bases; The Fibonacci sequence; Polynomials; Quaternions; Axioms of set theory and arithmetic; Glossary; Bibliography.
Mathematical World, Volume 21
September 2004, 194 pages, Softcover, ISBN 0-8218-3304-9, LC 2004054547, 2000 Mathematics Subject Classification: $01 \mathrm{~A} 05,11-03$, All AMS members \$23, List \$29, Order code MAWRLD/21N

## Geometry and Topology



# Advances in Differential Geometry and General Relativity 

S. Dostoglou, University of Missouri, Columbia, and P. Ehrlich, University of Florida, Gainesville, Editors

This volume consists of expanded versions of invited lectures given at The Beemfest: Advances in Differential Geometry and General Relativity (University of Missouri-Columbia) on the occasion of Professor John K. Beem's retirement. The articles address problems in differential geometry in general and in particular, global Lorentzian geometry, Finsler geometry, causal boundaries, Penrose's cosmic censorship hypothesis, the geometry of differential operators with variable coefficients on manifolds, and asymptotically de Sitter spacetimes satisfying Einstein's equations with positive cosmological constant.
The book is suitable for graduate students and research mathematicians interested in differential geometry.
This item will also be of interest to those working in mathematical physics.
Contents: P. E. Ehrlich and K. L. Easley, A Beemian sampler: 1966-2002; P. E. Parker, Geometry of bicharacteristics; L. Del Riego, Making the right connection?; A. Królak, Cosmic censorship hypothesis; S. G. Harris, Boundaries on spacetimes: An outline; G. J. Galloway, Cosmological spacestimes with $\Lambda>0$; T. Dray, General relativity and signature change.
Contemporary Mathematics, Volume 359
November 2004, 124 pages, Softcover, ISBN 0-8218-3539-4, LC 2004047672, 2000 Mathematics Subject Classification: 53-xx, $83-\mathrm{xx}, 58-\mathrm{xx}$, All AMS members $\$ 39$, List $\$ 49$, Order code CONM/359N


## Infinite Dimensional Complex Symplectic Spaces

W. N. Everitt, University of Birmingham, England, and L. Markus, University of Minnesota, Minneapolis
This item will also be of interest to those working in differential equations.
Contents: Introduction: Motivation and Organization of results; Complex symplectic spaces: Fundamental concepts and definitions; Symplectic weak topology; Algebraic and arithmetic invariants: Hilbert structures; Applications to the theory of symmetric linear operators; Aftermath; Acknowledgements; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 171, Number 810

July 2004, 76 pages, Softcover, ISBN 0-8218-3545-9, LC 2004049176, 2000 Mathematics Subject Classification: 51A50, 46A03, 37K05; 46C20, 35J40, Individual member \$31, List \$51, Institutional member \$41, Order code MEMO/171/810N


## 3-Manifolds

## John Hempel, Rice University, Houston, TX

From a review of the original edition:
A careful and systematic development of the theory of the topology of 3-manifolds, focusing on the critical role of the fundamental group in determining the topological structure of a 3-manifold ... self-contained ... one can learn the subject from it ... would be very appropriate as a text for an advanced graduate course or as a basis for a working seminar.

## -MathSciNet

For many years, John Hempel's book has been a standard text on the topology of 3-manifolds. Even though the field has grown tremendously during that time, the book remains one of the best and most popular introductions to the subject.
The theme of this book is the role of the fundamental group in determining the topology of a given 3 -manifold. The essential ideas and techniques are covered in the first part of the book: Heegaard splittings, connected sums, the loop and sphere theorems, incompressible surfaces, free groups, and so on. Along the way, many useful and insightful results are proved, usually in full detail. Later chapters address more advanced topics, including Waldhausen's theorem on a class of 3-manifolds that is completely determined by its fundamental group. The book concludes with a list of problems that were unsolved at the time of publication.
Hempel's book remains an ideal text to learn about the world of 3-manifolds. The prerequisites are few and are typical of a beginning graduate student. Exercises occur throughout the text.
Other key books on low-dimensional topology available from the AMS are Knots and Links, Lectures on Three-Manifold Topology, and The Knot Book.
Contents: Preliminaries; Heegaard splittings; Connected sums; The loop and sphere theorems; Free groups; Incompressible surfaces; Kneser's conjecture on free products; Finitely generated subgroups; More on connected sums; Finite and abelian subgroups; I-bundles; Group extensions and fibrations; Seifert fibered spaces; Classification of $P^{2}$-irreducible, sufficiently large 3-manifolds; Some approaches to the Poincaré conjecture; Open problems; References; Index; Symbols and notation.

## AMS Chelsea Publishing

November 2004, 195 pages, Hardcover, ISBN 0-8218-3695-1, LC 2004048971, 2000 Mathematics Subject Classification: 57N10, 57-01, All AMS members \$26, List \$29, Order code CHEL/349.HN

## Logic and Foundations



# Nonstandard Models of Arithmetic and Set Theory 

Ali Enayat, American University, Washington, $D C$, and Roman Kossak, City University of New York, NY, Editors

This is the proceedings of the AMS special session on nonstandard models of arithmetic and set theory held at the Joint Mathematics Meetings in Baltimore (MD). The volume opens with an essay from Haim Gaifman that probes the concept of non-standardness in mathematics and provides a fascinating mix of historical and philosophical insights into the nature of nonstandard mathematical structures. In particular, Gaifman compares and contrasts the discovery of nonstandard models with other key mathematical innovations, such as the introduction of various number systems, the modern concept of function, and non-Euclidean geometries.
Other articles in the book present results related to nonstandard models in arithmetic and set theory, including a survey of known results on the Turing upper bounds of arithmetic sets and functions. The volume is suitable for graduate students and research mathematicians interested in logic, especially model theory.
Contents: H. Gaifman, Non-standard models in a broader perspective; P. D'Aquino and J. F. Knight, Coding in $I \Delta_{0}$; A. Enayat, Automorphisms, Mahlo cardinals, and NFU; T. Forster, AC fails in the natural analogues of V and L that model the stratified fragment of ZF; H. M. Friedman, Working with nonstandard models; K. Hrbacek, Internally iterated ultrapowers; R. Jin, On some questions of Hrbacek and Di Nasso; A. M. McAllister, Turing upper bounds of jump ideals and Scott sets; J. H. Schmerl, Diversity in substructures; A. A. Togha, Automorphisms of countable recursively saturated models of set theory.
Contemporary Mathematics, Volume 361
October 2004, 167 pages, Softcover, ISBN 0-8218-3535-1, LC 2004051986, 2000 Mathematics Subject Classification: 03C62, 03C20, 03H05, 03H15, 03D50, 26E30, 03C55, 03E25, 03E99, $03 E 35$, All AMS members \$47, List \$59, Order code CONM/361N

# Number Theory 



Stark's Conjectures: Recent Work and New Directions

David Burns, King's College, London, England, Cristian Popescu, University of California, San Diego, Jonathan Sands, University of Vermont, Burlington, and David Solomon, King's College, London, England, Editors

Stark's conjectures on the behavior of $L$-functions were formulated in the 1970s. Since then, these conjectures and their generalizations have been actively investigated. This has led to significant progress in algebraic number theory.
The current volume, based on the conference held at Johns Hopkins University (Baltimore, MD), represents the state-of-the-art research in this area. The first four survey papers provide an introduction to a majority of the recent work related to Stark's conjectures. The remaining six contributions touch on some major themes currently under exploration in the area, such as non-abelian and $p$-adic aspects of the conjectures, abelian refinements, etc. Among others, some important contributors to the volume include Harold M. Stark, John Tate, and Barry Mazur.
The book is suitable for graduate students and researchers interested in number theory.
Contents: C. D. Popescu, Rubin's integral refinement of the abelian Stark conjecture; D. S. Dummit, Computations related to Stark's conjecture; C. Greither, Arithmetic annihilators and Stark-type conjectures; M. Flach, The equivariant Tamagawa number conjecture: A survey; J. W. Sands, Popescu's conjecture in multi-quadratic extensions; D. Solomon, Abelian conjectures of Stark type in $\mathbb{Z}_{p}$-extensions of totally real fields; H. M. Stark, The derivative of p-adic Dirichlet series at $\mathrm{s}=0$; J. Tate, Refining Gross's conjecture on the values of abelian $L$ functions; D. R. Hayes, Stickleberger functions for non-abelian Galois extensions of global fields; B. Mazur and K. Rubin, Introduction to Kolyvagin systems.
Contemporary Mathematics, Volume 358
October 2004, 221 pages, Softcover, ISBN 0-8218-3480-0, LC 2004049692, 2000 Mathematics Subject Classification: 11G40, 11R23, 11R27, 11R29, 11R33, 11R42, 11S40, 11Y40, All AMS members $\$ 55$, List $\$ 69$, Order code CONM/358N


# Mutually Catalytic Super Branching Random Walks: Large Finite Systems and Renormalization Analysis 

J. T. Cox, Syracuse University, NY, D. A. Dawson, Carleton University, Ottawa, ON, Canada, and A. Greven, University of Erlangen- Nurnberg, Germany

Contents: Introduction; Results: Longtime behavior of large finite systems; Results: Renormalization analysis and corresponding basic limiting dynamics; Results: Application of renormalization to large scale behavior; Preparation: Key technical tools; Finite system scheme (Proof of Theorems 1, 2); Multiple space-time scale analysis (Proof of Theorem 3, 5); Analysis of the interaction chain (Proof of Theorem 4, 6-8.
Memoirs of the American Mathematical Society, Volume 171, Number 809
July 2004, 97 pages, Softcover, ISBN 0-8218-3542-4, LC 2004049175, 2000 Mathematics Subject Classification: 60K35, 60G57, Individual member \$32, List \$54, Institutional member $\$ 43$, Order code MEMO/171/809N


> Superdiffusions and Positive Solutions of Nonlinear Partial Differential Equations

E. B. Dynkin, Cornell University, Ithaca, New York

This book is devoted to the applications of probability theory to the theory of nonlinear partial differential equations. More precisely, it is shown that all positive solutions for a class of nonlinear elliptic equations in a domain are described in terms of their traces on the boundary of the domain. The main probabilistic tool is the theory of superdiffusions, which describes a random evolution of a cloud of particles. A substantial enhancement of this theory is presented that will be of interest to anyone who works on applications of probabilistic methods to mathematical analysis.
The book is suitable for graduate students and research mathematicians interested in probability theory and its applications to differential equations.
Also of interest by this author is Diffusions, Superdiffusions and Partial Differential Equations in the AMS series, Colloquium Publications.
This item will also be of interest to those working in differential equations.

Contents: Introduction; Analytic approach; Probabilistic approach; $\mathbb{N}$-measures; Moments and absolute continuity properties of superdiffusions; Poisson capacities; Basic inequality; Solutions $w_{\Gamma}$ are $\sigma$-moderate; All solutions are $\sigma$ moderate; Appendix A: An elementary property of the Brownian motion; Appendix B: Relations between Poisson and Bessel capacities; References; Subject index; Notation index.
University Lecture Series, Volume 34
November 2004, 120 pages, Softcover, ISBN 0-8218-3682-X, LC 2004055059, 2000 Mathematics Subject Classification: $60-02$; 31B05, 35J60, 60J60, All AMS members \$23, List \$29, Order code ULECT/34N

## New AMS-Distributed Publications

## Algebra and Algebraic Geometry



Une conjecture de Lusztig pour les groupes classiques
Jean-Loup Waldspurger, Institute Mathématique de Jussieu, Paris, France

In this book, A Conjecture of Lusztig for Classical Groups, the author proves a conjecture of Lusztig connecting characters of irreducible representations with characteristic functions of character-sheaves for a classical group defined over a finite field of sufficiently large characteristic. Those functions are precisely normalized in the proof. The result generalizes Shoji's results to all classical groups. In particular, the even orthogonal group is considered, which is neither connected nor with connected center.
This item will also be of interest to those working in number theory.
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; Notations; Symboles; Faisceaux-caractères; Représentations quadratiques-unipotentes; Les théorèmes; Détermination des faisceaux-caractères quadra-tiques-unipotents; Valeurs des fonctions traces de faisceaux-caractères; Formules d'induction; Paramétrage de Lusztig; Quelques calculs de traces; Commutation à l'induction de Deligne-Lusztig; Fin de la preuve; Le cas du groupe symplectique; Bibliographie.

Mémoires de la Société Mathématique de France, Number 96

June 2004, 166 pages, Softcover, ISBN 2-85629-148-1, 2000 Mathematics Subject Classification: 11E57, 20C33, Individual member \$47, List \$52, Order code SMFMEM/96N

## Differential Equations

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Homéomorphismes de surfaces, théorémes de la fleur de Leau-Fatou et de la variété stable
Frédéric Le Roux, Université Paris Sud, Orsay, France

This book, Dynamics of Surface Homeomorphisms, Topological Versions of Leau-Fatou Flower Theorem and Stable Manifold Theorem, shows that the study of the dynamics of a surface homeomorphism in the neighborhood of an isolated fixed point leads to the following results: If the fixed point index is greater than 1, a family of attractive and repulsive petals is constructed, generalizing the Leau-Fatou flower theorem in complex dynamics. If the index is less than 1 , one gets a family of stable and unstable branches, generalizing the stable manifold theorem in differentiable hyperbolic dynamics.
This item will also be of interest to those working in geometry and topology.
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; Présentation des résultats de dynamique locale; Intermède : du local au global; Dynamique globale: énoncé et résultats préliminaires; Preuve du théorème principal de dynamique globale; Applications en dynamique locale; Appendice: Théorème de Schoenflies-Homma et variantes; Bibliographie; Index.
Astérisque, Number 292
June 2004, 120 pages, Softcover, ISBN 2-85629-153-8, 2000 Mathematics Subject Classification: 37E30, 37C25, Individual member \$23, List \$26, Order code AST/292N

# International Journal of Mathematics and Mathematical Sciences 

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## Recently Published Articles

- Backward Adaptive Biorthogonalization, L. Rebollo-Neira
- Combinatorial Polarization, Code Loops, and Codes of High Level, Petr Vojtěchovský
- Double-Dual $n$-Types over Banach Spaces Not Containing $\ell_{1}$, Markus Pomper
- Magill-Type Theorems for Mappings, Giorgio Nordo and Boris A. Pasynkov
- Minimizing Energy among Homotopic Maps, Pengzi Miao
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- On the Class of Square Petrie Matrices Induced by Cyclic Permutations, Bau-Sen Du
- Optical Leptons, Lubomir M. Kovachev
- Projectivity and Flatness over the Endomorphism Ring of a Finitely Generated Module, S. Caenepeel and T. Guédénon
- The Chromatic Sum of a Graph: History and Recent Developments, Ewa Kubicka
- Ulam's Pathological Liar Game with One Half-Lie, Robert B. Ellis and Catherine H. Yan


# Classified Advertisements 

## Positions available, items for sale, services available, and more

## CALIFORNIA

## HARVEY MUDD COLLEGE Department of Mathematics

Harvey Mudd College invites applications for a tenure-track position in statistics, biostatistics, or related statistical fields. The rank will be at the assistant or associate professor level. Excellence in teaching is essential, as is evidence of a strong and ongoing research program. Preference will given to candidates familiar with modern data analysis techniques with cross-disciplinary interests. Candidates must be willing to supervise undergraduate research, and work with others in departmental programs, such as the recently created mathematical biology major or the industrial projects-based clinic program.

Harvey Mudd College is a highly selective undergraduate institution of science, engineering and mathematics; the median SAT score is about 1470, a quarter of our students are National Merit Scholars, and one year of high school calculus is required for admission. Each year there are about 25 graduates in mathematics, CS/math, and mathematical biology with approximately half going to graduate school. Over $40 \%$ of mathematics alumni
from HMC have entered Ph.D. programs. The college enrolls about 700 students and is a member of the Claremont College consortium, which consists of four other undergraduate colleges, the Claremont Graduate University, and the Keck Graduate Institute of Applied Life Sciences, forming together an academic community of about 5,000 students. There is an active and vital research community of over 40 mathematicians and statisticians in the consortium.

Claremont is situated approximately 35 miles east of downtown Los Angeles, at the foot of the San Gabriel mountains. The community is known for its tree-lined streets and village charm. It is an easy drive from Claremont to the cultural attractions of the greater Los Angeles area, as well as the ocean, mountains, and deserts of Southern California.
Applicants should send a curriculum vitae, a description of their teaching philosophy and experience, a description of their current research program, undergraduate and graduate transcripts, and arrange to have three letters of recommendation sent to the address that appears below. Further information about the college and department may be found at http://www.math.hmc.edu/. Preference
will be given to applications completed by December 17, 2004.

Harvey Mudd College is an Equal Opportunity Employer and is committed to the recruitment of applicants historically underrepresented on college faculties.

Address for applications:
Professor Francis E. Su
Chair, Search Committee
Department of Mathematics
Harvey Mudd College
Claremont, CA 91711-5990
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UNIVERSITY OF CALIFORNIA, BERKELEY EMSW2 1 Postdoctoral Positions

We invite applications for two special (non-tenure-track) positions, effective July 1, 2005. Applicants should have a recent Ph.D., or the equivalent, in pure or applied mathematics. Preference will be given to applicants in the areas of representation theory, geometry and combinatorics. These positions are supported in part by the NSF through its EMSW21 Research Training Group program. NSF requires that applicants be citizens, nationals or permanent residents of the United States, its territories and possessions. The term of these appointments is three years, with a reduced

[^15]January 2005 issue-October 28, 2004; February 2005 issue-November 22, 2004; March 2005 issue-December 29, 2005; April 2005 issue-January 28, 2005
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.
teaching load of one course per semester. These appointments carry an additional stipend of $\$ 10,000$ in each of the first two years for summer research, and up to $\$ 2,500$ per year for travel and other re-search-related expenses.
Applicants should send a resume, reprints, preprints and/or dissertation abstract, and ask three people to send letters of evaluation to The Vice Chair for Faculty Affairs at the above address. All letters of evaluation are subject to Berkeley campus policies on confidentiality of letters of evaluation, a summary of which can be found at: http://apo. chance.berkeley. edu/evalltr.html. We request that applicants use the AMS standardized application form and indicate their subject area using the AMS subject classification numbers. The form is the Academic Employment in Mathematics Application Cover Sheet, available from the American Mathematical Society.

Applications must be postmarked by January 1, 2005. Applications postmarked after the deadline will not be considered. The University of California is an Equal Opportunity, Affirmative Action.

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## UNIVERSITY OF CALIFORNIA, BERKELEY Tenure-Track Position

Pending budget approval, we invite applications for one or more positions effective July 1, 2005, at the tenure-track (Assistant Professor) level, in the general areas of pure or applied mathematics.
Tenure-track applicants are expected to have demonstrated outstanding research potential, normally including major contributions beyond the doctoral dissertation. Such applicants must send a resume, and reprint or preprints, and/or dissertation abstract, and ask three people to send letters of evaluation to The Vice Chair for Faculty Affairs at the above address. It is the responsibility of the tenure-track applicants to make sure that letters of evaluation are sent. All letters of evaluation are subject to Berkeley campus policies on confidentiality of letters of evaluation, a summary of which can be found on our home page http://math.berkeley.edu/ overview_employment_academic.htm1.
All applicants are required to use the AMS standardized application form and to indicate their subject area using the AMS subject classification numbers. The form is the Academic Employment in Mathematics, Application Cover Sheet. It is available courtesy of the American Mathematical Society.
Applications must be postmarked by January 1, 2005. Applications postmarked after the deadline will not be considered. The University of California is an Equal Opportunity Employer.

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## CONNECTICUT

YALE UNIVERSITY<br>Josiah Willard Gibbs Instructorships/Assistant Professorships

Description: Offered to men and women with the doctorate who show definite promise in research in pure mathematics. Applications from women and members of minority groups are welcome. Appointments are for two/three years. The teaching load is kept light to allow ample time for research. This will consist of 3 one-semester courses. Part of the teaching duties over the term of the appointment may consist of a one-semester course at the graduate level in the general area of the instructor's research. Grant Amount: The 2005-2006 salary will be at least $\$ 53,800$. Deadline: January 1, 2005. Application information: Inquiries and applications can be obtained at the following website http://www.math.yale.edu. Inquiries and application-supporting documents should be sent to the Gibbs Committee, Department of Mathematics, Yale University, via e-mail: gibbs.committee@math.yale.edu. Yale University is an Affirmative Action/Equal Opportunity Employer.

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## ILLINOIS

## NORTHWESTERN UNIVERSITY Department of Mathematics 2033 Sheridan Road

 Evanston, Illinois 60208-2730Applications are invited for an anticipated tenure-track position starting September 2005. Priority will be given to exceptionally promising research mathematicians. Fields of interest within the department include Algebra, Algebraic Geometry, Analysis, Dynamical Systems, Mathematical Physics, Probability, Partial Differential Equations, and Topology.

Application material should be sent to Personnel Committee, at the department address and include: (1) the American Mathematical Society's Application Cover Sheet for Academic Employment, (2) a curriculum vitae, and (3) at least four letters of recommendation including one which discusses in some detail the candidate's teaching qualifications. Applications may also be made electronically at MathJobs.org: www.mathjobs.org. Inquiries may be sent via e-mail to: http://hi ring@math. northwestern.edu.
Applications are welcome at any time, but the review process starts in October 2004.

Northwestern University is an affirmative action, equal opportunity employer committed to fostering a diverse faculty;
women and minority candidates are especially encouraged to apply.

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## NORTHWESTERN UNIVERSITY Department of Mathematics <br> 2033 Sheridan Road <br> Evanston, Illinois 60208-2730 Boas Assistant Professor

Applications are solicited for up to three Ralph Boas assistant professorships of three years each starting in September 2005. Fields of interest within the department include Algebra, Algebraic Geometry, Analysis, Dynamical Systems, Mathematical Physics, Probability, Partial Differential Equations and Topology. They are non-tenure-track.

Applications should be sent to the Boas Selection Committee at the department address and include: (1) the American Mathematical Society's Application Cover Sheet for Academic Employment, (2) a curriculum vitae, and (3) three letters of recommendation including one which discusses in some detail the candidate's teaching qualifications. Applications may also be made electronically at http://MathJobs.org:www.mathjobs. org. Inquiries may be sent via e-mail to: http://hiring@math.northwestern.edu.

Applications are welcomed at any time, but the review process starts December 1, 2004. Northwestern University is an affirmative action, equal opportunity employer committed to fostering a diverse faculty; women and minority candidates are especially encouraged to apply.

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## UNIVERSITY OF CHICAGO Department of Mathematics

The University of Chicago Department of Mathematics invites applications for the following positions:

1. L.E. Dickson Instructor: This is open to mathematicians who have recently completed or will soon complete a doctorate in mathematics or a closely related field,and whose work shows remarkable promise in mathematical research and teaching. The appointment typically is for two years, with the possibility of renewal for a third year. The teaching obligation is up to four one-quarter courses per year For applicants who are U.S. citizens or permanent residents, there is the possibility of additional resources for summer support and travel from the department's VIGRE grant.
2. Assistant Professor: This is open to mathematicians who are further along in their careers, typically two or three years past the doctorate. These positions are intended for mathematicians whose work has been of outstandingly high caliber. Appointees are expected to have the potential to become leading figures in their fields. The appointment is generally for
three years, with a teaching obligation of three one-quarter courses per year.
Applicants will be considered for any of the positions above which seem appropriate. Complete applications consist of (a) cover letter, (b) a curriculum vitae, (c) three or more letters of reference, one of which addresses teaching ability, and (d) a description of previous research and plans for future mathematical research, including a brief (200 words or less) summary of your research interests. Applicants are strongly encouraged to include a statement describing your teaching experience and philosophy and an AMS cover sheet. If you have applied for an NSF Mathematical Sciences Postdoctoral Fellowship, please include that information in your application, and let us know how you plan to use it if awarded. Applications should be sent to:

Appointments Secretary
Department of Mathematics
University of Chicago
5734 S. University Avenue
Chicago, IL 60637
Applications may also be submitted online through www.mathjobs.org. We will begin screening applications on November 29, 2004. Screening will continue until all available positions are filled. The University of Chicago is an Equal Opportunity/Affirmative Action Employer.

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## INDIANA

UNIVERSITY OF NOTRE DAME
Department of Mathematics Notre Dame, IN 46556 Notre Dame Instructorship in Mathematics

The Department of Mathematics of the University of Notre Dame invites applications from recent doctorates for the position of Notre Dame Instructor in Mathematics. Candidates in any specialty compatible with the research interests of the department will be considered. The teaching load and salary will be competitive with those of distinguished instructorships at other AMS Group I universities. This position is for a term of three years beginning August 22,2005 , is non-renewable and non-tenure-track. Applications, including a curriculum vitae, a letter of application, and a completed AMS standard cover sheet, should be sent to: William G. Dwyer, Chair, at the above address. Applicants should also arrange for at least three letters of recommendation to be sent to the chair. These letters should address the applicant's research accomplishments and supply evidence that the applicant has the ability to communicate articulately and teach effectively. Notre Dame is an Equal Opportunity Employer. Women and minorities are urged to apply. The evaluation of candidates will begin December 1,
2004. Information about the department is available at http://www.science.nd. edu/math/.

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## UNIVERSITY OF NOTRE DAME Department of Mathematics Notre Dame, IN 46556 Regular Position in Algebra

The Department of Mathematics of the University of Notre Dame invites applications for a position in algebra, especially number theory, algebraic geometry, the Langlands program, and areas of algebra such as commutative algebra consonant with the research interests of the department. The starting date for the position is August 22, 2005. Candidates at any rank will be considered. The teaching load is one course one semester and two courses the other semester. The salary is competitive. Applications, including a curriculum vitae, a letter of application, and a completed AMS standard cover sheet, should be sent to: William G. Dwyer, Chair, at the above address. Applicants should also arrange for at least three letters of recommendation to be sent to the chair. These letters should address the applicant's research accomplishments and supply evidence that the applicant has the ability to communicate articulately and teach effectively. Notre Dame is an Equal Opportunity Employer. Women and minorities are urged to apply. The evaluation of candidates will begin December 1, 2004. Information about the department is available at http://www.math.nd.edu/math.

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## UNIVERSITY OF NOTRE DAME Department of Mathematics Notre Dame, IN 46556

Regular Position in Numerical Analysis
The Department of Mathematics of the University of Notre Dame invites applications from an applied mathematician with a special interest in numerical analysis. The starting date for the position is August 22, 2005. Candidates at any rank will be considered. The teaching load is one course one semester and two courses the other semester. The salary is competitive. Applications, including a curriculum vitae, a letter of application, and a completed AMS standard cover sheet, should be sent to: William G. Dwyer, Chair, at the above address. Applicants should also arrange for at least three letters of recommendation to be sent to the chair. These letters should address the applicant's research accomplishments and supply evidence that the applicant has the ability to communicate articulately and teach effectively. Notre Dame is an Equal Opportunity Employer. Women and minorities are urged to apply. The evaluation of candidates will begin December 1, 2004. Information about the department is available at http://www.science.nd.edu/math.

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## MARYLAND

## JOHNS HOPKINS UNIVERSITY Department of Mathematics

Subject to availability of resources and administrative approval, the following positions are available for the 2005-06 academic year.

1. One tenure-track or tenured positions in all areas of pure mathematics.
2. One non-tenure-track J. J. Sylvester Assistant Professor.
3. One FRG postdoc position: This is open to mathematicians who have recently completed or will soon complete a doctorate in mathematics and whose research interests concern Eigenfunctions of the Laplacian.
For questions, send an email to math@math.jhu.edu. Applications should be sent to: Appointments Committee, Department of Mathematics, Johns Hopkins University, 404 Krieger Hall, Baltimore, MD 21218-2689, and should include a complete curriculum vitae, at least four letters of recommendation (including a letter concerning teaching) and a description of current and planned research. Applications received by November 1, 2004, will be given priority. Johns Hopkins University is an Affirmative Action/Equal Opportunity Employer. Minorities and women candidates are encouraged to apply. See our ad online at http://www.mathematics.jhu. edu/mathnew/jobs.htm1.

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## MICHIGAN

## MICHIGAN STATE UNIVERSITY East Lansing, MI 48824 proMSc Program in Industrial Mathematics

Direct your students toward one of the professional M.Sc. programs. Industry needs business-savvy mathematicians. See http://www.sciencemasters.com/.

000001

## MICHIGAN STATE UNIVERSITY Department of Mathematics East Lansing, MI 48824-1027

Pending budgetary approval, the department will have a tenure-track position to begin Fall 2005. It is expected that successful applicants will be appointed at the rank of Assistant Professor, but truly outstanding candidates for appointment at higher ranks will be considered. Excellence is essential in both research and teaching, and it is expected that the successful candidate will have at least two years of experience beyond the Ph.D. While outstanding applicants from all mathematical research areas may be considered, preference will be given to those with significant research accomplishments in
interdisciplinary mathematics, especially in scientific computation as applied to nano-science, biological, optical/electromagnetic, or materials science. Application information: An applicant should send a vita as well as a brief statement of research interests, and arrange for at least four letters of recommendation to be sent, one of which must specifically address the applicant's ability to teach. Application via email is strongly encouraged. To receive an electronic application and information, send an email to: jobs@math.msu.edu with the message "send application-info". Application materials can also be addressed to The Hiring Committee, Department of Mathematics, Michigan State University, East Lansing, MI 48824-1027. Completed applications (including letters of recommendation) received by November 15, 2004, are assured of consideration, but applications will be considered until the position is filled. Women and minorities are strongly encouraged to apply. MSU is an Affirmative Action/Equal Opportunity Institution. Handicappers have the right to request and receive reasonable accommodation. http://www.math.msu.edu/. 000059

## UNIVERSITY OF MICHIGAN Department of Mathematics

Pending authorization, the department anticipates having one or more openings at the tenure-track or tenure level. Candidates should hold a Ph.D. in mathematics or a related field, and should show outstanding promise and/or accomplishments in both research and teaching. Applications are encouraged from any area of pure, applied, computational, or interdisciplinary mathematics, including mathematical biology, theoretical computer science, scientific computation, and actuarial or financial mathematics. Salaries are competitive and are based on credentials. Applicants should send a CV, bibliography, descriptions of research and teaching experience, and have three or four letters of recommendation, at least one of which addresses the candidate's teaching experience and capabilities, sent to: Personnel Committee, University of Michigan, Department of Mathematics, 2074 East Hall, Ann Arbor MI 48109-1109. Applications are considered on a continuing basis but candidates are urged to apply by November 1, 2004. Inquiries may be made by email to email: math-fac-search@ umich.edu. More detailed information regarding the department may be found on our web page: http://www.math.1sa. umich.edu. Women and minority candidates are encouraged to apply. The University is responsive to the needs of dual career couples and is an equal opportunity /affirmative action employer.

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## MINNESOTA

## UNIVERSITY OF MINNESOTAMINNEAPOLIS School of Mathematics Dunham Jackson Assistant Professor

This is a three-year appointment from fall semester 2005, through spring semester 2008, with a teaching load of 3 one-semester courses per academic year. Outstanding research and teaching abilities are required. Preference will be given to applicants whose research interests are compatible with those of the School. Applicants should have received or expect to receive a Ph.D. in mathematics no earlier than Jan. 1, 2004, and no later than August 25, 2005. Summer School teaching may be available during the summers of 2006 and 2007 to supplement regular stipend. Salary is competitive. For full consideration, applications and all supporting materials must be submitted electronically through http://www.mathjobs.org. by November 15, 2004. Applications received after the deadline will be considered as positions remain. No paper submission is needed unless the candidate is unable to submit electronically. Reference letter writers should be asked to submit their letters online through http://www.mathjobs.org. If they are unable to do so, they may send their letters to the following address: Lawrence F. Gray, Professor and Head, School of Mathematics, 127 Vincent Hall, 206 Church Street S.E. Mpls. MN 55455; email: mathsrch@tc.umn.
Applicants must include the following: curriculum vitae; at least 4 letters of recommendation, one of which should address teaching ability; and description of research. See also http://www.math.umn. edu. In addition please complete the Equal Opportunity Employment form at http://www.math.umn.edu/jobs/.
The University of Minnesota is an Equal Opportunity Employer and Educator.

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## UNIVERSITY OF MINNESOTAMINNEAPOLIS School of Mathematics <br> Tenured or Tenure-Track Positions

The School of Mathematics of the University of Minnesota is seeking outstanding candidates for 3-4 tenure-track or tenured faculty positions starting fall semester 2005. Particular attention will be paid to applicants at the assistant or associate professor level with strong interests in Algebra, Topology or Scientific Computation. Candidates should have a Ph.D. or equivalent terminal degree in mathematics or a closely related field and excellent records in both research and teaching. Women and people of color from all mathematical areas are encouraged to apply.
Additionally, a tenure-track or tenured appointment will be made in conjunction
with the INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS (IMA) in support of its activities and postdoctoral program. Since its founding in 1982 the IMA has established itself as a leading research center for mathematics and its applications. The successful candidate should have a strong research record and a commitment to the IMA mission of interdisciplinary mathematical research and will have the opportunity to benefit from the unique scientific environment at the IMA.
For full consideration, applications and all supporting materials must be submitted electronically through http://www. mathjobs.org by November 15, 2004. Applications received after the deadline will be considered as positions remain. No paper submission is needed unless the candidate is unable to submit electronically. Reference letter writers should be asked to submit their letters online through http://mw.mathjobs.org. If they are unable to do so, they may send their letters to the following address: Lawrence F. Gray, Professor and Head, School of Mathematics, 127 Vincent Hall, 206 Church Street S.E. Mpls. MN 55455; email: mathsrch@tc.umn.

Applicants must include the following: curriculum vitae; at least 4 letters of recommendation, one of which should address teaching ability; and description of research. See also http://www.math. umn. edu. In addition please complete the Equal Opportunity Employment form at http://www.math.umn.edu/jobs/.
The University of Minnesota is an Equal Opportunity Employer and Educator.

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## UNIVERSITY OF MINNESOTAMINNEAPOLIS <br> Tenure-track position with emphasis in Math and Math Education starting fall semester, 2005

The School of Mathematics will have available a tenure-track position (Assistant Professor or higher) starting fall semester, 2005. Ph.D. or equivalent degree in mathematics, teaching and related education experiences at the undergraduate level and related research are required. This position will emphasize:

- excellence in teaching, including experience with mathematically talented high school students;
- involvement with creative academic programs, curriculum development, and educational scholarship/professional activities (i.e., new curricula and curricula supplements, professional development materials, and relevant statistical/evaluative studies and publications);
- developing capabilities for educational leadership, and the ability to constructively work with management and public relations aspects of educational programs and projects. Experience working with K12 mathematics coursework and preservice/inservice teacher education is strongly
preferred. Preference will be given to applicants at any level whose background and experience are compatible with the above stated objectives. The position can be structured to allow opportunities to work on mathematics research. Salary will be commensurate with background and experience. Consideration of applicants will begin December 1, 2004, and will continue until the position is filled. Applications include a cover letter of interest, current curriculum vitae, including a complete description of related experience and research to this position, and four letters of recommendation, at least two of which comment on teaching and educational experiences. Send to: Math/Math Education Search, ITCEP/School of Math, University of Minnesota, 127 Vincent Hall, 206 Church Street SE, Minneapolis MN 55455.
The University of Minnesota is an equal opportunity educator and employer.
See also the ITCEP web page at http:// www.itcep.umn. edu.

000089

## NEW JERSEY

## THE INSTITUTE FOR ADVANCED STUDY School of Mathematics

The Institute for Advanced Study, School of Mathematics, has a limited number of memberships, some with financial support for research in mathematics and computer science at the Institute during the 2005-06 academic year. Candidates must have given evidence of ability in research comparable at least with that expected for the Ph.D. degree. During the academic year 2005-06 the School will host a program on Lie groups, representations and discrete mathematics. The program will be led by Alexander Lubotzky of The Hebrew University of Jerusalem. The goal of the program is to bring together mathematicians from several areas in order to strengthen the ties between the fields and generate further collaborations. For additional information on the program, see http:// www.math.ias.edu/liegroups. htm l.
The School of Mathematics and the Department of Mathematics at Princeton University have established the Veblen Research Instructorship, and three-year instructorships will be offered each year to candidates who have received their Ph.D. within the last 3 years. The first and third year of the instructorship will be spent at Princeton University and will carry regular teaching responsibilities. The second year will be spent at the Institute and dedicated to independent research of the instructor's choice.
Application materials for both the IAS MEMBERSHIPS and the VEBLEN RESEARCH INSTRUCTORSHIP positions may be requested from Applications, School of Mathematics, Institute for Advanced Study, Einstein Drive, Princeton, NJ 08540; email: applications@math.ias.edu. Application
forms may be downloaded via a web connection to http://www.math.ias.edu. Both deadlines are December 1.

000070

## NEW YORK

## CORNELL UNIVERSITY Department of Mathematics Tenure-track Assistant Professor

The Department of Mathematics at Cornell University invites applications for the position of tenure-track Assistant Professor (or, in an exceptional case and pending administrative approval, at a higher rank). Start date July 1, 2005. For information about fields of interest and application instructions, see: http://www.math. cornell.edu/Positions/facpositions. htm 1 . Deadline November 1, 2004. Early applications will be regarded favorably. Cornell University is an Affirmative Action/Equal Opportunity Employer.

000075

## CORNELL UNIVERSITY Department of Mathematics

The Department of Mathematics invites applications for the following positions beginning July 1, 2005: (1) One H. C. Wang Assistant Professor, non-renewable, 3-year term; (2) Three VIGRE Postdoctoral Associates (contingent upon funding), non-renewable, 3 -year term; beginning August 16,2005 : (3) Visiting positions, academic year or one semester teaching positions (any rank). For information about our positions and application instructions, see: http://www.math.cornell.edu/ Positions/facpositions.htm1. Applicants will be automatically considered for all eligible positions. Deadline December 1, 2004. Early applications will be regarded favorably. Cornell University is an Affirmative Action/Equal Opportunity Employer.

000076

## CORNELL UNIVERSITY Department of Mathematics

The Cornell University Department of Mathematics invites applications for our Teaching Program Visiting Faculty Positions beginning August 16, 2005. Two or more half-time visiting positions (any rank) for mathematics professors on sabbatical/other leaves from colleges, universities, and engineering schools. Candidates with substantial experience teaching undergraduate mathematics, and with teaching and research interests compatible with current faculty, are sought. Successful candidates are expected to pursue a program of study and/or research at Cornell. For information about these positions and application instructions, see: http://
www.math.cornell.edu/Positions/vp. htm 1 .

Deadline December 1, 2004. Cornell University is an Affirmative Action/Equal Opportunity Employer.

000077

## COLGATE UNIVERSITY Neil R. Grabois Chair in Mathematics

Colgate University announces the establishment of the Neil R. Grabois Chair in Mathematics. The chair will be filled at either the Associate or Full Professor level. We are looking for a mathematician with broad interests in the mathematical sciences, an established research reputation, and a record of excellence in teaching at the undergraduate level. The successful candidate will join a department committed to meeting the diverse needs of its students and will help the department enrich its curriculum in the mathematical sciences. Teaching assignments are typically five semester courses per year, with a sabbatical possible in every fourth year. The endowed chair offers a competitive and commensurate salary.

Colgate is a highly-selective liberal arts college, dedicated to rich academic interactions between students and faculty, including a strong commitment to undergraduate research. Mathematics majors, who typically make up $3 \%$ of Colgate's graduating class, go on to pursue a variety of professional and academic careers, including Ph.D.'s from top- 25 mathematics graduate programs. The ten-person department maintains an unusually strong scholarly profile; most have published papers in the last two years and three have held NSF research grants. Information on the math department and the university is available at http://math.colgate.edu and http://www. colgate.edu.

Hamilton is situated in the hills of central New York, an hour from Syracuse and five hours from Boston, New York, Philadelphia, and Toronto. The village of Hamilton is rural and picturesque with many features unusual for a town its size. Visit http://www.hamiltonny.com for more information.

An application should include a curriculum vitae and three letters of recommendation, and should provide evidence of the breadth of the candidate's interests in the mathematical sciences and the candidate's commitment to undergraduate teaching. Deadline for applications is December 1, 2004. Please direct applications to

Grabois Chair Search Committee Department of Mathematics
Colgate University
13 Oak Drive
Hamilton, NY 13346
Nominations are also welcome. No electronic submissions, please.

Colgate is an Equal Opportunity/Affirmative Action Employer committed to developing and sustaining a diverse faculty
and staff that will further the university's academic mission.

000066

## NEW YORK UNIVERSITY The Courant Institute of Mathematical Sciences

The Courant Institute of Mathematical Sciences anticipates having a small number of faculty positions in mathematics to begin in September 2005. Appointments may be made at either a junior or senior level. These positions will be in a range of areas in computational, applied and pure mathematics; some may be multidisciplinary appointments that are joint with a science department from the Faculty of Arts and Sciences. Applications should be addressed to: Appointments Committee, Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, NY 100123.

The Courant Institute at New York University is an Equal Opportunity/Affirmative Action Employer.
The deadline for applications is December 15, 2004.

000053

## NEW YORK UNIVERSITY

The Courant Institute of Mathematical Sciences

The Courant Institute is a center for advanced training and research in the mathematical sciences. It has long been an international leader in mathematical analysis, differential geometry, probability theory, applied mathematics, and scientific computation, with special emphasis on partial differential equations and their applications. Its scientific activities include an extensive array of research seminars and advanced graduate courses.

Each year a limited number of Courant Institute Instructorships in the Department of Mathematics are awarded to postdoctoral scientists. These appointments carry a light teaching load of one course per semester and ordinarily are for a threeyear term. These positions are primarily for recent Ph.D's and candidates must have a degree in mathematics or some affiliated field.

For an application and further information please visit Courant's website at http://www.cims.nyu.edu/ information/brochure/visiting.htm1. You may also write for information to: Visiting Membership Committee, Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, NY 10012-1185. In addition, forms may be obtained directly by sending e-mail to vm-apply@ cims.nyu.edu. Applications and supporting documents are due by December 15th for appointments to begin the following academic year.

The Courant Institute at New York University is an Equal Opportunity/Affirmative Action Employer.

The deadline for applications is December 15, 2004.

000054

## UNIVERSITY AT BUFFALO SUNY <br> Department of Mathematics

The Department of Mathematics anticipates the appointment of several tenuretrack assistant professors, effective August, 2005. Salary will be competitive. We seek candidates from all fields, particularly Algebra and Analysis. Applicants should have excellent research accomplishments and potential, a Ph.D. in the mathematical sciences and a strong commitment to teaching.
A complete application consists of a curriculum vitae, a statement of research interests and four letters of recommendation. These materials should be sent to:

Search Committee
Department of Mathematics
University at Buffalo, SUNY
Mathematics Building 244
Buffalo, NY 14260-2900
The deadline for applications is November 5,2004 . Late applications will be considered until the positions are filled. No electronic applications will be accepted.

The University at Buffalo is an Equal Opportunity Employer/Recruiter. We are interested in identifying prospective minority and women candidates. No person, in whatever relationship with the University at Buffalo, shall be subject to discrimination on the basis of age, color, creed, handicap, marital status, national origin, race, religion, sex, sexual orientation or veteran status.

000092

## PENNSYLVANIA <br> UNIVERSITY OF PITTSBURGH Number Theory/Cryptography or Algebraic Geometry/Representation Theory Tenure-Track Position

The Mathematics Department of the University of Pittsburgh invites applications for a tenure-track position in Number Theory /Cryptography or Algebraic Geometry /Representation Theory to begin in the Fall Term 2005, pending budgetary approval. The appointment is at the Assistant Professor level or above, depending on the credentials of the applicant. We seek excellence in teaching and research so applicants should demonstrate substantial research accomplishment and dedication to teaching. Send a vita, three letters of recommendation, a research statement and evidence of teaching accomplishments to: Search Committee in Algebra, Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260 . Review of completed files will begin on November 1, 2004, and
continue until the position is filled. The University of Pittsburgh is an Affirmative Action, Equal Opportunity Employer. Women and members of minority groups underrepresented in academia are especially encouraged to apply.

000083

## UNIVERSITY OF PITTSBURGH Scientific Computing/Numerical Analysis <br> Tenure-Track Position

The Mathematics Department of the University of Pittsburgh invites applications for a tenure-track position in Scientific Computing/Numerical Analysis to begin in the Fall Term 2005, pending budgetary approval. The appointment is at the Assistant Professor level. We seek excellence in teaching and research so applicants should demonstrate substantial research accomplishment and dedication to teaching. Send a vita, three letters of recommendation, a research statement and evidence of teaching accomplishments to: Search Committee in Numerical Analysis, Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260. Review of completed files will begin on November 1,2004 , and continue until the position is filled. The University of Pittsburgh is an Affirmative Action, Equal Opportunity Employer. Women and members of minority groups underrepresented in academia are especially encouraged to apply.

000084

## RHODE ISLAND <br> BROWN UNIVERSITY <br> J. D. Tamarkin Assistant Professorship

One three-year non-tenured non-renewable appointment, beginning July 1, 2005. The teaching load is one course one semester, and two courses the other semester, and it consists of courses of more than routine interest. Candidates are required to have received a Ph.D. degree or equivalent by the start of this appointment, and they may have up to three years of prior academic and/or postdoctoral research experience.

Applicants should have strong research potential and a commitment to teaching. Field of research should be consonant with the current research interests of the department. For full consideration, a curriculum vitæ, an AMS Standard Cover Sheet, and three letters of recommendation must be received by December 1, 2004. All inquiries and materials should be addressed to: Junior Search Committee, Department of Mathematics, Brown University, Providence, RI 02912. To access the AMS Standard Cover Sheet, visit our website: http://www.math.brown.edu/juniorsearch. shtm1. Email inquiries should be addressed to juniorsearch@math. brown. edu. Brown University is an Equal

Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

## BROWN UNIVERSITY Associate Professor level

One professorship at the Associate Professor level with tenure, the appointment to begin July 1, 2005. [Exceptionally qualified candidates may be considered for appointment at the level of Professor.] This position is targeted in the area of analysis, broadly construed. Candidates should have a distinguished research record and a strong commitment to excellence in undergraduate and graduate teaching. Preference will be given to applicants with research interests consonant with those of the present members of the Department (for a list of faculty members and their fields, see http://www.math. brown.edu/faculty/faculty.htm7). Applicants who wish to be considered for this position should send a letter of application together with a curriculum vitae and arrange to have at least five letters of recommendation sent to: Senior Search Committee, Department of Mathematics, Box 1917, Brown University, Providence, Rhode Island 02912. Applications must be postmarked by December 13, 2004, in order to receive full consideration. Later applications will be accepted and considered to the extent feasible. Email inquiries can be addressed to srsearch@math. brown.edu. This position is pending approval. Brown University is an Equal Opportunity/Affirmative Action employer and encourages applications from women and minorities.

000081

## BROWN UNIVERSITY Division of Applied Mathematics Prager Assistant Professorship

The Division of Applied Mathematics seeks applicants for the Prager Assistant Professorship: A three year non-tenured nonrenewable appointment, beginning July 1 , 2005. The teaching load is one course per semester. Candidates are required to have received a Ph.D. degree or equivalent by the start of this appointment, and they may have up to three years of prior academic and/or postdoctoral research experience. Applicants should have strong research potential and a commitment to teaching. Field of research should be consistent with the current research interests of the Division faculty. Consideration of the applications will begin on January 1, 2005. To ensure full consideration, applicants are urged to have a curriculum vitae, a research statement, sample publications or preprints, and three letters of recommendation (at least one of them should address teaching ability) in by this date. All inquiries and materials should be addressed to Search Committee, Prager Assistant Professorship, Division of Applied Mathe-
matics, Brown University, Providence, RI 02912; email: dam@dam. brown. edu. Brown University is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

000093

## TEXAS

## TEXAS A\&M UNIVERSITY The Department of Mathematics

The Department of Mathematics is in the second year of an aggressive hiring plan to increase its tenure and tenure-track faculty by $25 \%$ over the next several years. As part of this effort, we anticipate several openings for tenured, tenure-eligible, and visiting faculty positions beginning fall 2005. The field is open, but we particularly seek applications from individuals whose mathematical interests would augment and build upon existing strengths both within the Mathematics Department as well as other departments in the University. Salary, teaching loads and start-up funds are competitive. For a Tenured Position the applicant should have an outstanding research reputation and would be expected to fill a leadership role in the department. An established research program, including success in attracting external funding and supervision of graduate students, and a demonstrated ability and interest in teaching are required. Informal inquiries are welcome. For an Assistant Professorship, we seek strong research potential and evidence of excellence in teaching. Research productivity beyond the doctoral dissertation will normally be expected. We also have several visiting positions available. Our Visiting Assistant Professor positions are for a three year period and carry a three course per year teaching load. They are intended for those who have recently received their Ph.D. and preference will be given to mathematicians whose research interests are close to those of our regular faculty members. Senior Visiting Positions may be for a semester or one year period. For full consideration, the complete dossier should be received by December 15, 2004. Applicants should send the completed "AMS Application Cover Sheet", a vita, and arrange to have letters of recommendation sent to: Faculty Hiring, Department of Mathematics, Texas A\&M University, 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,
veterans. The University is responsive to the needs of dual career couples.

000082

## UNIVERSITY OF TEXAS ARLINGTON Department Chair Position

The Mathematics Department at The University of Texas-Arlington invites applications for the position of department chairman, a tenured full professor position. The appointment begins September 1,2005 , and is subject to the availability of funding.

Applicants should have an outstanding record of research and external funding, commensurate with appointment at the level of full professor. Special consideration will be given to candidates with a major research initiative compatible with the research interests of the faculty, and with administrative experience. The successful applicant will be committed to both graduate and undergraduate education, and will be an effective communicator with faculty, students and upper administration.
The University of Texas-Arlington, located in the Dallas/Fort Worth metroplex, is the second largest campus in the UT system and has 25,000 students. It has strong research programs in engineering and science. The Mathematics Department houses 23 tenured and tenure-track faculty, and has research strengths in both pure and applied fields. The department offers undergraduate, master's and doctoral degrees. As part of the university's College of Science, the department actively participates in interdisciplinary research efforts at the interface between mathematics/statistics, science, engineering and local industries.
Applications will be reviewed immediately upon receipt. The search will remain open until the position is filled. Applications should include a letter of interest, a current vita and the names of at least three references. Electronic applications are encouraged, and may be submitted to email: mathsearch@uta.edu. Hard-copy application materials should be sent to: Chairman, Math Chair search committee, Department of Mathematics, University of Texas at Arlington, Box 19408, Arlington, Texas 76019-0408.
More information may be obtained from the department's web page at http://www. uta.edu/math.
The University of Texas-Arlington is an Equal Opportunity and Affirmative Action Employer.

000052

## UTAH

## UNIVERSITY OF UTAH

Department of Mathematics
The Department of Mathematics at the University of Utah invites applications for the following positions:
Full-time tenure-track or tenured appointments at the level of assistant, associate professor or full professor. Applicants should receive their Ph.D. degrees in 2003 or earlier.
Visiting faculty positions of one year or less, in any of the professional ranks, depending upon availability of funding.
Mathematical Biology postdoctoral positions with Research Training Group.
Please see our website at http://www. math.utah.edu/positions for information regarding available positions, application requirements and deadlines. Applications must be completed through the website http://mathjobs.org.

The University of Utah is an Equal Opportunity, Affirmative Action Employer and encourages applications from women and minorities, and provides reasonable accommodation to the known disabilities of applicants and employees.

000060

## WASHINGTON

## UNIVERSITY OF WASHINGTON Department of Mathematics

Applications are invited for a tenure-track Assistant Professor position at the Department of Mathematics of the University of Washington, to begin in September 2005. Availability of the position is subject to budgetary approval. Applicants are required to have a Ph.D., and an established research record in mathematics. Duties include undergraduate and graduate teaching and independent research. In exceptional circumstances, appointment at the Associate Professor or Professor level may be considered for candidates who have demonstrated a commitment to mentoring underrepresented students in the sciences.
Applications should include a curriculum vitae, statements of research and teaching interests, and three letters of recommendation. Applications should be sent to: Appointments Committee Chair, Department of Mathematics, Box 354350 , University of Washington, Seattle, WA 98195-4350. Priority will be given to applicants whose complete applications, including recommendations, are received by November 15, 2004.
The University of Washington is building a culturally diverse faculty and strongly encourages applications from female and minority candidates. The University is an Equal Opportunity/Affirmative Action Employer.

000071

## UNIVERSITY OF WASHINGTON Department of Mathematics

Applications are invited for a full-time Lecturer position at the Department of Mathematics of the University of Washington, to begin in September 2005. Availability of the position is subject to budgetary approval. The successful candidate will be expected to teach two or three freshman courses per quarter, for a total of six or nine class hours per week, and to engage in related department activities such as course coordination and supervision of teaching assistants. The department is committed to excellence in teaching, and offers precalculus and calculus tracks serving science and engineering, life sciences, and business students. All precalculus and calculus courses were recently revised. Applicants should have a Ph.D., as well as an excellent record of teaching freshman mathematics. The initial appointment is for three years, with the possibility of renewal.

Applications should include a curriculum vitae, a statement on teaching interests, and three letters of recommendation. Applications should be sent to: Appointments Committee Chair (Lecturer Position), Department of Mathematics, Box 354350, University of Washington, Seattle, WA 98195-4350. Priority will be given to applicants whose complete applications, including recommendations, are received by November 30, 2004.

The University of Washington is building a culturally diverse faculty and strongly encourages applications from female and minority candidates. The University is an Equal Opportunity/Affirmative Action Employer.

000072

## WEST VIRGINIA

## WEST VIRGINIA UNIVERSITY Eberly College of Arts and Sciences Position in Applied Mathematics

An anticipated tenure-track Assistant Professorship is announced in the area of applied mathematics with an expected starting date of August 16, 2005. The successful applicant should have demonstrated outstanding research potential, excellent communication and classroom skills, and a commitment to undergraduate education, graduate supervision and establishing a thriving funded research program. The appointee should add expertise and research strength to one of our program initiatives, such as the joint undergraduate program in Industrial Mathematics and Statistics, a cooperative Ph.D. program in Computational Computing and Discrete Mathematics, or university wide initiatives in biometrics or nano-technology. An interest in interdisciplinary research connections and/or collaboration with industry and government research lab/agencies will be an advantage. The

Federal research presence in the area includes the National Energy Technology Laboratory, a NASA Software Independent Validation and Verification Facility, an FBI Identification Facility in Clarksburg, and a NIOSH facility.
Applicants should provide a letter of application, a vita with statements commenting on their research program and teaching philosophy, and names and contact information for references. Applications, nominations, inquiries and at least three letters of reference should be sent to:

Chair, Department of Mathematics
320 Armstrong Hall
West Virginia University
P.O. Box 6310

Morgantown, WV 26506-6310
email: jobs@math.wvu.edu
Priority will be given to applications received by January 15, 2005.
West Virginia University is an Equal Opportunity/Affirmative Action Employer. Minority, disabled, and women candidates are urged to apply.

## 000073

## $\frac{\text { WISCONSIN }}{\substack{\text { UNIVERSITY OF WISCONSIN-MADISON } \\ \text { Department of Mathematics }}}$

The Department of Mathematics anticipates an opening for one position to begin August 22, 2005, at the tenure-track (assistant professor) level.
Applications are invited in all areas of mathematics. Candidates should exhibit evidence of outstanding research potential, normally including significant contributions beyond the doctoral dissertation. Applicants in the areas of numerical analysis, probablity theory algebraic topology, and partial differential equations/geometric analysis are particularly encouraged to apply. A strong commitment to excellence in instruction is also expected. Additional departmental information is available on our website: http://www. math.wisc.edu.
Applicants should send a completed AMS Standard Cover Sheet, a curriculum vitae which includes a publication list, and brief descriptions of research and teaching to:

## Hiring Committee

Dept. of Mathematics, Van Vleck Hall University of Wisconsin-Madison 480 Lincoln Drive
Madison, WI 53706-1388
Applicants should also arrange to have sent to the above address, three to four letters of recommendation, at least one of which must discuss the applicant's teaching experiences and capabilities. Review of applications will begin on November 12, 2004. Applications will be accepted until the position is filled. Additional letters will be solicited by the department for
candidates who are finalists for a tenured position in the unlikely event that such a position is authorized.
The Department of Mathematics is committed to increasing the number of women and minority faculty. The University of Wisconsin is an Affirmative Action, Equal Opportunity Employer and encourages applications from women and minorities. Unless confidentiality is requested in writing, information regarding the applicants must be released upon request. Finalists cannot be guaranteed confidentiality.

000085

## WYOMING

## UNIVERSITY OF WYOMING <br> Department of Mathematics Tenure-Track Position in Nonlinear Partial Differential Equations and Free Boundary Problems

Applications are invited for an assistant professor tenure-track position starting August 2005. A higher rank is possible for persons with outstanding research qualifications. The minimum qualifications are an earned Ph.D., significant record of accomplishments in research, evidence of a strong commitment to teaching, and appropriate level of communication skills. Candidates with research emphasis in Nonlinear and Stochastic PDE, and Free Boundary Problems with applications in Fluid Mechanics and Geosciences are preferred. The position requires the ability and interest to advise undergraduates and supervise masters and doctoral students, to teach a variety of undergraduate, graduate and outreach courses, to collaborate with colleagues in the math department and faculty in related disciplines, and to develop a competitive, externally funded research program. Review of completed applications will begin December 15,2004 . A complete application will consist of a letter of application, a complete CV, a statement of research interests and accomplishments, and a statement of teaching philosophy. Please forward applications to: Analysis Search Committee, Department of Mathematics, University of Wyoming, Laramie, WY 82071-3036. Please have at least three letters of recommendations, one of which should address the candidate's teaching, sent directly to the search committee. For further information please refer to: http://math. uwyo.edu. UW is an EO/AA employer.

000061

## UNIVERSITY OF WYOMING Department of Mathematics Tenure-Track Position in Information Theory

Applications are invited for an assistant professor tenure-track position starting

August 2005. A higher rank is possible for persons with outstanding research qualifications. The minimum qualifications are an earned Ph.D., significant record of accomplishments in research, including computational aspects, and evidence of a strong commitment to teaching, with demonstrated strength in communication skills. Candidates with research emphasis in Computational Combinatorics, Computational Geometry/Algebraic Geometry, or Computational Number Theory with expertise in Information Theoretic applications including Coding Theory and/or Cryptology are preferred. The position requires the ability and interest to supervise master's and doctoral students, to advise undergraduate students, to teach a variety of our graduate and undergraduate and outreach courses, to collaborate with colleagues in the math department and faculty in related disciplines, and to develop a competitive, externally funded, research program. Review of complete applications will begin December 15, 2004.
A complete application will consist of a letter of application, complete CV, statement of research interests and accomplishments, and statement of teaching philosophy. Please forward applications to: The Information Theory Search Committee, Department of Mathematics, University of Wyoming, Laramie, WY 82071-3036. Please have at least three letters of recommendations, one of which should address the candidate's teaching, sent directly to the search committee. For further information please refer to: http://math. uwyo. edu. UW is an EO/AA employer.

000062

## CANADA

## UNIVERSITY OF BRITISH COLUMBIA Mathematics Department

The Mathematics Department at the University of British Columbia is seeking outstanding candidates for at least five positions, subject to funding, at the tenure-track Assistant Professor level, with a starting date of 1 July 2005. Postdoctoral experience is normally expected. Exceptional candidates at the Associate Professor or Professor level may be considered. Priority areas for this year are: Algebra, Analysis, Discrete Applied Mathematics, Partial Differential Equations, Topology.
Joint positions with other departments may be possible. In special circumstances, exceptional applicants in other areas of mathematics may be considered.
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 on-line as described at: http://www. math.ubc.ca/Dept/jobs.htm $\backslash$ \#Apply.

Alternatively, applicants may send a current CV including a list of publications, statement of research and teaching interests, 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 1 Z2
Applications must be received by November 22,2004 . Supporting material, in cluding letters of recommendation, should be received by December 1, 2004.

The Department is one of the leading Mathematics Departments in Canada and 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 for 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.

000086

## BRAZIL

## INSTITUTE FOR PURE AND APPLIED MATHEMATICS Rio de Janeiro, Brazil Chairs at IMPA

The Institute for Pure and Applied Mathematics (IMPA) invites applications for two endowed chairs carrying an appointment for up to four years. The successful applicant is expected to be a qualified mathematician within 2 to 12 years of his or her doctorate and to display a research oriented curriculum. For further information please refer to http://www.impa.br/ Concursos/chairs.htm7.

000064

# Call for Proposals for the 2006 Joint Summer Research Conferences 

The American Mathematical Society, the Institute of Mathematical Statistics, and the Society for Industrial and Applied Mathematics welcome proposals from mathematicians, either singly or in groups, for conferences to take place in the summer of 2006 as part of the Joint Summer Research Conferences, contingent upon a grant from the National Science Foundation. The conferences will take place at Snowbird Resort located in the beautiful Wasatch Mountains just outside Salt Lake City, Utah. For over twenty years these conferences have played a vital role in disseminating the latest research to more than 9,000 mathematicians whose research interests span the breadth of the mathematical sciences.

Individuals willing to serve as organizers should be aware that staff of the sponsoring societies handle the logistical details of the conferences, thus making it possible for the organizers to focus almost exclusively on the scientific aspects of their conference. In particular:

- Core funding for the conferences is provided by a grant from the National Science Foundation (pending for the 2006 series).
- The professional conference coordinators in the AMS office will provide full logistical support and assistance before, during, and after the conference, thereby freeing the organizers to concentrate on providing a highquality scientific program.
- Organizers are strongly encouraged to publish conference proceedings with one of the sponsoring societies. The sponsoring societies are committed to the rapid and widest possible dissemination of these proceedings as a means of sharing the conference research with those unable to attend.
- The selected proposals will represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Conferences typically run for one week with forty-five to sixty-five participants. However, there is some flexibility in structure; for example, conferences of longer duration may be permitted.
- Proposals for conferences designed specifically for very recent Ph.D.s in a focused area are especially welcome.


## Proposal Preparation

Proposals will be evaluated by the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. Members of this committee (see www.ams.org/meetings/srcscomm.htm7 for the member list and contact information) are willing to provide guidance on the preparation of proposals.

Proposal preparation is straightforward. All proposals must include:
(1) title of the proposed conference;
(2) the names and affiliations of proposed members and the chair(s) of the Organizing Committee. Please include the curriculum vitae of the chair(s) (compact version, no more than five pages);
(3) a three- to four-page narrative written for the nonspecialist, describing the focus of the topic, including the importance and timeliness of the topic. Keep in mind that the members of the Selection Committee are active research mathematicians from a variety of fields.
(4) a list of the recent conferences in the same or closely related areas;
(5) a list of the proposed principal speakers, the majority of whom have agreed to participate (denote with an asterisk those that have been contacted and have agreed to participate) and a description of how you plan to schedule the speakers (i.e., number and length of talks per day); and
(6) estimated total attendance and a tentative list of individuals to be invited to participate.

Organizers are expected to make a vigorous attempt to include qualified women, underrepresented minorities, and junior scientists (advanced graduate students and recent Ph.D.s) as participants in their conference, and as part of the Organizing Committee, where possible and appropriate.

## Sample Proposals

Complete information on submitting a proposal, including examples of recent successful proposals for reference, is available at www.ams.org/meetings/topics.htm1.


Tomography is important in pure and applied mathematics, as well as in several branches of applied sciences, in particular diagnostic radiology, nondestructive evaluation, and other forms of image reconstruction. The Short Course will cover the basic mathematics behind tomography and will describe important applications. The talks will be aimed at a general audience, beginning with elementary facts about the Radon transform and then introducing important current research areas, including impedance imaging, local tomography, wavelet methods, regularization and approximate inverse, and emission tomography. Several special sessions at the AMS Joint Meetings will continue the themes introduced in the Short Course.

Registration for this course will be available starting in September. Fees are: member of the AMS-\$85, nonmem-ber- $\$ 108$, student, unemployed, emeritus- $\$ 37$. Registration instructions will be posted on
http://www.ams.org/meetings/shcourse/html


Samples may also be requested by contacting the Meetings and Conferences Department as indicated below.

## Deadlines

There are three deadlines of which potential organizers should be aware.

Preproposal Submission: Members of the Selection Committee are willing to provide feedback on preproposals which address items (2) and (3) above and which include a tentative list of principal speakers who will be contacted IF a complete proposal is submitted. Preproposals should be submitted by October 15, 2004, to insure sufficient time for feedback from a member of the Selection Committee. Submission of preproposals is optional.

Intent to Submit a Proposal: A statement of intent to submit a proposal should be received by December 17,2004. Submission of intent to submit a proposal is optional.

Formal Proposal: For conferences to be held in the summer of 2006, the deadline for the complete formal proposal submission deadline is January 14, 2005. Conference proposers will be notified of the committee's decisions in late February.

Submit preproposals and proposals to: Joint Summer Research Conferences, AMS Meetings and Conferences Department, P.O. Box 6887, Providence, RI 02940; fax: 401-455-4004; e-mail: meet@ams.org. Electronic submissions are preferred. For questions concerning the proposal evaluation process, contact Dr. Jim Maxwell, AMS Associate Executive Director, via email (jwm@ams.org) or phone (401-455-4101).

# Mathematical Sciences Employment Center 

Atlanta Marriott Marquis, Atlanta, Georgia January 5, 6, 7, and 8, 2005

## 2005 Employment Center Schedule

October 25, 2004 Registration deadline for inclusion in Winter List books.
December 10, 2004 Advance registration deadline. After this date, all registration activities will happen on-site in Atlanta.
Wednesday, January 5
7:30 a.m.-4:00 p.m. Registration and materials pick-up.
9:00 a.m.-9:30 a.m. Short (optional) orientation session. 9:30 a.m.-4:00 p.m. Submission of Scheduled Employment Register interview request forms for both Thursday and Friday interviews. No request forms can be accepted after 4:00 p.m. Wednesday.
9:30 a.m.-6:00 p.m. Interview Center open.
No Scheduled Employment Register interviews are held on Wednesday.

## Thursday, January 6

7:00 a.m.-8:15 a.m. Distribution of interview schedules for both Thursday and Friday for those participating in the Scheduled Employment Register.
8:15 a.m.-4:40 p.m. Scheduled Employment Register interviews in 4 sessions: Session 1: 8:15 a.m.-9:50 a.m., Session 2: 10:00 a.m.-11:35 a.m., Session 3: 1:00 p.m.-2:35 p.m., Session 4: 3:00 p.m.-4:35 p.m.

8:00 a.m.-7:30 p.m. Interview Center open (doors open at 7:30 a.m.; do not schedule before 8:00 a.m.).
Friday, January 7
8:15 a.m.-4:40 p.m. Scheduled Employment Register interviews in 4 sessions: Session 5: 8:15 a.m.-9:50 a.m., Session 6: 10:00 a.m.-11:35 a.m., Session 7: 1:00 p.m.2:35 p.m., Session 8:3:00 p.m.-4:35 p.m.
8:00 a.m.-7:30 p.m. Interview Center open (doors open at 7:30 a.m.; do not schedule before 8:00 a.m.).
Saturday, January 8
9:00 a.m.-12 noon Interview Center open.
Note: Any participant who plans to use the Scheduled Employment Registermust appear at theEmployment Center on Wednesday by $4: 00$ p.m. to turn in the Interview Request/Availability Form. If unexpected delays occur while travelling, contact the AMS at 800-321-4267, ext. 4107.

## Overview of the Employment Center

The Employment Center (formerly the Employment Register) serves as a meeting place and information center for employers and Ph.D.-level job seekers attending the Joint Mathematics Meetings. Most applicants and employers began the search process in the fall and are looking for an opportunity to meet in person with those with whom they've already had communication. Some, however, use the Employment Center as a way to make some initial contacts, gather information, and distribute their own information. This is a less effective, but common, use of the program. The Employment Center allows everyone to choose a comfortable level of participation by seeking interviews for any of the open hours or by limiting schedules to certain days or hours.

The Employment Center is a three-day program which takes place on the Wednesday, Thursday, Friday, and Saturday (morning only) of the Joint Meetings. Most participants register in advance (by the October 25 deadline), and their brief résumé or job description is printed in a booklet which is mailed to participants in advance.

The Employment Center houses two services: the computer-scheduled interview tables (the Scheduled Employment Register) and the employer-scheduled interview tables (the Interview Center). Following three or four years of a job market favorable to candidates, the Employment Center applicant/employer ratio took a sharp turn in 2004. At the 2004 Employment Center, 504 candidates and 120 employers participated, giving an overall applicant-to-employer ratio of 4.2:1 (compared with 424 applicants and 129 employers in 2003, a ratio of 3.2:1). Those with the most interviews are those requested most by employers, usually as a result of a careful application process during the months before the Employment Center takes place. The total number of interviews arranged is dependent on the number of participating employers. Fewer employers will mean fewer interviews overall.

At the January 2005 Employment Center, job candidates will be able to choose how to participate. Two forms of participation will be available:

All Employment Center services (computerscheduling system, form posted in Winter List
of Applicants, Winter List of Employers received by mail, use of Employment Message Center, availability for employer-scheduled Interview Center).

Message Center and Winter Lists only (form posted in Winter List of Applicants, Winter List of Employers received by mail, use of Employment Message Center, availability for employerscheduled Interview Center, BUT NOT use of the computer-scheduling system).
No matter which option is chosen, advance registration works best so that the Applicant Form (received by October 25,2004 ) can be printed in the Winter List distributed to employers.

Employer forms submitted by registered employers have no connection with the AMS online job ads (EIMS). Submitted forms are not available for browsing on the Web. They are reproduced in the Winter List booklet for use by Employment Center participants.

The Mathematical Sciences Employment Center is sponsored by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics; it is managed by members of the AMS staff, with the general guidance of the AMS-MAA-SIAM Committee on Employment Opportunities.

## Employers: Choose one or both of these tables:

Computer-scheduled Employment Register table Employer-scheduled Interview Center table

## The Employment Register Computer-Scheduling System

Employers register in advance by the October 25 deadline, and their job listings ("Employer Forms") are printed and distributed in mid-December to applicants. Employers receive the book of brief, numbered applicant résumés in midDecember. Participants decide on Wednesday, January 5, which of the eight sessions (of five interviews each) they will participate in and submit their Availability/Interview Request Forms by 4:00 p.m. Wednesday. Employers can reserve time for other Joint Meetings events by marking "unavailable" for one or more of the eight sessions. Employers can request ten specific applicants per day, assuming they are available for all four sessions that day. Usually those requests will be filled by the scheduling algorithm, provided the applicants are present, except in the case of the few most-requested applicants. The rest of their interviews will be with applicants who ask to see them. Employers should be specific about their requirements on the Employer Form to avoid interviews with inappropriate candidates.

Schedules are distributed for all Thursday and Friday interviews on Thursday morning. The schedule allows

15-minute interviews, with 5 minutes between for note taking. One or more interviewers for the same position(s) may interview at the table separately, together, or in shifts (however, no more than two may sit at the table at one time). For follow-up interviews, the scheduled tables will also be available for use until 7:30 p.m. on Thursday and Friday and on Saturday morning from 9:00 a.m. to noon.

Participation in the scheduling program has become optional for applicants, so employers will notice some applicant résumés in the Winter List of Applicants with no applicant number. An employer can arrange to interview such an applicant outside of the scheduled interview ses-sions-for instance, between 4:40 p.m. and 7:30 p.m. Thursday or Friday, or on Saturday morning-or during sessions which they left unscheduled.

Employers who are interviewing for two distinct positions may wish to pay for two tables. See the instructions under "How to Register". Employers should bring school catalogs, corporate reports, or more lengthy job descriptions to the Employment Center early on Wednesday for perusal by applicants prior to interviews.

## The Employer-Scheduled Interview Center

The Interview Center allows any employer to reserve a table in an area adjacent to the Employment Center. Employers will arrange their own schedule of interviews, either in advance or on site, by using the Employment Message Center. Employers who have never used the Employment Center before might want to try conducting interviews at this convenient location. Since they will be setting their own schedules, employers will have complete control over whom they'll see, for how long, and when they'll be interviewing. This allows employers to pursue other activities at the Joint Meetings.

The center will be open only during the following hours: Wednesday, January 5, 2005, 9:30 a.m.-6:00 p.m.
Thursday, January 6, 2005, 8:00 a.m.-7:30 p.m.
Friday, January 7, 2005, 8:00 a.m.-7:30 p.m.
Saturday, January 8, 2005, 9:00 a.m.-noon
The fee for use of this area is the same as the normal employer fee, \$225. It is requested that all employers fill out an Employer Form for inclusion in the Winter List. This should clarify to Employment Center applicants what type of position is being filled. If an employer is unable to accept new applicants because the deadline has passed, that should be stated on the form.

The Winter List of Applicants, containing information about the candidates present at the Employment Center, will be mailed to all employers in advance of the meeting.

Employers scheduling interviews in advance should tell applicants to find the table with the institution's name in the Interview Center (not the numbered-table area). Employers can schedule any time during the open hours listed above. To schedule interviews after arriving in Atlanta, leave messages for Employment Center applicants in the Employment Message Center. Paper forms will be provided to help speed the invitation process. Each employer will be provided with a box in the Message Center where applicants can leave items.

Employers should have at most two interviewers per table at any time due to space limitations. There will be no outlets or electricity available at the interviewing tables. Only banners which can be draped over the four-foot table can be accommodated.

## About the Winter List of Applicants

This booklet contains hundreds of résumés of applicants registered by October 25 for the Employment Center. It will be mailed to all employers who register by October 25 who indicate on their Joint Meetings registration form that they would like their materials mailed. Employers should be aware that there will be hundreds of brief résumés to look through and should be sure to obtain the Winter List of Applicants as early as possible.

## Employers Not Planning to Interview

Employers who do not plan to participate in the Employment Center at all may place a job description in the book of employers. This description must be submitted on the Employer Form, which appears in the back of this issue, with the appropriate box checked, indicating that no interviews will take place. A fee of $\$ 50$ is charged for this service (paid through the Joint Meetings registration form). The form must be received in the Providence office (with payment or purchase order) by the October 25 deadline to appear in the Winter List of Employers. Forms received in the Providence office after that deadline will be displayed at the meeting. Those wishing to bring a one-page job description to the Employment Center desk for display during the meetings may do so at no charge.

## Employers: How to Register

The interviewer should register and pay for the Joint Mathematics Meetings. They should register for the Employment Center by completing the following steps:

Indicate on the Joint Meetings registration form (available either electronically in early September 2004, at www.ams.org/amsmtgs/ 2091_intro. htm7 or in the back of the October issue of the Notices) that you are also paying the Employment Center employer fee. Indicate your choice of tables. Mark all that apply.

Submit an Employer (job listing) Form electronically at www.ams.org/emp-reg, or use the print version in the back of this issue. Be sure the form indicates which type or types of tables will be used. This form will be printed in the Winter List of Employers.

It is important to register by the October 25 deadline in order for your form to be included in the Winter List of Employers. However, registration will be accepted up to December 10 for the normal fees or on site in Atlanta at the on-site rates. Call 800-321-4267, ext. 4105, with any questions or deadline problems.

Any representatives of the institution can sit at the table, together or working in shifts (however, the limit is
two at one time). If possible, their names should be listed on the Employer Form as a reference point for the applicants. Employment Center fees should be paid only for each table required, not for each person.

In a few unusual cases an institution will be conducting interviews in the Employment Center for two or more distinct positions and will not want to conduct these interviews at one table. In that case, two or more Employer Forms should be submitted, and separate tables and employer numbers will be provided. Applicants will then be able to request interviews for the appropriate job by employer number. First and second table fees should be paid.

The fee for all employers to register in advance is $\$ 225$ for the first table and $\$ 75$ for each additional table. On-site registration fees (any registrations after 12/10/04) are $\$ 305$ for the first table and $\$ 105$ for each additional table. Employers must also register for the Joint Meetings and pay the appropriate Joint Meetings fee.

## Employers: Registration on Site

Employers who do not register for the Joint Mathematics Meetings and the Employment Center by December 10 may register on site in Atlanta at the Joint Meetings registration desk. They must bring their receipt to the Employment Center desk between 7:30 a.m. and 4:00 p.m. on Wednesday, January 5, to receive their materials. A typed copy of the Employer Form (found in the back of this issue) can be brought to the Employment Center for posting on site (or the form can be handwritten on site). If registering for the employer-scheduled Interview Center only, registration on Thursday is possible.

## Applicants: Use of the computer-scheduled program is now optional

In 2005 applicants will be given flexibility in deciding how to participate in the Employment Center. There are two options:

All Employment Center services (computerscheduling system, form posted in Winter List of Applicants, Winter List of Employers received by mail, use of Employment Message Center, availability for employer-scheduled Interview Center).
Message Center and Winter Lists only (form posted in Winter List of Applicants, Winter List of Employers received by mail, use of Employment Message Center, availability for employerscheduled Interview Center, BUT NOT use of the computer-scheduling system). This option is available at a slightly lower price.
Applicants who participate in the 2005 Employment Center will find themselves talking with employers in two different settings:

1. A computer-scheduling program sets 15 -minute interviews at the Employment Register numbered tables.

This is the choice that has now become optional for applicants. Applicants do not have to hand in a computerscheduling form at all.
2. There is also an Interview Center, where employers set their own schedules. These employers do not participate in the scheduling program, so applicants have no automatic access to interviews with them. They determine their own schedules and make their own appointments privately, either in advance or on site using the Employment Message Center. These interviews have always been "optional" for applicants, since they may turn down any written invitation they receive. Applicants are reminded to respond to all invitations promptly. Many applicants prefer the interviews they are invited for in this setting since it's more relaxed and interviews tend to last longer.

Overall, many applicants report being disappointed that there are not more research-oriented jobs being interviewed for at the Employment Center. Applicants should expect that many of the jobs are best suited to enthusiastic and well-qualified candidates who can contribute on many levels in an academic setting.

## The Schedule

For applicants using all services there is a certain scheduling burden placed on them to juggle these simultaneous services. However, computer-scheduled sessions are in small blocks, for a total of eight sessions over the two days of interviews (Thursday and Friday). This allows applicants, once they receive invitations to interview in the Interview Center, to accept, knowing that when they submit the computer schedule request on Wednesday they can mark that they are unavailable for one or more of these sessions without seriously jeopardizing their chances of obtaining scheduled interviews. Likewise, applicants who are scheduled to give a talk can avoid interviews for that time. Applicants are encouraged to schedule their time in advance in this manner and not wait for the computer schedule to be distributed Thursday morning.

Applicants are advised to place as many selections as possible on their scannable request sheets; however, be advised that this may result in interviews with less-preferred employers. Applicants should be aware that each year approximately $10 \%$ of applicants signing up for all services fail to submit a schedule request sheet. This is often due to having too many schedule conflicts.

## Interviews

Applicants should understand that the Employment Center provides no guarantees of interviews or jobs. It is simply a convenient meeting place for candidates and employers who are attending the Joint Meetings. Those who have not yet begun their job search efforts may go unnoticed at the Employment Center (although applicants will likely receive between one and three interviews in the scheduled program). Attention generally goes to candidates who already have applied for open positions or to those who are well suited for teaching positions at liberal arts colleges.

Data from recent Employment Centers show that women represent about half of the most sought-after applicants, although they make up less than half of the total Employment Center applicant pool. Those without permanent authorization to work in the United States will find themselves far less requested than U.S. citizens or permanent residents. Newer Ph.D.'s tend to be invited for more interviews than those who have been working longer. Most jobs listed require a doctorate. Approximately $35 \%$ of applicants responding to a recent survey report having between zero and two interviews in the Interview Center. The rest reported higher numbers. More than half of the applicants reported that at least some of the Interview Center appointments had been arranged in advance of the Meetings.

## Preparations

Candidates just beginning a job search should realize that employers have no method to judge their credentials other than the brief résumé form, and they should make an effort to make it distinct and interesting.

Applicants who register in advance will receive the Winter List of Employers in mid-December. If time permits, they should apply for suitable open positions they notice in the Winter List of Employers after they receive it. Applicants are advised to bring a number of copies of their brief vita or résumé so that they may leave them with prospective employers. It is a good idea in the fall for applicants to alert any employer to whom applications are made that they plan to be present at the Joint Meetings. Also, they should bring enough materials with them to accompany requests for interviews they may want to leave in the Message Center boxes of the Interview Center employers.

Applicants are also encouraged to leave some extra copies of their résumés in their own message folders so that interested employers may find them there. Photocopying costs at a convention are high, so applicants should come prepared with a reasonably large number of copies. A brightly colored form in each folder gives applicants an opportunity to present for public perusal some information about their availability during the meetings.

The Winter List of Applicants is mailed to all employers in advance, so it is vital that the Joint Meetings registration form, applicant résumé form, and payments be received by the October 25 deadline so the Applicant Form can be printed in the book. This greatly increases an applicant's chances of being invited to the Interview Center.

Applicants should keep in mind that interviews arranged by the Employment Center represent only an initial contact with the employers and that hiring decisions are not ordinarily made during or immediately following such interviews.

## Results

In a recent survey, $66 \%$ of applicants responding reported being invited for at least one on-campus visit to an employer they had interviewed with during the Employment Center. $48 \%$ reported receiving at least one job offer in the months following the interview.

## Applicants: Register Early

Applicants need to complete the following steps by the advance deadline of October 25, 2004.

## 1. Pay fees

Register for the Joint Mathematics Meetings (see form in the back of the October issue of the Notices or the electronic information available in early September 2004, at www.ams.org/amsmtgs/2091_intro.html). You cannot participate in the Employment Center unless you are a meetings participant. Mark one of the two "Employment Center Applicant Fee" boxes on the Joint Meetings registration form and make payments. The fee in advance for applicants is \$42; "Message Center and Winter List ONLY" registration is $\$ 21$.

## 2. Send form

Submit the Applicant Form (a brief résumé form) electronically at www. ams .org/emp-reg/, or use the print version in the back of this issue.

## After Registration

Submission of the Applicant Form electronically will result in an email acknowledgement almost immediately. For registration and payments, the Meetings Service Bureau acknowledges all payments. When payments AND the Applicant Form have been received, another acknowledgement will go out by email, if possible, or by mail. Please allow a week or so for processing, but after that contact staff (AMS 800-321-4267, ext. 4105) if you do not receive acknowledgement from the Employment Center.

Around December 15 the Winter List of Employers will be mailed to all registered applicants unless they request otherwise.

## Registering after the Deadline

After October 25 applicants can still register for the Employment Center at the same prices until the final deadline of December 10. However, the Applicant Form will NOT be included in the Winter List of Applicants but will be posted on site at the Employment Center (a serious disadvantage). Those who do not register by December 10 must register on site at the Joint Meetings registration desk and pay higher fees (\$80 Employment Center fee; however, the "Message Center and Winter List ONLY" fee is always just \$21).

It is worthwhile to submit the applicant form even if you miss the October 25 deadline. An unexpected delay in publishing may allow your late form to get into the book. At the very least, your printed-out form will be brought to the meetings by staff and displayed there (after all the fees have been paid).

## When to Arrive

All participants in the scheduled section of the Employment Center must submit their Interview Request/ Availability forms in person between 9:30 a.m. and 4:00 p.m. on Wednesday, January 5, 2005, or they will
not be included when the interview-scheduling program runs Wednesday night. Should unexpected delays occur while travelling, contact the AMS at 800-321-4267, ext. 4107. Be sure to keep Employment Center materials with you, because in an emergency you can report your interview requests over the phone.

## Applicants: Registering on Site

Feel free to enter the Employment Center area first to consult staff about the decision to register on site and to check on which employers are participating. Full registration on site early Wednesday is allowed for a higher fee but is severely discouraged. Most employers will not notice an Applicant Form which arrives on Wednesday. Therefore, these individuals will receive only a couple of computerscheduled interviews. Registration on site is advisable only for those who know they will be interviewed in the Interview Center and would like a Message Center folder for employers to leave messages in. Registering on site for a mailbox only is possible, at the $\$ 21$ rate, on Wednesday and Thursday. Pay the fees at the Joint Meetings registration area and then bring your receipt to the Employment Center desk to register yourself.

# Instructions for Applicant and Employer Forms 

Applicant forms submitted for the Employment Center by the October 25 deadline will be reproduced in a booklet titled Winter List of Applicants. Employer forms submitted by the October 25 deadline will be reproduced for the Winter List of Employers.

Please use the electronic versions of Applicant and Employer forms (http://www.ams.org/emp-reg/). Paper forms should be submitted only by those who do not have access to the AMS website.

00 General
01 History and biography
03 Mathematical logic and foundations
05 Combinatorics
06 Order, lattices, ordered algebraic structures
08 General algebraic systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra, matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory, homological algebra
19 K-theory
20 Group theory and generalizations
22 Topological groups, Lie groups
26 Real functions
28 Measure and integration
30 Functions of a complex variable
31 Potential theory
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
37 Dynamical systems and ergodic theory
39 Difference and functional equations
40 Sequences, series, summability
41 Approximations and expansions
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations

If submitting a paper form, please type carefully. Do not type outside the box or beyond the lines indicated. Extra type will be omitted.

All forms must be received by the Society by October 25, 2004, in order to appear in the Winter List. However, meeting registration (and payment of fees) is required before the forms can be processed.

46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control; optimization
51 Geometry
52 Convex and discrete geometry
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Global analysis, analysis on manifolds
60 Probability theory and stochastic processes
62 Statistics
65 Numerical analysis
68 Computer science
70 Mechanics of particles and systems
74 Mechanics of deformable solids
76 Fluid mechanics
78 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum theory
82 Statistical mechanics, structure of matter
83 Relativity and gravitational theory
85 Astronomy and astrophysics
86 Geophysics
90 Operations research, mathematical programming
91 Game theory, economics, social and behavioral
sciences
92 Biology and other natural sciences
93 Systems theory; control
94 Information and communication, circuits
97 Mathematics education

## EMPLOYER FORM

## MATHEMATICAL SCIENCES EMPLOYMENT REGISTER <br> JANUARY 5-8, 2005 <br> ATLANTA, GEORGIA

1. Forms should be accessed and submitted electronically if possible. The URL for accessing Employment Register information and forms is http://www.ams.org/emp-reg/.
2. Paper or electronic forms are due, along with payment and your Advance Registration/ Housing Form, by October 25 (to AMS, P. O. Box 6887, Providence, RI 02940) in order to be included in the Winter List of Employers.
3. Please list all potential interviewers, for reference by applicants, but pay fees only for each separate table.
4. Forms will not be processed until registration and payment of fees have been received.

| EMPLOYER CODE: | Institution |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Department |  |  |  |
|  | Mailing address |  |  |  |
| E-mail address (one only) |  |  |  |  |
| URL (or other contact info) |  |  |  |  |
| Name(s) of Interviewer(s) 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |
| 4. |  |  |  |  |
| Specialties sought |  |  |  |  |
| Title(s) of position(s) |  |  |  |  |
| Number of positions |  |  |  |  |
| $\begin{array}{ll} \text { Starting date } \\ \text { Renewal } \end{array}$ |  | Term of appointment |  | Years |
|  |  | Tenure-track positi |  |  |
| Possible $\square$ Impossible |  | $\square \text { Yes } \square \text { No Teaching hours per week }$ |  |  |
| Degree preferred |  | Degree accepted |  |  |
| Duties |  |  |  |  |
| Experience preferred |  |  |  |  |
| Significant other requirements, needs, or restrictions which will influence hiring decisions |  |  |  |  |
| This position will be subject to a security clearance which will require U.S. citizenship: $\square$ Yes $\square$ No |  |  |  |  |
| THE EMPLOYER PLANS TO USE THE FOLLOWING SERVICES (check all that apply): |  |  |  |  |
| $\square$ One or more computer-scheduled Interview Tables |  |  |  |  |
| $\square$ One or more self-scheduled Interview Tables |  |  |  |  |
| $\square$ Placing thi | s form for information | ot using a table) |  |  |

## American Mathematical Society

## Headlines \&eDeadines

## a members-only email news service


#### Abstract

AMS members may subscribe to receive twice-a-month email notifications of news, announcements about programs, publications, and events, as well as alerts about deadlines for fellowship and grant applications, calls for proposals, and meeting registrations.


AMS members can sign up for the service at www.ams.org/enews.

2004 CLAY RESEARCH FELL OWS ANNOUNCED
Manolay Mathematics Institute (CMI) has aunceD
Venkartesh of the Mass Mirzakhani of Harvard Univur Research Fellows: Ciprian
Fellows' research for two years.

- Institute will fully support the

The National Academy NTISTS ELECTED TO NAE
associates, including the of Engineering (NAE) has ele
professor of applied mathematividuals in the mathematica 76 new members and 11 foreign
environmental entional science and engineering Institute of Technology; T. Leighton,
environmental engineering and computational sciengrams, and professor, Linda R. Petzold,
and John R. Willis lis. orofessor. $\qquad$
Headlines \& Deadlines from the AMS

- Merial Lecture

STURMFELS TO GIVE ERDOS ME will be given by Bernd Sturmele
The 2004 Erdos Memorial Leckley on May 15 . Tre Lectite Joint Meeting University of Califormia, , ce during the Sixth inemiana in Houston, May 13 -15. Geometry," will take place daring matematica Mexicana in the Sociedad Made possible of the AMS and the Sociedad Maten anual invited address meeting's full
The Erdos Memon andrew Beal, a Dallas
a fund created by An
a fund creale list of presenters at program. html .

## DEADLINES

CHINA TRAVEL GRANT APPLICATIONS The AMS is accepting applications for the nexi rouner 2005. Math departments in the U.S. and place during the 2004-05 academic year or summen by a young researcher from China, and Canada may apply to fund a visit to the to fund a visit to their institution by a prominent U.S. math departments in China may apply mathematician. This program is funded by a garch 15, 2004.
includes details and the application
ENTRIES FOR U.S. PROFESSORS OF THE YEAR PROGRAM and The Carnegie Foundati The Council for Advancent Teaching sponsor the U.S. Professors of the Year Program. Nationa for the Advancement of Teaching sponsortificate of recognition, and are honored at a winners receive a $\$ 5,000$ prize, framed winners are also named. In 2003, math professors luncheon held in Washington DC. State winners are (EI Camino Community College District) w Joseph Gallian (UMN Duluth) and Judy Kasabian (El Camin C. Wehsite The deadline for
awards. The Call for fatries
The deadlines for consideration of contributed papers in Special
Sessions at the first AMS fall Section Meetings are as follows:
Southeastern Section meeting at Vanderbilt University, Nashville, TN, October 16-17: JUNE 29, 2004. See
http://www.ams.org/amsmtgs/2108_deadlines.html.
Western Section meeting at the University of New Mexico, Albuquerque,
October 16-17: JUNE 29, 2004. See
http://www.ams.org/amsmtgs/2112_deadlines.html.

Headlines \& Deadlines is a twice-a-month email news service available to AMS members.

To unsubscribe from this mailing list visit http://www.ams.org/enews.

# APPLICANT RÉSUMÉ FORM <br> MATHEMATICAL SCIENCES EMPLOYMENT REGISTER <br> JANUARY 5-8, 2005 <br> ATLANTA, GEORGIA 

1. Forms should be accessed and submitted electronically if possible. The URL for accessing Employment Register information and forms is http://www.ams.org/emp-reg/.
2. Paper or electronic forms are due, along with payment and your Advance Registration/ Housing Form, by October 25 (to AMS, P. O. Box 6887, Providence, RI 02940) in order to be included in the Winter List of Applicants.
3. Forms will not be processed until registration and payment of fees have been received.


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## Dynamics of Foliations, Groups and Pseudogroups

PAWEL WALCZAK, University of Lodz, Poland
Foliations, groups and pseudogroups are objects, which are closely related via the notion of holonomy. In the 1980s they became considered as general dynamical systems. This book deals with their dynamics, concentrating on notions and results related to different ways of measuring complexity of the systems under consideration. It details different types of growth, entropies and dimensions of limiting objects. Invented in the 1980s (by E. Ghys, R. Langevin and the author) geometric entropy of a foliation is the principal object of interest among all of them.
2004/225 PP./HARDCOVER/\$119.00
ISBN 3-7643-7091-2
MONOGRAFIE MATEMATYCZNE, VOL. 64

## Projective Geometry and Formal Geometry

LUCIAN BADESCU, University of Genova, Italy
This monograph introduces the reader to some modern methods of projective geometry involving certain techniques of formal geometry. Some of these methods are illustrated in the first part through the proofs of a number of results of a rather classical flavor. Motivated by the first part, in the second formal functions on the formal completion XY of X along a closed subvariety Y is studied, especially the extension problem of formal functions to rational functions.
2004/APPROX. 224 PP./HARDCOVER/\$109.00 (TENT.)
ISBN 3.7643-7123-4
MONOGRAFIE MATEMATYCZNE, VOL. 65

## Applied Laplace Transforms and z-Transforms for Scientists and Engineers

A Computational Approach Using a Mathematica Package
URS GRAF, Hochschule für Technik und Architektur, Biel, Switzerland

This book presents the theory and applications of Laplace and $z$-transforms together with a Mathematica package developed by the author. The package substantially enhances the built-in facilities of Mathematica and includes algorithms for the numerical inversion of Laplace transforms. Many examples from applied sciences and engineering illustrate applications of the theory and the usage of the package.
2004/500 PP./HARDCOVER/S89.95
ISBN 3-7643-2427-9

## Rings, Modules, and the Total

FRIEDRICH KASCH, Icking, Germany; and ADOLF MADER, University of Hawaii, Honolulu, HI

The book deals with direct decompositions of modules and associated concepts. The central notion of partially invertible homomorphisms, namely those that are factors of a non-zero idempotent, is introduced in a very accessible fashion. Units and regular elements are partially invertible. The "total" consists of all elements that are not partially invertible. The total is particularly suited to deal with the endomorphism ring of a the direct sum of modules that all have local endomorphism rings and is applied in this case
2004/136 PP./SOFTCOVER/S49.95
ISBN 3-7643-7125-0
FRONTIERS IN MATHEMATICS

## Limit Operators and Their Applications in Operafor Theory

VLADIMIR RABINOVICH, National Politechnic Institute of Mexico, Mexico; STEFFEN ROCH; and BERND SILBERMANN
This book examines a class of operators that occur in almost every part of mathematics: band and banddominated operators on spaces of vector-valued sequences. The main emphasis is on Fredholm theory for these operators and the main tool to study this topic is the method of limit operators. This method provides a general approach to treat quite different classes of operators from a unique view: convolution type operators as well as pseudodifference operators on bad domains and with bad coefficients.
2004/392 PP./HARDCOVER/\$219.00
ISBN 3-7643-7081-5
OPERATOR THEORY: ADVANCES AND APPLICATIONS, VOL. 150

## Reconstructive Integral Geometry

VICTOR PALAMODOV, Tel Aviv University, Israel
This book covers facts and methods for reconstruction of a function in a real affine or projective space from data of integrals over lines, planes, and spheres. It collects recent results on explicit analytic methods. A concise introduction to harmonic analysis and distribution theory is provided in the first chapter. The first half of the book includes the ray, the spherical mean transforms in the plane or in 3-space, and inversion from incomplete data. Later chapters are devoted to the Funk-Radon transform on algebraic varieties of arbitrary dimension.
2004/APPROX. 164 PP./HARDCOVER/S99.00 (TENT.)
ISBN 3.7643-7129-3
MONOGRAPHS IN MATHEMATICS, VOL. 98

## Domain Decomposition in Optimal Control Problems

JACK E. LAGNESE, Georgetown University, Washington, DC; and GUNTER LEUGERING, Technische Universität Darmstadt, Germany (eds.)
While domain decomposition methods have a long history dating back well over one hundred years, it is only during the last decade that they have become a major tool in numerical analysis of partial differential equations. This monograph considers problems of optimal control for partial differential equations of elliptic and, more importantly, of hyperbolic types on networked domains.
2005/APPROX. 468 PP./HARDCOVER/S180.00 (TENT.) ISBN 3-7643-2194-6
INTERNATIONAL SERIES OF NUMERICAL MATHEMATICS, VOL. 148

## The Topology of Torus Actions on Symplectic <br> Manifolds <br> \section*{Second Edition}

MICHÈLE AUDIN, Université Louis Pasteur et CNRS, Strasbourg, France

In this book symplectic manifolds and torus actions are investigated, with numerous examples of torus actions, for instance on some moduli spaces. Although the book is still centered on convexity results, it contains more theorems, more (and better) proofs, more exercises, and many figures. In this extended second edition, the material and references have been updated.
2004/APPROX. 332 PP./HARDCOVER/S109.00 (TENT.)
ISBN 3-7643-2176-8
PROGRESS IN MATHEMATICS, VOL. 93

## Contributions to Current Challenges in Mathematical Fluid Mechanics

GIOVANNI P. GALDI, University of Pittsburgh, PA; JOHN G. HEYWOOD, University of Heidelberg, Germany; and ROLF RANNACHER, University of British Columbia, Vancouver (eds.)
The theory of the Navier-Stokes equations still present fundamental questions that continue to challenge mathematicians. This volume collects a series of articles whose objective is to furnish new contributions and ideas to these questions, with particular regard to turbulence modeling, regularity of solutions to the initial-value problem, flow in region with an unbounded boundary and compressible flow.
Contributors: A. Biryuk/ D. Chae and J. Lee/A. Dunca, V. John and W.J. Layton/T. Hishida/ T. Leọnaviciene and K. Pileckas
2004/151 PP./HARDCOVER/S99.00
ISBN 3-7643-7104-8
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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 programinformation withlinks to the abstract for each talk canbefound on the AMS website.Seehttp://www.ams.org/meetings/.Programs and abstracts will continue to be displayed on the AMS website in the Meetings and Conferences section until about three weeks after the meeting is over. Final programs for Sectional Meetings will be archived on the AMS website in an electronic issue of the Notices as noted below for each meeting.

## Nashville, Tennessee

Vanderbilt University

October 16-17, 2004
Saturday-Sunday

## Meeting \#999

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: August 2004
Program first available on AMS website: September 2, 2004
Program issue of electronic Notices: October 2004
Issue of Abstracts: Volume 25, Issue 4

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions:
Expired
For abstracts: Expired

## Invited Addresses

Ruth M. Charney, Brandeis University, Artin groups, mappling class groups, and automorphism groups.
Peter S. Ozsvath, Columbia University, Holomorphic disks and low-dimensional topology.
Sorin T. Popa, University of California Los Angeles, Deformation, rigidity, and the classification of $I_{1}$ factors.
Rudi Weikard, University of Alabama at Birmingham, Inverse problems for Sturm-Liouville equations.

## Special Sessions

Algebraic Geometry and Commutative Algebra, Juan C. Migliore, University of Notre Dame, and Uwe Nagel, University of Kentucky.
Biomathematics, Laurent Pujo-Menjouet and Glenn F. Webb, Vanderbilt University.
Geometry of Hyperbolic Manifolds, John G. Ratcliffe and Steven T. Tschantz, Vanderbilt University.
Graph Theory and Matroid Theory, Mark N. Ellingham and Michael D. Plummer, Vanderbilt University.
Index Theory and the Topology of Manifolds, Bruce Hughes and Guoliang Yu, Vanderbilt University.
Inverse Problems, Maeve L. McCarthy, Murray State University, and Rudi Weikard, University of Alabama at Birmingham.
Local and Homological Algebra, Florian Enescu, University of Utah, and Adela N. Vraciu, University of South Carolina.
Nonlinear Partial Differential Equations and Applications, Gieri Simonett, Vanderbilt University.
Operator Theory on Function Spaces, Dechao Zheng, Vanderbilt University.
Semigroup Theory, Matthew I. Gould, Vanderbilt University, and Karen Ann Linton, California State Polytechnic University, Pomona.
Topological Aspects of Group Theory, Michael L. Mihalik and Mark V. Sapir, Vanderbilt University.
Universal Algebra and Lattice Theory, Ralph N. McKenzie, Vanderbilt University, and George F. McNulty, University of South Carolina.

Von Neumann Algebras and Noncommutative Ergodic Theory, Dietmar Bisch, Vanderbilt University, and Sorin T. Popa, University of California Los Angeles.
Wavelets, Frames, and Sampling, Akram Aldroubi and Douglas P. Hardin, Vanderbilt University, and Qiyu Sun, University of Central Florida.

## Albuquerque, New Mexico

University of New Mexico

October 16-17,2004
Saturday-Sunday

## Meeting \#1000

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of Notices: August 2004
Program first available on AMS website: September 3, 2004
Program issue of electronic Notices: October 2004
Issue of Abstracts: Volume 25, Issue 4

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

## Invited Addresses

Sara C. Billey, University of Washington, Seattle, A combinatorial approach to solving Schubert problems on the flag manifold.
Peter Ebenfelt, University of California San Diego, Analytic and geometric properties of CR manifolds and their mappings.
Theodore Stanford, New Mexico State University, Knots modulo braids.
Craig A. Tracy, University of California Davis, The universality of the distribution functions of random matrix theory.

## Special Sessions

Algebraic Geometry, Hirotachi Abo and Chris Peterson, Colorado State University.
Analysis and Geometry in Carnot-Caratheodory Spaces, Luca Capogna, University of Arkansas, and Robert Smits, New Mexico State University.
Arithmetic Geometry, Alexandru Buium and Michael J. Nakamaye, University of New Mexico.
Braids and Knots, Theodore Stanford, New Mexico State University.
Categories and Operads in Topology, Geometry, Physics, and Other Applications, Hanna Ewa Makaruk and Robert Michal Owczarek, Los Alamos National Laboratory, and

Zbigniew Oziewicz, Universidad Nacional Autónoma de México.
Financial Mathematics: The Mathematics of Derivative Securities, Maria Cristina Mariani, New Mexico State University, and Osvaldo Mendez, University of Texas at El Paso. Interactions in Riemannian Geometry, Charles P. Boyer and Krzysztof Galicki, University of New Mexico.
Mathematical Methods in Turbulence, Monika Nitsche and Vachtang Poutkaradze, University of New Mexico.
Mathematics for Secondary Teachers: Curriculum and Assessment, Adriana Aceves and Kristin Umland, University of New Mexico.
Multiscale Methods and Sampling in Time-Frequency Analysis, Jeffrey Andrew Hogan, University of Arkansas, and Joseph D. Lakey, New Mexico State University.
Nonlinear Partial Differential Equations Applied to Materials Science, Patricia Bauman, Purdue University, and Tiziana Giorgi, New Mexico State University.
Probabilistic and Geometric Methods in Learning Theory, Vladimir Koltchinskii, University of New Mexico.
Random Matrix Theory and Growth Processes, Craig A. Tracy, University of California Davis.
Regularity in PDEs and Harmonic Analysis, Marianne Korten and Charles Nelson Moore, Kansas State University, and Maria C. Pereyra, University of New Mexico.
Several Complex Variables and CR Geometry, Peter Ebenfelt, University of California San Diego, and Marshall A. Whittlesey, California State University, San Marcos.
Spectral Geometry, Ivan G. Avramidi, New Mexico Institute of Mining and Technology, and Thomas Patrick Branson, University of Iowa.

## Evanston, Illinois

Northwestern University
October 23-24, 2004
Saturday-Sunday

## Meeting \#1001

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: August 2004
Program first available on AMS website: September 9, 2004
Program issue of electronic Notices: October 2004
Issue of Abstracts: Volume 25, Issue 4

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

## Invited Addresses

Ian Agol, University of Illinois at Chicago, Title to be announced.
Robert W. Ghrist, University of Illinois at Urbana-Champaign, Title to be announced.
Yuri Manin, Northwestern University, Title to be announced. Paul Seidel, Imperial College-London and University of Chicago, Title to be announced.

## Special Sessions

Algebraic Representations and Deformations, Stephen R. Doty and Anthony Giaquinto, Loyola University of Chicago. Algebraic Topology: Interactions with Representation Theory and Algebraic Geometry, Paul G. Goerss, Northwestern University, Jesper Kragh Grodal, University of Chicago, and Brooke E. Shipley, University of Illinois at Chicago.
Applications of Motives, Eric M. Friedlander, Northwestern University, Alexander Goncharov, Brown University, Mikhail Kapranov, Yale University, and Yuri Manin, Max Planck Institute for Mathematics.
Codes and Applications, William C. Huffman, Loyola University of Chicago, and Vera S. Pless, University of Illinois at Chicago.
Computability Theory and Applications, Robert I. Soare and Denis R. Hirschfeldt, University of Chicago.
Differential Geometry, Anders Ingemar Linner and Hongyou Wu, Northern Illinois University.
Extremal Combinatorics, Dhruv Mubayi and Yi Zhao, University of Illinois at Chicago.
Fluid Dynamics, Diffusion and Reaction, Peter S. Constantin and Leonid V. Ryzhik, University of Chicago.
Geometric Aspects of the Langlands Program, Edward Frenkel, University of California Berkeley, Dennis Gaitsgory, University of Chicago, Mark Goresky, Institute for Advanced Study, and Kari Vilonen, Northwestern University.
Geometric Partial Differential Equations, Gui-Qiang Chen and Jared Wunsch, Northwestern University.
Hopf Algebras at the Crossroads of Algebra, Category Theory, and Topology, Louis H. Kauffman and David E. Radford, University of Illinois at Chicago, and Fernando J. O. Souza, University of Iowa.
Index Theory, Morse Theory, and the Witten Deformation Method, Igor Prokhorenkov and Ken Richardson, Texas Christian University.
Iterated Function Systems and Analysis on Fractals, Ka-Sing Lau, Chinese University of Hong Kong, and Stephen S.-T. Yau, University of Illinois at Chicago.
Low-Dimensional Topology and Kleinian Groups, Ian Agol, John Holt, and Saul Schleimer, University of Illinois at Chicago.
Mathematical Problems in Robotics, Robert W. Ghrist, University of Illinois at Urbana-Champaign.

Mathematical Techniques in Musical Analysis, Judith Baxter, University of Illinois at Chicago, Richard Cohn, University of Chicago, and Robert Peck, Louisiana State University.
Modern Schubert Calculus, Ezra Miller, University of Minnesota, and Frank Sottile, University of Massachusetts.
Nonlinear Partial Differential Equations and Applications, Gui-Qiang Chen, Northwestern University, and Mikhail Feldman, University of Wisconsin at Madison.
Nonlinear Waves, Jerry L. Bona, University of Illinois at Chicago, Shuming Sun, Virginia Polytechnic Institute and State University, and Bingyu Zhang, University of Cincinnati.
Representation Theory of Reductive Groups, Jeffrey D. Adler, University of Akron, and Ju-Lee Kim, University of Illinois at Chicago.
Solving Polynomial Systems, Anton Leykin and Jan Verschelde, University of Illinois at Chicago.
Special Functions, Orthogonal Polynomials, and their Applications, George Gasper, Northwestern University, and Ahmed I. Zayed, DePaul University.
Spectral Problems of Differential Operators, Qingkai Kong, Hongyou Wu, and Anton Zettl, Northern Illinois University.
Stability Issues in Fluid Dynamics, Susan J. Friedlander and Roman Shvydkoy, University of Illinois at Chicago.

## Pittsburgh, Pennsylvania

University of Pittsburgh

## November 6-7, 2004

Saturday-Sunday

## Meeting \#1002

## Eastern Section

Associate secretary: Lesley M. Sibner
Announcement issue of Notices: September 2004
Program first available on AMS website: September 23, 2004
Program issue of electronic Notices: November 2004
Issue of Abstracts: Volume 25, Issue 4

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: September 14, 2004

## Invited Addresses

Jeffrey F. Brock, Brown University, Title to be announced. Der-Chen Chang, Georgetown University, Geometric analysis on a class of degenerate elliptic operators.

Robert Schapire, Princeton University, Title to be announced.
Ofer Zeitouni, University of Minnesota, Minneapolis, Homogenization in asymmetrical random media: Recent results and challenges.

## Special Sessions

Convexity and Combinatorics (Code: SS 2A), James F. Lawrence and Valeriu Soltan, George Mason University.
Geometric Analysis and Partial Differential Equations in Subelliptic Structures (Code: SS 12A), Cristian E. Gutíerrez, Temple University, Guozhen Lu, Wayne State University, and Juan J. Manfredi, University of Pittsburgh.
Graph Polynomials (Code: SS 8A), E. Glen Whitehead Jr., University of Pittsburgh.
Invariants of Knots and 3-Manifolds (Code: SS 1A), Marta M. Asaeda, University of Maryland, Jozef H. Przytycki, George Washington University, and Adam S. Sikora, SUNY at Buffalo.
Knots and Macromolecules (Code: SS 7A), Kenneth C. Millett, University of California Santa Barbara, and Eric J. Rawdon, Duquesne University.
Mathematical Biology (Code: SS 13A), Jonathan E. Rubin and Bard Ermentrout, University of Pittsburgh.
Mathematical Finance (Code: SS 11A), David Saunders and John Chadam, University of Pittsburgh.
Mathematical Modeling of Nonlinear Phenomena in Biology and Mechanics (Code: SS 6A), Anna Vainchtein and William C. Troy, University of Pittsburgh.

Modularity of Galois Representations and Serre's Conjecture (Code: SS 14A), Mark E. T. Dickinson, University of Pittsburgh.
Multiscale Algorithms in Computational Fluid Dynamics (Code: SS 5A), William J. Layton, University of Pittsburgh, and Anastasios Liakos, U.S. Naval Academy.
Multivariate Hypergeometric Functions: Combinatorial and Algebro-Geometric Aspects (Code: SS 9A), Eduardo Cattani, University of Massachusetts, Amherst, Alicia M. Dickenstein, Universidad de Buenos Aires, and Laura Felicia Matusevich, Harvard University.
PDE-Based Methods in Imaging and Vision (Code: SS 15A), Stacey E. Levine, Duquesne University, and Yunmei Chen, University of Florida.
Partial Differential Equations and Applications (Code: SS 4A), Xinfu Chen and Dehua Wang, University of Pittsburgh.
The History of Mathematics (Code: SS 3A), Robert E. Bradley, Adelphi University, and Lawrence A. D'Antonio, Ramapo College of New Jersey.
Trends in Operator Theory and Banach Spaces (Code: SS 10A), Christopher J. Lennard and Thomas A. Metzger, University of Pittsburgh.

## Atlanta, Georgia

## Atlanta Marriott Marquis and Hyatt Regency Atlanta

January 5-8, 2005
Wednesday-Saturday

## Meeting \#1003



Joint Mathematics Meetings, including the 111th Annual Meeting of the AMS, 88th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association of Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: October 2004
Program first available on AMS website: November 1, 2004
Program issue of electronic Notices: January 2005
Issue of Abstracts: Volume 26, Issue 1

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: October 5, 2004
For summaries of papers to MAA organizers: September 14, 2004

## Joint AMS-MAA Invited Addresses

Andrea L. Bertozzi, University of California Los Angeles, Processing images using nonlinear PDEs, Wednesday, 11:10 a.m.

Bernd Sturmfels, University of California Berkeley, Algebraic statistics, Friday, 11:10 a.m.

AMS Committee on Science Policy-MAA Science Policy Committee Government Speaker, Friday, 5:00 p.m., Speaker and title to be announced

## Joint Prize Session

Prize Session and Reception: In order to showcase the achievements of the recipients of various prizes, the AMS and MAA are cosponsoring this event at $4: 25$ p.m. on Thursday. A cash bar reception will immediately follow. All participants are invited to attend. The AMS, MAA, and SIAM will award the Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student. The MAA will award the Chauvenet Prize, Certificates of Meritorious Service, the Deborah and Franklin Haimo Awards for Distinguished College or University Teaching of Mathematics, the Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics, and JPBM Communications Award. The AMS will announce the winners of the AMS Book Prize, Bôcher Memorial Prize, Levi L. Conant Prize, Frank Nelson Cole Prize in Number Theory, Ruth Lyttle Satter Prize in Math-
ematics, Albert Leon Whitman Memorial Prize, and the Leroy P. Steele Prizes. The AWM will present the Louise Hay Award for Contributions to Mathematics Education and the Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman. This session will also be the venue to announce the winner of the Leonard M. and Eleanor B. Blumenthal Award for the Advancement of Research in Pure Mathematics.

## 111th Annual Meeting of the AMS

## AMS Invited Addresses

Ingrid Daubechies, Princeton University, The Interplay between Analysis and Algorithms (Josiah Willard Gibbs Lecture), Wednesday, 8:30 p.m.
Eleny Ionel, University of Wisconsin, Embedded curves and Gromov-Witten invariants, Thursday, 2:15 p.m.
Bruce A. Kleiner, University of Michigan, Ann Arbor, Title to be announced, Wednesday, 10:05 a.m.
Robert K. Lazarsfeld, University of Michigan, How polynomials vanish: Singularities, integrals, and ideals (Colloquium Lectures), Wednesday, Thursday, and Friday, 1:00 p.m.

Gunther Uhlmann, University of Washington, Recent developments in inverse problems, Friday, 9:00 a.m.
Avi Wigderson, Institute for Advanced Study, The power and weakness of randomness (when you are short on time), Thursday, 3:20 p.m.
Steven M. Zelditch, Johns Hopkins University, Title to be announced, Friday, 10:05 a.m.

## AMS Special Sessions

Some sessions are cosponsored with other organizations. These are noted within the parentheses at the end of each listing, where applicable. Time frames are tentative.
Algebraic Geometry Codes (Code: SS 13A), Shuhong Gao and Gretchen L. Matthews, Clemson University; Friday afternoon.
Algorithmic Algebraic and Analytic Geometry (Code: SS 34A), Saugata Basu, Georgia Institute of Technology, Victoria A. Powers, Emory University, Mika K. Sepälä, Florida State University, Tanush T. Shaska, University of Idaho, and Emil J. Volcheck, National Security Agency; Friday and Saturday mornings and Saturday afternoon.
Analysis and Applications in Nonlinear Partial Differential Equations (Code: SS 27A), Michael T. Lacey, Jason L. Metcalfe, Gerd Mockenhaupt, Ronghua Pan, and Andrzej J. Swiech, Georgia Institute of Technology (AMS-SIAM); Saturday morning and afternoon.
Analysis Problems in Modern Physics (Code: SS 30A), Steven M. Zelditch, Johns Hopkins University; Wednesday and Thursday mornings and Thursday afternoon.
Arithmetic Algebraic Geometry (Code: SS 32A), Matthew H. Baker and Dino J. Lorenzini, University of Georgia; Friday morning and Saturday afternoon.

Commutative Algebra (Code: SS 20A), Srikanth B. Iyengar, University of Missouri, Sean M. Sather-Wagstaff, University of Illinois at Urbana-Champaign, Anurag K. Singh, Georgia Institute of Technology, and Carolyn A. Yackel, Mercer University; Wednesday and Thursday mornings and Wednesday afternoon.
Complex and Functional Analysis (Code: SS 25A), Mihaly Bakonyi, Georgia State University, and Imre Patyi, University of California San Diego; Saturday morning and afternoon.
Current Events (Code: SS 1A), David Eisenbud, Mathematical Sciences Research Institute and University of California Berkeley; Friday afternoon.
Design Theory and Graph Theory (Code: SS 24A), Mike Daven, Mount Saint Mary College, and Atif A. Abueida, University of Dayton; Wednesday morning and afternoon.
D-Modules (Code: SS 14A), Steven Sperber, University of Minnesota, Minneapolis, and Uli Walther, Purdue University; Wednesday morning and afternoon.
Dynamic Equations on Time Scales: Integer Sequences and Rational Maps (Code: SS 26A), Martin J. Bohner, University of Missouri-Rolla, Marc A. Chamberland, Grinnell College, Billur Kaymakcalan, Georgia Southern University, llan C. Peterson, University of Nebraska-Lincoln, and Diana M. Thomas, Montclair State University (AMS-SIAM); Wednesday and Thursday mornings and afternoons.
Dynamics of Mapping Class Groups on Moduli Spaces (Code: SS 10A), Richard J. Brown, American University; Friday morning and Saturday afternoon.
History of Mathematics (Code: SS 3A), Joseph W. Dauben, Lehman College (CUNY), Patti Hunter, Westmont College, and Karen H. Parshall, University of Virginia (AMS-MAA); Friday and Saturday afternoons and Saturday morning.
Integrable Systems and Special Functions (Code: SS 31A), Andras Balogh, University of Texas-Pan American, Mourad E. H. Ismail, University of Central Florida, WenXiu Ma, University of South Florida, and Zhijun Qiao, Los Alamos National Laboratory. (AMS-SIAM); Friday and Saturday mornings and Saturday afternoon.
Inverse Spectral Geometry (Code: SS 16A), Carolyn S. Gordon, Dartmouth University, and Ruth Gornet and Peter A. Perry, University of Kentucky; Friday and Saturday mornings and Saturday afternoon.
In the Wake of Jacobi and Hamilton 200 Years Later (Code: SS 37A), Maria-Clara Nucci, University of Perugia, and Pavel Winternitz, Centre de Recherches Mathématiques, Université de Montréal; Wednesday morning and Thursday afternoon.
Mathematical Image Processing (Code: SS 36A), Jianhong Shen, University of Minnesota, Minneapolis, and Tony F. Chan, University of California Los Angeles (AMS-SIAM); Wednesday morning and afternoon.
Mathematical Sciences Contributions to the Biomedical Sciences (Code: SS 29A), Peter D. March, Ohio State University, De Witt L. Sumners, Florida State University, and

John Whitmarsh, The National Institutes of Health; Thursday morning and afternoon.
Mathematical Sciences Research for the Department of Energy's Computational Biology Needs (Code: SS 7A), Jennifer R. Slimowitz, Board on Mathematical Sciences and Their Applications; Wednesday afternoon.
Mathematicians' Work on Mathematics Education (Code: SS 19A), William G. McCallum, University of Arizona; Friday afternoon.
Mathematics and Education Reform (Code: SS 2A), William H. Barker, Bowdoin College, Jerry L. Bona and Naomi Fisher, University of Illinois at Chicago, Kenneth C. Millett, University of California Santa Barbara, and Bonnie Saunders, University of Illinois at Chicago (AMS-MAA-MER); Wednesday and Thursday mornings and afternoons.
Mathematics and Mathematics Education in Fiber Arts (Code: SS 21A), Sarah-Marie Belcastro, Xavier University, and Carolyn A. Yackel, Mercer University; Friday afternoon.
Modular Representation Theory of Finite and Algebraic Groups (Code: SS 8A), David J. Hemmer, University of Toledo, and Cornelius Pillen, University of South Alabama; Friday and Saturday mornings and Saturday afternoon.
Nonsmooth Analysis in Variational and Imaging Problems (Code: SS 17A), M. Zuhair Nashed, University of Central Florida, and Otmar Scherzer, University of Innsbruck. (AMS-SIAM); Friday and Saturday mornings and Saturday afternoon.
Orthogonal Polynomials-Random Matrices-Integrable Systems: Interdisciplinary Aspects (Code: SS 38A), Jinho Baik, University of Michigan, Ann Arbor, Steven B. Damelin, Georgia Southern University, and Peter D. Miller, University of Michigan, Ann Arbor (AMS-SIAM); Thursday morning and afternoon.
Quantum Topology (Code: SS 15A), Stavros Garoufalidis and T. T. Q. Le, Georgia Institute of Technology; Thursday morning and afternoon.
Radon Transform and Inverse Problems (Code: SS 5A), Adel Faridani, Oregon State University, Gestur Olafsson, Louisiana State University, and Todd Quinto, Tufts University; Wednesday and Thursday mornings and afternoons.
Reaction Diffusion Equations and Applications (Code: SS 28A), Xu-Yan Chen, Georgia Institute of Technology, Yuanwei Qi, University of Central Florida, Junping Shi, The College of William and Mary, and Ratnasingham Shivaji, Mississippi State University (AMS-SIAM); Friday morning and afternoon.
Recent Advances in Mathematical Ecology (Code: SS 18A), Semen Koksal, Florida Institute of Technology, Sebastian Schreiber, The College of William and Mary, and Robert van Woesik, Florida Institute of Technology (AMS-SIAM); Friday morning and afternoon.
Representations of Lie Algebras (Code: SS 23A), Brian D. Boe, University of Georgia, Ben L. Cox, College of Charleston, Vyacheslav M. Futorny, Universidade de Sao

Paulo, William A. Graham, University of Georgia, Duncan J. Melville, St. Lawrence University, and Daniel K. Nakano, University of Georgia; Wednesday and Thursday afternoons and Thursday morning.
Research in Mathematics by Undergraduates (Code: SS 9A), Darren A. Narayan and Tamara A. Burton, Rochester Institute of Technology, Michael J. Fisher, California State University, Fresno, and Carl V. Lutzer, Rochester Institute of Technology (AMS-MAA-SIAM); Friday and Saturday afternoons and Saturday morning.
Reverse Mathematics (Code: SS 6A), Jeff L. Hirst, Appalachian State University, and Reed Solomon, University of Connecticut (AMS-ASL); Wednesday and Thursday mornings and Thursday afternoon.
Riemannian Geometry (Code: SS 11A), Igor Belegradek, Georgia Institute of Technology, and Mohammad Ghomi, Georgia Institute of Technology and Pennsylvania State University; Wednesday and Thursday mornings and Wednesday afternoon.
Spaces of Vector-Valued Functions (Code: SS 22A), Terje Hõim, Florida Atlantic University, and David A. Robbins, Trinity College; Friday morning and afternoon.
Stochastic, Large-Scale, and Hybrid Systems (Code: SS 12A), A. S. Vatsala, University of Louisiana at Lafayette, and G. S. Ladde, University of Texas at Arlington (AMS-SIAM); Thursday morning and afternoon.
Theoretical and Computational Aspects of Inverse Problems (Code: SS 4A), Gunther Uhlmann, University of Washington, and David L. Colton, University of Delaware (AMSSIAM); Wednesday and Thursday mornings and afternoons.
Topics in Geometric Function Theory (Code: SS 33A), Abdelkrim Farouk Brania, Morehouse College, David A. Herron, University of Cincinnati, and Shanshuang Yang, Emory University; Friday afternoon and Saturday morning.
Tropical Geometry (Code: SS 35A), Michael Develin and Bernd Sturmfels, University of California Berkeley (AMSMAA); Thursday morning and afternoon.

## AMS Contributed Papers

There will be sessions for contributed papers of ten minutes' duration. Contributed papers will be grouped by related Mathematics Subject Classification into sessions insofar as possible. The author(s) and their affiliation(s) and the title of each paper accepted will be listed in the program along with the date and time of presentation. Abstracts will be published in Abstracts Presented to the American Mathematical Society and should be submitted electronically. See www. ams.org/meetings/abstracts/ for the form. Select AMS CP 1 as the event code. See the beginning of this announcement for pertinent deadlines.

## Other AMS Sessions

Do the Math! Thursday, 10:00 a.m. to 11:00 a.m., organized by Michael A. Breen and Annette W. Emerson, AMS; and William T. Butterworth, Barat College of DePaul University. This is an updated version of the popular game Who Wants To Be A Mathematician. This year, eight high-
school students from Atlanta and the surrounding region will have a chance to win $\$ 4,000$ by answering questions about mathematics. Contestants can ask for help from anyone in the audience, so the more people in the audience who know mathematics, the better it is for the contestants. You are invited to come and take part in this educational and fun presentation.
Hilbert's First Problem, Thursday, 10:30 p.m. to 12:00 noon, moderated by Keith Devlin, Stanford University. Presenters include Paul J. Cohen, Stanford University; Donald A. Martin, University of California Los Angeles; and W. Hugh Woodin, University of California Berkeley. This panel is cosponsored by the Association for Symbolic Logic.
T. A. Development Using Case Studies: A Workshop for Faculty, Friday, 9:30 a.m.-10:55 a.m. and 1:00 p.m.-2:30 p.m. Solomon Friedberg, Boston University, will guide workshop participants in the effective use of the case studies method as a tool in preparing Teaching Assistants for their important roles as classroom instructors. The faculty edition of the publication Teaching Mathematics in Colleges and Universities: Case Studies for Today's Classroom will be provided to workshop participants at no charge, compliments of the AMS. For more information on the publication, visit the AMS Bookstore (www.ams.org/bookstore) and enter "CBMATH/10.F" in the QuickSearch window. There is a separate registration fee of $\$ 20$ to participate; see the registration and housing form. There are also modest travel grants for this workshop available on a very limited basis. For the application process and other details see www.ams.org/amsmtgs/2091_amswork.htm1

AMS Committee on Science Policy Panel Discussion: Friday, 2:30 p.m. to 4:00 p.m.

AMS Committee on Education Panel Discussion: Saturday, 8:30 a.m. to 10:00 a.m.

## Other AMS Events

Council: Tuesday, 1:00 p.m.
Business Meeting: Saturday, 11:10 a.m.
The secretary notes the following resolution of the Council: Each person who attends a business meeting of the Society shall be willing and able to identify himself or herself as a member of the Society. In further explanation, it is noted that each person who is to vote at a meeting is thereby identifying himself or herself as and claiming to be a member of the American Mathematical Society. The Society has a Committee on the Agenda for Business Meetings. The purpose is to make business meetings orderly and effective. The committee does not have legal or administrative power. It is intended that the committee consider what may be called "quasipolitical" motions. The committee has several possible courses of action on a proposed motion, including but not restricted to:
(a) doing nothing,
(b) conferring with supporters and opponents to arrive at a mutually accepted amended version to be circulated in advance of the meeting,
(c) recommending and planning a format for debate to suggest to a business meeting,
(d) recommending referral to a committee, and
(e) recommending debate followed by referral to a committee.

There is no mechanism that requires automatic submission of a motion to the committee. However, if a motion has not been submitted through the committee, it may be thought reasonable by a business meeting to refer it rather than to act on it without benefit of the advice of the committee.

In order that a motion for this business meeting receive the service offered by the committee in the most effective manner, it should be in the hands of the AMS Secretary by December 8, 2004.

## AMS Short Course

This two-day course on The Radon Transform and Applications to Inverse Problems is organized by Gestur Olafsson, Louisiana State University, and Todd Quinto, Tufts University, and takes place on Monday and Tuesday, January 3 and 4. Please see the complete article on pages 1128-1130. Speakers are Todd Quinto, An introduction to tomography and Radon transforms; Adel Faridani, Oregon State University, Tomography and sampling theory; Alfred Louis, Universitaet des Saarlandes, Development of algorithms in CT; Peter Kuchment, Texas A\&M University, Generalized transforms of Radon type and their applications; Liliana Borcea, Rice University, Coherent interferometric array imaging in random media; and Peter Massopust, Tuboscope Pipeline Services, Inverse problems in pipeline inspection. There are separate registration fees to participate. See the fee schedule on the registration form at the back of this issue.

## 88th Annual Meeting of the MAA

## MAA Invited Addresses

Georgia Benkart, University of Wisconsin, Madison, Square ice is very nice, but can you put a match to it?, Saturday, 9:00 a.m.
Erik D. Demaine, Massachusetts Institute of Technology, Origami, linkages, and polyhedra: folding with algorithms, Thursday, 10:05 a.m.
Fernando Q. Gouvêa, Colby College, What are p-adic numbers and what are they for?, Wednesday, 2:15 p.m.
Steven G. Krantz, Washington University, Symmetry in complex analysis, Saturday, 10:05 a.m.
Ravi D. Vakil, Stanford University, Given four lines in space, how many other lines meet all four?: The geometry, topology, and combinatorics behind linear algebra, Wednesday, 3:20 p.m.
Robin J. Wilson, The Open University, Victorian combinatorics (Student Lecture), Friday, 1:00 p.m.

## MAA Minicourses

Minicourses are open only to persons who register for the Joint Meetings and pay the Joint Meetings Registration fee in addition to the appropriate minicourse fee. The

MAA reserves the right to cancel any minicourse that is undersubscribed.

Minicourse \#1: Visual linear algebra, organized by Eugene A. Herman, Grinnell College; Michael D. Pepe, Seattle Central Community College; and Eric P. Schulz, Walla Walla Community College; Part A: Wednesday, 9:00 a.m.-11:00 a.m. and Part B: Friday, 9:00 a.m.-11:00 a.m. This minicourse will introduce participants to a new, visual approach to teaching linear algebra. The primary objective is to create a dynamic learning environment in which students are actively engaged in learning the central concepts of linear algebra. Course materials stress the development of visualization skills to acquire strong geometric intuition. The materials, taken as a whole, provide everything needed to teach a comprehensive first course in linear algebra. Versions of the materials have been developed for use with Maple and Mathematica. Participants will have the option of working with the materials on either of these platforms. Cost is $\$ 95$; enrollment limit is 30 .

Minicourse \#2: Teaching a Galois theory for undergraduates, organized by John R. Swallow, Davidson College; Part A: Wednesday, 2:15 p.m.-4:15 p.m. and Part B: Friday, 1:00 p.m.-3:00 p.m. Participants explore Galois theory from an undergraduate perspective, gaining materials and technological tools for use teaching an undergraduate course. The course outlines the theory from a concrete, computational point of view, assuming only one semester of abstract algebra. The course also introduces AlgFields: a package for use with Maple or Mathematica, facilitating computation in number fields. Participants study examples, solve exercises, and pose new problems, all built around the concept of an algebraic number with complex approximation. Only basic facility with one of the symbolic computation systems is necessary. Handouts and web links to the freely available package will be distributed. Cost is $\$ 95$; enrollment limit is 30 .

Minicourse \#3: Creating interactive workbooks using MS Excel, organized by Sarah L. Mabrouk, Framingham State College; Part A: Wednesday, 4:30 p.m.-6:30 p.m. and Part B: Friday, 3:15 p.m.-5:15 p.m. Using the control toolbox, one can create interactive workbooks containing scroll bars, buttons, and graphs that can be used for course demonstrations and for course assignments/projects, as well as workbooks that allow students to explore concepts. Creating interactive workbooks using MS Excel requires only basic knowledge of graph and data creation, and students need only MS Excel to use these workbooks; no specialized knowledge is needed to create them, and the Internet is not required in order to use them. Participants will create interactive workbooks containing graph and data components. Sample topics include analysis of spring-mass system and numerical integration. Cost is \$95; enrollment limit is 30 .

Minicourse \#4: Java applets in teaching mathematics, organized by Joe Yanik, Emporia State University, and David M. Strong, Pepperdine University; Part A: Thursday, 8:00 a.m.-10:00 a.m. and Part B: Saturday, 9:00 a.m.-11:00 a.m. This minicourse will introduce the participants to
the Java programming language and its use in creating mathematical activities. No previous experience in Java programming will be assumed. Through the use of a Visual Development Environment and a MathToolkit that was developed with the support of an NSF grant, this handson workshop will lead the participants through the creation of some sample applets and introduce them to the MathToolkit. In addition, they will be provided with a more complete tutorial that they can take home that will teach them the Java programming language and its use in creating mathematical applets. Cost is \$95; enrollment limit is 30 .

Minicourse \#5: Hands-on discrete mathematics with technology, organized by Douglas E. Ensley, and Katherine G. McGivney, Shippensburg University; Part A: Thursday, 10:15 a.m.-12:15 p.m. and Part B: Saturday, 1:00 p.m.-3:00 p.m. Discrete math is a course that primarily serves students studying math and computer science. This minicourse will focus on three major areas of discrete math (sets/relations/graphs, combinatorics/probability, and writing mathematical proofs) that are common to most discrete math courses and on how computer technology can be used to make these courses more student centered. We will use Maple for the first day and predesigned Flash movies for the second day, and in each case we will spend some time on special features of the software and some time on design issues for effective classroom use. The minicourse participants will come away with new ideas and customized material for their own discrete math courses. Some familiarity with Maple syntax is expected, but no experience with Flash will be assumed. Cost is $\$ 95$; enrollment limit is 30 .

Minicourse \#6: WeBWorK, an Internet-based system for generating and delivering homework problems to students, organized by Arnold K. Pizer, Michael E. Gage, and Vicki Roth, University of Rochester; Part A: Thursday, 1:00 p.m.-3:00 p.m. and Part B: Saturday, 3:15 p.m.-5:15 p.m. This minicourse introduces participants to WeBWorK, a freely available system for checking and grading homework problems. WeBWorK won the 1999 ICTCM Award for Excellence and Innovation with the Use of Technology in Collegiate Mathematics. Supported by grants from NSF, WeBWorK has already been adopted by a large number of colleges and universities. WeBWorK can handle most homework problems found in a typical calculus text and is distributed with an extensive library of over 4,000 problems covering college algebra and trigonometry, precalculus, single and multivariable calculus, differential equations, linear algebra, statistics, and probability. There is also a larger national library of problems. It's easy to modify current WeBWorK problems or to write new ones. Participants will actively participate in using WeBWorK and writing WeBWorK problems. Readers can learn more about WeBWorK by connecting to http://www.math. rochester. edu/webwork. Cost is $\$ 95$; enrollment limit is 30.

Minicourse \#7: Developing your department's assessment plan, organized by William A. Marion, Valparaiso University; and Bonnie Gold, Monmouth University; Part A: Wednesday, 9:00 a.m.-11:00 a.m. and Part B: Friday, 9:00
a.m.-11:00 a.m. Most universities and, thus, individual departments are under pressure from accrediting agencies to develop and implement assessment plans to assess student learning. During the minicourse, pairs (or larger groups) of members of a mathematical sciences department will develop in workshop format, a proposed departmental mission statement and the skeleton of its individualized assessment plan. Sample assessment programs (developed by teams of mathematics faculty under the auspices of the MAA's NSF-funded assessment project, Supporting Assessment in Undergraduate Mathematics) will be discussed and participants will share ideas with groups from similar departments to develop their own programs. Cost is $\$ 60$; enrollment limit is 50 .

Minicourse \#8: Mathematical finance, organized by Walter R. Stromquist, Bryn Mawr College; Part A: Wednesday, 2:15 p.m.-4:15 p.m. and Part B: Friday, 1:00 p.m.-3:00 p.m. We will begin by introducing the "standard model" for stock prices, geometric Brownian motion, and we will examine market price statistics to test the validity of this model. We will then cover two main ideas of modern finance: portfolio optimization and option valuation. Portfolio optimization means allocating a fixed investment fund among various risky assets; we will see how this is turned into a quadratic programming problem and how it leads to the capital asset pricing model. Option valuation includes the well-known Black-Scholes formula, which we will cover thoroughly. The presenter will draw on practical examples from his consulting work and from his financial mathematics class at Bryn Mawr College. Cost is $\$ 60$; enrollment limit is 50 .

Minicourse \#9: Infusing connections into core courses for future secondary teachers, organized by Steve R. Benson and Al Cuoco, Education Development Center; Karen J. Graham, University of New Hampshire; and Neil Portnoy, Stony Brook University; Part A: Wednesday, 4:30 p.m.-6:30 p.m. and Part B: Friday, 3:15 p.m.-5:15 p.m. National recommendations call for content courses for prospective teachers that make explicit connections between the mathematics that teachers learn and the mathematics that they will use as teachers. Most content courses for preservice secondary teachers are core courses for the mathematics major, and texts for these courses do not typically address these connections. Minicourse participants will work with materials that contain the mathematical rigor of an upper division course and help prospective teachers build connections to secondary mathematics, discuss implementation issues with colleagues who have used such materials, and begin to adapt these materials for the courses they teach. Cost is $\$ 60$; enrollment limit is 50 .

Minicourse \#10: Bridging the gap between mathematics and the physical sciences, organized by Tevian Dray, Oregon State University; Part A: Thursday, 9:00 a.m.-11:00 a.m. and Part B: Saturday, 9:00 a.m.-11:00 a.m. There is a surprisingly large gap between the way mathematicians on the one hand, and physical scientists and engineers on the other, do mathematics. The key to bridging this gap between mathematics and the physical sciences is geometric reasoning. This minicourse will introduce participants
to the art of teaching geometric reasoning, emphasizing, but not limited to, vectors and vector calculus. Participants will use and discuss open-ended group activities intended to foster geometric reasoning, which have been developed as part of the NSF-funded Vector Calculus Bridge Project at Oregon State University. These materials have been used successfully by several instructors at a variety of institutions. More information on this project is available online at http://www.math.oregonstate.edu/bridge. Cost is $\$ 60$; enrollment limit is 40 .

Minicourse \#11: Fair enough? Mathematics of equity, organized by John C. Maceli and Stanley E. Seltzer, Ithaca College; Part A: Thursday, 1:00 p.m.-3:00 p.m. and Part B: Saturday, 1:00 p.m.-3:00 p.m. Topics of fairness make terrific subject matter for contemporary mathematics courses. This minicourse introduces some fairness topics-apportionment, voting power, elections, fair allocation and equity, the census-with the goals of helping participants learn about these topics, see and use activities that support a course in fairness, and prepare to teach such a course. We will provide sample activities, projects, and a list of resources, including original papers accessible to undergraduates. Active participation is expected. Cost is $\$ 60$; enrollment limit is 50 .

Minicourse \#12: Getting students involved in undergraduate research, organized by Aparna W. Higgins, University of Dayton; and Joseph A. Gallian, University of Minnesota, Duluth; Part A: Wednesday, 9:00 a.m.-11:00 a.m. and Part B: Friday, 9:00 a.m.-11:00 a.m. This course will cover many aspects of facilitating research by undergraduates, such as finding appropriate problems, deciding how much help to provide, and presenting and publishing the results. Examples will be presented of research in summer programs and research that can be conducted during the academic year. Although the examples used will be primarily in the area of discrete mathematics, the strategies discussed can be applied to any area of mathematics. Cost is $\$ 60$; enrollment limit is 50 .

Minicourse \#13: Origami in undergraduate mathematics courses, organized by Thomas C. Hull, Merrimack College; Part A: Wednesday, 2:15 p.m.-4:15 p.m. and Part B: Saturday, 1:00 p.m.-3:00 p.m. Those who have studied origami may have unfolded their creations and marveled at the pattern of creases in the paper that result. Lovely mathematics lurks behind these creases, from geometry, combinatorics, and algebra. This material is easily understood by undergraduate majors, leads to numerous open questions, and offers a great opportunity for hands-on, dis-covery-based learning. This workshop will offer participants hands-on experience with the main areas of "origamimath" (modular origami, geometric constructions, and combinatorial modeling) to incorporate into their own classes. Experience either in paper folding or in teaching geometry, algebra, or combinatorics would be useful. Cost is $\$ 70$; enrollment limit is 30 .

Minicourse \#14: Euler, organized by William W. Dunham, Muhlenberg College, and Edward C. Sandifer, Western Connecticut State University; Part A: Wednesday, 4:30
p.m.-6:30 p.m. and Part B: Friday, 3:15 p.m.-5:15 p.m. Euler wrote and published over 850 books and papers. They form the basis for huge segments of modern mathematics. We will survey his many contributions and take a close look at a few of them. We will demonstrate how to use Euler's eighteenth-century mathematics in a twenty-firstcentury environment, and we will show by example why Laplace was giving good advice when he said, "Read Euler, read Euler. He is the master of us all." Cost is \$60; enrollment limit is 50 .

Minicourse \#15: ConcepTests and Peer Instruction: Active learning in the calculus classroom, organized by Deborah Hughes Hallett and David O. Lomen, University of Arizona; and Maria Robinson, Seattle University; Part A: Thursday, 9:00 a.m.-11:00 a.m. and Part B: Saturday, 9:00 a.m.-11:00 a.m. ConcepTests and Peer Instruction-powerful tools for improving student learning-were originally developed by Eric Mazur at Harvard to teach introductory physics and are now used in biology and astronomy. ConcepTests have now been written for calculus, in which they have shown the same impressive results as in the sciences. Starting with an overview of the use and effectiveness of ConcepTests, this workshop will give participants hands-on experience with their use in mathematics classrooms. Cost is $\$ 60$; enrollment limit is 50.

Minicourse \#16: Music and mathematics, organized by Leon Harkleroad, Wilton, ME; Part A: Thursday,1:00 p.m.-3:00 p.m. and Part B: Friday, 1:00 p.m.-3:00 p.m. Over the years people have used mathematics in various ways to describe, analyze, and create music. This minicourse will explore the applications of mathematical areas such as number theory, probability, and group theory to musical topics such as tuning systems, bell ringing, and twentieth-century compositional technique. Emphasis will be placed on how minicourse participants can incorporate this material into their classes or even design a service course on music and mathematics. Cost is $\$ 60$; enrollment limit is 50 .

## MAA Invited Paper Sessions

Modeling Problems of the Environment, Friday, 1:00 p.m. $-3: 00 \mathrm{pm}$, organized by Ben Fusaro, Florida State University. The speakers are Sherry Brandt-Williams, Atlantic Ecology Division of the EPA, Using energy systems language to diagram and stimulate a complex biological model; Daniel E. Campbell, Atlantic Ecology Division of the EPA, Stability and renewal in heavily exploited populations; Lothar S. Dohse, UNC-Asheville, A cooperative modeling initiative betwen industry and academia; and Donald E. Miller, Saint Mary's College, Modeling the spread and control of oil spills.

Symmetry in Analysis, Saturday, 1:00 p.m.-3:00 p.m., organized by Steve Krantz, Washington University in St. Louis. Speakers are Robert E. Greene, UCLA; Kang-Tae Kim, Pohang University of Science and Technology (Korea); Jeffery McNeal, Ohio State University; and Harold Parks, Oregon State University.

Worlds of Interactive Mathematics, Part I: The Legacy of Elias Deeba, Saturday, 9:00 a.m.-10:55 a.m.; Part II: The

Legacy of James E. White, Saturday, 3:15 p.m.-5:10 p.m., organized by Ananda Gunawardena, Carnegie Mellon University; Dan Kalman, American University; and Gerald J. Porter, University of Pennsylvania. One of the initial authoring environments for the creation of interactive texts was the Mathkit language developed by Jim White. White's work led to the creation of the MAA's Interactive Mathematical Text Project (IMTP), funded by IBM and the NSF. White not only provided much of the intellectual material for this project but he also, through this project and the subsequent Project Welcome, provided hands-on training in the use of the tools. Elias Deeba was both a participant in these endeavors and the director of the IMTP at the University of Houston, Downtown. We take this opportunity to honor them for their leadership and to continue the work that they have begun. In these sessions we will highlight some of their contributions, as well as showcasing recent developments in the field which bear the stamp of their influence. Speakers include Ananda Gunawardena, Elias Deeba's work; Zuhair Nashed, University of Central Florida, Some paradigms in elementary linear algebra which Elias liked; Dan Kalman and Gerald J. Porter, James White's work; Samad Mortabit, Metropolitan State University, Mathwright activities; and Margie A. Hale, Stetson University, Interactive investigation of geometry through light rays.

## MAA Contributed Paper Sessions

The organizers listed below solicit contributed papers pertinent to their sessions. Sessions generally limit presentations to ten minutes, but selected participants may extend their contributions up to twenty minutes. A proposal should not be sent to more than one organizer. If your paper cannot be accommodated in the session for which it was submitted, it will be automatically considered for the general contributed paper session. In scheduling talks in the general session, preference will be given to authors who have not had a paper accepted in another session.

Each session room contains an overhead projector and screen; blackboards will not be available. Persons needing additional equipment should contact as soon as possible but prior to September 14, 2004, the session organizer whose name is followed by an asterisk (*). Please note that the dates and times scheduled for these sessions remain tentative.

Getting Students to Discuss and to Write about Mathematics (MAA CP A1), Wednesday morning and Thursday afternoon; Sarah L. Mabrouk*, Framingham State College (mabrouk@frc.mass.edu).

My Favorite Demo: Innovative Strategies for Mathematics Instructors (MAA CP B1), Wednesday morning and Thursday afternoon; David R. Hill*, Temple University (hi11@math. temple.edu), and Lila F. Roberts, Georgia College and State University.

Courses below Calculus: A NewFocus(MAACPC1), Wednesday morning and Friday afternoon; Mary Robinson*, University of New Mexico-Valencia Campus (maryrobn@ unm. edu); Florence S. Gordon, New York Institute of Technology; Laurette B. Foster, Prairie View A\&M University;

Arlene H. Kleinstein, Farmingdale State University of New York;Norma M. Agras, Miami Dade Community College; and Linda Martin, Albuquerque T-VI.

Mathematics and Sports(MAA CP D1), Wednesday morning and Friday afternoon; Douglas Drinen*, University of the South (ddrinen@sewanee. edu); Sean L. Forman, St. Joseph's University; Howard L.Penn, U.S. Naval Academy.

Mathematics in the Islamic World (MAA CP E1), Wednesday afternoon; Glen Van Brummelen*, Bennington College (gvanbrum@bennington. edu), and Victor J. Katz, University of the District of Columbia.

Mathlets for Teaching and Learning Mathematics (MAA CP F1), Wednesday afternoon; David M. Strong*, Pepperdine University (David.Strong@pepperdine.edu); Thomas E. Leathrum, Jacksonville State University; and Joe Yanik, Emporia State University.

Drawing on Our Students' Thinking to Improve the Mathematical Education of Teachers (MAA CP G1), Wednesday afternoon; Dale R. Oliver*, Humboldt State University (dale.oliver@humboldt.edu), and Mary Kay Abbey, Montgomery College.

History of Undergraduate Mathematics in America, 1900-2000 (MAA CP H1), Thursday morning; Jack Winn*, SUNY Farmingdale (winnja@farmingda1e. edu); Walter J. Meyer, Adelphi University; Joseph Malkevitch, York College of CUNY; and Amy E. Shell-Gellasch, Grafenwoehr, Germany.

Initializing and Sustaining Undergraduate Research Projects and Programs (MAA CP I1), Thursday morning; Margaret M. Robinson*,MountHolyokeCollege(robinson@ mtholyoke. edu), and Suzanne M. Lenhart, University of Tennessee.

Projects and Demonstrations That Enhance a Differential Equations Course (MAA CP J1), Thursday morning; Richard J. Marchand*, Slippery Rock University (Richard. Marchand@SRU. edu), and Shawnee L. McMurran, California State University, San Bernardino.

Countering "I Can't Do Math"; Strategies for Teaching Underprepared, Math-Anxious Students (MAA CP K1), Thursday morning; Suzanne Dorée*, Augsburg College (doree@augsburg.edu); Bonnie Gold, Monmouth University; and Richard J. Jardine, Keene State College.

Using Real-World Data to Illustrate Statistical Concepts (MAA CP L1), Thursday afternoon and Friday morning; Thomas L. Moore*, Grinnell College (mooret@ grinne11. edu), and John D. McKenzie Jr., Babson College.

Environmental Mathematics and the Interdisciplinary (MAA CP M1), Friday morning; Karen Bolinger*, Clarion University(kbolinge@mail.clarion.edu); Ben Fusaro, Florida State University; and William Stone, New Mexico Institute of Mining \& Technology.

Teaching Visualization Skills (MAA CP N1), Friday morning; Mary L. Platt*, Salem State College (mplatt@ salemstate.edu); Catherine A. Gorini, Maharishi University of Management; and Sarah J. Greenwald, Appalachian State University.

Teaching and Assessing Problem Solving (MAA CP 01), Friday morning; Alex J. Heidenberg*, U.S. Military Academy (alex.heidenberg@usma.edu), and Michael Huber, U.S. Military Academy.

Philosophy of Mathematics (MAA CP P1), Friday afternoon; Charles R. Hampton*, The College of Wooster (Hampton@ wooster. edu), and Bonnie Gold, Monmouth University. This session will be followed by the Philosophy of Mathematics SIGMAA Business Meeting and Reception. Everyone interested in the philosophy of mathematics is invited to attend.

Using Handheld Technology to Facilitate StudentCentered Teaching/Learning Activities at the Developmental Algebra Level (MAA CP Q1), Friday afternoon; Ed Laughbaum*, The Ohio State University (elaughba@math. ohio-state.edu), and Maria DeLucia, Middlesex County College.

My Three Favorite Original Calculus Problems (MAA CP R1), Saturday morning; J.D. Phillips*, Wabash College (phil1ipj@ wabash. edu), and Timothy J. Pennings, Hope College.

Meeting the Challenge: Relationship between Mathematics and Biology in the 21st Century (MAA CP S1), Saturday morning; Catherine M. Murphy*, Purdue University Calumet (murphycm@ca7umet. purdue.edu); G. Elton Graves, RoseHulman Institute of Technology; and David A. Smith, Duke University.

Mathematics Experiences in Business, Industry, and Government (MAA CP T1), Saturday morning; Philip E. Gustafson*, Mesa State College (pgustafs@mesastate.edu), and Michael G. Monticino, University of North Texas.

Mathematical Experiences for Students outside the Classroom (MAA CP U1), Saturday afternoon; Kay B. Somers*, Moravian College (somersk@moravian. edu), and Jody M. Sorensen, Grand Valley State University.

Research on the Teaching and Learning of Undergraduate Mathematics (MAA CP V1), Saturday afternoon; William O. Martin*, North Dakota State University (william. martin@ndsu.nodak.edu); Barbara E. Edwards, Oregon State University; and Draga D. Vidakovic, Georgia State University.

In-Service Training Programs for $K-12$ Mathematics Teachers (MAA CP W1), Saturday afternoon; Zsuzsanna Szaniszlo*, Valparaiso University(zsuzsanna.szaniszlo@ valpo. edu); Judith L. Covington, Louisiana State University, Shreveport; and Tamas Szabo, Weber State University.

General Contributed Paper Session (MAA CP X1), Wednesday, Thursday, Friday, Saturday mornings and afternoons; Daniel E. Otero*, Xavier University (otero@xavier. xu.edu). Papers may be presented on any mathematical topic. Papers that fit into one of the other sessions should be sent to that organizer, not to this session.

## Submission Procedures for MAA Contributed Papers

Send your abstract directly to the AMS. At the same time, send a detailed one-page summary of your paper directly via email to the organizer, indicated with an asterisk (*). To enable the organizer to evaluate the appropriateness of your paper, include as much detailed information as possible within the one-page limitation. The summary need not duplicate the information in the abstract. Participants may speak in at most two MAA contributed paper sessions. If your paper cannot be accommodated in the session for which it was submitted, it will be automatically considered
for the general session. Speakers may give only one presentation in the general session because of time/space limitations. A proposal should not be sent to more than one organizer. The summary must reach the organizer by Tuesday, September 14, 2004. Abstracts must reach the AMS by Tuesday, October 5, 2004.

The AMS will publish abstracts for the talks in the MAA sessions. Abstracts must be submitted electronically to the AMS. No knowledge of $\mathrm{ET}_{\mathrm{E}} \mathrm{X}$ is necessary; however, $\mathrm{ET} \mathrm{T}_{\mathrm{E}} \mathrm{X}$ and $\mathcal{A}_{\mathcal{M}} \mathcal{S}^{S}$-ETE X are the only typesetting systems that can be used if mathematics is included or special formatting is desired. The abstracts submission page is at www. ams.org/cgi-bin/abstracts/abstract.p1. Simply fill in each field as instructed. Submitters will be able to view their abstracts before final submission.

All questions concerning the submission of abstracts should be addressed to abs-coord@ams.org.

## Other MAA Sessions

Training T. A.s in Departments and at Section Meetings, Wednesday, 8:30 a.m.-10:55 a.m., organized by Louise A. Raphael, Howard University. The presenters will be Diane L. Herrmann, University of Chicago, and Maria S. Terrell and Thomas W. Rishel, Cornell University.How are T.A. training sessions set up? What are the similarities and differences between such sessions? How can case studies be used in support of T. A. training? How might T. A. training compare with preparing your faculty? We will provide a skeleton outline of possible training approaches for individual institutions, as well as for section-level training programs. The session is sponsored by the MAA Committee on Graduate Students.

Doctoral Programs in Mathematics Education: Their Nature and How to Find Them, Wednesday, 9:30 a.m.-10:50 a.m., organized by Robert E. Reys, University of Missouri. Since the year 2000 more than 120 different institutions in the United States have awarded doctorates with a major emphasis in mathematics education. These programs vary greatly in structure as well as visibility. The Association of Mathematics Teacher Educators has developed a tool to collect and disseminate information about doctoral programs in mathematics education. This session will showcase this tool and highlight some ways it might be used by faculty and students looking for doctoral programs in mathematics education.

A Problem-Based Core Program, Wednesday, 9:30 a.m. -10:50 a.m., organized by Donald B. Small, U.S. Military Academy. In 2003, the U.S. Military Academy refocused its core program to emphasize problem solving and modeling. First semester focuses on problems from management science using concepts from data analysis, matrix algebra, network theory, and Markov chains. The second semester emphasizes analyzing continuous change (differentiation of functions of one and several variables), and the third semester treats integration of one and several variables, along with differential equations. The fourth semester focuses on probability and statistics. Several program threads, such as data analysis, serve to unify the four-semester core program. Gary W. Krahn and Alex J. Heidenberg of the U.S. Military Academy have been in-
volved in the development and implementation of the refocused program. Michael E. Moody, Olin University, will address the transportability issues of this program to other schools.

Developing Undergraduate Research Projects That Are Not in Discrete Mathematics, Wednesday, 2:15 p.m.-3:45 p.m., organized by Edwin P. Herman, University of Wisconsin at Stevens Point. Are you looking for research ideas to give to your undergraduate students? This session includes panelists from a variety of fields who will offer advice on how to develop research topics at a level appropriate for the undergraduate. They will discuss how to identify suitable topics and how to keep your students on track, as well as how to give the students sufficient background to tackle an interesting problem. This session was organized by the 1994-2000 Project NExT Fellows to address issues of concern to faculty who have four to ten years of teaching experience. Panelists include Carl C. Cowen, Indiana University-Purdue University at Indianapolis; David W. Farmer, American Institute of Mathematics; Mario U. Martelli, Claremont McKenna College; Bruce Reznick, University of Illinois at Urbana-Champaign; and Patrick J. Van Fleet, University of St. Thomas. The session is sponsored by Project NExT.

Career Paths for Undergraduates in Mathematics, Wednesday, 2:15 p.m.-3:35 p.m., organized by James E. Hamblin, Shippensburg University; John A. Vano, University of Wisconsin at Madison; and John A. Kuchenbrod, The MITRE Corp. A common question asked by undergraduates is: What can I do with a degree in mathematics? In this session, the panelists will discuss the many varied careers that an undergraduate degree can lead toward. The session is sponsored by the Young Mathematicians Network.

Ph.D. Programs in Research in Undergraduate Mathematics, Wednesday, 2:15 p.m.-3:35 p.m., organized by John Selden, New Mexico State University. A number of mathematics departments have granted, and some may be considering granting, Ph.D.s whose research specialty is mathematics education. This panel will discuss examples of specific Ph.D. programs in research in undergraduate mathematics education (RUME) housed in mathematics departments. There will also be a brief description of the SIGMAA on RUME guidelines for such programs. Thus the panel will describe both commonalities (the guidelines) and variations (the examples) among such programs. Panelists include Shandy Hauk, University of Northern Colorado; Michael Oehrtman, Arizona State University; Karen J. Graham, University of New Hampshire; and John Selden. The session is sponsored by the SIGMAA on RUME Guidelines Committee.

Dealing with the Two-Body Problem, Wednesday, 3:50 p.m.-5:10 p.m., organized by Kimberly A. Roth, Wheeling Jesuit University, and Karrolyne Fogel, California Lutheran University. Finding a job for one mathematician is hard enough, but what if you need jobs for two? Panelists who have searched for a personal solution to a two-body problem will discuss their attempts at a solution, the compromises and logistics involved, and their degree of satisfaction with each "solution" they tried. The session is
sponsored by the Young Mathematicians' Network and Project NExT.

How to Interview for Your First Job, Wednesday, 3:30 p.m.-4:50 p.m., organized by Louise A. Raphael, Howard University. The presenters will be David Manderschied, University of Iowa, and Thomas W. Rishel, Cornell University. The session is sponsored by the MAA Committee on Graduate Students.

Refocused College Algebra: A Basis for QL Programs, Wednesday, 3:50 p.m.-5:10 p.m., organized by Donald B. Small, U.S. Military Academy. Faculty in quantitative disciplines urge mathematics departments to send them students having experience with elementary data analysis, plotting and interpreting plots, problem solving in the modeling sense, small-group work, and the use of technology. These aspects are basic to refocused college algebra programs. In addition, college algebra is the largest gateway course (in terms of student enrollment) and is thus well positioned to provide a basis for QL programs. Panelists include Norma M. Agras, Miami-Dade College; Dora C. Ahmadi, Morehead State University; Laurette B. Foster, Prairie View A\&M University; and Bernard L. Madison, University of Arkansas. The panel will be moderated by Harriet S. Pollatsek, Mount Holyoke College, and is sponsored by the MAA CUPM Subcommittee on Curriculum Renewal Across the First Two Years (CRAFTY).

What Faculty Can Do to Promote Diversity in Mathematics, Thursday, 8:30 a.m.-10:00 a.m., organized by T. Christine Stevens, St. Louis University; Joseph A. Gallian, University of Minnesota Duluth; and Aparna W. Higgins, University of Dayton. This panel focuses on concrete steps that faculty can take, alone or in small groups, to promote diversity in mathematics. Topics include running summer programs for women or minorities; promoting the success of underrepresented groups in classes; organizing a Sonja Kovalevsky Day for middle or high school girls; successful programs that attract minorities to major in mathematics; resources that are available to assist in promoting diversity in mathematics; promoting diversity in such a way that it will further one's career and increase one's chance for tenure. Panelists include Deanna B. Haunsperger, Carleton College; Nathaniel Dean, Texas Southern University; Robert E. Megginson, Mathematical Sciences Research Institute; and Stephanie Fitchett, Florida Atlantic University. The session is sponsored by Project NExT.

Emerging Technologies in Undergraduate Mathematics, Thursday, 8:30 a.m.-11:30 a.m., organized by Jack Picciuto, U.S. Military Academy. This session and future sessions will focus on the use or proposed use of emerging technologies that could improve the learning of undergraduate mathematics. We want to begin now to examine how we can effectively use technologies that are expected to become widespread and affordable over the next five years. This year's session will focus on the use of true three-dimensional displays. Increasingly affordable three-dimensional display technologies range from the old-fashioned colored glasses used in such movies as Spy Kids 3D and Shrek 3D to the new Sharp notebook computer (\$3K) that displays brilliant 3D without the need for special glasses and the inexpensive ( $\$ 10 \mathrm{~K}$ ) GeoWall 3D pro-
jection system (http: //geowal1.geo.1sa.umich.edu/) that is commonly used in the GeoScience community. This session will demonstrate or introduce some of those technologies and resources for undergraduate mathematics that exploit them. We also invite speakers to discuss lessons already learned as well as address the big questions: Are these true 3D technologies just a gimmick? Can they enhance learning? Could my school ever afford this?

National Science Foundation Programs Supporting Learning and Teaching in the Mathematical Sciences, Thursday, 9:00 a.m.-10:20 a.m., organized by John R. Haddock, Elizabeth J. Teles, and Lee L. Zia, NSF/Division of Undergraduate Education; John S. Bradley, NSF/Division of Elementary, Secondary, and Informal Education; James H. Lightbourne, Senior Advisor for Planning, Analysis, and Policy; and Lloyd E. Douglas, NSF/Division of Mathematical Sciences. A number of NSF divisions offer a variety of grant programs that support innovations in learning and teaching in the mathematical sciences. These programs will be discussed, along with examples of successful projects. In addition, anticipated budget highlights and other new initiatives for the next fiscal year will be presented.

Recruiting Students for Mathematics Departments, Thursday, 10:30 a.m.-noon, organized by Brian Birgen, Wartburg College, and Mary D. Shepherd, Northwest Missouri State University. The job opportunities for college graduates with degrees in mathematics are just about unlimited, yet the percentage of students who seek degrees in mathematics is quite small. Somehow we must do a better job recruiting students into mathematics. The members of this panel are from departments that have been able to consistently recruit large numbers of students into their mathematics programs. They will describe what they and other members of their faculty do to help recruit students into mathematics. This session was organized by the 1994-2000 Project NExT Fellows to address issues of concern to faculty who have four to ten years of teaching experience. Panelists include Genevieve M. Knight, Coppin State University; Joel S. Foisy, State University of New York-College at Potsdam; Jim Lewis, University of Nebraska; and Matthew P. Richey, St. Olaf College. The session is sponsored by Project NExT.

How Changes in High School Mathematics Could Influence Collegiate Mathematics, Thursday, 10:45 a.m.-12:05 p.m., organized by Bernard L. Madison, University of Arkansas. Recent changes in high school mathematics, largely influenced by the NCTM standards, have not been matched by comparable changes throughout college mathematics. The presidents of AMATYC and NCTM, an award-winning high school teacher, and the Chair of the MAA Committee on Articulation and Placement will discuss the resulting differences and implications of these differences for student learning. Panelists include Judy E. Ackerman, Montgomery College, President of AMATYC; Dan Kennedy, Baylor School; Cathy L. Seeley, University of Texas at Austin, President of NCTM; and Bernard L. Madison. The session is sponsored by the MAA Committee on Articulation and Placement.

Using the CUPM Curriculum Guide 2004 to Get Grants to Facilitate Change, Thursday, 10:45 a.m.-12:05 p.m., organized by Janet L. Andersen, Hope College, and David M. Bressoud, Macalester College. One of the underutilized sources of NSF funding is the Adaptation and Implementation (A\&) component of the Course, Curriculum, and Laboratory Instruction (CCLI) program. This session will explain how the CUPM Curriculum Guide 2004 and its supplement, the CUPM Illustrative Resources, can be used to identify programs at other institutions that can be adapted and implemented to meet significant needs at your own institution. It will also address how to put together a CCLI-A\&I grant proposal that is attractive to NSF. Panelists will include: Dennis Davenport, U.S. Military Academy; Wade Ellis, West Valley College; and Stephanie Fitchett, Florida Atlantic University.

Using CUPM Curriculum Guide 2004: Assessing and Improving the Program for the Major in Mathematics, Thursday, 1:00 p.m.-2:20 p.m., organized by William E. Haver, Virginia Commonwealth University, and Harriet S. Pollatsek, Mount Holyoke College. CUPM Guide 2004 was approved by the MAA Committee on Reports in September 2003. It has been available on MAA Online since then. Copies were mailed to all mathematical sciences departments in March 2004. The panel will describe ways departments can use CUPM Guide 2004 to develop, refine, and/or implement an assessment plan for the major program. Indeed, the first recommendation in CUPM Guide 2004 directs departments to (1) understand the strengths, weaknesses, career plans, and aspirations of their students; (2) determine the extent to which the goals of courses and programs offered are aligned with the needs of students, as well as the extent to which these goals are achieved; and (3) strengthen courses and programs to better align with student needs and assess the effectiveness of such efforts. Panelists will discuss efforts at a range of institutions and serving a variety of departmental missions. They include Richard M. Grassl, University of Northern Colorado; Matthew P. Richey, St. Olaf College; and R. Bruce Mattingly, SUNY Cortland. The panel will be moderated by William E. Haver.

Learning to Prove: Strategies to Improve Students' Proof Writing Skills, Thursday, 1:00 p.m.-2:20 p.m., organized by Annie Selden, New Mexico State University; Barbara E. Edwards, Oregon State University; Nancy L. Hagelgans, Ursinus College; and Ahmed I. Zayed, DePaul University. This session will focus on what works. There will be brief descriptions from several presenters and then participants will choose from several small group discussions. The topics addressed will include outlining the proof; the genre of proof; getting students to use definitions; and assessment of proofs, including the use of multiple drafts and peer review. The session is sponsored by the MAA Committee on the Teaching of Undergraduate Mathematics (CTUM).

Undergraduate Mathematics and NSDL: the National Science Technology Engineering and Mathematics Education Digital Library, Thursday, 1:00 p.m.-4:00 p.m., organized by Franklin A. Wattenberg, U.S. Military Academy. In addition to the resources in the MAA's MathDL, the

NSDL has a wide variety of scientifically and pedagogically outstanding resources that can be used in undergraduate mathematics courses. This session will look at resources from collections ranging across all the sciences. The emphasis is on very interactive resources that excite and engage students and that demonstrate the power and usefulness of mathematics. Speakers will include mathematicians, scientists, and engineers.

Environmental Mathematics SIGMAA Invited Address, Council Meeting, and Business Meeting, Thursday, 1:00 p.m.-3:00 p.m., organized by Ben Fusaro, Florida State University. This session will begin with an Invited Address by Benoit Mandelbrot, Yale University.

Young Mathematicians' Network-MAA Project NExT Poster Session, Thursday, 2:00 p.m.-4:00 p.m., organized by Kevin E. Charlwood, Washburn University, and Kenneth A. Ross, University of Oregon. Junior mathematicians who are no more than five years beyond their Ph.D. are invited by MAA Project NExT and the Young Mathematicians' Network to submit abstracts for the session. The poster size will be $48^{\prime \prime}$ (length) by $36^{\prime \prime}$ (height). Posterboard and materials for posting pages on the posters will be provided on site. Applications should be submitted to Kevin E. Charlwood, kevin.charlwood@washburn.edu, and Kenneth A. Ross, ross@math.uoregon.edu, by December 7, 2004.

Speaking of Mathematics, Thursday, 2:30 p.m.-3:50 p.m., organized by Jon T. Jacobsen, Harvey Mudd College, and Lewis D. Ludwig, Denison College. The purpose of this panel is to share techniques for improving students' oral communication skills. Communication is an integral part of mathematics and professional life. Students have ample opportunities to communicate with their professors and peers but are often challenged when it comes to communicating to the nonspecialist. This is particularly relevant in mathematics, with its many special symbols and notations. Panelists Joseph A. Gallian, University of Minnesota at Duluth, Jon T. Jacobsen, and Lewis D. Ludwig will share their curricular and extended efforts developed to hone these skills. For example, panelist Jacobsen has developed a course in which students give expository talks of varying lengths and provide peer feedback. Some talks are videotaped for their benefit. Panelist Ludwig has integrated oral communication into Denison's "Introduction to Proofs" course in a novel way. Panelist Gallian is also a well-recognized expert in communication. We hope to provide a forum for the exchange of ideas toward improving this fundamental skill in our nation's undergraduate mathematics education.

The Senior Seminar or "Capstone" Experience for Undergraduate Mathematics Majors, Thursday, 2:30 p.m.-3:50 p.m., organized by Padraig M. McLoughlin, Morehouse College. More and more faculty and mathematics departments seem to indicate that part of an undergraduate mathematics program should include some undergraduate research. However, although it seems that the "capstone" experience has been adopted, there are several versions of a senior seminar at colleges and universities. This session is designed to compare or contrast programs or to propose a model for the senior seminar.

A panel of faculty from various departments will describe their undergraduate capstone, thesis, or senior seminar programs. Then a discussion will focus on innovations that support or create sustainable end-of-program experiences for undergraduates. The panel will discuss techniques used in the program, appropriate problems, how the experience is assessed, whether it is a one-term or full-year experience, the amount of writing required or expected, amount of faculty involvement in the program, whether the capstone experience has been an attractor for more majors, and successes or limitations of the programs. Panelists include Colin L. Starr, Willamette University; Xinxin Jiang, Rhodes College; John W. Emert, Ball State University; Carol S. Schumacher, Kenyon College; David Brown, Ithaca College; Abdelikrim Brania, Morehouse College; and Michael Johnson, U.S. Military Academy.

Moore Method Calculus by Those Who Do It, Thursday, 3:15 p.m.-4:35 p.m., organized by James P. Ochoa, Hardin-Simmons University, and William T. Mahavier, Lamar University. This panel discussion addresses the use of the Moore Method in the teaching of calculus. Each panelist has numerous years of experience using the Moore Method in calculus courses. Panelists will discuss how they have adapted the Moore Method to calculus courses. Cooperative learning, inquiry-based learning, and problembased learning will also be discussed. Materials are available for those who are interested in using the Moore Method. Panelists will talk about these materials. This session will be the fourth in a series of highly successful panel sessions offered in 1999, 2001, and 2003. Previous sessions were well attended, videotaped, and archived for their historical significance. Panelists include: Charles S. Allen, Drury University; Gregory D. Foley, Appalachian State University; Tom Ingram, Baylor University; and William T. Mahavier.

History of Mathematics SIGMAA Annual Meeting and Guest Lecture, Thursday, 6:00 p.m.-8:00 p.m., organized by Amy Shell-Gellasch,Grafenwoer, Germany. Thomas Archibald, Dibner Institute at MIT and Arcadia University, will speak on John Charles Fields: A career in mathematics. For more information, please go to the HOM SIGMAA website, accessible from the MAA website, or contact Amy Shell-Gellasch at amy.shellgellasch@us.army.mil.

Proposal Writing Workshop for Grant Applications to the NSF Division of Undergraduate Education, Friday, 9:00 a.m.-10:20 a.m., organized by John R. Haddock, Elizabeth J. Teles, and Lee L. Zia, NSF/Division of Undergraduate Education. Presenters will describe the general NSF grant proposal process and consider particular details relevant to programs in the Division of Undergraduate Education. Attendees of this session will have an opportunity to read sample proposals and take part in a "mock" panel review of proposals.

Long-Term Mathematics Faculty Outside of the Tenure Track: Possibilities, Pitfalls, and Practicalities, Friday, 9:00 a.m.-10:20 a.m., organized by David J. Lutzer, College of William and Mary. Panel members will discuss issues associated with long-term mathematics faculty outside of the tenure track who focus primarily on teaching. The CBMS2000 report and the lead story in the April 16,

2004, Chronicle of Higher Education show that such faculty members are more and more common in mathematics departments. The panel's focus is not on whether a department should use such faculty but rather on options for long-term job security in case a department decides to use non-tenure-track faculty to cover its courses. Such job security allows these faculty members to enter more fully into the department's advising and curriculum planning (especially at the lower division), thereby addressing issues in the MAA Board of Governor's resolution on non-tenure-track teaching faculty, available at www.mathsci. appstate.edu/~sjg/maasciencepolicycommittee/ res2.htm1. Panel members will present the perspectives of department chairs and of long-term non-tenure-track faculty in mathematics departments. Panelists include Susan C. Geller, Texas A\&M University; Joel K. Haack, University of Northern Iowa; David R. Morrison, Duke University; and David J. Lutzer. The session is sponsored by the MAA Committee on the Profession.

Just the Facts: Profiles and Inferences from Data on Permanently Temporary Faculty, Friday, 1:00 p.m.-2:20 p.m., organized by Kevin Charlwood, Wabash University; Judith L. Baxter, University of Illinois at Chicago; and Bettye Anne Case, Florida State University. Panelists will provide a description of the non-tenure-stream faculty and the perceptions and realities of the contributions they make to undergraduate education in the mathematical sciences. Despite their critical and varied roles in mathematics departments, they typically operate in a separate fiefdom from the rest of their colleagues. Discussion will center on data available from AMS Annual Surveys, the CBMS Survey (2000), and NRC/NAS data and on some important inferences from this data as to the impact on departments of full-time lecturers, adjuncts, and other faculty members who are employed for long periods of time but who are not in the professorial ranks. Panelists include Mary W. Gray, American University; Pat Shure, University of Michigan; Stephen B. Rodi, Austin Community College; James W. Maxwell, AMS; and Bettye Anne Case. The panel will be moderated by Kevin Charlwood and is sponsored by the AMS/MAA Joint Committee on Teaching Assistants and Part-Time Instructors (TA/PTI).

Using Mathematically Rich Activities to Develop K-12 Curricula: Part I, Friday 9:00 a.m.-10:55 a.m., organized by Robert P. Moses, Cambridge, MA; Robert E. Megginson, Mathematical Sciences Research Institute; and Ed Dubinsky, Kent State University. Many early elementary mathematics curricula make extensive use of manipulatives to introduce the basic arithmetic of rational numbers. By the time pre-algebra and algebra classes are taught, drawing on physical experience to motivate the underlying mathematical concepts is rarely done. The purpose of this special presentation is to introduce and explore the ideas inherent in employing mathematically rich activities to develop curricula, especially at the late middle/early high school level. The "Road Coloring Problem", an example of such a "mathematically rich activity", will be introduced. Participants in the session will work through a portion of the ninth-grade curriculum, developed under an NSF grant to the Algebra Project, surrounding this unsolved problem
that is still under active investigation. This hands-on activity will be used to initiate discussion of the usefulness of the approach and to discuss other mathematically rich activities that could possibly be developed in the same manner. The Algebra Project demonstration will be led by Gregory M. Budzban, Southern Illinois University, and Robert P. Moses. This will be followed by brief presentations of alternative approaches in a similar spirit by David W. Henderson, Cornell University; William G. McCallum, University of Arizona; and Ed Dubinsky. Part II of the presentation is scheduled for Saturday, 1:00 p.m.-3:00 p.m.

The Great Divide: Graphing Calculators in Secondary and College Education, Friday, 1:00 p.m.-2:20 p.m., organized by Thomas W. Tucker, Colgate University. A major, perhaps the major, articulation problem between secondary and college mathematics education is the use of graphing calculators. Nearly all secondary teachers have probably operated a graphing calculator in the last month, whereas the majority of college teachers haven't operated one in many years, if ever. The debates about the uses of technology in mathematics education ended for computers years ago, with acceptance at both the secondary and college level, but for graphing calculators the debates ended with different conclusions: widespread and wholehearted adoption at the secondary level and sporadic support, benign neglect, or outright antipathy at the college level. Worse, this state of affairs seems to be news to both camps. At the least, dialogue is needed, which this panel will provide. Panelists include Gail F. Burrill, Michigan State University, former President NCTM; Raymond J. Cannon, Baylor University, College Board Advanced Placement Program; Richard H. Escobales, Canisius College; and Thomas Tucker. The session is sponsored by the MAA Committee on Articulation and Placement.

Planning a Sabbatical, Friday, 1:00 p.m.-2:30 p.m., organized by Jeffrey T. Barton, Bernadette Mullins, and Barry S. Spieler, Birmingham-Southern College. Do you want to spend your sabbatical doing research, writing a textbook, working for a government agency, or something entirely different? Our panelists will discuss their varied experiences and answer questions about every step of the process, from generating ideas to writing a proposal to working out the logistics, and funding your sabbatical. This session was organized by the 1994-2000 Project NExT Fellows to address issues of concern to faculty who have four to ten years of teaching experience. Panelists include William A. Marion, Valparaiso University; Neil Portnoy, Stony Brook University; and Barbara Reynolds, Cardinal Stritch University. The session is sponsored by Project NExT.

Projects Supported by the NSF Division of Undergraduate Education, Friday, 1:00 p.m.-3:00 p.m., organized by Jon W. Scott, Montgomery College. This session will feature principal investigators (PIs) presenting progress and outcomes from various NSF-funded projects in the Division of Undergraduate Education. The poster session format will permit ample opportunity for attendees to engage in small-group discussions with the PIs and to network with each other. Information about presenters and their projects will appear in the program.

Classroom Networks for Developing Mathematical Understanding, Friday, 2:30 p.m.-3:50 p.m., organized by Franklin D. Demana, The Ohio State University, and Jeremy Roschelle, SRI International. In this session, we will explore the range of new possibilities that classroom networks bring to teaching and learning mathematics. Classroom networks connect student graphing calculators to a central computer and a project display, enabling the teacher to more quickly distribute and harvest student work. In one application, students can each graph a target function that fits some criteria (e.g., find a curve that fits these data points). The lecturer can then explore students' differing mathematical solutions to these problems. Possible generalizations can thus emerge from students' work. Presenters will discuss their applications of classroom network technology and how this technology improves classroom teaching and learning. Panelists will include James J. Kaput, University of Massachusetts, Dartmouth; Walter Stroup, University of Texas, Austin; and Louis Abrahamson, Better Education, Inc.

Presentations by Teaching Award Recipients, Friday, 2:30 p.m.-4:00 p.m. Winners of the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching will give presentations on the secrets of their success.

Information Session on Actuarial Education, Friday 2:45 p.m. $-4: 45$ p.m., organized by Bettye Anne Case and Steve Paris, Florida State University; Matthew J. Hassett, Arizona State University; and Krzysztof M. Ostaszewski, Illinois State University. There will be a presentation by Richard London, University of Connecticut, on the dramatic changes in the professional actuarial education system effective in 2005, followed by an open information discussion. Refreshments will be provided.

WEB SIGMAA Business Meeting, Friday 4:00 p.m.-5:00 p.m., organized by Kirby A. Baker, University of California Los Angeles.

System-Wide Quantitative Literacy Initiatives, Friday, 4:00 p.m.-5:20 p.m., organized by Judith F. Moran, Trinity College, Caren L. Diefenderfer, Hollins University. Representatives from Washington, Illinois, and Georgia will discuss efforts in their states to implement statewide QL standards and programs. Joined by a national leader in the QL effort, they will be discussing issues of definitions, standards, assessment, articulation agreements, and political hurdles. Panelists include: Linda R. Sons, Northern Illinois University; Kathleen B. Burk, Pensacola Junior College; Kimberly M. Vincent, Washington State University; and Bernard L. Madison, University of Arkansas. A reception will follow the panel discussion. The session is sponsored by the SIGMAA for Quantitative Literacy.

Revisiting Crossroads: The Teaching and Learning of Mathematics in Two-Year Colleges, Saturday, 9:00 a.m.-10:20 a.m., organized by Susan S. Wood, J. Sargeant Reynolds Community College. Panelists will update attendees on the progress of the project to revisit the 1995 AMATYC Standards with attention to the student and learning, faculty and teaching, mathematics content challenges, assessment, and connections with outside communities. A written document that emphasizes imple-
mentation and builds on the 1995 Crossroads will be released in fall 2006 with supporting digital products that use a variety of media. Connections to MAA's CUPM Curriculum Guide 2004 will be discussed, as well as strategies for implementing change. The goals of the session are to inform attendees about the project to revisit the 1995 AMATYC Standards, Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus, and to engage attendees in dialogue about recommendations for teaching, learning, and assessing mathematics in the first two years of college. Audience participation and feedback will be used by the writing team for the AMATYC Crossroads Revisited Project. Panelists include: Judy E. Ackerman, Montgomery College; Susan L. Ganter, Clemson University; and Susan S. Wood.

MAA/RUME Panel Discussion on the ICME- 10 Meeting, Saturday, 9:00 a.m.-10:20 a.m., organized by Martha J. Siegel, Towson University, and Andy R. Magid, University of Oklahoma. Panelists will report on international perspectives on mathematics education gleaned from the ICME-10 meeting in Copenhagen.

First-Semester Calculus: Meeting the Needs of Our Students, Saturday, 1:00 p.m.-2:20 p.m., organized by David M. Bressoud, Macalester College, and William E. Haver, Virginia Commonwealth University. Once upon a time mainstream first-semester calculus was the first exposure to calculus for students going into mathematically intensive majors. It presupposed its students were among the strongest in mathematics, had not studied calculus before college, and would continue in calculus beyond this course. In many colleges and universities, the course has not changed, but the student audience has. Many of the strongest students do not take first-semester calculus in college. Many of the students who start with this course and want to pursue a full year of calculus need more help to succeed in it. Many students, especially those in the biological or life sciences, take it with no intention of taking a second course in calculus. The CUPM Curriculum Guide 2004 calls on departments to "determine the extent to which the goals of courses and programs offered are aligned with the needs of students." This panel will suggest ways to recast this course so that it meets actual student needs.

Faculty Development for Adjuncts and New Faculty, Saturday, 1:00 p.m.-2:20 p.m., organized by Donald B. Small, U.S. Military Academy. Adjuncts teach the majority of sections of beginning-level courses in many two-year colleges and universities. For the most part, these people only have responsibility for their own sections and are not integrated into the workings of their department, thus making it more difficult for beginning-level courses to act as a pump for upper-level courses. The panelists will discuss successful faculty development programs for adjunct and new faculty. Panelists include Michael D. Phillips, U.S. Military Academy; William E. Haver, Virginia Commonwealth University; Robert Kimball, Wake Tech Community College; and Pat Shure, University of Michigan. The panel will be moderated by Philip H. Mahler, Middlesex Community College, and is sponsored by the MAA CUPM

Subcommittee on Curriculum Renewal Across the First Two Years (CRAFTY).

Using Mathematically Rich Activities to Develop K-12 Curricula, Part II, Saturday, 1:00 p.m.-3:00 p.m., organized by Robert P. Moses, Cambridge, MA; Robert E. Megginson, Mathematical Sciences Research Institute; and Ed Dubinsky, Kent State University. Many early elementary mathematics curricula make extensive use of manipulatives to introduce the basic arithmetic of rational numbers. By the time pre-algebra and algebra classes are taught, drawing on physical experience to motivate the underlying mathematical concepts is rarely done. The purpose of this presentation is to introduce and explore the ideas inherent in employing mathematically rich activities to develop curricula, especially at the late middle/early high school level. Discussion of the "Road Coloring Problem", the example of such a "mathematically rich activity" introduced in Part I will be continued. Participants in the session will work through a portion of the ninth grade curriculum, developed under an NSF grant to the Algebra Project, surrounding this unsolved problem that is still under active investigation. This hands-on activity will be used to continue discussion of the usefulness of the approach, after which there will be a panel discussion of the ideas presented in this special session. The panelists will be: William G. McCallum, University of Arizona, Judith Roitman, University of Kansas, and Robert P. Moses. (Part I of this discussion was scheduled on Friday, 9:00-10:55am.)

Mathematical Outreach and the Environment, Saturday, 2:30 p.m.-3:50 p.m., organized by Patricia Clark Kenschaft, Montclair State University. The panel will focus on how environmental issues can be used as a vehicle for mathematicians' outreach into the community. Three forms of this outreach will be explored, followed by audience discussion. Speakers include James M. Wright, Green Mountain College, "Media, Mathematics, and the Environment"; Michael P. Cohen, Assistant Director for Survey Programs, Bureau of Transportation Statistics, "Government Careers in Mathematics and the Environment"; and William Dean Stone, New Mexico Tech, "Earth Day Talks: High School Outreach". The session is sponsored by the MAA Committee on Mathematics and the Environment.

Open Discussion on Refocusing the Courses Before Calculus, Saturday, 2:30 p.m.-3:50 p.m., organized by Donald B. Small, U.S. Military Academy. The moderator, Jack Bookman, Duke University, and panelists Nancy Baxter Hastings, Dickinson College, and Bruce Crowder, Oklahoma State University, are active members of the combined MAA/AMATYC/NCTM committee that is leading a national movement to refocus college algebra/precalculus courses. They will address the activities of this committee, as well as CRAFTY's Position Paper on courses below calculus. The session is sponsored by the MAA CUPM Subcommittee on Curriculum Renewal Across the First Two Years (CRAFTY).

## MAA Student Activities

Robin J. Wilson, The Open University, Victorian combinatorics, Friday, 1:00 p.m. (Student Lecturer).

Undergraduate Student Poster Session, Friday, 4:00 p.m.-6:30 p.m., organized by Mario Martelli, Claremont McKenna College and sponsored by the Committee on Undergraduate Student Activities and Chapters (CUSAC). Send title and abstract (not longer than one-half page) by email to mmarte11i@mckenna.edu, or by regular mail to Mario Martelli, Mathematics Department, Claremont McKenna College, Claremont, CA 91711 by December 7, 2004. Include author"s name, address, phone number, email, affiliation, name and affiliation of faculty advisor, name of the sponsoring program (NSF-REU, NSA, etc), and request for an electronic outlet if needed for the presentation. When the poster is authored by more than one student, please indicate the one who will communicate with the organizer. Notification of acceptance will be emailed two weeks after the abstract has been received. Apply early! Space is limited. The session is reserved to undergraduates and first-year graduate students submitting posters on work done while undergraduates. Each poster will be evaluated by at least three judges and the best posters will receive monetary awards provided by the MAA, AMS, AWM, The Moore Foundation, and CUR. Trifold, self-standing 48 " by 36 " tabletop posterboard will be provided. Additional material or equipment is the responsibility of the presenters.

## MAA Short Course

Eight lectures on random graphs, Monday and Tuesday, January 3 and 4, organized by Alan M. Frieze, Carnegie Mellon University.

The subject began properly with a sequence of seminal papers in the 1960s by Paul Erdös and Alfred Rényi. Erdös had already used randomly generated graphs as a tool for showing the existence of various structures, but these papers began the study of random graphs as objects in their own right. Since that time there has been much research establishing the likely structure of various models of random graph and finding uses for this knowledge. In this course we provide some of the basic results and tools used in the area. Presenters include Thomas A. Bohman, Carnegie Mellon University, Evolution of $G_{n, m}$; Oleg Pikhurko, Carnegie Mellon University, Thresholds for some basic properties; Benny Sudakov, Princeton University, Probabilistic Method; Andrzej Rucin'ski, Adam Mickiewicz University, Small subgraphs; Nick Wormald, University of Waterloo, Random regular graphs; Dimitris Achlioptas, Microsoft Research, Graph coloring and random k-SAT; Michael Molloy, University of Toronto, Title to be announced; and Alan M. Frieze, Carnegie Mellon University, Web graphs.

Please note that there is a separate registration fee for this Short Course. To register in advance, please use the Advance Registration/Housing Form found at the back of this issue, or see http://www.ams.org/amsmtgs/ 2091_registration.htm1. Advance registration fees are \$125/member; \$175/nonmember; and \$50/student, unemployed, emeritus. On-site registration fees are \$140/ member; \$190/nonmember; and \$60/student, unemployed, emeritus.

## Other MAA Events

Board of Governors, Tuesday, 8:30 a.m.-4:00 p.m.
Section Officers,Wednesday, 2:30 p.m.-5:00 p.m.
Business Meeting, Saturday, 11:45 a.m.-12:15 a.m.
See the listings for various receptions in the "Social Events" section.

## Activities of Other Organizations

Several organizations or special groups are having receptions or other social events. Please see the "Social Events" section of this announcement for details.

## Association for Symbolic Logic (ASL)

This two-day program on Friday and Saturday will include sessions of contributed papers and Invited Addresses by: Mathias Aschenbrenner, University of Illinois at Chicago, Asymptotic differential algebra; Andres Caicedo, Institut fur formale Logik (Vienna), Projective well-orderings of the reals; Tetsuya Ishiu, University of Kansas, Lawrence, The nonstationary ideal and club guessing ideals; Olivier Lessman, University of Oxford, A survey of excellence; Joseph Mileti, University of Illinois at Urbana-Champaign, Partition theorems and computability theory; Bjorn Poonen, University of California Berkeley, Extensions of Hilbert's Tenth Problem; and W. Hugh Woodin, University of California Berkeley, Structural equivalences for the determinacy of real games. See also the Special Session jointly sponsored by the ASL in the "AMS Special Sessions" section, as well as a cosponsored panel discussion on Hilbert's First Problem listed in the "Other AMS Sessions" section.

## Association for Women in Mathematics (AWM)

Twenty-Sixth Annual Emmy Noether Lecture, Thursday, 9:00 a.m.-9:50 a.m., will be given by Lai-Sang Young, Courant Institute, New York University, From limit cycles to strange attractors.

A dinner in honor of the lecturer will be held on Wednesday evening. See the "Social Events" section for details on how to participate.

Achieving Diversity in Graduate Programs, Part I: The Challenge to Retain Women, Wednesday, 3:20 p.m.-4:20 p.m., organized by Suzanne M. Lenhart, University of Tennessee, and Sylvia T. Bozeman, Spelman College. This panel discussion is cosponsored by the National Association of Mathematicians; see the description of Part II of this presentation on Saturday at 9:00 a.m. under NAM's listing of events.

Just before the panel discussion, AWM will recognize the Alice T. Schafer prizewinner, runner-up, and honorablemention honorees. Note that formal prizewinner announcements are made at the Joint Prize Session on Thursday afternoon (see the AWM inclusion in the "Joint Sessions" section at the beginning of this announcement).

Business Meeting, Wednesday, 4:20 p.m.-4:50 p.m.
Focus: Future: Wednesday, 4:50 p.m. $-5: 30$ p.m. At the conclusion of the business meeting, members and others interested in the AWM are invited to come and share ideas at this session organized by the AWM Long-Range Planning

Committee. Helen Moore, American Institute of Mathematics, will serve as moderator.

Workshop, Saturday, 8:30 a.m.-5:00 p.m. With funding from the Office of Naval Research and the National Security Agency (pending final funding approval), AWM will conduct its workshop for women graduate students and women who have received the Ph.D. within the last five years. Organizers are Dawn A. Lott, New Jersey Institute of Technology, Judy L. Walker, University of Nebraska, and Claudia Polini, University of Notre Dame.

Twenty women mathematicians have been selected in advance of this workshop to present their research. The selected graduate students will present posters, and the recent Ph.D.'s will give 20-minute talks. Travel funds are provided to the twenty selected presenters. The workshop will also include a panel discussion on issues of career development. Participants will have the opportunity to meet with other women mathematicians at all stages of their careers. All mathematicians (female and male) are invited to attend the entire program. Departments are urged to help graduate students and recent Ph.D.'s who do not receive funding to obtain some institutional support to attend the workshop and the associated meetings. The deadline for applications for presenting and funding has expired. Inquiries regarding future workshops may be made to AWM by telephone: 301-4057892, by email: awm@math.umd.edu, or by visiting http://www.awm-math.org/.

AWM seeks volunteers to lead discussion groups and to act as mentors for workshop participants. If you are interested in volunteering, please contact the AWM office.

Reception, Wednesday, 9:30 p.m.-11:00 p.m. See the listing in the "Social Events" section of this announcement.

National Association of Mathematicians (NAM) Granville-Brown-Haynes Session of Presentations by Recent Doctoral Recipients in the Mathematical Sciences, Friday, 2:15 p.m.-4:00 p.m.

Cox-Talbot Address, to be given Friday after the banquet; speaker and title to be announced.

Achieving Diversity in Graduate Programs, Part II: The Challenge to Retain Underrepresented Groups, Saturday, 9:00 a.m.-9:50 a.m., organized by Nathaniel Dean, Texas Southern University, and Rhonda J. Hughes, Bryn Mawr College. This panel discussion is cosponsored by the Association of Women in Mathematics; see the description of Part I of this presentation on Wednesday at 3:20 p.m. under AWM's listing of events.

Business Meeting, Saturday, 10:00 a.m.-10:50 a.m.
Claytor-Woodard Lecture: Saturday, 1:00 p.m., speaker and title to be announced.

See details about the banquet on Friday in the "Social Events" section.

## National Science Foundation (NSF)

The NSF will be represented at a booth in the exhibit area. NSF staff members will be available to provide counsel and information on NSF programs of interest to mathematicians. The booth is open the same days and
hours as the exhibits. Times that staff will be available will be posted at the booth.

## Pi Mu Epsilon (PME)

Council Meeting, Friday, 8:00 a.m.-11:00 a.m.

## Rocky Mountain Mathematics Consortium (RMMC)

Board of Directors Meeting, Friday, 2:15 p.m.-4:10 p.m.

## Society for Industrial and Applied Mathematics (SIAM)

A two-day program on Wednesday and Thursday will include an Invited Address and minisymposia. The Invited Address will be given by Pavel Pevzner, University of California San Diego, Transforming men into mice (and into chimpanzees, dogs, chickens, etc.) at 11:10 a.m. on Thursday.Minisymposia and their organizers include Undergraduate Linear Algebra and Differential Equations: Projects, Problems, and Issues, William Briggs, University of Colorado at Denver; Discontinuous Glaerkin Methods, Paul Castillo, University of Puerto Rico; and Error-Correcting Codes, Vera Pless, University of Illinois at Chicago. See also the Special Sessions jointly sponsored by SIAM in the "AMS Special Sessions" section.

## Young Mathematicians Network (YMN)

Concerns of Young Mathematicians: A Town Meeting, Wednesday, 7:15 p.m.-8:15 p.m., organized by David Kung, St. Mary's College of Maryland. This panel discussion will focus on the current primary concerns of young mathematicians, from undergraduates to newly tenured professors, with emphasis on audience participation.

Also see details about the poster session (Thursday at 2:00 p.m.) and panel discussions (Wednesday at 2:15 p.m. and 3:50 p.m. ) cosponsored by YMN under the "Other MAA Sessions" section.

## Others

Math on the Web, Wednesday-Saturday, various times. The problem of communicating Math on the Web is really no different from communicating math via other media. Namely, authoring and displaying mathematical notation is difficult. On top of that, the Web is a dynamic medium, where users can interact with rich media documents in sophisticated ways. This introduces a whole new layer of challenges and possibilities for engaging, interactive communication between authors and readers. There will be several presentations on the exhibit hall floor throughout the meeting.

Summer Program for Women in Mathematics (SPWM), Thursday, 2:00 p.m.-4:00 p.m., organized by Murli Gupta, George Washington University. SPWM participants will describe their experiences from past programs.

## Ancillary Conferences

American Statistical Association (ASA): A one-day course will be offered January 4 preceding the Joint Mathematics Meetings in Atlanta. Visit the LearnSTAT site at http://www.amstat.org/education/1earnstat.htm1
for more details as they are developed. Inquiries can be directed to learnstat@amstat.org.

## Social Events

It is strongly recommended for any event requiring a ticket, that tickets be purchased through advance registration. Only a very limited number of tickets, if any, will be available for sale on site. If you must cancel your participation in a ticketed event, you may request a $50 \%$ refund by returning your ticket(s) to the Mathematics Meetings Service Bureau (MMSB) by December 27. After that date no refunds can be made. Special meals are available at banquets upon advance request, but this must be indicated on the Advance Registration/Housing Form.

Student Hospitality Center, Wednesday-Friday, 9:00 a.m.-5:00 p.m., and Saturday, 9:00 a.m.-3:00 p.m., organized by Richard Neal, University of Oklahoma. A reception for undergraduates will be held here on Wednesday, 4:00 p.m.-5:00 p.m.

Reception for First-Time Participants,Wednesday, 5:00 p.m. $-6: 00$ p.m. The AMS and the MAA Committee on Membership are cosponsoring this social hour. All participants (especially first-timers) are encouraged to come and meet some old-timers and pick up a few tips on how to survive the environment of a large meeting. Refreshments will be served.

Graduate Student Reception, Wednesday, 6:00 p.m.7:00 p.m., organized by Betty Mayfield, Hood College, and Shawnee McMurran, California State University San Bernardino. Mathematicians representing a wide range of disciplines will join interested graduate students at an informal reception. Complimentary food and beverages will be served. NOTE: This event is only for students who sign up on the Advance Registration/Housing Form.

Mathematical Sciences Institutes Open House, Wednesday, 5:30 p.m.-8:00 p.m. Participants are warmly invited to attend this open house sponsored by several of the mathematical institutes in North America.

All participants are invited to a dinner to honor AWM's Noether Lecturer on Wednesday. A sign-up sheet for those interested will be located at the AWM table in the exhibit area and also at the AWM panel discussion.

AWM Reception: There is an open reception on Wednesday at 9:30 p.m. after the AMS Gibbs Lecture. This has been a popular, well-attended event in the past.

MAA Two-Year College Reception, Thursday, 5:45 p.m. -7:00 p.m., is open to all meeting participants, particularly two-year faculty members. This is a great opportunity to meet old friends and make some new ones. There will be hot and cold refreshments and a cash bar. Sponsored by Addison Wesley Longman.

Lehigh University Reception, Thursday, 5:45 p.m.-7:00 p.m. All friends and graduates of the Lehigh Math Program are invited to attend.

Association of Lesbian, Gay, Bisexual, and Transgendered Mathematicians Reception, Thursday, 6:00 p.m.8:00 p.m. Everyone is welcome to attend this open recep-
tion. Meet some new friends or get together with some old friends. Please join us!

University of Chicago Department of Mathematics Alumni Reception, Thursday, 6:00 p.m.-7:00 p.m.

MER Banquet: The Mathematicians and Education Reform (MER) Forum welcomes all mathematicians who are interested in precollege, undergraduate, and/or graduate educational reform to attend the MER banquet on Thursday evening. This is an opportunity to make or renew contacts with other mathematicians who are involved in education projects and to engage in lively conversation about educational issues. The after-dinner discussion is an open forum for participants to voice their impressions, observations, and analyses of the current education scene. There will be a cash bar beginning at $6: 30$ p.m. Dinner will be served at 7:30 p.m. Tickets are $\$ 45$ each, including tax and gratuity.

Knitting Circle, Thursday, 8:15 p.m. $-9: 45$ p.m. Bring a project (knitting/crochet/tatting/beading/etc.) and chat with other mathematical crafters.

Joint PME and MAA Student Chapter Advisors' Breakfast, Friday, 7:00 a.m. to 8:00 a.m.

Reception for Mathematicians in Business, Industry, and Government, Friday, 5:00 p.m.-6:00 p.m., organized by Michael Monticino, University of North Texas. This welcome reception is open to all conference participants and in particular those interested in the mathematics of business, government, and industry (BIG). The reception will be a great opportunity to interact with BIG mathematicians and learn more about BIG mathematics. The reception is sponsored by the BIG SIGMAA.

New Mexico State University Mathematics Association Reception, Friday, 5:30 p.m.-7:30 p.m. All members and friends are invited; there will be a no-host bar available.

NAM Banquet, Friday, 5:30 p.m.-9:00 p.m. The National Association of Mathematicians will host a banquet on Friday evening. A cash bar reception will be held at 5:30 p.m., and dinner will be served at 6:00 p.m. Tickets are $\$ 48$ each, including tax and gratuity.

Mathematical Reviews Reception, Friday, 6:00 p.m.7:00 p.m. All friends of Mathematical Reviews (MR) are invited to join reviewers and MR editors and staff (past and present) for a reception in honor of all the efforts that go into the creation and publication of the Mathematical Reviews database. Refreshments will be served.

Budapest Semesters in Mathematics (BSM) Reunion, Friday, 6:30 p.m. to 8:30 p.m. All BSM alums are invited to attend. Please stop by the BSM booth in the exhibit area for more details.

MAA Project NExT Reception, Friday, 8:30 p.m.10:30 p.m. All MAA Project NExT national and Section NExT Fellows, consultants, and other friends of MAA Project NExT are invited.

Notices Tenth Anniversary Reception, Saturday, 5:00 p.m.-6:00 p.m. All meeting participants are invited to join Notices Editorial Board members and AMS staff for a reception in honor of the tenth anniversary of the Notices transition into its present magazine-style format and wider-ranging expository content. Refreshments will be served.

AMS Banquet: As a fitting culmination to the meetings, the AMS banquet provides an excellent opportunity to socialize with fellow participants in a relaxed atmosphere. The participant who has been a member of the Society for the greatest number of years will be recognized and will receive a special award. The banquet will be held on Saturday, with a cash bar reception at 6:30 p.m. and dinner at 7:30 p.m. Tickets are \$44, including tax and gratuity.

## Other Events of Interest

AMS Information Booth: All meeting participants are invited to visit the AMS Information Booth during the meeting. Complimentary coffee and tea will be served. A special gift will be available for participants, compliments of the AMS. AMS staff will be at the booth to answer questions about AMS programs and membership.

Book Sales and Exhibits: All participants are encouraged to visit the book, education media, and software exhibits from 12:15 p.m. to 5:30 p.m. on Wednesday, 10:00 a.m. to 6:00 p.m. on Thursday, 9:30 a.m. to 5:30 p.m. on Friday, and 9:00 a.m. to noon on Saturday. Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. These discounts will be available only to registered participants wearing the official meetings badge. Most major credit cards will be accepted for book sale purchases at the meetings. Also, AMS electronic products and the AMS website will be demonstrated. Participants visiting the exhibits will be asked to display their meetings badge in order to enter the exhibit area.

Mathematical Sciences Employment Center: Those wishing to participate in the Mathematical Sciences Employment Center should read carefully the important article about the center beginning on page 1117 in this issue of Notices or at http://www.ams.org/emp-reg/.

Networking Opportunities: There are many opportunities to meet new friends and greet old acquaintances, in addition to the vast array of scientific sessions offered at these meetings. These opportunities are listed on the newcomers page at http://www.ams.org/amsmtgs/ 2091_newcomers.htm1. Newcomers may want to investigate the many receptions listed in the "Social Events" section, the Student Hospitality Center, and the Employment Center. On site a Networking Center featuring casual seating and lists of registered participants sorted by school and math subject classification will be available for your perusal. This is a great place to relax between sessions and forge new friendships.

## Registering in Advance and Obtaining Hotel Accommodations

How to Register in Advance: The importance of advance registration cannot be overemphasized. Advance registration fees are considerably lower than the fees that will be charged for registration at the meeting. Participants registering by November 5 will receive their badges,
programs, and tickets purchased in advance by mail approximately three weeks before the meetings, unless they check the appropriate box to the contrary on the Advance Registration/Housing Form. Because of delays that occur in U.S. mail to Canada, advance registrants from Canada must pick up their materials at the meetings. Because of delays that occur in U.S. mail to overseas, materials are never mailed overseas. There will be a special Registration Assistance Desk at the Joint Meetings to assist individuals who either do not receive this mailing or who have a problem with their registration. Please note that a $\$ 5$ replacement fee will be charged for programs and badges that are mailed but not taken to Atlanta. Acknowledgments of registrations will be sent by email to the email addresses given on the Advance Registration/Housing Form. If you do not wish your registration acknowledged by email, please mark the appropriate box on the form.

Email Advance Registration: This service is available for advance registration and housing arrangements by requesting the forms via email from meetreg-request@ ams.org or by visiting http://www.ams.org/amsmtgs/ 2091_reghsg.htm7. VISA, MasterCard, Discover, and American Express are the only methods of payment that can be accepted for email advance registration, and charges to credit cards will be made in U.S. funds. Completed email forms should be sent to meetreg-submit@ams.org. All advance registrants will receive acknowledgment of payment prior to the meetings.

Internet Advance Registration: This service is available for advance registration and housing arrangements at http://www.ams.org/amsmtgs/2091_reghsg. htm1. VISA, MasterCard, Discover, and American Express are the only methods of payment that are accepted for Internet advance registration, and charges to credit cards will be made in U.S. funds. All Internet advance registrants will receive acknowledgment of payment upon submission of this form.

Cancellation Policy: Those who cancel their advance registration for the meetings, MAA Minicourses, or Short Courses by December 31 (the deadline for refunds for banquet tickets is December 27) will receive a $50 \%$ refund of fees paid. No refunds will be issued after this date.

## Joint Mathematics Meetings Registration Fees

by Dec. 10
at meeting
Member of AMS, ASL, Canadian Mathematical Society, MAA, SIAM \$199
Emeritus Member of AMS, MAA; Graduate Student; Unemployed; Librarian; High School Teacher; Developing Countries Special Rate 3949
Undergraduate Student 21
Temporarily Employed $158 \quad 181$
Nonmember $\quad 308 \quad 401$
High School Student $\quad 2 \quad 5$
One-Day Member of AMS, ASL, CMS, MAA, SIAM n/a 142
One-Day Nonmember $\quad$ n/a 220
$\begin{array}{lll}\text { Nonmathematician Guest } & 10 & 10\end{array}$

| MAA Minicourses |  |  |
| :--- | ---: | ---: |
| Minicourses \#1-6 (computers) | $\$ 95$ | $\$ 95^{*}$ |
| Minicourses \#7-12, 14-16 | 60 | $60^{*}$ |
| Minicourse \#13 | 70 | $70^{*}$ |
| $\quad$ *if space is available |  |  |
| Employment Center (please note that earlier deadlines <br> apply for inclusion in the Winter Lists) |  |  |
| Employer (first table, <br> $\quad$ computer or self-scheduled) | $\$ 225$ | $\$ 305$ |
| Employer (each additional table, <br> $\quad$ computer or self-scheduled) |  |  |
| Employer Posting Fee | 75 | 105 |
| Applicants (all services) | 50 | $\mathrm{~N} / \mathrm{A}$ |
| Applicants (Winter List \& | 42 | 80 |
| $\quad$ message center only) |  |  |
| AMS Short Course | 21 | 21 |
| Member of AMS or MAA |  |  |
| Nonmember | $\$ 85$ | $\$ 115$ |
| Student/Unemployed/Emeritus | 108 | 140 |
| MAA Short Course | 37 | 55 |
| MAA Member |  |  |
| Nonmember | $\$ 125$ | $\$ 140$ |
| Student/Unemployed/Emeritus | 175 | 190 |

Full-Time Students: Those currently working toward a degree or diploma. Students are asked to determine whether their status can be described as graduate (working toward a degree beyond the bachelor's), undergraduate (working toward a bachelor's degree), or high school (working toward a high school diploma) and to mark the Advance Registration/Housing Form accordingly.

Emeritus: Any person who has been a member of the AMS or MAA for twenty years or more and who retired because of age or long-term disability from his or her latest position.

Librarian: Any librarian who is not a professional mathematician.

Unemployed: Any person currently unemployed, actively seeking employment, and not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

Developing Country Participant: Any person employed in developing countries where salary levels are radically noncommensurate with those in the U.S.

Temporarily Employed: Any person currently employed but who will become unemployed by June 1, 2005, and who is actively seeking employment.

Nonmathematician Guest: Any family member or friend who is not a mathematician and who is accompanied by a participant in the meetings. These official guests will receive a badge and may attend all sessions and the exhibits.

Participants Who Are Not Members of the AMS and who register for the meetings as nonmembers will receive mailings after the meetings are over with a special membership offer.

Advance registration and on-site registration fees only partially cover the expenses of holding meetings. All
mathematicians who wish to attend sessions are expected to register and should be prepared to show their badges if so requested. Badges are required to enter the exhibit area, to obtain discounts at the AMS and MAA Book Sales, and to cash a check with the Joint Meetings cashier.

Advance registration forms accompanied by insufficient payment will be returned, thereby delaying the processing of any housing request, or a $\$ 5$ charge will be assessed if an invoice must be prepared to collect the delinquent amount. Overpayments of less than $\$ 5$ will not be refunded.

For each invalid check or credit card transaction that results in an insufficient payment for registration or housing, a $\$ 5$ charge will be assessed. Participants should check with their tax preparers for applicable deductions for education expenses as they pertain to these meetings.

If you wish to be included in a list of individuals sorted by mathematical interest, please provide the one mathematics subject classification number of your major area of interest on the Advance Registration/Housing Form. (A list of these numbers is available by sending an empty email message to abs-submit@ams.org; include the number 983 as the subject of the message.) Copies of this list will be available for your perusal in the Networking Center.

If you do not wish to be included in any mailing list used for promotional purposes, please indicate this in the appropriate box on the Advance Registration/Housing Form.

## Advance Registration Deadlines

There are four separate advance registration deadlines, each with its own advantages and benefits.

## EMPLOYMENT CENTER advance registration

(inclusion in the Winter Lists)
October 25
EARLY meetings advance registration (room lottery)

October 29
ORDINARY meetings advance registration
(hotel reservations, materials
mailed)
November 5
FINAL meetings advance registration (advance registration, Short Courses, Employment Center, MAA Minicourses, banquets)

December 10
Employment Center Advance Registration: Applicant and employer forms must be received by October 25 in order to appear in the publications distributed to all participants. For detailed information on the Employment Center, see the separate article on page 1117.

Early Advance Registration: Those who register by the early deadline of October 29 will be included in a random drawing to select winners of complimentary hotel rooms in Atlanta. Multiple occupancy is permissible. The location of rooms to be used in this lottery will be based on the number of complimentary rooms available in the various hotels. Therefore, the free room may not necessarily be in the winner's first-choice hotel. The winners will be notified by mail prior to December 17. So register early! (See the list of the winners in Phoenix.) Also, applicant and em-


## Room Lottery: (See the How to

Register in Advance section to learn how to qualify for this year's room lottery.) Last year's winners were Peter Brooksbank, Bao Qi Feng, J. T. Halbert, Leon Harkleroad, Lili Ju, Rose Marie Kinik, Michael Kozdron, Gerald Kruse, Stephanie Lafortune, Marc Lengfield, Di Liu, John Marafino, Lianwen Wang, and Mahmoud Yousef.

## Rates:

- Subject to $14 \%$ state tax
- Only certified students or unemployed mathematicians qualify for student rates.
- See ARH Form for detailed rate structure of each property.

Questionnaire lottery: Those who turn in their completed questionnaires by noon on Friday, $1 / 7 / 05$, will be eligible to win a free hotel room at the 2006 Joint Mathematics Meetings in San Antonio. Last year's winner was Luis Saldivia.

General Instructions: Participants must register in advance in order to obtain hotel accommodations through the Mathematics Meetings Service Bureau (MMSB). Special meeting rates have been negotiated at the following hotels. These rates apply exclusively to reservations made through the MMSB. Hotels will start accepting reservations directly after December 13, at which time rooms and rates will be based on availability. A higher rate will be applied to any rooms reserved directly with any of the hotels before December 13.

To make a reservation, please submit a completed housing section of the Advance Registration/Housing (ARH) Form (paper or electronic) with a guarantee by November 5. Sorry, reservations cannot be taken by phone. Participants interested in reserving suites should contact the MMSB for further information.

## General Information:

- Check-in: 4:00 p.m./checkout: noon - Marriott; For all others, check-in is at 3:00 p.m., checkout is noon
- Windows do not open in rooms unless otherwise indicated.
- Children at different ages are free in existing beds only.
- Limited availability of cribs, free of charge
- All hotels have a limited environmental policy regarding linens where all requests for a limited change of linens will be honored.
- Distance from hotel to Marriott and Hyatt is indicated in each listing.
- Airport shuttles to hotels are provided by Atlanta Link Airport Shuttle.
- Wireless available in some hotels; Please see descriptions below. - All hotels are in acceptable compliance with ADA. All hotels have TTYs/TDDs text telephones on the premises.
\& To take the handicapped accessible route from the Marriott to the Hyatt, it is necessary to go through the skywalk that connects the Peachtree Center Mall to the Hyatt. There are two lifts: 1) One lift in Peachtree Center Mall, located at the beginning of the skywalk you have to cross on way to the Hyatt; and 2) Once you cross the skywalk, there is another lift located just inside the Hyatt at the bottom of the entry steps. Each lift has a call box directly to the security department who will operate lifts for you. Please allow 2 to 5 minutes for security to show up.


## Deadlines:

- Room lottery qualification: October 29, 2004
- Reservations through MMSB: November 5, 2004
- Changes/cancellations through MMSB:
December 3, 2004


## Hyatt Regency Atlanta

 (co-headquarters)(across street from Marriott)
265 Peachtree Street, NE
Atlanta, GA 30303-1294 404-577-1234
Regular single/double - $\$ 144$ Student single/double - \$116
Restaurants; Lounge; Fitness Center; Outdoor heated pool; Steam room; Business center; 3 Towers: Atrium (glass elevators), Ivy, and International; Parking \$20 (valet only); All rooms have full amenities including cordless phones, dual phone lines, and safes; Windows open; Children under 16 years free; Wireless high speed internet access is available in sleeping rooms only at a cost of $\$ 9.95$ per day. Guests need to have their own wireless access card or can rent OTC wireless device from hotel Business Center at $\$ 10$ fee per day. All changes to departure dates must be made at check-in to avoid a $\$ 50$ penalty charge.

## Atlanta Marriott <br> Marquis <br> (co-headquarters)

 (across street from Hyatt) 265 Peachtree Center Avenue Atlanta, GA 30303 404-521-0000Regular single/double - $\$ 144$ Student single/double - \$116
Restaurants; Lounge; Health club; Sauna; Indoor/Outdoor pool; Business center with
Kinko's; Atrium; Glass elevators; Valet parking \$20; All rooms have full amenities including dual phone lines, refrigerators and safes; Children 16 years and younger free; Wireless is available in common areas of lobby, convention level, and garden level only at a cost of $\$ 2.95$ for first 15 minutes and $\$ .25$ for first 15 minutes and $\$ .25$
for each additional minute. for each additional minute.
Laptop has to be wireless capable. Wired for business is available in sleeping rooms offering unlimited local, long distance and high speed internet access for $\$ 9.95$ per day. Hotel will charge one night deposit 72 hours before arrival

## AmeriSuites <br> (1 block)

330 Peachtree Street Atlanta, GA 30308 404-577-1980 Single/Double - $\$ 99$

All suites; No restaurant complimentary hot breakfast buffet served and room service provided from restaurant next door; Fitness center; Selfservice laundry; Parking \$12/day; Windows open; All suites have full amenities including microwave, refrigerator, VCR, two phone lines, wireless high speed internet access, and data port lamp; Children under 18 years free. Hotel will charge one night deposit 72 hours before arrival

## Days Inn Atlanta

## Downtown

(1 block)
300 Spring Street
Atlanta, GA 30308
404-523-1144 Single/Double - \$99

24-hour Restaurant; Lounge, Exercise facility; Outdoor pool; Parking \$12/day; Self-service laundry; Windows open; All rooms have full amenities including data ports, modem lines, and safes; Microwave, refrigerator and desk in
king/queen rooms only; Children under 18 years free; Wireless is not available;, All changes to departure dates must be made at check-in to avoid a $\$ 25$ penalty charge.

## Holiday Inn Atlanta <br> Downtow <br> (3 blocks)

101 Andrew Young International Blvd.
Atlanta, GA 30303
404-524-5555
Single/Double - \$99
Restaurant; Lounge; Fitness center; Outdoor pool; Jacuzzi; Parking \$15/day; Windows open; All rooms have full amenities including data ports and high speed internet access; Children under 18 years free; Wireless is available in the rooms at no charge. All changes to departure dates must be made at check-in to avoid a $\$ 75$ penalty charge.

Best Western Inn at

## Peachtree

(1 block)
330 West Peachtree Street
Atlanta, GA 30306
404-577-6970
Single/Double - $\$ 89$
No restaurant- complimentary hot breakfast buffet served; Fitness center, Parking \$8/day; Self-service laundry; Windows open; All rooms have full amenities including data ports and high speed internet access; No tubs in rooms; Children under 17 years free; Free wireless is available in most rooms

## Attention Students

As an alternative housing choice, Atlanta International Hostel is located in the middle of downtown. The City Bus stops in front of the hostel and the subway (MARTA) is 4 blocks up Ponce de Leon Ave. MARTA goes into the Airport near baggage claim and the Amtrak station is only 2 miles. It is approximately $3 / 4$ mile from Hyatt or Marriott.

## \$19-\$55/day

223 Ponce de Leon Avenue
Atlanta GA, USA
(404) 875-9449
fax: (404) 870-0042
website: http://www.hostel-atlanta.com/
Please go online or call directly for further information and reservations.
ployer forms must be received by October 25 in order to be reproduced in the Winter Lists for the Employment Center.

Ordinary Advance Registration: Those who register after October 29 and by the ordinary deadline of November 5 may use the housing services offered by the MMSB but are not eligible for the room lottery. You may also elect to receive your badge and program by mail in advance of the meetings. In appreciation for using our housing service (MMSB), we are holding a lottery for anyone who books a hotel room through us by November 5 . The winner will receive a new HP Graphing Calculator.

Final Advance Registration: Those who register after November 5 and by the final deadline of December 10 must pick up their badges, programs, and any tickets for social events at the meetings. Unfortunately, it is not possible to provide final advance registrants with housing. Please note that the December 10 deadline is firm; any forms received after that date will be returned and full refunds issued. Please come to the registration desk in the lobby area of the Grand Hall on the exhibit level of the Hyatt Regency Atlanta.

## Hotel Reservations

Participants should be aware that the AMS and MAA contract only with facilities that are working toward being in compliance with the public accommodations requirements of the ADA.

Participants requiring hotel reservations should read the instructions on the hotel pages. Participants who did not reserve a room during advance registration and would like to obtain a room at one of the hotels listed should call the hotels directly after December 15. However, after that date the MMSB can no longer guarantee availability of rooms or special convention rates. Participants should be aware that most hotels are starting to charge a penalty fee to guests for departure changes made before or after guests have checked into their rooms. These hotels are indicated on the hotel page at http: //www. ams.org/amsmtgs/2091_hote1page.htm1. Participants should also inquire about this at check-in and make their final plans accordingly.

Participants should also be aware that it is general hotel practice in most cities to hold a nonguaranteed reservation until 6:00 p.m. only. When one guarantees a reservation by paying a deposit or submitting a credit card number as a guarantee in advance, however, the hotel usually will honor this reservation up until checkout time the following day. If the individual holding the reservation has not checked in by that time, the room is then released for sale, and the hotel retains the deposit or applies one night's room charge to the credit card number submitted.

If you hold a guaranteed reservation at a hotel but are informed upon arrival that there is no room for you, there are certain things you can request the hotel do. First, they should provide for a room at another hotel in town for that evening at no charge. (You already paid for the first night when you made your deposit.) They should pay for taxi fares to the other hotel that evening and back to the meetings the following morning. They should also pay for one telephone toll call so that you can let people know you are
not at the hotel you expected. They should make every effort to find a room for you in their hotel the following day and, if successful, pay your taxi fares to and from the second hotel so that you can pick up your baggage and bring it to the first hotel. Not all hotels in all cities follow this practice, so your request for these services may bring mixed results or none at all.

## Miscellaneous Information

Audiovisual Equipment: Standard equipment in all session rooms is one overhead projector and screen. (Invited 50-minute speakers are automatically provided with two overhead projectors.) Blackboards are not available. Organizers of sessions that by their nature demand additional equipment (e.g., VCR and monitor or projection panel) and in which the majority of speakers in the session require this equipment should contact the audiovisual coordinator for the meetings at the AMS office in Providence at 401-455-4140 or by email at wsd@ams.org to obtain the necessary approvals. Individual speakers must consult with the session organizer(s) if additional equipment or services are needed. If your session has no organizer, please contact the audiovisual coordinator directly. All requests should be received by November 4.

Equipment requests made at the meetings most likely will not be granted because of budgetary restrictions. Unfortunately, no audiovisual equipment can be provided for committee meetings or other meetings or gatherings not on the scientific program.

Child Care: The American Mathematical Society and the Mathematical Association of America will be offering childcare services for the Atlanta Joint Mathematics Meetings to registered participants.

The child care will be offered through KiddieCorp Children's Program. KiddieCorp is an organization that has been providing high-quality programs for children of all ages at meetings throughout the United States and Canada since 1986. Read all about them at http://www.kiddiecorp. com/.

The child-care services provided at the JMM are for children ages 6 months through 12 years old. Space per day will be limited on a space-available basis. The dates and times for the program are January 5-8, 2005, 8:00 a.m. to 5:00 p.m. each day. It will be located at the Hyatt Regency Atlanta in Atlanta, GA. Parents are encouraged to bring snacks and beverages for their children, but items such as juice boxes, Cheerios, and crackers will be provided. KiddieCorp can arrange meals for children at cost plus $15 \%$, or parents can be responsible for meals for their children.

Registration starts in September. The registration fee is $\$ 25$ per family (nonrefundable). Additional cost will be $\$ 8$ per hour per child or $\$ 6$ per hour per child for graduate students. These reduced child-care rates are made possible for the meeting participant by the American Mathematical Society and the Mathematical Association of America. Parents must be registered for the JMM to participate. Full payment is due at the time of registration with KiddieCorp. Deadline for registering is December 8, 2004.

If parents do not pick up their children at the time scheduled or by the end of the day (no later than 5:00 p.m.), they will be charged a late fee of $\$ 5.00$ per child for every 15 min utes thereafter.

Cancellations must be made to KiddieCorp prior to December 8, 2004, for a full refund. Cancellations made after that date will be subject to a $50 \%$ cancellation fee. Once the program has begun, no refunds will be issued.

This program is being offered on an experimental basis for the 2005 Atlanta meetings. Its reception at this meeting will help determine the possibility of future programs.

To register, go to https://www.kiddiecorp.com/ jmmkids.htm or call KiddieCorp at (858) 455-1718 to request a form.

Email Services:Limited email access for all Joint Meeting participants will be available. The hours of operation will be published in the program.

Information Distribution: Tables are set up in the exhibit area for dissemination of general information of possible interest to the members and for dissemination of information of a mathematical nature not promoting a product or program for sale.

If a person or group wishes to display information of a mathematical nature promoting a product or program for sale, they may do so in the exhibit area at the Joint Books, Journals, and Promotional Materials exhibit for a fee of $\$ 58$ (posters are slightly higher) per item. Please contact the exhibits manager, MMSB, P.O. Box 6887, Providence, RI 02940, for further details.

The administration of these tables is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for Joint Mathematics Meetings.

Local Information: See www.atlanta.net/ visitors/index.asp for information about the city.

Petition Table: At the request of the AMS Committee on Human Rights of Mathematicians, a table will be made available in the exhibit area at which petitions on behalf of named individual mathematicians suffering from human rights violations may be displayed and signed by meetings participants acting in their individual capacities. For details contact the director of meetings in the Providence office at 401-455-4137 or by email at dms@ams . org.

Signs of moderate size may be displayed at the table but must not represent that the case of the individual in question is backed by the Committee on Human Rights unless it has, in fact, so voted. Volunteers may be present at the table to provide information on individual cases, but notice must be sent at least seven days in advance of the meetings to the director of meetings in the Providence office. Because space is limited, it may also be necessary to limit the number of volunteers present at the table at any one time. The Committee on Human Rights may delegate a person to be present at the table at any or all times, taking precedence over other volunteers.

Any material that is not a petition (e.g., advertisements, résumés) will be removed by the staff. At the end of the exhibits on Saturday, any material on the table will be discarded, so individuals placing petitions on the table should be sure to remove them prior to the close of exhibits.

Telephone Messages: The most convenient method for leaving a message is to do so with the participant's hotel. Another method would be to leave a message at the meetings registration desk from January 5 through 8 during the hours that the desk is open. These messages will be posted on the Math Meetings Message Board; however, staff at the desk will try to locate a participant in the event of a bona fide emergency. The telephone number will be published in the program and daily newsletter.

## Discounted Air Travel

Atlanta is on Eastern Standard Time. Hartsfield Atlanta International Airport (ATL) is located about twelve miles south of the Atlanta metropolitan area and is served by all major airlines.

The official airline for the meetings is Delta, which uses Atlanta as its major hub. Given the volatility in airfares because of "fare wars", we cannot guarantee that these will be the lowest fares when you make your arrangements. However, we strongly urge participants to make use of this special deal if at all possible, as the AMS and MAA can earn complimentary tickets. These tickets are used to send meetings staff (not officers or other staff) to the Joint Mathematics Meetings, thereby keeping the costs of the meetings (and registration fees) down.

The following specially negotiated rates are available only for these meetings and exclusively to mathematicians and their families for the period December 30, 2004-January 11, 2005. Other restrictions/discounts may apply, and seats are limited.

Delta is offering

- the most deeply discounted online fares, available through the meeting homepage at www.ams.org/ amsmtgs/2091_intro.htm1. Click on the Delta icon on the bottom right of the page. Once you select your itinerary, click on "negotiated rate" to see if your flight qualifies for an extra meeting discount.
-a $5 \%$ discount off published round-trip fares within the continental U.S., excluding A, D, I, U, and T classes of service.
- a 10\% discount off Delta's domestic published unrestricted round-trip coach fare (Y06/YR06) rates. No advance reservations or ticketing is required.
- an additional 5\% bonus discount if you purchase your ticket 60 days or more prior to your departure through Meeting Network Reservations (800-241-6760, 8:00 a.m. to 11:00 p.m. Eastern Standard Time, Monday through Sunday; cite File \#205778A) or your travel agent. This discount is not available for online purchases.

Ground Transportation from the Airport: MARTA offers rail service directly from the airport to Peachtree Center, very close to both the Hyatt and Marriott hotels for $\$ 1.75$ each way, from 5:00 a.m. until 1:00 a.m. Mondays through Fridays. and 6:00 a.m. until 12:20 a.m. weekends and holidays. Trains run every 10 minutes on weekdays and every 15 minutes on weekends and holidays. The trip takes about 15 minutes. Call 404-848-4711 for personalized help from MARTA to plan your route.

Taxis are available outside the baggage claim area. The approximate fare is $\$ 25$ to downtown for one person (\$13 each for two people).

The Atlanta Link (shuttle service) offers airport-todoor service. Vans usually depart every 15 minutes from 6:00 a.m. to midnight. The fare to downtown is $\$ 16$ one way or $\$ 28$ round trip. Reservations are not necessary for the downtown area. For details or more information call 404-524-3400.

Driving directions to the Marriott and Hyatt: From the South (airport): Go north on I-85 about twelve miles. Take the International Blvd. exit (248C) to Peachtree Center Ave. Turn right and go two blocks; the main Marriott entrance is on the right, and the Hyatt motor lobby entrance is on the left.

From the North: Take I75/85 south. Take the Courtland St./Georgia State University exit (249A). Take a right onto International Blvd. and turn right again onto Peachtree Center Ave. Follow as above.

## Discounted Car Rental

Avis Rent A Car is the official car rental company for the meeting. All car rentals include unlimited free mileage and are available to renters 25 years and older. Avis offers special convention rental rates effective December 29, 2004-January 15, 2005:

| Car Type | Daily | Weekly | Weekend Daily |
| :--- | :---: | :---: | :---: |
| Subcompact | $\$ 46$ | $\$ 194$ | $\$ 26$ |
| Compact | 47 | 204 | 27 |
| Intermediate | 49 | 216 | 29 |
| Full-Size 2-Door | 51 | 237 | 36 |
| Full-Size 4-Door | 53 | 237 | 36 |
| Premium | 58 | 247 | 38 |
| Luxury, Minivan, | 71 | 309 | 72 |

Convertible, or
Sport Utility
Should a lower qualifying rate become available, Avis is pleased to present a $5 \%$ discount off the lower qualifying rate or the meeting rate, whichever is lowest. Rates do not include any state or local surcharges, tax, optional coverages, or gas refueling charges. Renters must meet Avis's age, driver, and credit requirements. Reservations can be made by calling 800-331-1600; cite group ID number J098887. Reservations can also be made online at www.avis.com.

## Weather

The temperature ranges from a nighttime low of about $33^{\circ} \mathrm{F}$. to a daytime high of about $52^{\circ} \mathrm{F}$. Average precipitation in January is 5 inches, and light snow is a possibility. Visit your favorite weather site for up-to-the-minute forecasts, or see http://asp. usatoday.com/weather/CityForecast. aspx?LocationID=USAGA0028\&ps=L1.

## Bowling Green, Kentucky

Western Kentucky University

March 18-19, 2005
Friday-Saturday

## Meeting \#1004

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: January 2005
Program first available on AMS website: February 3, 2005
Program issue of electronic Notices: March 2005
Issue of Abstracts: Volume 26, Issue 2

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: November 30, 2004
For abstracts: January 25, 2005

## Invited Addresses

Bennett Chow, University of California San Diego, Title to be announced.
Robert McCann, University of Toronto, Title to be announced.
Susan Montgomery, University of Southern California, Title to be announced.

## Special Sessions

Advances in the Study of Wavelets and Multiwavelets (Code: SS 5A), Douglas P. Hardin, Vanderbilt University, and Bruce Kessler, Western Kentucky University.
Commutative Ring Theory (Code: SS11A), Michael C. Axtell, Wabash College, and Joe Alyn Stickles Jr., University of Evansville.
Dynamic Equations on Time Scales and Applications (Code: SS 3A), Ferhan M. Atici and Daniel C. Biles, Western Kentucky University, and Billur Kaymakcalan, Georgia Southern University.
Graph Theory (Code: SS 2A), Mustafa Atici, Western Kentucky University.
Hopf Algebras and Related Topics, (Code: SS10A), David E. Radford, University of Illinois at Chicago, and Bettina Richmond, Western Kentucky University.
Knot Theory and its Applications (Code: SS 4A), Yuanan Diao, University of North Carolina Charlotte, and Claus Ernst, Western Kentucky University.
L-functions (Code: SS 9A), Heather Russell, Nilabh Sanat, and Dominic Lanphier, Western Kentucky University.
Numerical Analysis, Approximation and Computational Complexity: Interdisciplinary Aspects (Code: SS 1A), David

Benko, Western Kentucky University, and Steven B. Damelin, Georgia Southern University.
Representation Theory (Code: SS 6A), Markus Hunziker, University of Georgia.
Semigroups of Operators and Applications (Code: SS 7A), Khristo Boyadzhiev, Ohio Northern University, Lan Nguyen, Western Kentucky University, and Quoc-Phong Vu, Ohio University.
Topology, Convergence, and Order, in honor of Darrell Kent (Code: SS 8A), Gary Richardson, University of Central Florida, and Thomas A. Richmond, Western Kentucky University.

## Newark, Delaware

## University of Delaware

April 2-3, 2005
Saturday-Sunday

## Meeting \#1005

## Eastern Section

Associate secretary: Lesley M. Sibner
Announcement issue of Notices: February 2005
Program first available on AMS website: February 17, 2005
Program issue of electronic Notices: April 2005
Issue of Abstracts: Volume 26, Issue 2

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: December 14, 2004
For abstracts: February 8, 2005

## Invited Addresses

Xiu Xiong Chen, University of Wisconsin, Title to be announced.
Anna Gilbert, AT\&T Labs-Research, Title to be announced. Alex Lubotzky, Hebrew University of Jerusalem, Title to be announced.
Lorenz Schwachhoefer, University of Dortmund, Title to be announced.

## Special Sessions

Asymptotic Behavior of Evolution Equations (Code: SS 4A), Gaston M. N'Guerekata, Morgan State University, and Nguyen Van Minh, James Madison University.
Designs, Codes, and Geometries (Code: SS 5A), James A. Davis, University of Richmond, Keith E. Mellinger, Mary Washington College, and Qing Xiang, University of Delaware.
Homotopy Theory (in Honor of Donald M. Davis's and Martin Bendersky's 60th Birthdays) (Code: SS 1A), Kenneth G. Monks, University of Scranton, and W. Stephen Wilson, Johns Hopkins University.

Mathematical Methods in Electromagnetic Wave Propagation (Code: SS 3A), Fioralba Cakoni and Peter B. Monk, University of Delaware.
Singular Analysis and Spectral Theory of Partial Differential Equations (Code: SS 2A), Juan B. Gil, Pennsylvania State University, Altoona, and Gerardo A. Mendoza, Temple University.

## Lubbock, Texas

## Texas Tech University

April 8-10, 2005
Friday-Sunday

## Meeting \#1006

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: February 2005
Program first available on AMS website: February 24, 2005
Program issue of electronic Notices: April 2005
Issue of Abstracts: Volume 26, Issue 3

## Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: December 21, 2004
For abstracts: February 15, 2005

## Invited Addresses

Nikolai Ivanov, Michigan State University, Title to be announced.
Mattias Jonsson, University of Michigan, Title to be announced.
Nicolas Monod, University of Chicago, Title to be announced.
Hee Oh, California Institute of Technology, Title to be announced.

## Special Sessions

Classical and Differential Galois Theory (Code: SS 3A), Lourdes Juan and Arne Ledet, Texas Tech University, and Andy R. Magid, University of Oklahoma.
Differential Geometry and Its Applications (Code: SS 2A), Josef F. Dorfmeister, Munich University of Technology, Magdalena D. Toda, Texas Tech University, and Hongyou Wu, Northern Illinois University.
Homological Algebra and Its Applications (Code: SS 4A), Alex Martsinkovsky, Northeastern University, and Mara D. Neusel, Texas Tech University.

Real Algebraic Geometry (Code: SS 6A), Anatoly Korchagin and David Weinberg, Texas Tech University.
Recent Advances in Complex Function Theory (Code: SS 5A), Brock Williams, Roger W. Barnard, and Kent Pearce, Texas Tech University.

Topology of Continua (Code: SS 1A), Wayne Lewis, Texas Tech University.
Topology of Dynamical Systems (Code: SS 7A), Brian Raines, Baylor University.

## Santa Barbara, California

University of California Santa Barbara
April 16-17, 2005
Saturday-Sunday

## Meeting \#1 007

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of Notices: February 2005
Program first available on AMS website: March 3, 2005
Program issue of electronic Notices: April 2005
Issue of Abstracts: Volume 26, Issue 3

## Deadlines

For organizers: September 16, 2004
For consideration of contributed papers in Special Sessions: December 28, 2004
For abstracts: February 22, 2005

## Invited Addresses

Mei-Chu Chang, University of California Riverside, Title to be announced.

Mischa Kapovich, University of California Davis, Title to be announced.

Mihai Putinar, University of California Santa Barbara, Title to be announced.
James Sethian, University of California Berkeley, Title to be announced.

## Special Sessions

Automorphisms of Surfaces (Code: SS 4A), Anthony Weaver, Bronx Community College of the City University of New York.

Dynamical Systems in Neuroscience (Code: SS 1A), Eugene M. Izhikevich, The Neurosciences Institute.

Geometric Methods in Three Dimensions (Code: SS 6A), Daryl Cooper, David Darren Long, and Martin G. Scharlemann, University of California Santa Barbara.
History of Mathematics (Code: SS 2A), Shawnee L. McMurran, California State University San Bernardino, and James J. Tattersall, Providence College.
Noncommutative Geometry and Algebra (Code: SS 5A), Kenneth R. Goodearl, University of California Santa Barbara, J. T. Stafford, University of Michigan, and J. J. Zhang, University of Washington.

Recent Advances in Combinatorial Number Theory (Code: SS 3A), Mei-Chu Chang, University of California Riverside, and Van Ha Vu, University of California San Diego.
Representation Theory of Algebras (Code: SS 7A), Alex Martsinkovsky, Northeastern University, Dan Zacharia, Syracuse University, and Birge K. Huisgen-Zimmermann, University of California Santa Barbara.

## Mainz, Germany

June 16-19, 2005
Thursday-Sunday

## Meeting \#1008

Joint International Meeting with the Deutsche MathematikerVereinigung (DMV) and the Oesterreichische Mathematische Gesellschaft (OMG)
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: February 2005
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

## Invited Addresses

Helene Esnault, University of Essen, Title to be announced. Richard Hamilton, Columbia University, Title to be announced.
Michael J. Hopkins, Massachusetts Institute of Technology, Title to be announced.
Christian Krattenthaler, University of Lyon-I, Title to be announced.
Frank Natterer, University of Muenster, Title to be announced.

Horng-Tzer Yau, New York University and Stanford University, Title to be announced.

## Special Sessions

Algebraic Combinatorics, Patricia Hersh, University of Michigan, Christian Krattenthaler, University of Lyon-I, and Volkmar Welker, Philipps University Marburg.
Algebraic Geometry, Yuri Tschinkel, Georg-August-Universität Göttingen, and Brendan E. Hassett, Rice University.
Discrete Geometry, Jacob Eli Goodman, The City College of New York (CUNY), Emo Welzl, Eidgen Technische Hochschule, and Gunter M. Ziegler, Technical University of Berlin.

Functional Analytic and Complex Analytic Methods in Linear Partial Differential Equations, R. Meise, University of

Dusseldorf, B. A. Taylor, University of Michigan, and Dietmar Vogt, University of Wuppertal.
History of Mathematics: Mathematics and War, Thomas W. Archibald, Acadia University, John H. McCleary, Vassar College, Moritz Epple, University of Stuttgart, and Norbert Schappacher, Technische Universität Darmstadt.
Homotopy Theory, Paul G. Goerss, Northwestern University, Hans-Werner Henn, Institut de Recherche Mathématique Avancée, Strasbourg, and Stefan Schwede, Universität Bonn.
Hopf Algebras and Quantum Groups, Susan Montgomery, University of Southern California, and Hans-Jurgen Schneider, University of Munich.
Mathematics Education, Gunter Torner, Universität Duis-burg-Essen, and Alan Schoenfeld, School of Education, Berkeley.
Nonlinear Waves, Herbert Koch, University of Dortmund, and Daniel I. Tataru, University of California Berkeley.
Stochastic Analysis on Metric Spaces, Laurent Saloff-Coste, Cornell University, Karl-Theodor Sturm, University of Bonn, and Wolfgang Woess, Graz Technical University.
Topics in Applied Mathematics and Mechanics: Mathematical Control Theory and Numerical Methods, Peter Benner, Fakultat fur Mathematik.
Topics in Applied Mathematics and Mechanics: Mechanics, Friedrich Pfeiffer, Technical University of Munich.
Topics in Applied Mathematics and Mechanics: Multiscale Problems, Oscillations in PDEs, and Homogenization, Alexander Mielke, University of Hannover.
Topics in Applied Mathematics and Mechanics: Numerical PDEs, Equations with Inherent Conditions, Rolf Jeltsch, Eidgen Technische Hochschule, Maria Lukacova, Technical University of Brno, and Mac Hyman, Los Alamos National Laboratory.
Topics in Applied Mechanics: Algebraic Approaches to Preconditioning, Heike Fassbender, Technical University of Braunschweig, and Andreas Frommer, University of Wuppertal.
Topology of Manifolds, Matthias Kreck, University of Heidelberg, and Andrew Ranicki, University of Edinburgh.

## Annandale-onHudson, New York

Bard College

October 8-9, 2005
Saturday-Sunday
Meeting \#1009
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: August 2005
Program first available on AMS website: August 25, 2005

Program issue of electronic Notices: October 2005
Issue of Abstracts: Volume 26, Issue 4

## Deadlines

For organizers: March 8, 2005
For consideration of contributed papers in Special Sessions: June 21, 2005
For abstracts: August 16, 2005

## Invited Addresses

Persi Diaconis, Stanford University, Title to be announced (Erdős Memorial Lecture).

## Johnson City, Tennessee

## East Tennessee State University

October 15-16, 2005
Saturday-Sunday

## Meeting \#1010

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: August 2005
Program first available on AMS website: September 1, 2005
Program issue of electronic Notices: October 2005
Issue of Abstracts: Volume 26, Issue 4

## Deadlines

For organizers: March 15, 2005
For consideration of contributed papers in Special Sessions: June 28, 2005
For abstracts: August 23, 2005

## Lincoln, Nebraska

University of Nebraska in Lincoln
October 21-22, 2005
Friday-Saturday

## Meeting \#1011

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: August 2005
Program first available on AMS website: September 8, 2005
Program issue of electronic Notices: October 2005
Issue of Abstracts: Volume 26, Issue 4

## Deadlines

For organizers: March 22, 2005
For consideration of contributed papers in Special Sessions: July 5, 2005
For abstracts: August 30, 2005

## Invited Addresses

Howard Masur, Universiy of Illinois at Chicago, Title to be announced.

Alejandro Uribe, University of Michigan, Title to be announced.
Judy Walker, University of Nebraska, Title to be announced. Jack Xin, University of Texas, Title to be announced.

## Special Sessions

Algebraic Geometry (Code: SS 1A), Brian Harbourne, University of Nebraska-Lincoln, and Bangere P. Purnaprajna, University of Kansas.

## Eugene, Oregon

## University of Oregon

November 12-13, 2005
Saturday-Sunday

## Meeting \#1012

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of Notices: September 2005
Program first available on AMS website: September 29, 2005
Program issue of electronic Notices: November 2005
Issue of Abstracts: Volume 26, Issue 4

## Deadlines

For organizers: April 12, 2005
For consideration of contributed papers in Special Sessions: July 26, 2005
For abstracts: September 20, 2005

## Taiwan

December 14-18, 2005
Wednesday-Sunday

## Meeting \#1013

First Joint International Meeting between the AMS and the Taiwanese Mathematical Society.
Associate secretary: John L. Bryant
Announcement issue of Notices: May 2005
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

## San Antonio, Texas

Henry B. Gonzalez Convention Center

## January 12-15, 2006

Thursday-Sunday
Joint Mathematics Meetings, including the 112th Annual Meeting of the AMS, 89th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: John L. Bryant
Announcement issue of Notices: October 2005
Program first available on AMS website: To be announced
Program issue of electronic Notices: January 2006
Issue of Abstracts: To be announced

## Deadlines

For organizers: April 12, 2005
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

## Durham, New Hampshire

## University of New Hampshire

## April 22-23, 2006

Saturday-Sunday
Southeastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: To be announced Program first available on AMS website: To be announced Program issue of electronic Notices: To be announced Issue of Abstracts: To be announced

## Deadlines

For organizers: September 22, 2005
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

## San Francisco, California

San Francisco State University

April 29-30, 2006
Saturday-Sunday
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of Notices: To be announced
Program first available on AMS website: To be announced Program issue of electronic Notices: To be announced Issue of Abstracts: To be announced

## Deadlines

For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

## New Orleans, Louisiana

## New Orleans Marriott and Sheraton New Orleans Hotel

## January 4-7, 2007

## Thursday-Sunday

Joint Mathematics Meetings, including the 113th Annual Meeting of the AMS, 90th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: October 2006
Program first available on AMS website: To be announced Program issue of electronic Notices: January 2007
Issue of Abstracts: To be announced

## Deadlines

For organizers: April 4, 2006
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

## San Diego, California

## San Diego Convention Center

January 6-9, 2008
Sunday-Wednesday
Joint Mathematics Meetings, including the 114th Annual Meeting of the AMS, 91st Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL). Associate secretary: Michel L. Lapidus
Announcement issue of Notices: October 2007
Program first available on AMS website: November 1, 2007
Program issue of electronic Notices: January 2008
Issue of Abstracts: Volume 29, Issue 1

## Deadlines

For organizers: April 6, 2007
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

## Washington, District of Columbia

Marriott Wardman Park Hotel and Omni Shoreham Hotel

January 7-10, 2009
Wednesday-Saturday
Joint Mathematics Meetings, including the 115th Annual Meeting of the AMS, 92nd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL). Associate secretary: Lesley M. Sibner
Announcement issue of Notices: October 2008
Program first available on AMS website: November 1, 2008
Program issue of electronic Notices: January 2009
Issue of Abstracts: Volume 30, Issue 1

## Deadlines

For organizers: April 7, 2008
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

## San Francisco, California

## Moscone Center West and the San Francisco Marriott

January 6-9, 2010
Wednesday-Saturday
Joint Mathematics Meetings, including the 116th Annual Meeting of the AMS, 93rd Annual Meeting of the Mathematical Associaion of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL). Associate secretary: John L. Bryant
Announcement issue of Notices: October 2009
Program first available on AMS website: November 1, 2009
Program issue of electronic Notices: January 2010
Issue of Abstracts: Volume 31, Issue 1

## Deadlines

For organizers: April 5, 2009
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

## New Orleans, Louisiana

## New Orleans Marriott and Sheraton New Orleans Hotel <br> January 3-8, 2011 <br> Monday-Saturday <br> 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). Associate secretary: Susan J. Friedlander <br> Announcement issue of Notices: October 2010 <br> Program first available on AMS website: November 1, 2010 <br> Program issue of electronic Notices: January 2011 <br> Issue of Abstracts: Volume 32, Issue 1

## Deadlines

For organizers: April 2, 2010
For consideration of contributed papers in Special Sessions:
To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

# AMS Short Course 

# The Radon Transform and Applications to Inverse Problems 

Organizers: Gestur Olafsson, Louisiana State University, and Todd Quinto, Tufts University

Atlanta, Georgia, January 3-4, 2005

It is planned that lecture notes will be available to those who register for this course. Advance registration fees are $\$ 85$ for AMS/MAA members, $\$ 108$ for nonmembers, and $\$ 37$ for students/unemployed/emeritus; on-site registration fees are $\$ 115$ for AMS/MAA members, $\$ 140$ for nonmembers, and $\$ 55$ for students/unemployed/emeritus. Registration and housing information can be found in this issue of the Notices; see the section "Registering in Advance and Hotel Accommodations" in the announcement for the meetings in Atlanta. The registration form is at the back of this issue.

## General Introduction

The mathematical model of X-ray tomography is the Radon transform, named after the Austrian mathematician Johann Radon, who proved important properties of the transform in a seminal 1917 article. Mathematicians and scientists did not know that this pure mathematical transform had applications to medicine and science until after Nobel Laureate Allan Cormack made the first CT (computerized tomography) scanner and he and others developed the mathematics to image objects from this indirect X-ray data. Since then, tomography has become important in pure and applied mathematics, as well as in several branches of applied sciences, in particular diagnostic radiology, nondestructive evaluation, and other forms of image reconstruction. The aim of this short course is to introduce nonspecialists to the basic mathematics and ideas behind tomography. Then several important applications will be described in diagnostic radiology, electron microscopy,
radar, and sonar. All talks will be aimed at a general audience.

We will begin with elementary facts about the Radon transform and then introduce important current research areas, including local tomography, 3-D tomography and regularization, interferometric imaging, sampling theory, wavelet methods, and emission tomography. Several special sessions at the AMS meeting will continue the themes introduced in the short course.

The titles of the talks, the names of the speakers, and the abstracts are as follows:

## An Introduction to Tomography and Radon Transforms

## Todd Quinto, Tufts University

In tomography, one finds information about the inside of objects using indirect data. X-ray tomography has revolutionized diagnostic radiology, and CT scans (in which the body is X-rayed from multiple positions around the body) provide the intricate structure of the inside of the body without exploratory surgery. The classical Radon transform is the mathematical model of X-ray tomography, and it integrates functions over lines, the lines along which the Xrays travel. From these data, inversion formulas give accurate and detailed pictures of the inside of the body.

This will be the first talk of the session, and we will introduce some of the basic mathematics of tomography. We will start by defining the Radon transform and introducing a few fundamental theorems, including the projection slice theorem.

We will then describe some limited data tomographic problems that occur in science. Finally, we plan to introduce microlocal analysis and use it to understand what singularities (object boundaries, etc.) are well imaged from limited data.

## Reading List

[1] S. Helgason, The Radon Transform, $2^{\text {nd }}$ edition, Birkhauser, Boston, 1999.
[2] F. Natterer and F. Wuebbeling, Mathematical Methods in Image Reconstruction, SIAM, New York, Monographs on Mathematical Modeling and Computation, 2001.
[3] E.T. Quinto, Singularities of the X-ray transform and limited data tomography in $\mathrm{R}^{2}$ and $\mathrm{R}^{3}$, SIAM J. Math. Anal., 24 (1993), 1215-1225.

## Development of Algorithms in CT

## Alfred Louis, Angewandte Mathematik, Universitaet des Saarlandes

The success of CT relies dramatically on the ability to quickly reconstruct the searched-for information from the measured data. Compared with the first commercial scanners, the speed-up in computing time is much more influenced by the new mathematical algorithms than by the new computer hardware.

Hence in this talk we study the principles of the development of algorithms in CT. We start with the simplest case, the 2-D parallel beam geometry leading to the so-called filtered backprojection algorithm. We consider this as a special case of regularization method for inverse problems, the approximate inverse that allows for precomputing independently of the data reconstruction kernels and using invariances of the problem. These tools are then applied to the inversion problems of 3-D cone beam tomography. We present reconstructions from real data and many open problems.

## Reading List

[1] A. KATSEvich, A general scheme for constructing inversion algorithms for cone beam CT, International Journal on Mathematics and Mathematical Sciences, 21 (2003), 1305-1321.
[2] A.K. Louis, The approximate inverse for linear and some nonlinear problems, Inverse Problems, 12 (1996),175-190.
[3] A.K. Louis, Filter design in three-dimensional cone beam tomography: circular scanning geometry, Inverse Problems, 19 (2003),S31-S40.
[4] F. Natterer and, F. Wuebbeling, Mathematical Methods in Image Reconstruction, vol. 5, SIAM, Philadelphia, PA, 2001.

## Generalized Transforms of Radon Type and their Applications

## Peter Kuchment, Texas A\&M University

Radon-type transforms, in the simplest cases, integrate a function on a Euclidean space over all affine planes of a given dimension. In many types of medical, geophysical, and industrial tomography problems, the measured data are a Radon transform of an unknown distribution of certain quantity of interest (e.g., CAT scan data produces integrals of the density of the body over "all" lines in a plane). Hence invertibility of the transform, availability of inversion formulas and/or algorithms, and stability of the inversion (that is, not being very sensitive to errors in the data) are crucial for many applications.

In the last couple of decades, many new examples have been found in which one needs to invert some generalized
transforms of Radon type. This means that the transform involves certain weighted integrals and/or the manifolds over which the integration is conducted are not flat (e.g., in some applications integration over spheres is involved). The lecture will contain some examples of such transforms arising in applications, as well as discussion of the available results about them.

## References

[1] F. NATtERER, The Mathematics of Computerized Tomography, Wiley, New York, 1986.
[2] F. Natterer and F. Wuebbeling, Mathematical Methods in Image Reconstruction, Monographs on Mathematical Modeling and Computation, vol. 5, SIAM, Philadelphia, PA, 2001.

## Tomography and Sampling Theory

## Adel Faridani, Department of Mathematics, Oregon State University

Computed tomography entails the reconstruction of a function from measurements of its line integrals. In this talk we explore the question: How many and which line integrals should be measured in order to achieve a desired resolution in the reconstructed image? Answering this question may help to reduce the amount of measurements and thereby the radiation dose, or to obtain a better image from the data one already has. Our exploration leads us to a mathematically and practically fruitful interaction of Shannon sampling theory and tomography. For example, sampling theory helps to identify efficient data acquisition schemes, provides a qualitative understanding of certain artifacts in tomographic images, and facilitates the error analysis of some reconstruction algorithms. On the other hand, applications in tomography have stimulated new research in sampling theory, e.g., on nonuniform sampling theorems and estimates for the aliasing error.

## References

[1] A. FARIDANI, Sampling theory and parallel-beam tomography, Sampling, Wavelets, and Tomography, (J.J. Benedetto and A. I. Zayed, eds.), Birkhauser, Boston, 2004, pp. 225-254.
[2] A. Faridani, Introduction to the mathematics of computed tomography, Inside Out: Inverse Problems and Applications, G. Uhlmann (ed.), MSRI Publications, Vol. 47, Cambridge University Press, 2003, pp. 1-46.
[3] www.oregonstate.edu/~faridana/preprints/ preprints.htm1.

## Inverse Problems in Pipeline Inspection

## Peter Massopust, Tuboscope Pipeline Services, Houston, TX

One of the techniques to detect defects and anomalies in pipelines is based on the magnetization of the pipe wall. Anomalies and defects in the pipe cause changes in the induced magnetic field, and these changes are measured by a set of sensors. From these measurements, the shape
and type of defect needs to be inferred. Several factors (e.g., sensor sensitivity, probability of detection, noise) can impede these measurements, making the solution of the inverse problem indirect measurements_geometrymore difficult. In this introductory lecture, we discuss the fundamental model to solve the inverse problem and show how B-spline and wavelet techniques can be successfully applied to remedy measurement impediments.

## References

[1] J. D. Jackson, Classical Electrodynamics, John Wiley \& Sons, 3rd edition, 1998.
[2] I. Daubechies, Ten Lectures on Wavelets, SIAM, 1992.
[3] C. DE Boor, A Practical Guide to Splines, Springer-Verlag, 2001.

## Coherent Interferometric Array Imaging in Random Media

## Liliana Borcea, Computational \& Applied Mathematics, Rice University

In important applications, such as ultrasound medical imaging, foliage or ground penetrating radar, land and shallow water mine detecting, etc., one seeks to detect and image small or extended scatterers (reflectors) embedded in inhomogeneous, cluttered media. Such media can be modeled as randomly inhomogeneous, with properties such as acoustic impedance having a deterministic largescale variation, assumed known, and an additional weak, small-scale variation that is unknown and is represented by a random function of space. The strong scatterers embedded in such media are to be imaged with an array of transducers that emit acoustic pulses and record the backscattered echoes.

Traditional array imaging methods known as synthetic aperture sonar, Kirchhoff Migration, etc., are well understood and work well in known media. However, these methods fail in random media and new ideas must be explored in order to obtain reliable images. I will describe a new, coherent interferometric approach to imaging in clutter, which is based on an asymptotic stochastic analysis of wave propagation in random media, in regimes with strong multipath. To achieve stable results, this method uses cross-correlations of nearby traces recorded at the array, the interferograms. We also exploit the existence of a frequency coherence band in order to achieve good resolution of the images. Naturally, the spatial and frequency coherence of the data at the array depend on the random medium, and we show how they quantify explicitly the resolution of the images. The efficiency and robustness of the proposed method in clutter will be illustrated with several numerical results.

## References

[1] P. BLOMGREN, G. PAPANICOLAOU, and H. ZHAO, Super-resolution in time-reversal acoustics, Journal of the Acoustical Society of America, 111 (2002), 238-248.
[2] L. Borcea, G. PAPANICOLAOU, and C. TSOGKA, Theory and applications of time reversal and interferometric imaging, Inverse Problems, 19 (2003), S134-164.
[3] L. BORCEA, G. PAPANICOLAOU, C. TSOGKA, and J. BERRYMAN, Imaging and time reversal in random media, Inverse Problems, 18, No. 5, (2002), 1247-1279.
[4] G. PAPANICOLAOU, L. RYZHIK, and K. SOLNA, Statistical stability in time reversal, SIAM J. Applied Mathematics, in press. Available from G. Papanicolaou's webpage: http://georgep. stanford.edu/~papanico/pubs.htm7.

# Atlanta, Georgia 

 TimetableATLANTA, GEORGIA January 5-8, 2005


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\text { M O N D A Y, JANUARY } 3
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## 9:00 a.m. - 5:00 p.m. AMS SHORT COURSE: RADON TRANSFORM AND APPLICATIONS TO INVERSE PROBLEMS, I <br> 9:00 a.m. - 5:00 p.m. MAA SHORT COURSE: EIGHT LECTURES ON RANDOM GRAPHS, I

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\text { T UESDAY, JANUARY } 4
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## 8:30 a.m. - 4:00 p.m. <br> MAA BOARD OF GOVERNORS

9:00 a.m. - 5:00 p.m.
9:00 a.m. - 5:00 p.m.
AMS SHORT COURSE: RADON TRANSFORM AND APPLICATIONS TO INVERSE PROBLEMS, II MAA SHORT COURSE: EIGHT LECTURES ON RANDOM GRAPHS, II 1:30 p.m. - 10:00 p.m.
3:00 p.m. - 8:00 p.m.

## AMS COUNCIL

JOINT MEETINGS REGISTRATION Full registration will be conducted from 3:00 p.m. until 7:00 p.m. Registration badge/program pickup only will be open until 8:00 p.m.

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\text { W E D N ESD AY, J A N U A RY } 5
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7:30 a.m. - 4:00 p.m.
7:30 a.m. - 4:00 p.m.
8:00 a.m. - 10:50 a.m.

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8:00 a.m. - 10:50 a.m.
8:00 a.m. - 10:50 a.m.
8:00 a.m. - 10:50 a.m.
8:00 a.m. - 10:55 a.m.
AMS CONTRIBUTED PAPER SESSION
MAA CONTRIBUTED PAPER SESSIONS
8:00 a.m. - 10:55 a.m.
8:00 a.m. - 10:55 a.m.
8:00 a.m. - 10:55 a.m.
8:00 a.m. - 10:55 a.m.

## JOINT MEETINGS REGISTRATION

## EMPLOYMENT CENTER REGISTRATION

AMS-SIAM SPECIAL SESSIONS

Mathematical Image Processing, I
Theoretical and Computational Aspects of Inverse Problems, I
AMS-ASL SPECIAL SESSION ON REVERSE MATHEMATICS, I
AMS SPECIAL SESSIONS
Riemannian Geometry, I
D-Modules, I
Commutative Algebra, I
Design Theory and Graph Theory, I
Analysis Problems in Modern Physics, I
In the Wake of Jacobi and Hamilton 200 Years Later, I
Radon Transform and Inverse Problems, I

Getting Students To Discuss and To Write About Mathematics, I
Courses Below Calculus: A New Focus, I
Mathematics and Sports, I

## AMS-MAA-MER SPECIAL SESSION ON MATHEMATICS AND EDUCATION REFORM, I

Dynamic Equations on Time Scales; Integer Sequences and Rational Maps, I

My Favorite Demo: Innovative Strategies for Mathematics Instructors, I

| 8:00 a.m. - 10:55 a.m. | , I |
| :---: | :---: |
| 8:00 a.m. - 10:50 a.m. | SIAM MINISYMPOSIUM ON ERROR-CORRECTING CODES |
| 8:30 a.m. - 10:55 a.m. | maA Committee on graduate students special presentation Training T. A.s in departments and at section meetings. |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#12: PART A Getting students involved in undergraduate research. |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#1: PART A Visual linear algebra. |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#7: PART A Developing your department's assessment plan. |
| 9:30 a.m. - 10:50 a.m. | MAA SPECIAL PRESENTATION Doctoral programs in mathematics education: Their nature and how to find them. |
| 9:30 a.m. - 10:50 a.m. | MAA SPECIAL PRESENTATION A problem-based core program. |
| 10:05 a.m. - 10:55 a.m. | AMS INVITED ADDRESS Title to be announced. Bruce A. Kleiner |
| 11:10 a.m. - 12:00 p.m. | AMS-MAA INVITED ADDRESS Processing images using nonlinear PDEs. Andrea L. Bertozzi |
| 12:15 p.m. - 5:30 p.m. | EXHIBITS AND BOOK SALES |
| 1:00 p.m. - 1:50 p.m. | AMS COLLOQUIUM LECTURES: LECTURE I How polynomials vanish: Singularities, integrals, and ideals (Part I). Robert K. Lazarsfeld |
| 2:15 p.m. - 3:05 p.m. | MAA INVITED ADDRESS What are p-adic numbers and what are they for? Fernando Q. Gouvêa |
| 2:15 p.m. - 6:05 p.m. | AMS-MAA-MER SPECIAL SESSION ON MATHEMATICS AND EDUCATION REFORM, II |
|  | AMS-SIAM SPECIAL SESSIONS |
| 2:15 p.m. - 6:05 p.m. | Dynamic Equations on Time Scales; Integer Sequences and Rational Maps, II |
| 2:15 p.m. - 6:05 p.m. | Mathematical Image Processing, II |
| 2:15 p.m. - 6:05 p.m. | Theoretical and Computational Aspects of Inverse Problems, II |
|  | AMS SPECIAL SESSIONS |
| 2:15 p.m. - 6:05 p.m. | Riemannian Geometry, II |
| 2:15 p.m. - 6:05 p.m. | D-Modules, II |
| 2:15 p.m. - 6:05 p.m. | Commutative Algebra, II |
| 2:15 p.m. - 6:05 p.m. | Representations of Lie Algebras, I |
| 2:15 p.m. - 6:05 p.m. | Design Theory and Graph Theory, II |
| 2:15 p.m. - 6:05 p.m. | Radon Transform and Inverse Problems, II |
| 2:15 p.m. - 6:05 p.m. | Mathematical Sciences Research for the Department of Energy's Computational Biology Needs |
| 2:15 p.m. - 4:15 p.m. | MAA MINICOURSE \#13: PART A Origami in undergraduate mathematics courses. |
| 2:15 p.m. - 4:15 p.m. | MAA MINICOURSE \#2: PART A Teaching a Galois theory for undergraduates. |
| 2:15 p.m. - 4:15 p.m. | MAA MINICOURSE \#8: PART A Mathematical finance. |
|  | MAA CONTRIBUTED PAPER SESSIONS |
| 2:15 p.m. - 6:00 p.m. | Mathematics in the Islamic World |
| 2:15 p.m. - 6:00 p.m. | Mathlets for Teaching and Learning Mathematics |
| 2:15 p.m. - 6:00 p.m. | Drawing on Our Students' Thinking to Improve the Mathematical Education of Teachers |
| 2:15 p.m. - 6:00 p.m. | MAA GENERAL CONTRIBUTED PAPER SESSION, II |
| 2:15 p.m. - 6:00 p.m. | SIAM MINISYMPOSIUM ON UNDERGRADUATE LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS: PROJECTS, PROBLEMS, AND ISSUES |
| 2:15 p.m. - 6:00 p.m. | SIAM MINISYMPOSIUM ON DISCONTINUOUS GALERKIN METHODS: THEORY AND APPLICATIONS |
| 2:15 p.m. - 3:45 p.m. | MAA PROJECT NEXT PANEL DISCUSSION Developing undergraduate research projects that are not in discrete mathematics. |

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\text { WEDNESDAY, JANUARY } 5 \text { (cont'd) }
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| 2:15 p.m. - 3:35 p.m. | SIGMAA ON RUME GUIDELINES COMMITTEE PANEL DISCUSSION Ph.D. programs in research in undergraduate mathematics. |
| :---: | :---: |
| 2:15 p.m. - 3:35 p.m. | MAA-YOUNG MATHEMATICIANS' NETWORK PANEL DISCUSSION Career paths for undergraduates in mathematics. |
| 2:15 p.m. - 5:55 p.m. | AMS SESSION FOR CONTRIBUTED PAPERS |
| 2:30 p.m. - 5:00 p.m. | MAA SECTION OFFICERS |
| 3:20 p.m. - 4:05 p.m. | MAA INVITED ADDRESS Given four lines in space, how many other lines meet all four?: The geometry, topology, and combinatorics behind linear algebra. Ravi D. Vakil |
| 3:20 p.m. - 4:20 p.m. | AWM-NAM PANEL DISCUSSION Achieving diversity in graduate programs, Part I: The challenge to retain women. |
| 3:30 p.m. - 4:50 p.m. | MAA COMMITTEE ON GRADUATE STUDENTS SPECIAL PRESENTATION How to interview for your first job. |
| 3:50 p.m. - 5:10 p.m. | MAA PROJECT NEXT-YOUNG MATHEMATICIANS' NETWORK PANEL DISCUSSION Dealing with the two-body problem. |
| 3:50 p.m. - 5:10 p.m. | MAA CUPM SUBCOMMITTEE ON CURRICULUM RENEWAL ACROSS THE FIRST TWO YEARS (CRAFTY) PANEL DISCUSSION Refocused college algebra: A basis for QL programs. |
| 4:00 p.m. - 5:00 p.m. | WELCOMING RECEPTION FOR UNDERGRADUATE STUDENTS |
| 4:20 p.m. - 4:50 p.m. | AWM BUSINESS MEETING |
| 4:30 p.m. - 6:30 p.m. | MAA MINICOURSE \#14: PART A Euler. |
| 4:30 p.m. - 6:30 p.m. | MAA MINICOURSE \#3: PART A Creating interactive workbooks using MS Excel. |
| 4:30 p.m. - 6:30 p.m. | MAA MINICOURSE \#9: PART A Infusing connections into core courses for future secondary teachers. |
| 4:50 p.m. - 5:30 p.m. | AWM FOCUS DISCUSSION Focus: Future. |
| 5:00 p.m. - 6:00 p.m. | RECEPTION FOR FIRST-TIME PARTICIPANTS |
| 5:30 p.m. - 8:00 p.m. | MATHEMATICAL INSTITUTES OPEN HOUSE |
| 6:00 p.m. - 7:00 p.m. | GRADUATE STUDENT RECEPTION |
| 8:30 p.m. - 9:30 p.m. | AMS JOSIAH WILLARD GIBBS LECTURE The Interplay between Analysis and Algorithms. Ingrid Daubechies |

## THURSDAY, JANUARY 6

9:30 p.m. - 11:00 p.m.
7:00 a.m. - 7:30 p.m.
7:30 a.m. - 4:00 p.m.
8:00 a.m. - 11:50 a.m.
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8:00 a.m. - 11:50 a.m.

AWM RECEPTION
EMPLOYMENT CENTER
JOINT MEETINGS REGISTRATION
AMS-MAA-MER SPECIAL SESSION ON MATHEMATICS AND EDUCATION REFORM, III
AMS-MAA SPECIAL SESSIONS
Tropical Geometry, I
AMS-SIAM SPECIAL SESSIONS
Stochastic, Large-Scale and Hybrid Systems, I
Dynamic Equations on Time Scales; Integer Sequences and Rational Maps, III
Ortogonal Polynomials—Random Matrices—Integrable Systems: Interdisciplinary Aspects, I
Theoretical and Computational Aspects of Inverse Problems, III

| 8:00 a.m. - 11:50 a.m. | AMS-ASL SPECIAL SESSION ON REVERSE MATHEMATICS, II |
| :---: | :---: |
|  | AMS SPECIAL SESSIONS |
| 8:00 a.m. - 11:50 a.m. | Mathematical Sciences Contributions to the Biomedical Sciences, I |
| 8:00 a.m. - 11:50 a.m. | Riemannian Geometry, III |
| 8:00 a.m. - 11:50 a.m. | Quantum Topology, I |
| 8:00 a.m. - 11:50 a.m. | Commutative Algebra, III |
| 8:00 a.m. - 11:50 a.m. | Representations of Lie Algebras, II |
| 8:00 a.m. - 11:50 a.m. | Analysis Problems in Modern Physics, II |
| 8:00 a.m. - 11:50 a.m. | Radon Transform and Inverse Problems, III |
| 8:00 a.m. - 10:00 a.m. | MAA MINICOURSE \#4: PART A Java applets in teaching mathematics. |
|  | MAA CONTRIBUTED PAPER SESSIONS |
| 8:00 a.m. - 12:00 p.m. | History of Undergraduate Mathematics in America, 1900-2000 |
| 8:00 a.m. - 12:00 p.m. | Initializing and Sustaining Undergraduate Research Projects and Programs |
| 8:00 a.m. - 12:00 p.m. | Projects and Demonstrations that Enhance a Differential Equations Course |
| 8:00 a.m. - 12:00 p.m. | Countering "I Can't Do Math": Strategies for Teaching Under-Prepared, Math-Anxious Students |
| 8:00 a.m. - 12:00 p.m. | MAA GENERAL CONTRIBUTED PAPER SESSION, III |
| 8:00 a.m. - 11:55 a.m. | AMS SESSION FOR CONTRIBUTED PAPERS |
| 8:30 a.m. - 10:00 a.m. | MAA PROJECT NEXT PANEL DISCUSSION What faculty can do to promote diversity in mathematics. |
| 8:30 a.m. - 11:30 a.m. | MAA SPECIAL PRESENTATION Emerging technologies in undergraduate mathematics. |
| 9:00 a.m. - 9:50 a.m. | AWM EMMY NOETHER LECTURE From limit cycles to strange attractors. Lai-Sang Young |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#10: PART A Bridging the gap between mathematics and the physical sciences. |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#15: PART A Conceptests and Peer Instruction: Active learning in the calculus classroom. |
| 9:00 a.m. - 10:20 a.m. | MAA SPECIAL PRESENTATION National Science Foundation programs supporting learning and teaching in the mathematical sciences. |
| 10:00 a.m. - 11:00 a.m. | AMS SPECIAL PRESENTATION Do the Math! |
| 10:00 a.m. - 6:00 p.m. | EXHIBITS AND BOOK SALES |
| 10:05 a.m. - 10:55 a.m. | MAA INVITED ADDRESS Origami, linkages, and polyhedra: Folding with algorithms. Erik D. Demaine |
| 10:15 a.m. - 12:15 p.m. | MAA MINICOURSE \#5: PART A Hands-on discrete mathematics with technology. |
| 10:30 p.m. - 12:00 p.m. | AMS-ASL PANEL DISCUSSION Hilbert's first problem. |
| 10:30 a.m. - 12:00 p.m. | MAA PROJECT NEXT PANEL DISCUSSION Recruiting students for mathematics departments. |
| 10:45 a.m. - 12:05 p.m. | MAA PANEL DISCUSSION Using the CUPM Curriculum Guide 2004 to get grants to facilitate change. |
| 10:45 a.m. - 12:05 p.m. | MAA COMMITTEE ON ARTICULATION AND PLACEMENT PANEL DISCUSSION How changes in high school mathematics could influence collegiate mathematics. |
| 11:10 a.m. - 12:00 p.m. | SIAM INVITED ADDRESS Transforming men into mice (and into chimpanzees, dogs, chickens, etc.). Pavel Pevzner |
| 1:00 p.m. - 1:50 p.m. | AMS COLLOQUIUM LECTURES: LECTURE II How polynomials vanish: Singularities, integrals, and ideals (Part II). Robert K. Lazarsfeld |
| 1:00 p.m. - 3:50 p.m. | AMS-MAA-MER SPECIAL SESSION ON MATHEMATICS AND EDUCATION REFORM, IV |

THURSDAY, JANUARY 6 ( $c o n t^{\prime} d$ )

| 1:00 p.m. - 3:50 p.m. | AMS-MAA SPECIAL SESSIONS |
| :---: | :---: |
|  | Tropical Geometry, II |
|  | AMS-SIAM SPECIAL SESSIONS |
| 1:00 p.m. - 3:50 p.m. | Stochastic, Large-Scale and Hybrid Systems, II |
| 1:00 p.m. - 3:50 p.m. | Dynamic Equations on Time Scales; Integer Sequences and Rational Maps, IV |
| 1:00 p.m. - 3:50 p.m. | Ortogonal Polynomials-Random Matrices-Integrable Systems: Interdisciplinary Aspects, II |
| 1:00 p.m. - 3:50 p.m. | Theoretical and Computational Aspects of Inverse Problems, IV |
| 1:00 p.m. - 3:50 p.m. | AMS-ASL SPECIAL SESSION ON REVERSE MATHEMATICS, III |
|  | AMS SPECIAL SESSIONS |
| 1:00 a.m. - 3:50 a.m. | Mathematical Sciences Contributions to the Biomedical Sciences, II |
| 1:00 p.m. - 3:50 p.m. | Quantum Topology, II |
| 1:00 p.m. - 3:50 p.m. | Representations of Lie Algebras, III |
| 1:00 p.m. - 3:50 p.m. | Analysis Problems in Modern Physics, III |
| 1:00 p.m. - 3:50 p.m. | In the Wake of Jacobi and Hamilton 200 Years Later, II |
| 1:00 p.m. - 3:50 p.m. | Radon Transform and Inverse Problems, IV |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#11: PART A Fair enough? Mathematics of equity. |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#16: PART A Music and mathematics. |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#6: PART A Webwork, an internet-based system for generating and delivering homework problems to students. |
|  | MAA CONTRIBUTED PAPER SESSIONS |
| 1:00 p.m. - 4:10 p.m. | Getting Students To Discuss and To Write About Mathematics, II |
| 1:00 p.m. - 4:10 p.m. | My Favorite Demo: Innovative Strategies for Mathematics Instructors, II |
| 1:00 p.m. - 4:10 p.m. | Using Real-World Data to Illustrate Statistical Concepts, I |
| 1:00 p.m. - 4:10 p.m. | MAA GENERAL CONTRIBUTED PAPER SESSION, IV |
| 1:00 p.m. - 3:00 p.m. | ENVIRONMENTAL MATHEMATICS SIGMAA INVITED ADDRESS, COUNCIL MEETING, AND BUSINESS MEETING The featured speaker is Benoit B. Mandelbrot, Yale University. |
| 1:00 p.m. - 2:20 p.m. | MAA PANEL DISCUSSION Using CUPM Curriculum Guide 2004: Assessing and improving the program for the major in mathematics. |
| 1:00 p.m. - 2:20 p.m. | MAA SPECIAL PRESENTATION Learning to prove: Strategies to improve students' proof writing skills. |
| 1:00 p.m. - 4:00 p.m. | MAA SPECIAL PRESENTATION Undergraduate mathematics and NSDL: The National Science Technology Engineering and Mathematics Education Digital Library. |
| 1:00 p.m. - 4:10 p.m. | AMS SESSION FOR CONTRIBUTED PAPERS |
| 2:00 p.m. - 4:00 p.m. | MAA PROJECT NEXT-YOUNG MATHEMATICIANS' NETWORK POSTER SESSION |
| 2:00 p.m. - 4:00 p.m. | SUMMER PROGRAM FOR WOMEN IN MATHEMATICS |
| 2:15 p.m. - 3:05 p.m. | AMS INVITED ADDRESS Embedded curves and Gromov-Witten invariants. Eleny lonel |
| 2:30 p.m. - 3:50 p.m. | MAA PANEL DISCUSSION Speaking of mathematics. |
| 2:30 p.m. - 3:50 p.m. | MAA PANEL DISCUSSION The senior seminar or "capstone" experience for undergraduate mathematics majors. |
| 3:15 p.m. - 4:35 p.m. | MAA PANEL DISCUSSION Moore method calculus by those who do it. |
| 3:20 p.m. - 4:10 p.m. | AMS INVITED ADDRESS The power and weakness of randomness (when you are short on time). Avi Wigderson |
| 4:25 p.m. - 5:45 p.m. | JOINT PRIZE SESSION |
| 5:45 p.m. - 6:30 p.m. | JOINT PRIZE SESSION RECEPTION |

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5:45 p.m. - 7:00 p.m. LEHIGH UNIVERSITY RECEPTION
5:45 p.m. - 7:00 p.m.
6:00 p.m. - 8:00 p.m.
6:00 p.m. - 7:00 p.m.
6:00 p.m. - 8:00 p.m.
    ASSOCIATION OF LESBIAN, GAY, BISEXUAL, AND TRANSGENDERED MATHEMATICIANS
    RECEPTION
6:00 p.m. - 9:30 p.m.
    MER BANQUET
7:30 p.m. - 8:30 p.m.
8:15 p.m. - 9:45 p.m.
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## MAA TWO-YEAR COLLEGE RECEPTION

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SIGMAA ON THE HISTORY OF MATHEMATICS ANNUAL MEETING The guest lecturer is Thomas Archibald, Dibner Institute at MIT and Arcadia University.
UNIVERSITY OF CHICAGO DEPARTMENT OF MATHEMATICS ALUMNI RECEPTION
ASSOCIATION OF LESBIAN, GAY, BISEXUAL, AND TRANSGENDERED MATHEMATICIANS RECEPTION
MER BANQUET
YOUNG MATHEMATICIANS' NETWORK TOWN MEETING
KNITTING CIRCLE
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F R I D A Y, J A N U A R Y 7

7:00 a.m. - 8:00 a.m.
7:30 a.m. - 4:00 p.m.

8:00 a.m. - 10:50 a.m.
8:00 a.m. - 10:50 a.m.
8:00 a.m. - 10:50 a.m.
8:00 a.m. - 10:50 a.m.
AMS SPECIAL SESSIONS
8:00 a.m. - 10:50 a.m. Dynamics of Mapping Class Groups on Moduli Spaces, I
8:00 a.m. - 10:50 a.m. Inverse Spectral Geometry, I
8:00 a.m. - 10:50 a.m. Spaces of Vector-Valued Functions, I
8:00 a.m. - 10:50 a.m. Arithmetic Algebraic Geometry, I
8:00 a.m. - 10:50 a.m. Algorithmic Algebraic and Analytic Geometry, I
8:00 a.m. - 10:50 a.m. Modular Representation Theory of Finite and Algebraic Groups, I
MAA CONTRIBUTED PAPER SESSIONS
8:00 a.m. - $10: 55$ a.m. Using Real-World Data to Illustrate Statistical Concepts, II
8:00 a.m. - 10:55 a.m. Environmental Mathematics and the Interdisciplinary
8:00 a.m. - 10:55 a.m. Teaching Visualization Skills
8:00 a.m. - 10:55 a.m. Teaching and Assessing Problem Solving
8:00 a.m. - 10:55 a.m. MAA GENERAL CONTRIBUTED PAPER SESSION, V
8:00 a.m. - 10:55 a.m. AMS SESSION FOR CONTRIBUTED PAPERS
8:00 a.m. - 5:00 p.m.
3:00 a.m. - 10:55 a.m.
8:15 a.m. - 7:30 p.m.
9:00 a.m. - 9:50 a.m.
9:00 a.m. - 11:00 a.m.
9:00 a.m. - 11:00 a.m.
9:00 a.m. - 11:00 a.m.
9:00 a.m. - 10:20 a.m.
JOINT PME AND MAA STUDENT CHAPTER ADVISORS' BREAKFAST
JOINT MEETINGS REGISTRATION

## AMS-SIAM SPECIAL SESSIONS

Recent Advances in Mathematical Ecology, I
Nonsmooth Analysis in Variational and Imaging Problems, I
Reaction Diffusion Equations and Applications, I
Integrable Systems and Special Functions, I

Using Real-World Data to IIlustrate Statistical Concepts,
Environmental Mathematics and the Interdisciplinary

ASL INVITED ADDRESSES AND CONTRIBUTED PAPERS
PME COUNCIL

## EMPLOYMENT CENTER

AMS INVITED ADDRESS Recent developments in inverse problems. Gunther Uhimann
MAA MINICOURSE \#12: PART B Getting students involved in undergraduate research.
MAA MINICOURSE \#1: PART B Visual linear algebra.
MAA MINICOURSE \#7: PART B Developing your department's assessment plan.
MAA COMMITTEE ON THE PROFESSION PANEL DISCUSSION Long-term mathematics faculty

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\text { FRIDAY, JANUARY } 7 \text { (cont'd) }
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| 9:00 a.m. - 10:55 a.m. | MAA SPECIAL PRESENTATION Using mathematically rich activities to develop $K-12$ curricula: Part $I$. |
| :---: | :---: |
| 9:00 a.m. - 10:20 a.m. | MAA SPECIAL PRESENTATION Proposal writing workshop for grant applications to the NSF division of undergraduate education. |
| 9:30 a.m. - 10:55 a.m. | AMS WORKSHOP T.A. development using case studies: A workshop for faculty (Part 1). |
| 10:00 a.m. - 6:00 p.m. | EXHIBITS AND BOOK SALES |
| 10:05 a.m. - 10:55 a.m. | AMS INVITED ADDRESS Title to be announced. Steven M. Zelditch |
| 11:10 a.m. - 12:00 p.m. | AMS-MAA INVITED ADDRESS Algebraic statistics. Bernd Sturmfels |
| 1:00 p.m. - 1:50 p.m. | AMS COLLOQUIUM LECTURES: LECTURE III How polynomials vanish: Singularities, integrals, and ideals (Part III). Robert K. Lazarsfeld |
| 1:00 p.m. - 1:50 p.m. | MAA STUDENT LECTURE Victorian combinatorics. Robin J. Wilson |
| 1:00 p.m. - 5:50 p.m. | AMS-MAA-SIAM SPECIAL SESSION ON RESEARCH IN MATHEMATICS BY UNDERGRADUATES, I |
| 1:00 p.m. - 5:50 p.m. | AMS-MAA SPECIAL SESSIONS History of Mathematics, I |
|  | AMS-SIAM SPECIAL SESSIONS |
| 1:00 p.m. - 5:50 p.m. | Recent Advances in Mathematical Ecology, II |
| 1:00 p.m. - 5:50 p.m. | Reaction Diffusion Equations and Applications, II |
|  | AMS SPECIAL SESSIONS |
| 1:00 p.m. - 5:50 p.m. | Algebraic Geometry Codes |
| 1:00 p.m. - 6:00 p.m. | Current Events |
| 1:00 p.m. - 5:50 p.m. | Mathematics and Mathematics Education in Fiber Arts |
| 1:00 p.m. - 5:50 p.m. | Mathematicians' Work on Mathematics Education |
| 1:00 p.m. - 5:50 p.m. | Spaces of Vector-Valued Functions, II |
| 1:00 p.m. - 5:50 p.m. | Topics in Geometric Function Theory, I |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#16: PART B Music and mathematics. |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#2: PART B Teaching a Galois theory for undergraduates. |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#8: PART B Mathematical finance. |
|  | MAA CONTRIBUTED PAPER SESSIONS |
| 1:00 p.m. - 5:50 p.m. | Courses Below Calculus: A New Focus, II |
| 1:00 p.m. - 5:50 p.m. | Mathematics and Sports, II |
| 1:00 p.m. - 5:50 p.m. | Philosophy of Mathematics |
| 1:00 p.m. - 5:50 p.m. | Using Handheld Technology To Facilitate Student-Centered Teaching/Learning Activities at the Developmental Algebra Level |
| 1:00 p.m. - 5:50 p.m. | MAA GENERAL CONTRIBUTED PAPER SESSION, VI |
| 1:00 p.m. - 3:00 p.m. | MAA INVITED PAPER SESSION ON MODELING PROBLEMS OF THE ENVIRONMENT |
| 1:00 p.m. - 3:00 p.m. | MAA POSTER SESSION ON PROJECTS SUPPORTED BY THE NSF DIVISION OF UNDERGRADUATE EDUCATION |
| 1:00 p.m. - 2:30 p.m. | AMS WORKSHOP T.A. development using case studies: A workshop for faculty (Part 2). |
| 1:00 p.m. - 2:30 p.m. | MAA PROJECT NEXT PANEL DISCUSSION Planning a sabbatical. |
| 1:00 p.m. - 2:20 p.m. | AMS-MAA JOINT COMMITTEE ON TEACHING ASSISTANTS AND PART-TIME INSTRUCTORS |


|  | PANEL DISCUSSION Just the facts: Profiles and inferences from data on permanently temporary faculty. |
| :---: | :---: |
| 1:00 p.m. - 2:20 p.m. | MAA COMMITTEE ON ARTICULATION AND PLACEMENT PANEL DISCUSSION The great divide: Graphing calculators in secondary and college education. |
| 1:00 p.m. - 5:55 p.m. | AMS SESSION FOR CONTRIBUTED PAPERS |
| 2:15 p.m. - 4:00 p.m. | NAM GRANVILLE-BROWN-HAYNES SESSION OF PRESENTATIONS BY RECENT DOCTORAL RECIPIENTS IN THE MATHEMATICAL SCIENCES |
| 2:15 p.m. - 4:10 p.m. | RMMC BOARD OF DIRECTORS |
| 2:30 p.m. - 4:00 p.m. | MAA PRESENTATIONS BY TEACHING AWARD RECIPIENTS |
| 2:30 p.m. - 4:00 p.m. | AMS COMMITTEE ON SCIENCE POLICY PANEL DISCUSSION |
| 2:30 p.m. - 3:50 p.m. | MAA PANEL DISCUSSION Classroom networks for developing mathematical understanding. |
| 2:45 p.m. - 4:45 p.m. | MAA SPECIAL PRESENTATION Information session on actuarial education. |
| 3:15 p.m. - 5:15 p.m. | MAA MINICOURSE \#14: PART B Euler. |
| 3:15 p.m. - 5:15 p.m. | MAA MINICOURSE \#3: PART B Creating interactive workbooks using MS Excel. |
| 3:15 p.m. - 5:15 p.m. | MAA MINICOURSE \#9: PART B Infusing connections into core courses for future secondary teachers. |
| 4:00 p.m. - 6:30 p.m. | MAA COMMITTEE ON UNDERGRADUATE STUDENT ACTIVITIES AND CHAPTERS (CUSAC) POSTER SESSION Undergraduate student poster session. |
| 4:00 p.m. - 5:20 p.m. | SIGMAA FOR QUANTITATIVE LITERACY System-wide quantitative literacy initiatives. |
| 4:00 p.m. - 5:00 p.m. | WEB SIGMAA BUSINESS MEETING |
| 5:00 p.m. - 5:50 p.m. | AMS COMMITTEE ON SCIENCE POLICY-MAA SCIENCE POLICY COMMITTEE GOVERNMENT SPEAKER Speaker and title to be announced. |
| 5:00 p.m. - 6:00 p.m. | RECEPTION FOR MATHEMATICIANS IN BUSINESS, INDUSTRY, AND GOVERNMENT |
| 5:00 p.m. - 6:00 p.m. | MAA BUSINESS, INDUSTRY AND GOVERNMENT WELCOMING RECEPTION |
| 5:30 p.m. - 9:00 p.m. | NAM RECEPTION, BANQUET, AND COX-TALBOT ADDRESS Speaker and title to be announced. |
| 5:30 p.m. - 7:00 p.m. | NEW MEXICO STATE UNIVERSITY MATHEMATICS ASSOCIATION RECEPTION |
| 6:00 p.m. - 7:00 p.m. | MATHEMATICAL REVIEWS RECEPTION |
| 6:30 p.m. - 8:30 p.m. | BUDAPEST SEMESTERS IN MATHEMATICS REUNION |

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SA T UR DA Y, J A N U A R Y 8
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| 8:30 p.m. - 10:30 p.m. | PROJECT NEXT RECEPTION |
| :--- | :--- |
| 7:30 a.m. - 2:00 p.m. | JOINT MEETINGS REGISTRATION |
| 8:00 a.m. - 10:50 a.m. | AMS-MAA-SIAM SPECIAL SESSION ON RESEARCH IN MATHEMATICS BY UNDERGRADU- |
|  | ATES, II |
|  | AMS-MAA SPECIAL SESSIONS |
| 8:00 a.m. - 10:50 a.m. | History of Mathematics, II <br>  <br>  <br> 8:00 a.ms-SIAM SPECIAL SESSIONS |
|  | AM 10:50 a.m. | | Nonsmooth Analysis in Variational and Imaging Problems, II |
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S ATURDAY, JANUARY 8 (coont,d)
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| $\begin{aligned} & \text { 8:00 a.m. }- \text { 10:50 a.m. } \\ & \text { 8:00 a.m. - 10:50 a.m. } \end{aligned}$ | Analysis and Applications in Nonlinear Partial Differential Equations, I Integrable Systems and Special Functions, II |
| :---: | :---: |
|  | AMS SPECIAL SESSIONS |
| 8:00 a.m. - 10:50 a.m. | Inverse Spectral Geometry, II |
| 8:00 a.m. - 10:50 a.m. | Complex and Functional Analysis, I |
| 8:00 a.m. - 10:50 a.m. | Topics in Geometric Function Theory, II |
| 8:00 a.m. - 10:50 a.m. | Algorithmic Algebraic and Analytic Geometry, II |
| 8:00 a.m. - 10:50 a.m. | Modular Representation Theory of Finite and Algebraic Groups, II |
|  | MAA CONTRIBUTED PAPER SESSIONS |
| 8:00 a.m. - 10:55 a.m. | My Three Favorite Original Calculus Problems |
| 8:00 a.m. - 10:55 a.m. | Meeting the Challenge: Relationship Between Mathematics and Biology in the 21st Century |
| 8:00 a.m. - 10:55 a.m. | Mathematics Experiences in Business, Industry, and Government |
| 8:00 a.m. - 10:55 a.m. | MAA GENERAL CONTRIBUTED PAPER SESSION, VII |
| 8:00 a.m. - 10:55 a.m. | AMS SESSION FOR CONTRIBUTED PAPERS |
| 8:00 a.m. - 5:00 p.m. | ASL INVITED ADDRESSES AND CONTRIBUTED PAPERS |
| 8:30 a.m. - 5:00 p.m. | AWM WORKSHOP |
| 8:30 a.m. - 10:00 a.m. | AMS COMMITTEE ON EDUCATION PANEL DISCUSSION |
| 9:00 a.m. - 9:50 a.m. | MAA INVITED ADDRESS Square ice is very nice, but can you put a match to it? Georgia Benkart |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#10: PART B Bridging the gap between mathematics and the physical sciences. |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#15: PART B Conceptests and Peer Instruction: Active learning in the calculus classroom. |
| 9:00 a.m. - 11:00 a.m. | MAA MINICOURSE \#4: PART B Java applets in teaching mathematics. |
| 9:00 a.m. - 10:55 a.m. | MAA INVITED PAPER SESSION ON WORLDS OF INTERACTIVE MATHEMATICS, PART I: THE LEGACY OF ELIAS DEEBA |
| 9:00 a.m. - 10:20 a.m. | MAA/RUME PANEL DISCUSSION The ICME-10 meeting. |
| 9:00 a.m. - 10:20 a.m. | MAA PANEL DISCUSSION Revisiting crossroads: The teaching and learning of mathematics in two-year colleges. |
| 9:00 a.m. - 9:50 a.m. | NAM-AWM PANEL DISCUSSION Achieving diversity in graduate programs, Part II: The challenge to retain underrepresented groups. |
| 9:00 a.m. - 12:00 p.m. | EXHIBITS AND BOOK SALES |
| 9:00 a.m. - 12:00 p.m. | EMPLOYMENT CENTER |
| 10:00 a.m. - 10:50 a.m. | NAM BUSINESS MEETING |
| 10:05 a.m. - 10:55 a.m. | MAA INVITED ADDRESS Symmetry in complex analysis. Steven G. Krantz |
| 11:10 a.m. - 11:40 a.m. | AMS BUSINESS MEETING |
| 11:45 a.m. - 12:15 p.m. | MAA BUSINESS MEETING |
| 1:00 p.m. - 1:50 p.m. | NAM CLAYTOR-WOODARD LECTURE Speaker and title to be announced. |
| 1:00 p.m. - 5:50 p.m. | AMS-MAA-SIAM SPECIAL SESSION ON RESEARCH IN MATHEMATICS BY UNDERGRADUATES, III |
| 1:00 p.m. - 5:50 p.m. | AMS-MAA SPECIAL SESSIONS History of Mathematics, III |

SATURDAY, JANUARY8 (Cont d)

|  | AMS-SIAM SPECIAL SESSIONS |
| :---: | :---: |
| 1:00 p.m. - 5:50 p.m. | Nonsmooth Analysis in Variational and Imaging Problems, III |
| 1:00 p.m. - 5:50 p.m. | Analysis and Applications in Nonlinear Partial Differential Equations, II |
| 1:00 p.m. - 5:50 p.m. | Integrable Systems and Special functions, III |
|  | AMS SPECIAL SESSIONS |
| 1:00 p.m. - 5:50 p.m. | Dynamics of Mapping Class Groups on Moduli Spaces, II |
| 1:00 p.m. - 5:50 p.m. | Inverse Spectral Geometry, III |
| 1:00 p.m. - 5:50 p.m. | Complex and Functional Analysis, II |
| 1:00 p.m. - 5:50 p.m. | Arithmetic Algebraic Geometry, II |
| 1:00 p.m. - 5:50 p.m. | Algorithmic Algebraic and Analytic Geometry, III |
| 1:00 p.m. - 5:50 p.m. | Modular Representation Theory of Finite and Algebraic Groups, III |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#11: PART B Fair enough? Mathematics of equity. |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#13: PART B Origami in undergraduate mathematics courses. |
| 1:00 p.m. - 3:00 p.m. | MAA MINICOURSE \#5: PART B Hands-on discrete mathematics with technology. |
|  | MAA CONTRIBUTED PAPER SESSIONS |
| 1:00 p.m. - 5:30 p.m. | Mathematical Experiences for Students Outside the Classroom |
| 1:00 p.m. - 5:30 p.m. | Research on the Teaching and Learning of Undergraduate Mathematics |
| 1:00 p.m. - 5:30 p.m. | In-Service Training Programs For K-12 Mathematics Teachers |
| 1:00 p.m. - 5:30 p.m. | MAA GENERAL CONTRIBUTED PAPER SESSION, VIII |
| 1:00 p.m. - 3:00 p.m. | MAA INVITED PAPER SESSION ON SYMMETRY IN ANALYSIS |
| 1:00 p.m. - 2:20 p.m. | MAA SPECIAL PRESENTATION First-semester calculus: Meeting the needs of our students. |
| 1:00 p.m. - 3:00 p.m. | MAA PANEL DISCUSSION Using mathematically rich activities to develop K-12 curricula, part II. |
| 1:00 p.m. - 2:20 p.m. | MAA CUPM SUBCOMMITTEE ON CURRICULUM RENEWAL ACROSS THE FIRST TWO YEARS PANEL DISCUSSION Faculty development for adjuncts and new faculty. |
| 1:00 p.m. - 5:55 p.m. | AMS SESSION FOR CONTRIBUTED PAPERS |
| 2:30 p.m. - 3:50 p.m. | MAA COMMITTEE ON MATHEMATICS AND THE ENVIRONMENT PANEL DISCUSSION Mathematical outreach and the environment. |
| 2:30 p.m. - 3:50 p.m. | MAA CUPM SUBCOMMITTEE ON CURRICULUM RENEWAL ACROSS THE FIRST TWO YEARS (CRAFTY) PANEL DISCUSSION Open discussion on refocusing the courses before calculus. |
| 3:15 p.m. - 5:15 p.m. | MAA MINICOURSE \#6: PART B Webwork, an internet-based system for generating and delivering homework problems to students. |
| 3:15 p.m. - 5:10 p.m. | MAA INVITED PAPER SESSION ON WORLDS OF INTERACTIVE MATHEMATICS, PART II: THE LEGACY OF JAMES E. WHITE |
| 5:00 p.m. - 6:00 p.m. | NOTICES TENTH ANNIVERSARY RECEPTION |
| 6:30 p.m. - 7:30 p.m. | AMS BANQUET RECEPTION |
| 7:30 p.m. - 10:30 p.m. | AMS BANQUET |

# Meetings and Conferences of the AMS 

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The Meetings and Conferences section of the Notices gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. Information in this issue may be dated. Up-to-date meeting and conference information can be found at www. ams.org/meetings/.

## Meetings:

2004
October 16-17 Nashville, Tennessee p. 1127
October 16-17
October 23-24
November 6-7

2005
January 5-8
March 18-19
April 2-3
April 8-10
April 16-17
June 16-19
October 8-9

October 15-16
October 21-22
November 12-13
December 14-18

2006
January 12-15

Albuquerque, New Mexico
Evanston, Illinois
p. 1128
p. 1128

Pittsburgh, Pennsylvania
p. 1129

April 22-23
April 29-30
2007
January 4-7
2008
January 6-9
2009
January 7-10
2010
January 6-9
2011
January 3-8

Durham, New Hampshire
p. 1158

San Francisco, California
p. 1159

New Orleans, Louisiana
p. 1159

Annual Meeting
San Diego, California
Annual Meeting
Washington, DC
p. 1159

Annual Meeting
San Franciso, California p. 1160
Annual Meeting
New Orleans, Louisiana
p. 1160

## Important Information regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 84 in the January 2004 issue of the Notices for general information regarding participation in AMS meetings and conferences.


#### Abstract

s Several options are available for speakers submitting abstracts, including an easy-to-use interactive Web form. No knowledge of $L^{2} T_{E} \mathrm{X}$ is necessary to submit an electronic form, although those who use $I^{A} T E_{E} \mathrm{X}$ may submit abstracts with such coding, and all math displays and similarily coded material (such as accent marks in text) must be typeset in $L^{A} T E^{2}$. To see descriptions of the forms available, visit http:// www.ams.org/abstracts/instructions.html, or send mail to abs-submit@ams.org, typing help as the subject line; descriptions and instructions on how to get the template of your choice will be e-mailed to you.

Completed email abstracts should be sent to abs-submit@ ams.org, typing submission as the subject line. Questions about abstracts may be sent to abs-info@ams.org.



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Nonmathematician guest badge name $\qquad$

## Registration Fees

Joint Meetings
$\square$ Member AMS, ASL, CMS, MAA, SIAM

- Nonmember
$\square$ Graduate Student
- Undergraduate Student
- High School Student
- Unemployed
- Temporarily Employed
$\square$ Developing Countries Special Rate
- Emeritus Member of AMS or MAA
- High School Teacher
- Librarian
$\square$ Nonmathematician Guest
AMS Short Course: The Radon Transform
and Applications to Inverse Problems (1/3-1/4)

| $\square$ Member of AMS or MAA | $\$ 85$ | $\$ 115$ |
| :--- | :--- | :--- |
| $\square$ Nonmember | $\$ 108$ | $\$ 140$ |

$\square$ Student, Unemployed, Emeritus
by Dec 10 at mtg Subtotal $\begin{array}{ll}\text { Dec } 10 & \text { at } \mathbf{~ m t} \\ \$ 199 & \$ 259\end{array}$ $\begin{array}{ll}\$ 199 & \$ 259 \\ \$ 308 & \$ 401\end{array}$
\$ $39 \quad \$ 49$
21 \$ 27
\$ 2 \$ 5
$39 \quad \$ 49$
\$158 \$181
\$ 39 \$ 49
$39 \quad \$ 49$
\$ 39 \$ 49
\$ 39 \$ 49
\$ 10
\$ 10
\$ $\qquad$

## Payment

Registration \& Event Total (total from column on left)
Hotel Deposit (only if paying by check)

Total Amount To Be Paid
$\qquad$
\$ $\qquad$
(Note: A $\$ 5$ processing fee will be charged for each returned check or invalid credit card. Debit cards are not accepted.)

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$\square$ Purchase order \#
(please enclose copy)
MAA Short Course: Seven Lectures on Random Graphs (1/3-1/4)

| $\square$ Member of MAA or AMS | $\$ 125$ | $\$ 140$ |
| :--- | :--- | :--- |
| $\square$ Nonmember | $\$ 175$ | $\$ 190$ |
| $\square$ Student, Unemployed, Emeritus | $\$ 50$ | $\$ 60$ |

\$ $\qquad$

## Other Information

Mathematical Reviews field of interest \#
How did you hear about this meeting? Check one: $\square$ Colleague(s) $\square$ Notices - Focus

- Internet

MAA Minicourses (see listing in text)
I would like to attend: $\square$ One Minicourse $\square$ Two Minicourses Please enroll me in MAA Minicourse(s) $\qquad$ and/or \# In order of preference, my alternatives are: \# $\qquad$ and/or \# $\qquad$
Prices: \$95 for Minicourses \#1-6; \$60 for \#7-12, \#14-16; \$70 for \#13
$\square$ This is my first Joint Mathematics Meeting.

- I am a mathematics department chair.
- For planning purposes for the MAA Two-year College Reception, please check if you are a faculty member at a two-year college.
$\square$ Please do not include my name on any promotional mailing list.
$\square$ Please $\checkmark$ this box if you have a disability requiring special services.


## Mail to:

## Mathematics Meetings Service Bureau (MMSB)

P. O. Box 6887

Providence, RI 02940-6887 Fax: 401-455-4004
Questions/changes call: 401-455-4143 or 1-800-321-4267 $\times 4143$; mmsb@ams.org

## Deadlines Please register by the following dates for:

Résumés/job descriptions printed in the Winter Lists
To be eligible for the room lottery:
For housing reservations, badges/programs mailed:
For housing changes/cancellations through MMSB:
For advance registration for the Joint Meetings, Employment
Center, Short Courses, MAA Minicourses, \& Tickets: Dec. 10, 2004
For $50 \%$ refund on banquets, cancel by:
For $50 \%$ refund on advance registration, Minicourses \&
Short Courses, cancel by:
*no refunds after this date

Dec. 27, 2004*

Dec.31, 2004*
Oct. 25, 2004
Oct. 29, 2004
Nov. 5, 2004
Dec. 3, 2004

Registration for the Joint Meetings is not required for the Short Courses, but it is required for the Minicourses and the Employment Center

## Other Events

$\square$ Graduate Student Reception (1/5) (no charge)

- AMS Workshop TA Development Using Case Studies \$ 20 \$ $\qquad$


## Atlanta Joint Meetings Hotel Reservations

To ensure accurate assignments, please rank hotels in order of preference by writing $1,2,3$, etc., in the column on the left and by circling the requested room type and rate. If the rate or the hotel requested is no longer available, you will be assigned a room at a ranked or unranked hotel at a comparable rate. Participants are urged to call the hotels directly for details on suite configurations, sizes, and availability; however, suite reservations can be made only through the MMSB to receive the convention rates listed. Reservations at the following hotels must be made through the MMSB to receive the convention rates listed. Guarantee requirements: First night deposit by check (add to payment on reverse of form) or a credit card guarantee.
$\square$ Hold with my credit card Card Number
Exp. Date

## Child (give age(s)


If you are not making a reservation, please check off one of the following:

- I plan to make a reservation at a later date.
- I will be making my own reservations at a hotel not listed. Name of hotel:
I I live in the area or will be staying privately with family or friends.
I I plan to share a room with.
Signature
Date and Time of Departure
Departure Date
Arrival Date
- I have disabilities as defined by the ADA that require a sleeping room that is accessible to the physically challenged. My needs are:
$\square$ Other requests:
- I am a member of a hotel frequent-travel club and would like to receive appropriate credit.
The hotel chain and card number are:



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## SPRINGER FOR MATHEMATICS



## ARNOLD'S PROBLEMS

VLADIMIR I. ARNOLD, Steklov
Math institute, Moscow, Russia and CEREMADE, Paris University, France (ed.)

This book contains mathematical problems, which have been brought up by Vladimir Arnold in his famous seminar at Moscow State University over several decades. In addition, there are problems published in his numerous papers and books. The invariable peculiarity of these problems was that mathematics was considered not as a game with deductive reasonings and symbols, but as a part of natural science (especially of physics), i.e. as an experimental science. Many of these problems are at the frontier of research still today and are still open, and even those that are mainly solved keep stimulating new research appearing every year in journals all over the world.
The second part of the book is a collection of comments of mostly Arnold's former students about the current progress in the problems' solution (featuring bibliography inspired by them). It will be of great interest to researchers and graduate students in mathematics and mathematical physics. 2004/639 PP./HARDCOVER/\$114.00
ISBN 3 540-206140

## INTRODUCTION TO THE MATHEMATICS OF FINANCE

From Risk Management to Options Pricing steven roman, California State University, Fullerton, CA
The Mathematics of Finance has become a hot topic ever since the discovery of the Black-Scholes option pricing formulas in 1973. Unfortunately, there are very few undergraduate textbooks in this area. This book is specifically written for advanced undergraduate or beginning graduate students in mathematics, finance or economics. With the exception of an optional chapter on the Capital Asset Pricing Model, the book concentrates on discrete derivative pricing models, culminating in a careful and complete derivation of the Black-Scholes option pricing formulas as a limiting case of the Cox-Ross-Rubinstein discrete model. The final chapter is devoted to American options.
The mathematics is not watered down but is appropriate for the intended audience. No measure theory is used and only a small amount of linear algebra is required. All necessary probability theory is developed throughout the book on a "need-to-know" basis. No background in finance is required, since the book also contains a chapter on options. 2004/360 PP., 55 ILLUS./HARDCOVER/\$79.95 ISBN 0.387-21375-9 UNDERGRADUATE TEXTS IN MATHEMATICS

ALSO IN SOFTCOVER:
\$49.95/ISEN 0-387-213643

## SELECTED PAPERS

On the Classification of Varieties and Moduli Spaces
DAVID MUMFORD, Brown University, Providence, RI
David Mumford is a well-known American mathematician known for distinguished work in algebraic geometry, and then for research into vision and pattern theory. He is a Fields Medallist and currently a professor at Brown University, having previously had a long academic career at Harvard University. These 30 articles span the years from 1961-1980 while Mumford was an active researcher in algebraic geometry. In addition, each of the three sections is introduced with never before published commentary by David Gieseker, Eckart Viehweg, and George Kempf and Herbert Lange.
2004/APPROX 796 PP./CLOTH BOUND/\$99.00 ISBN 0.387.21092-x

## CREDITRISK+ IN THE BANKING INDUSTRY

MATTHIAS GUNDLACH, Aareal Bank AG, Wiesbaden; and FRANK LEHRBASS, Dt. GenossenschaftsHypothekenbank AG, Hamburg, both, Germany (eds.) CreditRisk+ is an important and widely implemented default-mode model of portfolio credit risk, based on a methodology borrowed from actuarial mathematics. This book giyes an account of the status quo as well as of new and recent developments of the credit risk model CreditRisk + , which is widely used in the banking industry. It gives an introduction to the model itself and to its ability to describe, manage and price credit risk. The book is intended for an audience of practitioners in banking and finance, as well as for graduate students and researchers in the field of financial mathematics and banking. It contains carefully refereed contributions from experts in the field, selected for mutual consistency and edited for homogeneity of style, notation, etc. The discussion ranges from computational methods and extensions for special forms of credit business to statistical calibrations and practical implementations. This unique and timely book constitutes an indispensable tool for both practitioners and academics working in the evaluation of credit risk.
2004/369 PP./HARDCOVER/\$89.95/ISBN 3-540-20738-4 SpRinger finance

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## MAKING TRANSCENDENCE TRANSPARENT

An Intuitive Approach to Classical Transcendental Number Theory EDWARD B. BURGER, Williams College, Williamstown, MA; and ROBERT TUBBS, University of
Colorado at Boulder, CO
Making Transcendence Transparent provides the reader with an understanding of the basic principles and tools of transcendence theory and an intuitive framework within which the major results can be appreciated and their proofs can be understood. The book includes big picture overviews of the over-arching ideas, and general points of attack in particular arguments, so the reader will enjoy and appreciate the panoramic view of transcendence.
2004/APPROX 262 PP., 4 ILLUS./HARDCOVER/\$39.95 ISBN 0.387-21444-5

## AN OPTIMIZATION PRIMER

On Models, Algorithms, and Duality JOHN L. NAZARETH, Washington State University, Pulliman, WA
Optimization is the task of finding the best member of a finite or infinite set of possible choices, based on some objective measure of the merit of each choice in the set. This book provides a very gentle introduction to modeling, algorithms and duality and should appeal to several audiences at once: students (as a supplement to a regular textbook), general readers such as people in business (as an introduction to how optimization affects their everyday lives), and instructors (as a source of ideas for how to teach optimization differently).
2004/APPROX 114 PP., 28 ILLUS./SOFTCOVER/\$29.95 ISBN 0.387-21155-1

## THEORY AND PRACTICE OF FINITE ELEMENTS

ALEXANDRE ERN, CERMICS, ENPG, MarnelaVallee; and JEAN-LUC GUERMOND, LIMSI, CNRS, Orsey, both, France
This book presents the mathematical theory of finite elements, starting from basic results on approximation theory and finite element interpolation and building up to more recent research topics, such as Discontinuous Galerkin, subgrid viscosity stabilization, and a posteriori error estimation. Written at the graduate level, the text contains numerous examples and exercises and is intended to serve as a graduate textbook.
2004/524 PP., 89 ILLUS./HARDCOVER/\$79.95 ISBN 0-387-205748 APPUED MATHEMATICAL SCIENCES, VOL. 159

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[^0]:    Lenore Blum is Distinguished Career Professor of Computer Science at Carnegie Mellon University. Her email address is 1blum@cs.cmu.edu.
    This article is based on the AWM Noether Lecture given by Lenore Blum at the Joint Mathematics Meetings in San Diego, January 2001.

[^1]:    Supported in part by NSF grant \# CCR-0122581. The author is grateful to the Toyota Technological Institute at Chicago for the gift of space-time to write this article.

[^2]:    ${ }^{1}$ A main proviso is that integers are not coded in unary. ${ }^{2}$ I am rephrasing their result. The usual statement is: SAT is NP-complete.

[^3]:    ${ }^{6}$ Although Turing states in this paper that "a development of the theory of functions of a real variable expressed in terms of computable numbers" would be forthcoming, I am not aware of any further such development by him in this direction.
    ${ }^{7}$ By Fermat, the only rational points on the curve are $(0,1)$ and $(1,0)$.

[^4]:    ${ }^{8}$ By Brownawell and Kollar, we only need check the case $D=d^{n}$, which by Masser and Philippon is optimal. (See [Yger01] for discussion and [KPSO1] for refinements.)

[^5]:    ${ }^{9}$ Emphasis mine.

[^6]:    ${ }^{11}$ It should be clear what formal definitions we are supposing here. The proof requires a construction.

[^7]:    ${ }^{12}$ The Traveling Salesman Problem (TSP) is generally stated as a search problem: Find the shortest (cheapest) path traversing all nodes. To view TSP as a decision problem, we introduce bounds: Given kis there a path of length (cost) at most $k$ traversing all nodes?
    ${ }^{13}$ Toward this goal, a sequence of five papers by Mike Shub and Steve Smale on the related Bezout's Theorem presents a comprehensive analysis of the complexity of solving polynomial systems approximately and probabilistically.

[^8]:    ${ }^{14}$ Emphasis mine.

[^9]:    ${ }^{16}$ The third equation is the second plus . 01 times the first.
    ${ }^{17}$ Emphasis mine.
    ${ }^{18} \log ^{+} x=\log x$ for $x \geq 1$, otherwise $\log ^{+} x=0$.

[^10]:    ${ }^{20}$ By giving the simplest results here, I am hardly doing justice to the full extent of Renegar's and others' work in this area but hope this discussion will spur the reader to investigate this area more fully.
    ${ }^{21}$ Recall that in each case, i.e., over $\mathbb{R}$ and in the bit model, complexity is a function of input word size. However, over $\mathbb{R}$, the input size for a rational linear program is the vector length of the input (approximately $m \times n$ ), whereas in the bit model it is the bit length (approximatelym $\times n \times k$, where $k$ is the maximum height of the coefficients).
    ${ }^{22}$ For more on probabilistic algorithms and probabilistic analysis see [BCSS98]. For more results on complexity estimates depending on condition and round-off error, see [CS98].

[^11]:    Allyn Jackson is senior writer and deputy editor of the Notices. Her email address is axj@ams.org.

[^12]:    Luc Illusie is professor of mathematics at the Université Paris-Sud. His email address is luc.illusie@math. u-psud.fr. The author wishes to thank P. Deligne, O. Gabber, A. Jackson, G. Laumon, W. Messing, A. Ogus, and M. Raynaud for their help in the preparation of this column.

[^13]:    David Lindsay Roberts is an independent scholar specializing in the history of mathematics education. His email address is Robertsd1@ao1.com.

[^14]:    * Only one Associate Secretary at a time is a voting member of the Council, namely the cognizant Associate Secretary for the scientific sessions.

[^15]:    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.
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    Upcoming deadlines for classified advertising are as follows: November 2004 issue-August 27, 2004; December 2004 issue-September 28, 2004;

