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Sheng Gong, Academia Sinica, Beijing, People's Republic of China

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In 1989, Professor Gong wrote and published a short book in Chinese, The Bieberbach Conjecture, outlining the history of the related problems and de Branges' proof. The present volume is the English translation of that Chinese edition with modifications by the author. In particular, he includes results related to several complex variables. Open problems and a large number of new mathematical results motivated by the Bieberbach conjecture are included.

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*Michel Raynaud*

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**From Schwarz to Pick to Ahlfors and Beyond**

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**To Teach, per Chance, to Dream**

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Frank Nelson Cole (1861-1926) was secretary of the AMS and editor-in-chief of the Bulletin for more than twenty years. In his honor the AMS Cole Prize is awarded twice every five years—once in algebra and once in number theory. The most recent recipients are Michel Raynaud and David Harbater (in algebra in 1995) and Andrew Wiles (in number theory in 1997). In the November 1997 Notices one reads, "The original [Cole Prize] fund was donated by Professor Cole from moneys presented to him on his retirement, was augmented by contributions from members of the Society, and was later doubled by his son."

Some information about Cole may be found in a book on the history of the first fifty years of the AMS, written by Raymond Clare Archibald. Archibald writes, "After two years under Klein at Leipzig, Cole spent the next three years at Harvard, where his career as an undergraduate had been so brilliant. Aglow with enthusiasm, he gave courses in modern higher algebra, and in the theory of functions of a complex variable, geometrically treated, as in Klein's famous course of lectures at Leipzig in 1881-82. He was the first to open up modern mathematics to Prof. Osgood, a student, who characterized the lectures as 'truly inspiring.' Another student, M. Böcher, as well as nearly all members of the Department, attended his lectures. He received the doctor's degree from Harvard."

Thomas S. Fiske, founder of the AMS, took on the combined roles of the first secretary of the AMS and founding editor of the Bulletin. Archibald writes, "[Cole] was appointed prof. of math. at Columbia U. and Barnard C. in 1895, and immediately relieved Fiske of his burden as secretary of the Society; two years later he became an associate editor of the Bulletin. In the following spring Fiske was appointed chm. of a committee, whose recommendations later led to the founding of the Transactions. Work on this committee demanded so much of his time and thought, that he resigned as editor-in-chief of the Bulletin, and Cole assumed this office in Feb. 1899 and continued as both secretary and editor to the end of 1920."

"Cole's twenty-two years of joint service as secretary of the Society and editor-in-chief of the Bulletin began just as the decision had been made to publish the Transactions, twenty-one volumes of which were issued during his tenure, and added not a little to the load that he carried as secretary....Except for changes which would naturally result from [thirty years of increasing mathematical activity], the general style of the Bulletin was simply a continuation of the features so thoughtfully developed by Prof. Fiske. Cole (as Fiske before him) suppressed any reference to himself as editor-in-chief, and put in one group the names of assistant editors and members of the committee of publication...."Beginning with 1921, a period of many changes was initiated. The tremendous load carried by Cole was...divided between Prof. Richardson, the new secretary, and Prof. Hedrick, the new editor-in-chief of the Bulletin...."

"The frontispiece of the AMS Bulletin, v. 27 (1920-21) is an excellent likeness of Cole at that time, and the Council ordered that the v. be dedicated to him, 'in appreciation of his devotion to the Society during his twenty-six years as Secretary and in recognition of his leadership in the editorial work of the Bulletin for the past twenty-four years.'"
Rochester Four Years Later: From Crisis to Opportunity

Douglas C. Ravenel

The events that took place at the University of Rochester in 1995-96 are known to many of the readers of the Notices. In November 1995 the university announced its Renaissance Plan, a comprehensive strategy to cut costs while improving the quality of undergraduate education. Most alarmingly to the mathematics community, the cost cutting measures included reducing the size of the permanent faculty in mathematics by more than half and the elimination of its graduate program.

The events of the ensuing four months are now referred to in Rochester as “the war” or “the crisis”. Nearly two hundred letters of protest were sent to the administration by mathematicians, scientists, and alumni. The AMS was most helpful in rallying this support. They surmised that if Rochester could eliminate its graduate mathematics program, several other universities would follow suit in short order. Articles about the controversy appeared in the Notices, the New York Times, Science, the Chronicle of Higher Education, and eventually the Encyclopedia Britannica. The matter had become a cause célèbre in the scientific community.

Meanwhile senior members of the department conferred with senior administrators and with the heads of various departments in science and engineering. The end result of these conversations was a decision by the university at the end of March 1996 to reinstate the graduate program (albeit on a smaller scale than before) and to plan on less severe long-term cuts in the size of the faculty. In the midst of all this confusion, I was asked to take over as department chair.

In this article I will address the following questions:
• Why was mathematics the subject of such severe cuts?
• What has the Rochester mathematics department done since then to improve its position in the university?
• What can other mathematics departments learn from these events?

Why Were Cuts Planned for Mathematics at Rochester?

The answer to the first question is rooted in patterns of behavior common in mathematics departments today, namely:
• We were doing a reasonably good job at undergraduate teaching, but we made no effort to convey this fact to anyone outside the department. (In this article “we” will always refer to mathematics faculty at Rochester.) As a result, we were blamed for the mathematical shortcomings of science and engineering majors. The mathematical preparation of incoming students had been gradually declining for many years, but the expectations of other departments were not declining with them. We were caught in the middle of a widening gap between the amount of mathematics that incoming freshmen knew and what sophomores were expected to know.
• We had little interest in or understanding of university affairs. Like most mathematicians, we were apolitical, if not antipolitical. We regarded administrators as adversaries rather than as partners. We regarded ourselves as a friendly, enlightened group surrounded by ignorance and hostility. Few of us had any contacts or friends outside the department.
• These traits are probably familiar to many readers. They add up to a department that is perceived as insular and detached from the institution that supports it and one that is therefore vulnerable in times of financial stress.

Mathematics departments need to communicate effectively with their administration, with faculty in other departments, with their students, and with the outside world. However, it is common for academic mathematicians not to regard this as part of their job description. The best
calculus teaching in the world can go unnoticed if no effort is made to let the rest of the university know what is being done. Deans are not telepathic, and if a department is doing something good, they need to be told about it. A good mathematics program can be a source of pride to any school, and giving the administration something to brag about is always a good idea. A calculus program that is perceived as friendly is a great asset.

The Importance of Good Calculus Instruction

Inevitably the bulk of any mathematics department's interaction with the rest of the school is through calculus. Huge numbers of students take it, and for them the stakes are very high. Anyone with career aspirations in science, engineering, or medicine must do well in calculus. A poor showing can be a major setback, if not a career crisis. This central fact of undergraduate life should be understood by all concerned: by the faculty and teaching assistants in the mathematics department, by faculty in neighboring departments, by the administration, and by the school's academic support apparatus. If university officials do not understand the importance of good calculus instruction, it is the mathematics department's responsibility to educate them about it.

Here are two examples of how this understanding has played out at Rochester recently.

- In 1996 we persuaded the university to include a mathematics placement exam in the orientation program for entering freshmen, 70 percent of whom take calculus. We said that it was better for a student to have a bad summer afternoon caused by an exam than to have a bad semester caused by being in the wrong course.
- In 1997 we argued successfully for some new temporary faculty positions on the grounds that without them we would have to double the size of many calculus classes. The dean, knowing that for many students calculus is the most challenging course, did not want to add to their stress by depersonalizing the classroom.

The Conflict with Engineering

Like many mathematics departments, we had a conflict with some of our engineering faculty about how mathematics should be taught, and for a few years they were teaching courses in direct competition with ours. We have since solved this problem, but similar difficulties remain elsewhere.

Mathematicians and engineers may disagree over what topics should be covered, how much theory should be stressed, and how technology should be used in the classroom. Dialogue is essential for dealing with each of these topics. In some but not all cases much of the conflict can be relieved by a straightforward exchange of views. The mathematicians need to know what the engineers want and why. The engineers need to have realistic expectations about how much can be taught in the time allotted.

In any case, it is the responsibility of the mathematicians to be at least as knowledgeable as the engineers about all relevant educational questions. In particular, the former must be familiar with any technological issues that are on the table. Ignorance of or unwillingness to master software is not a sound pedagogical argument against using it.

The Rochester Mathematics Department Today

Our situation now is much improved over 1995. A crisis is characterized by both danger and opportunity, and we have had plenty of the latter. We have gone from being nearly invisible within the university to being a high-profile department. We are well represented in the university's legislative bodies. We publish an annual newsletter. We run seminars that are well attended by faculty from other departments. Overall enrollment in our courses has increased despite a planned reduction in the size of the student body. Two of our faculty (Michael Gage and Steven Gonek) have won generously endowed university-wide teaching awards, and the department itself was given a substantial prize for the improvements in our calculus program. These include the following:

- In anticipation of attracting better students through an improved recruiting strategy, the university has encouraged departments to develop a series of challenging courses for highly motivated freshmen. Nearly a third of all enrollments in such courses are in mathematics. The number of students in our honors sequence (possibly the most challenging freshman/sophomore-level course in the entire university) has doubled.
- In these courses traditional recitations have been replaced by two-hour calculus workshops. Here students work together on assignments in small groups, guided by a teaching assistant trained to facilitate their active participation. Student response to the workshops has been so positive that we are extending them to other courses.
- In the months after the crisis ended we met individually with every department having a mathematics requirement for its major and discussed the mathematical needs of their students. These meetings were extremely useful. They resulted in the strengthening of the mathematics requirement for computer science and led to the development of a new sophomore-level course on linear algebra and differential equations. More importantly, we made it clear that we were interested in helping other programs succeed and that their faculty could come to us with mathematics-related problems. Good will is an invaluable asset.
- Before 1996 it was impossible for us to grade calculus homework, and this was a major weakness of our program. We have developed a software package called WeBWorK that delivers and grades homework through the Internet. It is now being used by 700 students, and homework counts for a substantial portion of every calculus grade. WeBWorK was written by two of our faculty, Michael Gage and Arnold Pizer. For a hands-on demonstration of it, see http://webwork.math.rochester.edu/
input and is smart enough to know when a student's answer is mathematically equivalent to the correct one. It tells the student immediately if the answer is correct (no hints are given for wrong answers) and allows any number of retries, up to a deadline. This immediate feedback is a good motivator. Roughly half of all students using WeBWorK eventually get every single homework problem right for the whole semester.

What Does It Mean to Be the Queen of the Sciences?

Every mathematics department needs to have a clear vision of its role in its university. Mathematics professors are not merely researchers reluctantly teaching on the side in order to pick up a paycheck. Mathematics is a tool used in essential ways by many disciplines, and a university where it is not done well cannot succeed. This means that mathematicians in academia have both special privileges and special responsibilities. This vision needs to be shared within the department (it is not enough for just the chair to have it), and it needs to be communicated to faculty and administrators outside the department.

The central role of mathematics in science, engineering, and technology gives each mathematics department the opportunity to be a linchpin in the mission of its college or university. Too often, as in the case of Rochester before 1996, this role has been abdicated by mathematics professors. They tend to be too wrapped up in their research to care about their institution.

The Renaissance Plan at Rochester was formulated as a strategy for improving the quality of undergraduate education, because our administration reached a clear understanding of the importance that undergraduate education holds for the future of the institution. Ultimately it is the undergraduates who pay most of the bills. Surely Rochester is not unique in this respect. Most universities are under increasing financial pressure and can no longer afford to shortchange their students, as many have done in the past. Mathematicians in research universities may be accustomed to administrations that pay lip service to good teaching while rewarding only good research, but this folly is unlikely to continue forever.

It is likely that many schools will pay more attention to their undergraduate programs in the future, and mathematics departments should see this as the great opportunity that it is. Their role in this enterprise is indispensable, and they can use it to great advantage. A politically savvy department chair can parlay the intellectual centrality of mathematics into an influential role for mathematics in university affairs. It is a pleasant surprise to see how much this effort has been welcomed at Rochester.

Every mathematics department can become a major player in its university by interacting effectively with faculty and other officials outside the confines of its own building. Too many mathematicians dismiss this effort as a waste of time. It most certainly is not.

News Flash

Proof Announced of Taniyama-Shimura-Weil Conjecture

At the opening lecture June 21 of the Institute for Advanced Study/Park City Mathematics Institute (PCMI) on arithmetic algebraic geometry, Kenneth Ribet of the University of California at Berkeley stunned his audience when he mentioned in passing that all elliptic curves over the rationals are known to be modular. The modularity of such elliptic curves is the celebrated Taniyama-Shimura-Weil Conjecture. Ribet was saying that the conjecture was now a theorem!

When quizzed about his comment after the lecture, Ribet explained that the result had been announced several weeks earlier by Christophe Breuil, Brian Conrad, Fred Diamond, and Richard Taylor. Ribet had learned of this announcement in an e-mail message; he imagined incorrectly that the news had already reached most members of the audience.

As it happened, Brian Conrad was a co-organizer of the research program of the PCMI. Conrad gave two one-hour lectures on the result during the conference, focusing on the new ingredients needed to treat those cases of the conjecture that were not covered by previous work.

Following work of G. Frey, Y. Hellegouarch, B. Mazur, and J.-P. Serre, Ribet proved in 1986 that the Taniyama-Shimura-Weil Conjecture implies Fermat's Last Theorem. Andrew Wiles, partly in collaboration with Richard Taylor, then proved Fermat's Last Theorem in 1994 by establishing the Taniyama-Shimura-Weil Conjecture for all elliptic curves with square-free conductor—this was sufficient because elliptic curves arising from prospective counterexamples to Fermat's Last Theorem have square-free conductor. Ribet wrote for the Notices about the Wiles approach in a July/August 1993 article.

Until recently the best result in the direction of the full Taniyama-Shimura-Weil Conjecture was a proof when the conductor is not divisible by 27. This result is due to Conrad, Diamond, and Taylor and appears in a 1999 article in the Journal of the American Mathematical Society (vol. 12, pp. 521-567).

The validity of the Taniyama-Shimura-Weil Conjecture provides further evidence for the "Langlands program", a far-reaching web of conjectures due to Robert Langlands that relates congruences over finite fields to infinite-dimensional representation theory.

—Anthony W. Knapp
The goal of algebraic geometry is the study of solutions of polynomial equations with coefficients in a commutative field \( k \), or more generally a commutative ring. An "affine variety" is defined by equations \( f_i = 0 \) with \( i \) in some set \( I \) and \( f_i \) in \( k[X_1, \ldots, X_n] \); a "projective variety" is defined similarly by homogeneous equations \( f_i = 0 \), for \( i \in I \), in the projective space \( P^n \) with homogeneous coordinates \( X_0, \ldots, X_n \). According to a theorem of Hilbert one can limit oneself to finite families \( I \).

When \( k \) is the field of real numbers \( \mathbb{R} \) or that of the complex numbers \( \mathbb{C} \), the set of solutions inherits a topology from \( \mathbb{R} \) or \( \mathbb{C} \); this is compact in the projective case. For the needs of arithmetic, it is appropriate to consider the case where \( k = \mathbb{Q} \) or \( \mathbb{Z} \). By reduction modulo a prime number \( p \), one then obtains a variety over the finite field \( \mathbb{F}_p \). If \( X \) is an algebraic variety defined over a finite field \( k \) with \( q \) elements, \( X \) possesses a finite number of points \( v_n \) in the field \( k_n \), the extension of \( k \) of degree \( n \).

The knowledge of \( v_n \) is equivalent with the knowledge of the "zeta function" of \( X \), introduced by E. Artin [1]. In 1940, in a note in the Comptes Rendus de l'Académie des Sciences [11], André Weil announced the proof of an analog of the Riemann hypothesis for the zeta function of curves over finite fields. In a long letter to E. Artin dated July 1942 [15], Weil explained the principle of the argument.

Andre Weil's book Foundations of Algebraic Geometry was published by the AMS in 1946. The goal of this book is to establish algebraic geometry rigorously over an arbitrary commutative field and to insist quite particularly on an intersection theory. It marks a break with respect to the works of his predecessors—B. L. Van der Waerden [10] and the German school, O. Zariski and the Italian geometers. To signal this clearly, the book contains no bibliography. The emphasis is systematically put on fields: fields of definition of varieties, fields of rational functions. Fifteen years later, Grothendieck [3], in developing the language of schemes, would bring out the role of rings.
Weil fixes a **universal domain** \( K \), an algebraically closed field of infinite transcendence degree over the prime field. Let \( p \geq 0 \) be its characteristic. The points of algebraic varieties are going to have coordinates in \( K \). In what follows, \( k \) is a subfield of \( K \) such that \( K \) has infinite transcendence degree over \( k \).

For an integer \( n \geq 0 \), a point of the affine space \( S^n \) is an \( n \)-tuple \( x = (x_1, \ldots, x_n) \) of elements of \( k \). Let \( k(x) \) be the subfield of \( K \) generated by \( k \) and \( x \). Let \( f \) be the prime ideal in the ring of polynomials \( k[x_1, \ldots, x_n] \) formed from all \( F \) such that \( F(x_1, \ldots, x_n) = 0 \), so that \( k(x) \) is the field of fractions of the quotient integral domain \( R = k[x_1, \ldots, x_n]/f \). A point \( y = (y_1, \ldots, y_n) \) of \( S^n \) is a **specialization** of \( x \) if \( F(y_1, \ldots, y_n) = 0 \) for all \( F \) in \( f \). For example, if \( k = \mathbb{Q} \) and \( k = \mathbb{C} \) and \( x = (i, \pi) \), then \( I \) is the prime ideal \( (X^2 + 1) \) in \( \mathbb{Q}[X, Y] \), and the specializations of \( x \) are all points \((\pm i, y_2)\).

A **generic** point \( x \) of a variety \( V \) is defined as the point \( k(x) \) in a **regular** extension of \( k \); the points of \( V \) are the specializations \( y \) of \( x \). The condition of regularity is a technical condition that ensures that for every extension \( k' \) of \( k \), \( k(x) \otimes_k k' \) is still free of zero divisors.

In the example above, \( x = (i, \pi) \), is not generic since \( i \otimes 1 + 1 \otimes i \) is a zero divisor in \( \mathbb{Q}(i, \pi) \otimes \mathbb{Q}(i) \); this property corresponds to the fact that the set of specializations of \( x \) is reducible, being the union of all \((i, y_2)\) and all \((i, y_2)\). If we had chosen \( k = \mathbb{Q}(i) \), however, then the ideal \( I \) would have been \( (X^2 - i) \) and \( x \) would have been generic, defining a variety.

This said, the scene is set: Weil is occupied first on morphisms and a functorial point of view and would minimize the role of rational mappings. Weil introduced **abstract varieties**, defined by an atlas of affine charts, on the model of differentiable manifolds. He distinguished those that are "complete" (these correspond to compact varieties in the case where \( k = \mathbb{C} \)) by means of specializations and freed himself thereby from projective geometry. But it is only with M. Nagata [7] in 1958 and H. Hironaka [5] in 1962 that one would know that there exist complete varieties that are not projective.

We come to the heart of the book—intersection theory. Given two subvarieties \( A \) and \( B \) of a variety \( V \), one wants, under certain conditions, to define the intersection \( A \cap B \), which will be a cycle on the variety \( V \) with integer coefficients \( \geq 0 \). The difficulty consists in defining the coefficients of this cycle, that is to say, the **intersection multiplicities**.

Well begins by defining a "simple" point \( x \) of a variety \( V \). We note first that for polynomials, partial derivatives exist, given by the usual formulas, without reference to a topology on \( k \) and the notion of limit. Consequently, over an arbitrary field \( k \), one has available a purely algebraic differential calculus. One says that a point \( x \) of a variety \( V \) is **simple** (nowadays one says **smooth**) if locally \( V \) can be defined by \( m \) equations \( f_1 = \cdots = f_m = 0 \) that satisfy a Jacobian condition: the matrix \( (\partial f_i / \partial x_j)(x) \) is of rank \( m \) at \( x \). When \( V \) is smooth of dimension \( r \), embedded in an affine space \( S^n \), one constructs affine linear mappings of \( S^n \) into \( S^r \) such that the composition \( V - \phi \to S^r \) is "etale" at \( x \). These Weil calls **linearizations** of \( V \) at \( x \). If \( A \) and \( B \) are subvarieties of \( V \), of respective dimensions \( a \) and \( b \), there is no difficulty in defining the irreducible components of \( A \cap B \). Let \( C \) be one of them. One says that \( C \) is a **proper component** of \( A \cap B \). If a generic point of \( C \) is smooth in \( V \) and if \( C \) is of dimension \( a + b - r \), the goal is to define the multiplicity in the cycle \( A \cap B \) of a proper component \( C \) of the intersection of \( A \) and \( B \).

Well examines first the case where \( V \) is the affine space \( S^r \) and where \( B \) is a linear affine subvariety \( L \) of \( S^r \), of dimension \( r - a \). When \( L \) is generic, the intersection \( L \cap A \) is situated in the smooth locus of \( A \) and the intersection multiplicity is elementary to define as the length of a suitable Artinian ring. When \( L \) is no longer generic, Weil

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1. In terms of the integral domain \( R = k[x_1, \ldots, x_n] / f \), one is at the same time very close to the language of schemes, since each point \( y \) of \( V \) corresponds to a prime ideal of \( R \), and also very far; partly because the language of specializations masks the role of the ring \( R \) and partly because a prime ideal \( Q \) of \( R \) corresponds to several points—the different ways of embedding the zero divisor-free algebraic ring \( R / Q \) into \( K \)—therefore to infinitely many points as soon as \( R / Q \) is not algebraic over \( k \).

2. An etale mapping is the algebraic geometer's version of a local isomorphism in the complex analytic case.
reduces to the previous case by an argument of specialization of multiplicities. He treats in an analogous way the intersection of A with a linear subvariety of codimension \(\leq a\). Finally, the general case of a proper component C of \(A \cap B\) reduces to the previous case by using linearizations and an argument of reduction to the diagonal, due to Van der Waerden. The latter consists in realizing \(A \times B\) as the intersection of \(A \times V\) with the diagonal \(A \cap V\).

Let us not lose sight of the fact that these works are contemporaneous with those of C. Chevalley [2] developing the notion of multiplicity of a local Noetherian ring. Then would come the contributions of P. Samuel [8]. It is only in 1957 that J.-P. Serre [9] would give a local definition of intersection multiplicity as an alternating sum of lengths of certain "Tor" modules, making the argument of specialization unnecessary. Afterwards Weil presents the operations that one can make on cycles, in particular in the case of complete varieties.

In 1948 André Weil published *Courbes Algébriques et Variétés Abéliennes*. This magnificent book, clearly less austere than *Foundations*, rich in geometry and topological motivation, is a masterful illustration of the use of the theory of intersections.

The first part treats curves. Suppose that an algebraic curve \(X\) over \(k\), complete and smooth, has genus \(g\). As in the complex case, \(g\) is the dimension over \(k\) of the vector space of global algebraic differential 1-forms. After a study of divisors on \(X\) leading to the Riemann-Roch theorem comes the study of correspondences, already considered by the Italian geometers, in particular F. Severi. If \(X\) is a complete smooth curve of genus \(g\), a correspondence on \(X\) is given by a divisor \(D\) on \(X \times X\), modulo the equivalence relation generated by linear equivalence of divisors and by the divisors that come from \(X\) by one or the other of the two projections. These correspondences can be added and composed to form a ring with an involution \(D \rightarrow D'\) that exchanges the two factors of \(X \times X\). Intuitively a correspondence corresponds to a multivalued algebraic map of \(X\) into \(X\); if \(p\) and \(q\) denote the projections of \(D\) on the first and second factors \(X\), the correspondence associates to a point \(x\) of \(X\) the cycle on \(X\) equal to \(q(p^{-1}(x))\). Moreover, in the second part, Weil will show that this ring of correspondences is naturally identified with the ring of endomorphisms of the "Jacobian variety" of \(X\), the involution providing duality.

To a correspondence \(\xi\) represented by a divisor \(D\), Weil associates an integer \(\sigma(\xi)\) equal to the degree of the intersection \(D = (X \times A) + D = (b \times X) - D \cdot \Delta\) (where \(a\) and \(b\) are points of \(X\) and \(\Delta\) is the diagonal of \(X \times X\)). The integer \(\sigma(\xi)\) plays the role of a trace. More precisely, when \(X\) is defined over the complex numbers, the Lefschetz fixed-point formula shows that \(\sigma(\xi)\) is interpreted as the trace of the correspondence \(\xi\) operating on the cohomology in degree 1, say rational cohomology, of the topological variety associated to \(X\). The essential point is that \(\sigma(\xi') \geq 0\) and that \(\sigma(\xi') = 0\) if and only if \(\xi = 0\). Castelnuovo had proved this in the complex case. The reader can see in [6] a short proof, due to Grothendieck, tying Castelnuovo's result to the index theorem.

The preceding result is going to allow Weil to establish the "Riemann hypothesis" for the zeta function of curves over finite fields. Suppose that the curve \(X\) is defined over a finite field \(k\) with \(q\) elements, and let \(k_n\) be the unique extension of \(k\) of degree \(n\). Let \(v_n\) be the number of points of \(X\) with values in \(k_n\). The zeta function of \(X\),

\[
Z(T) = \prod_{x \in X} (1 - T^{\deg(x)})^{-1},
\]

is tied to \(v_n\) by the formula

\[
TZ' / Z = \sum_{n \geq 1} v_n T^n.
\]

This zeta function for curves over a finite field was introduced by E. Artin in his thesis [1] by analogy with the classical Riemann zeta function

\[
\zeta(s) = \sum_{n=1}^{\infty} n^{-s} = \prod_{p \text{ prime}} (1 - p^{-s})^{-1}.
\]

Suppose that \(X\) is smooth and complete. Use of the Riemann-Roch theorem permits one to rewrite \(Z(T)\), as Hasse and Schmidt [4] already observed, in the form

\[
Z(T) = P(T)/(1 - \alpha(T)),
\]

where

\[
P(T) = \prod_{i=1}^{2g} (1 - \alpha_i(T))
\]

is a polynomial of degree \(2g\) with integer coefficients such that if \(\alpha\) is the reciprocal of a root of \(P\), so is \(q/\alpha\).

The Riemann hypothesis in the case of curves over finite fields says that the complex numbers \(\alpha_i\) have modulus \(\sqrt{q}\). It was first proved by Hasse [4] in the case of elliptic curves (\(g = 1\)).

To treat the general case, Weil introduces the graph \(I_n\) of the \(n\)-th iterate of the Frobenius endomorphism of \(X\) and notes that it cuts \(\Delta\) transversally, from which he deduces that \(\sigma(I_n) = 1 + a^n - v_n\). Upon writing, for \(x\) and \(y\) integers, that the correspondence \(\xi\) defined by \(x\Delta + yI_n\) satisfies \(\sigma(\xi\Delta) \geq 0\), one finds that \(|\sigma(I_n)| = |1 + a^n - v_n| \leq 2gq^{1/2}\). Since

\[
d \log P(T)/dT = -\sum n \sigma(I_n) n! dT / T,
\]

Weil

\[3\text{In coordinates, the Frobenius endomorphism takes each coordinate to its }q\text{th power.} \]
concludes that the $\alpha_i$ are of modulus $\leq q^{1/2}$ and therefore, by symmetry, are of modulus $q^{1/2}$.

The second part of the book is devoted to Jacobian varieties of curves and to abelian varieties. This algebraic study, valid over an arbitrary field, requires approaches quite different from the transcendental methods used over the complex numbers.

Weil begins by defining a "group variety", and abelian varieties are complete group varieties. To construct group varieties, Weil introduces the notion of normal law on a variety $V$: it is a partially defined composition law satisfying certain conditions, a sort of "kernel of group variety". He shows that there exists a group variety $G$, unique up to isomorphism, and a birational mapping between $V$ and $G$, compatible with the composition laws. If now $X$ is a curve of genus $g$ with base point, the Riemann-Roch theorem furnishes a normal law on the $g$-fold symmetric product of $X$. The associated group variety is the Jacobian variety. Later, M. Rosenlicht would construct in the same way generalized Jacobian varieties, and A. Neron would use a relative version of normal laws to obtain his models of abelian varieties over a discrete valuation ring.

Every endomorphism $u$ of an abelian variety $A$ has a degree $\nu(u)$. If one takes $u$ to be multiplication in $A$ by an integer $n \geq 0$, one finds that the degree is $n^{2g}$. If $n$ is prime to the characteristic $p$, the kernel $A_n$ of multiplication by $n$ is a finite group isomorphic to $\mathbb{Z}/n\mathbb{Z}$. If one then chooses a prime number $\ell \neq p$, the projective system of the $A_{\ell^n}$, as $m$ varies, furnishes a free $\mathbb{Z}_\ell$ module $T_{\ell}(A)$, of rank $2g$. These $\ell$-adic modules, constructed starting from the torsion points of $A$, have become one of the basic tools in the arithmetic study of abelian varieties. They furnish $\ell$-adic representations of the Galois group $\text{Gal}(\overline{k}/k)$, and one has a faithful representation of the ring $\text{End} A$ on the ring of endomorphisms of the $\ell$-module $T_{\ell}(A)$. Finally, starting from an endomorphism $u$ of $A$, Weil defines its characteristic polynomial. Over the complex numbers, one can take the characteristic polynomial of the endomorphism induced by $u$ on the lattice of periods. In the general case, Weil shows, by intersection theory, that for $x$ and $y$ integers, $v(xId + yU)$ is a homogeneous polynomial $P$ of degree $2g$ with integer coefficients. He establishes that $P$ is equal also to the characteristic polynomial of $u$ in its $\ell$-adic representation; in particular, this last polynomial has integer coefficients, independent of the prime number $\ell \neq p$.

This study of curves and abelian varieties convinced Weil that algebraic varieties over finite fields could behave like topological varieties and that "Betti cohomology" was still playing a role. In the case of curves the interesting degree of cohomology is degree $1$; it corresponds to the numerator $P(T)$ of the zeta function. After having studied the zeta functions of monomial hypersurfaces of arbitrary dimension $d$, for which the interesting degree of cohomology is $d$, Weil was ready to formulate in 1949 his conjectures concerning smooth complete varieties over finite fields.

References

In his pivotal 1916 paper [P], Georg Pick begins somewhat provocatively with the phrase, “The so-called Schwarz Lemma says...”, followed by a reference to a 1912 paper of Carathéodory. Pursuing that lead, one finds a reference to the original source in the expanded notes from a lecture course at the Eidgenössische Polytechnische Schule in Zürich given by Hermann Amandus Schwarz during 1869-70 ([S], 108-132). The lecture notes start by stating the Riemann Mapping Theorem from Riemann's doctoral dissertation of 1851 and noting that Riemann's argument did not provide a fully rigorous proof. The goal of the lecture course is to provide the first complete proof for a general class of domains. The Riemann mapping theorem states that any simply connected plane domain other than the entire plane can be mapped one-to-one and conformally onto the interior of the unit circle. (The plane domains considered at the time appear to have been domains bounded by a simple closed curve.) The lecture notes prove the theorem for domains bounded by a closed convex curve.

Schwarz's proof is based on his earlier work on domains bounded by polygons and what is now known as the Schwarz-Christoffel formula. Schwarz's paper ([S], 65-83) appeared in 1869. In it he notes that back in 1863-64, when he attended a course by Weierstrass on the theory of analytic functions, he did not know of a single special case of a plane figure given in advance for which one could establish a conformal mapping onto the unit disk. He decides to start with the simplest case of a square. (It is in that context that he proves his famous “reflection principle” for analytic functions.) He goes on to give a general formula, noting that Christoffel developed it independently. He credits Weierstrass for filling in the details of showing that the arbitrary constants involved in the integral expression can be chosen to give the desired mapping for a polygon of any number of sides, whereas Schwarz himself had succeeded for just four sides.

Once in possession of a mapping for polygons, Schwarz proceeds to approximate an arbitrary convex domain by domains bounded by polygons and to show that the corresponding mappings converge to a limit mapping with the desired properties. This proof has long been forgotten, since the result was superseded by more general results, leading eventually to a proof of the full theorem. However, the first step in his argument for convex domains is precisely the statement and proof of an early version of what eventually became known as the “Schwarz Lemma”.

**Lemma 1 (The Schwarz Lemma).** Let \( f(z) \) be analytic on a disk \( D = \{ |z| < R_1 \} \), and suppose that \( |f(z)| < R_2 \) on \( D \) and \( f(0) = 0 \). Then

\[
|f(z)| \leq \frac{R_2}{R_1} |z| \quad \text{for } |z| < R_1.
\]

It is also generally noted (although not originally by Schwarz) that strict inequality holds in (1) for every \( z \neq 0 \) unless \( f \) is of the special form

\[
f(z) = \frac{R_2}{R_1} e^{i\alpha} z \quad \text{for some real } \alpha.
\]

As immediate corollaries, one has:

**Corollary 1 (Liouville's Theorem).** A bounded analytic function in the entire plane is constant.

**Proof.** \( R_2 \) is fixed, and \( R_1 \) may be chosen arbitrarily large.

**Corollary 2.** If \( R_1 = R_2 \), then
A slightly less obvious, but still elementary corollary is

**Corollary 3.** If \( R_1 = R_2 \) and if \( f \) maps the boundary to the boundary, then at any point \( b \) with \(|b| = R_1 \) where \( f'(b) \) exists, one has

\[
|f'(b)| \geq \frac{1}{1 + |f'(0)|}.
\]

The proof follows immediately from the fact that distances to the origin are shrunk under \( f \), and therefore distances from the boundary are stretched. More precisely, for \( t \) real, \( 0 < t < 1 \), we have

\[
|f(tb) - f(b)| \geq |R_1 - tR_1| = |tb - b|
\]

from which (4) follows.

We will return later to the possible significance of this elementary observation. Although we will not make use of it here, we note that a refinement of the above argument gives a stronger and sharp boundary equality; namely, with \( R_1 = R_2 = 1 \), if a single boundary point \( b \) maps to the boundary and if \( f'(b) \) exists, then

\[
|f'(b)| \geq \frac{1}{1 + |f'(0)|}.
\]

A proof may be found in [O3].

The standard proof of the Schwarz Lemma—not the proof that Schwarz himself originally gave—consists of observing that the condition \( f(0) = 0 \) implies that the function \( g(z) = f(z)/z \) is a regular analytic function in the disk \(|z| < R_1\); apply the maximum principle to \( g(z) \) in each disk \(|z| \leq r\), and take the limit as \( r \to R_1 \). That proof, according to Carathéodory (in his 1952 book *Conformal Representation*, p. 114, Note 13) is due to Erhard Schmidt, but was first published by Carathéodory in 1905. Carathéodory also notes that a similar proof had been given by Poincaré back in 1884.

Corollary 1 above, Liouville’s Theorem, is a fundamental result of complex function theory, with many important consequences. The relation of the Schwarz Lemma to Liouville’s Theorem is a prototypical example of what is often known as “Bloch’s Principle”, whose author, André Bloch, is probably best known on three counts: one of them is “Bloch’s Theorem”, which we discuss below; a second is “Bloch’s Principle”; and the third is the fact that both of these, as well as a considerable amount of other interesting mathematics, were obtained while Bloch was in a psychiatric hospital. He had been confined there after murdering his brother and his aunt and uncle at the end of World War I; he had served for three months at the front and then had to be discharged as a result of a fall from the top of an observation post (see the 1988 articles in French and English by Henri Cartan and Jacqueline Ferrand).

Bloch’s Principle is more a heuristic device than a result. It states, in essence, that whenever one has a global result such as Liouville’s Theorem, there should be a stronger, finite version from which the general result will follow. The move from Liouville’s Theorem to the Schwarz Lemma is a perfect example of such a result. Bloch himself gave another example, by proving a finite result that not only implies Picard’s Theorem, but was a simple “elementary proof” of Picard’s Theorem, not relying on the use of the elliptic modular function or the Koebe uniformization theorem.

**Theorem 1** (Bloch’s Theorem). There is a universal constant \( B \), \( B > 0 \), with the property that for every value of \( R < B \), every function \( f(z) \) analytic in the unit disk \( D \) and normalized so that \( |f'(0)| = 1 \) maps some subdomain of \( D \) one-to-one conformally onto a disk of radius \( R \).

The largest value of \( B \) for which Bloch’s Theorem holds is known as Bloch’s Constant.

We shall return to Bloch’s Theorem and Bloch’s Constant later. Let us now resume our story with the paper of Pick [P] referred to at the outset. In that paper, Pick made a crucial observation relating the Schwarz Lemma to hyperbolic geometry which one might have thought would have been made earlier by Klein or Poincaré.

**Lemma 2** (Schwarz-Pick Lemma). Let \( f(z) \) be a holomorphic map of the unit disk \( D \) into the unit disk. Then

(5) \[ \bar{d}(f(z_1), f(z_2)) \leq \bar{d}(z_1, z_2) \] for all \( z_1, z_2 \in D \), where \( \bar{d} \) refers to distances measured in the hyperbolic metric in \( D \).

For future reference let us note the explicit form of these quantities. We shall use the unit disk model of the hyperbolic plane, in which the hyperbolic metric is given by

(6) \[ d\bar{s}^2 = \left( \frac{2}{1 - |z|^2} \right)^2 |dz|^2 \]

and its Gauss curvature \( \hat{K} \) satisfies

(7) \[ \hat{K} = -1. \]

Integrating (6) yields

(8) \[ \bar{d}(0, z) = \log \frac{1 + |z|}{1 - |z|} = 2 \tanh^{-1} |z|. \]

What Pick observed was that we can compose \( f \) with linear fractional transformations of \( D \) onto \( D \), taking \( z_1 \) to \( 0 \) and \( f(z_1) \) to \( 0 \). These linear fractional transformations preserve the metric (6) and are therefore isometries of the hyperbolic plane. Hence (5) reduces to

(9) \[ \bar{d}(0, f(z_2)) \leq \bar{d}(0, z_2). \]
But hyperbolic distance to the origin, given by (8), is a monotonic function of Euclidean distance, so that (9) is equivalent to (1) when $R_1 = R_2 = 1$. Furthermore, equality holds in the Schwarz Lemma if and only if distances to the origin are preserved; hence the same holds for hyperbolic distances. It follows that equality holds in the Schwarz-Pick Lemma if and only if $f$ is an isometry of the hyperbolic plane, which is to say, a linear fractional transformation of the unit disk onto itself.

An equivalent formulation of the Schwarz-Pick Lemma states that every holomorphic map of the unit disk into itself is either linear fractional—hence a non-Euclidean isometry—or else it shrinks the hyperbolic length of every curve.

Among the many generalizations of the Schwarz-Pick Lemma, probably the single most influential one was that of Ahlfors [A1] in 1938 (or [A2], pp. 350-355).

**Lemma 3 (Schwarz-Pick-Ahlfors Lemma).** Let $f$ be a holomorphic map of the unit disk $D$ into a Riemann surface $S$ endowed with a Riemannian metric $ds^2$ with Gauss curvature $K \leq -1$. Then the hyperbolic length of any curve in $D$ is at least equal to the length of its image. Equivalently,

$$\rho(f(z_1), f(z_2)) \leq \hat{\rho}(z_1, z_2) \quad \text{for all } z_1, z_2 \in D$$

or

$$\|df_z\| \leq 1 \quad \text{everywhere},$$

where the norm is taken with respect to the hyperbolic metric on $D$ and the given metric on the image, and $\rho$ denotes distances on $S$ with respect to that metric.

For proof, Ahlfors offers a clever but elementary argument based on the fact that the Laplacian of a real function must be nonnegative at a local minimum. Pulling back a conformal metric on the image surface $S$ under the conformal map $f$, one obtains a conformal metric on the unit disk, to be compared with the original hyperbolic metric.

When his collected papers [A2] were published in 1982, Ahlfors had the opportunity to evaluate his earlier work with the wisdom of hindsight. He confesses that his generalization of the Schwarz Lemma “has more substance than I was aware of,” but still says that “without applications my lemma would have been too lightweight for publication” ([A2], p. 341). Of the applications he gave, the most striking is an elementary new proof of Bloch’s Theorem (Theorem 1 above) with an explicit lower bound for Bloch’s constant $B$, namely $B \geq \frac{3\pi}{4}$. Despite many attempts over the years, only slight improvements on this lower bound have been obtained; a more detailed discussion of all these matters can be found in the article [O1].

Over the course of the twentieth century, a whole line of investigations has extended the approach of Pick and Ahlfors to the Schwarz Lemma, where a key factor is that the unit disk is complete in the hyperbolic metric. (See, for example, Theorems 3 and 4 below.) However, in the past decade another approach has allowed a return to the original Schwarz Lemma, in which one has a map of a finite disk into a finite disk. Let us start with some examples of such results.

A geodesic disk of radius $R$ on a surface is the diffeomorphic image of a Euclidean disk of radius $R$ under the exponential map. Equivalently, one has geodesic polar coordinates:

$$ds^2 = dp^2 + G(p, \theta)^2 d\theta^2,$$

where $p$ represents distance to the center of the disk, and

$$G(0, \theta) = 0, \quad \frac{\partial G}{\partial p}(0, \theta) = 1, \quad G(p, \theta) > 0$$

for $0 < p < R$.

We shall use the following notation throughout this article: $D_R$ denotes the disk $\{ |z| < R \}$, and $ds^2$ is a Riemannian metric on $D_R$. Let $f$ map $D_R$ into a geodesic disk centered at $f(0)$ on a surface $S$ with metric $ds^2$. Then

$$\rho(p) = \text{distance on } S \text{ from } f(0) \text{ to } p$$

$$\hat{\rho}(z) = \text{distance on } D_R \text{ from } 0 \text{ to } z.$$  

**Example 1.** Let $f$ be a holomorphic map of $|z| < R_1$ into a geodesic disk of radius $R_2$ centered at $f(0)$ on a surface $S$ with Gauss curvature $K \leq 0$. Then

$$\rho(f(z)) \leq \frac{R_2}{R_1} |z| \quad \text{for } |z| < R_1.$$

Note that this is a direct extension of the original Schwarz Lemma, and it has exactly the same consequences:

**Corollary 1.** Any holomorphic map of the entire plane into a geodesic disk on a surface with $K \leq 0$ must be constant.

**Corollary 2.** If $R_2 \leq R_1$, then $\|df_0\| \leq 1$.

**Corollary 3.** If $R_2 = R_1$ and if at some point $z$ with $|z| = R_1$, $\rho(f(z)) = R_1$ and $df_z$ exists, then

$$\|df_z\| \geq 1.$$  

**Remarks.** (1) This example is a slightly more general form of the first part of Lemma 6 of Ros [R]; his proof goes through without change. (2) Corollary 1 is false for $K > 0$; the inverse of stereographic projection is a nonconstant conformal map of the entire plane onto a geodesic disk consisting of the sphere minus a point.
Example 2. Let \( f \) be a holomorphic map of \( \{ |z| < r \} \) into a geodesic disk of radius \( \rho_2 \) centered at \( f(0) \) on a surface \( S \) whose Gauss curvature satisfies \( K \leq -1 \). Let \( \rho_1 \) be the hyperbolic radius of \( |z| = r \); i.e.,
\[
\rho_1 = \log \frac{1 + r}{1 - r}
\]
by (8). If \( \rho_2 \leq \rho_1 \) and \( d\bar{s}^2 \) is the hyperbolic metric on \( |z| < 1 \), then
\[
\rho(f(z)) \leq \hat{\rho}(z) \quad \text{for} \quad |z| < r.
\]

Corollary 1. Under the same hypotheses,
\[
(19) \quad \|df_0\| \leq 1.
\]

Corollary 2. If, furthermore, \( \rho_2 = \rho_1 \) and \( f \) maps the boundary into the boundary, then at any point \( z \) on \( |z| = r \) where \( df_z \) exists,
\[
(20) \quad \|df_z\| \geq 1.
\]

Note that in both these examples we can assert only distance shrinking from the center, unlike in the Schwarz-Pick Lemma and its descendants. In fact, as (17) and (20) indicate, the reverse is likely to be true near the boundary. However, one can show that the original Ahlfors extension of the Schwarz-Pick Lemma is in fact a consequence of the finite version in Example 2 (see [O2]).

Before stating the general shrinking lemma, let us note some of the generalizations of the Ahlfors Lemma that have been made.

Theorem 2. Yau ([Y], 1973). Let the surface \( \hat{S} \) be complete, with Gauss curvature \( \hat{K} \geq -1 \), and let \( f \) be a holomorphic map of \( \hat{S} \) into \( S \), with \( K \leq -1 \). Then \( \|df_0\| \leq 1 \) for all \( p \) in \( S \); i.e., the length of every curve in \( S \) is greater than or equal to the length of its image.

Theorem 3. Troyanov ([TJ], 1991), Ratto-Rigoli-Véron ([RRV], 1994). Let \( \hat{S} \) be complete, and let \( f \) map \( \hat{S} \) holomorphically into \( S \). Suppose that
\[
(21) \quad K(f(p)) \leq \hat{K}(p),
\]
which represents the natural culmination of the line of investigation initiated by Ahlfors. The underlying philosophy is that the more negative the curvature in the image domain, the more a holomorphic map will shrink distances and curve lengths. Note that we are really comparing two metrics on the same domain: the original metric \( d\bar{s}^2 \) and the pullback of the metric \( ds^2 \) under \( f \). In fact all of the Ahlfors-type lemmas may be stated as comparison theorems between two conformally related metrics, and, again, the philosophy is that the more negative the curvature the shorter the curve lengths in the metric.

This type of result seems oddly reminiscent, but in apparent reverse, of the standard comparison theorems from Riemannian geometry, which say roughly that the more negative the curvature the more certain curves are stretched. Specifically, one has:

Lemma 4 (Riemannian comparison lemma). Let \( ds^2 \) and \( d\bar{s}^2 \) be metrics given in geodesic polar coordinates by
\[
\begin{align*}
   ds^2 &= d\rho^2 + G(\rho, \theta)^2 \, d\theta^2 \\
   d\bar{s}^2 &= \hat{d}\rho^2 + \hat{G}(\rho, \theta)^2 \, d\theta^2.
\end{align*}
\]

If
\[
(23) \quad K(\rho, \theta) \leq \hat{K}(\rho, \theta) \quad \text{for} \quad 0 < \rho < \rho_0,
\]
then
\[
(24) \quad \frac{1}{\hat{G}} \frac{\partial \hat{G}}{\partial \rho} \geq \frac{1}{G} \frac{\partial G}{\partial \rho}
\]
and
\[
(25) \quad G(\rho, \theta) \geq \hat{G}(\rho, \theta) \quad \text{for} \quad 0 < \rho < \rho_0.
\]

Note that
\[
(26) \quad \frac{d}{d\theta} = \frac{ds}{d\theta} \quad \text{along the geodesic circle} \quad \rho = \rho_1,
\]
so that (25) implies that
\[
(27) \quad L(\rho_1) \geq \hat{L}(\rho_1) \quad \text{for} \quad 0 < \rho_1 < \rho_0,
\]
where \( L(\rho) \) and \( \hat{L}(\rho) \) refer to the lengths in their respective metrics of geodesic circles of radius \( \rho \).

An obvious question is what relation, if any, exists between the Ahlfors-type lemmas as in Lemma 3 and the Riemannian comparison lemma (Lemma 4). The answer is twofold: First, there is a heuristic argument, based on (17) and (20), that provides a link between the two. Second, we can use the Riemannian comparison lemma to prove a general finite shrinking lemma that contains our Example 2 above as a special case and therefore provides a new route to proving the original Ahlfors Lemma.

Let us start with a brief look at the heuristic argument relating the two forms of comparison. We have a geodesic disk \( D \) of radius \( \rho_1 \) on a surface with Riemannian metric
\[
d\bar{s}^2 = \hat{d}\rho^2 + \hat{G}(\rho, \theta)^2 \, d\theta^2,
\]
where for any point \( P \) in \( \hat{D} \), \( \hat{\rho}(P) \) is the distance between \( P \) and the center \( O \) of the disk. We map \( \hat{D} \) conformally by \( f \) into a surface \( S \) with metric \( ds^2 \) and assume that the image lies in a geodesic disk \( D \) of the same radius centered at the point \( f(0) \). Under suitable curvature restrictions we wish to show that

\[
(28) \quad \rho(f(P)) \leq \hat{\rho}(P) \quad \text{for all } P \text{ in } \hat{D},
\]

where \( \rho(Q) \) is the distance on \( S \) from \( f(0) \) to \( Q \). We introduce geodesic polar coordinates

\[
ds^2 = d\rho^2 + G(\rho, \theta)^2 \, d\theta^2,
\]

with \( 0 \leq \rho < \rho_1 \) and \( 0 \leq \theta < 2\pi \), on the image, and we assume that the curvature relation is

\[
(29) \quad K(\rho, \theta) \leq \hat{K}(\hat{\rho}, \hat{\theta}) \quad \text{when } \rho = \hat{\rho} ;
\]

that is, for each fixed \( \theta \), the curvature of the image geodesic disk is at most equal to the curvature of the original at the same distance from the center. Then what we want to show, inequality (28), is that each geodesic disk \( \hat{\rho} < c \), for \( c < \rho_1 \), maps into the geodesic disk \( \rho < c \) in the image. Heuristically, the images of the interior disks are likely to be largest when \( f \) maps \( \hat{D} \) onto the full disk \( D \). So let us assume that \( f \) is such a map and \( f \) takes the boundary \( \hat{\rho} = \rho_1 \) to the boundary \( \rho = \rho_1 \). Let us further assume that \( f \) is defined and conformal in a slightly larger disk, \( \hat{\rho} < \rho_0 \). Then the Riemannian comparison lemma applies, and we have inequality (27), which tells us that \( globally \) the map \( f \) takes the geodesic circle \( \hat{\rho} = \rho_1 \) of length \( \hat{L}(\rho_1) \) onto a geodesic circle of greater or equal length \( L(\rho_1) \); \( locally \), by virtue of (26), the inequality (25) tells us that under the map of \( \hat{\rho} = \rho_1 \) to \( \rho = \rho_1 \) that relates points with the same angular coordinate \( \theta \), we have

\[
(30) \quad \frac{ds}{d\hat{s}} \geq 1.
\]

However, \( f \) will not in general preserve \( \theta \), so that inequality (27) tells us only that (30) holds on average, where \( s \) and \( \hat{s} \) represent arclength along \( \rho = \rho_1 \) and \( \hat{\rho} = \rho_1 \) under the map \( f \). The final heuristic assumption is that (30) holds along the whole curve \( \rho = \rho_1 \), under the map \( f \). Then conformality of \( f \) implies that the same inequality also holds in the radial direction, so that along each “radius” \( \theta = \theta_0 \) of \( \hat{D} \), we have

\[
(31) \quad \frac{d\rho}{d\hat{\rho}} \bigg|_{\rho = \rho_1} \geq 1.
\]

Here \( \rho(\hat{\rho}) \) is the function whose value is \( \rho(f(P)) \) at the point \( P \) in \( \hat{D} \) with coordinates \( (\hat{\rho}, \theta_0) \). Suppose now that we have strict inequality in (31), so that points in \( \hat{D} \) near the boundary \( \hat{\rho} = \rho_1 \) move farther from the boundary \( \rho = \rho_1 \) of \( D \) and therefore move closer to the center of \( D \). Then (28) holds, in fact with strict inequality, for points \( P \) in some annular region near the boundary of \( \hat{D} \). We are then back to our original situation on a disk of smaller radius in \( \hat{D} \), and we may expect the same kind of contraction (28) to extend.

In brief, the heuristic connection is that an equality like (29) on Gauss curvature implies an expansion of the boundary \( \hat{\rho} = \rho_1 \) to \( \rho = \rho_1 \), which by conformality of \( f \) implies an expansion in the radial direction from the boundary, or a movement of points toward the center, and therefore a contraction in the sense of (28).

We have not been able to turn this heuristic argument into a complete proof under the full generality of (29), but we have been able to obtain the result for a very broad class of metrics, including those of Examples 1 and 2, namely, for all metrics \( d\hat{s}^2 \) which have circular symmetry.

**Theorem 4** (General Finite Shrinking Lemma). Let \( \hat{D} \) be a geodesic disk of radius \( \rho_1 \) with respect to a metric \( d\hat{s}^2 \). Assume that \( d\hat{s}^2 \) is circularly symmetric, so that

\[
(32) \quad d\hat{s}^2 = d\rho^2 + \hat{G}(\hat{\rho})^2 \, d\theta^2 \quad \text{for } 0 \leq \hat{\rho} < \rho_1,
\]

where \( \hat{G} \) depends on \( \hat{\rho} \) only and not on \( \theta \). Let \( f \) be a holomorphic map of \( \hat{D} \) into a geodesic disk \( D \) of radius \( \rho_2 \) on a surface \( S \), with center at the image under \( f \) of the center of \( \hat{D} \). If \( \rho_2 \leq \rho_1 \) and if

\[
(33) \quad K(\rho, \theta) \leq \hat{K}(\hat{\rho}, \hat{\theta}) \quad \text{for } \rho = \hat{\rho},
\]

then

\[
(34) \quad \rho(f(P)) \leq \hat{\rho}(P) \quad \text{for all } P \text{ in } \hat{D}.
\]

For details of the proof we refer to [02].

There are several remarks to be made concerning this result.

First, as stated it does not immediately include the full form of Example 1 above, because of the assumption \( \rho_2 \leq \rho_1 \). However, the proof yields a more general statement (Theorem 2 of [02]) without that assumption; Example 1 then appears as a special case.

Second, the results described in Theorem 3 above represent the natural culmination of a century-long process starting with Carathéodory’s 1905 publication of what we now call the “Schwarz Lemma”, through the Pick interpretation, and the successive generalizations by Ahlfors and Yau (Theorem 2 above), with the overall philosophy that a holomorphic map of one surface into another whose curvature is more negative will shrink distances. All of the earlier results, prior to those of the papers [T] and [RRV] referred to in Theorem 4, required a uniform bound below on curvatures in the domain of the map that dominates a global bound above in the image. What Theorem 3 shows is that, under suitable hypotheses, pointwise bounds will suffice.
Theorem 4 completes in a certain sense this circle of ideas by going back to the original Schwarz-type lemma for a map of a finite disk into a finite disk, in contrast to the Schwarz-Pick-Ahlfors-Yau-Troyanov-Ratto-Rigoli-Veron versions, all of which require the domain of the map to be provided with a complete Riemannian metric. At the same time, it applies to maps in which one has a pointwise comparison of Gauss curvatures. However, whereas the hypotheses of the papers [T] and [RRV] described in Theorem 3 compare the curvatures at each point of the image with that at the preimage of the point under a given holomorphic map, Theorem 4 compares curvatures in the image with curvatures in the domain at comparable distances from fixed points, independent of the map. In cases such as the original Ahlfors Lemma and the Yau generalization, where there are global bounds on curvatures, there is no difference between the two types of comparison.

We conclude with two final notes.

First, the Schwarz Lemma may be pictured as the progenitor of a huge family tree, branching out in many directions. In this article, we have followed just one of those branches, but there are many others. To name just two, there are the many generalizations to higher dimensions and the "Discrete Schwarz-Pick Lemma" for circle packings proved by A. F. Beardon and K. Stephenson in 1991, which was applied in 1996 by Z.-X. He and O. Schramm to give a new proof of Thurston's innovative approach to the Riemann mapping theorem via circle packing.

Second, the particular branch we have pursued here has blossomed in a most remarkable way in a recent result [BE] announced by M. Bonk and A. Eremenko. We can describe their main result as follows.

Consider a triangulation of the Riemann sphere consisting of four equilateral triangles with vertices at the points of an inscribed regular tetrahedron. Let \( f \) be a conformal map of a Euclidean equilateral triangle onto one of those four spherical triangles. By successive reflections, \( f \) can be extended to a meromorphic function in the entire plane whose image will be an infinite-sheeted Riemann surface over the sphere with simple branch points at each of the vertices of the triangulation. Each circular disk on the sphere whose boundary circle passes through three vertices of the triangulation will have an infinite number of unbranched sheets of the surface lying over its interior. Said differently, every such circular disk on the sphere is the one-one conformal image under \( f \) of (infinitely many) simply connected regions in the domain.

What Bonk and Eremenko assert is that, for any smaller disk on the sphere, every meromorphic function in the plane has the property that its image contains an unbranched disk of at least that size. In other words, the surface described above is the extremal surface, giving the precise value of another Bloch-type constant, analogous to the one in Bloch's Theorem (Theorem 1 above). Furthermore, the authors show that their result implies the original Bloch Theorem, as well as its striking generalization by Ahlfors to the "five-island theorem," stating that for any five Jordan domains on the sphere whose closures are disjoint, at least one of them must be simply covered by the image of any nonconstant meromorphic function in the plane.

A key idea in the Bonk-Eremenko proof is to introduce a metric on a branched Riemann surface over the unit sphere that is the ordinary spherical metric away from branch points and has infinite negative curvature at the branch points. One considers the surface to be the union of spherical triangles satisfying certain conditions. Then the idea, in the authors' words, is that "if the triangles are small enough, then the negative curvature concentrated at the vertices dominates the positive curvature spread over the triangles. Thus on a large scale our surface looks like one whose curvature is bounded above by a negative constant."

And so the fundamental insight of Ahlfors concerning the Schwarz-Pick Lemma continues to bear fruit in the most beautiful and unexpected new ways.

References

To Teach, per Chance, To Dream

Daniel Rockmore and J. Laurie Snell

"What's the chance of that!?" It is a question that almost all people ask—sometimes after the fact—in trying to make sense of a seemingly improbable event and, at other times, in preparation for action, as an attempt to foresee and plan for all the possibilities that lie ahead. In either case, it is mathematics in general, and probability and statistics in particular, that the public looks to for a final answer to this question. One out of one hundred, 4 to 1 odds, an expected lifetime of 75 years—these are the sorts of answers people want. When used honestly and correctly, numbers can help clarify the essence of a confusing situation by decoupling it from prejudicial assumptions or emotional conclusions. When used incorrectly—or even worse, deceitfully—they can lend a false sense of scientific objectivity to an assertion, misleading those who are not careful enough or knowledgeable enough to look into the reasoning underlying the numerical conclusions.

Daniel Rockmore is associate professor of mathematics and computer science at Dartmouth College. His e-mail address is rockmore@cs.dartmouth.edu.

J. Laurie Snell is professor emeritus of mathematics at Dartmouth College. His e-mail address is jl-snell@dartmouth.edu.

Illustration above by Erica Wood.

It is important to be able to distinguish between these two scenarios. Chance is a part of life, and its quantification is the stuff of science, social policy, and individual decision making. As such, it is a place where it is easy to show that the techniques and problem-solving approach of mathematics make a real difference. In this way, the study of chance can provide a real pedagogical opportunity for mathematics departments.

It is in this spirit of pedagogy and quantitative reasoning that nine years ago, a Chance course was first conceived by Laurie Snell (Dartmouth College) and Bill Peterson (Middlebury College) and was funded by the Pew Foundation. Subsequently, the project was funded by the National Science Foundation and grew into a project encompassing a Web site, newsletter, lecture series, and workshops.

Originally, the intent was to create a case study course based on the kind of articles that appear in Chance Magazine. Chance Magazine is a magazine of the American Statistical Association, whose aim is to show the applications of probability and statistics in everyday life to a broad audience. This first version of the Chance course was to be restricted to the study of four or five significant probability and statistics applications chosen from topics typically discussed in Chance Magazine and the media in general, such as political polls, DNA fingerprinting in the courts, the census, streaks in sports, coincidences, and clinical trials. Peterson developed such a Chance course at Middlebury as part of the freshman writing seminar program.

Soon after, some firsthand experience with the freewheeling Geometry and the Imagination course—created at Princeton University by John H.
Conway, Peter Doyle, and Bill Thurston—led to the creation of a more dynamic version of Chance, as well as to a successful proposal to the NSF for funding the Chance Project as a consortium consisting of Dartmouth College (John Finn and Laurie Snell), Grinnell College (Tom Moore), Middlebury College (Bill Peterson), Spelman College (Nagambal Shah), University of California at San Diego (Peter Doyle), and University of Minnesota (Joan Garfield).

The full version of Chance is now taught at Dartmouth to about one hundred students per year, as well as at several other institutions around the country. Based on current events, the course uses all possible sources of statistical or numerical claims—such as advertising, the media, and scientific journals—as the material for classroom discussion and analysis. This style of course was first taught in the spring of 1992 at Princeton University by Doyle and Snell.

In a typical Chance class students are given a current news article and three or four discussion questions related to it. Examples of news topics used recently are the year 2000 census, depression related to Internet use, genetic testing, and coaching for the SATs. Students are asked to form groups of three or four, read the article, and spend fifteen or twenty minutes answering the discussion questions. The group's answers form the basis for a general discussion of the article and the probability or statistical issues that it raises.

Here is one of the discussion questions from the first day of the first-ever Chance class, taught at Princeton:

The recipe for pizza from Laurel's Kitchen says: Let the dough rise only once, about 1 and 1/2 hours. How long should you let the dough rise if you use Fleischmann's Rapid Rise Yeast, whose package states that it "rises 50% faster"?

The students gave what we thought were reasonable interpretations, but when we called the Fleischmann Company to ask what they meant by it, we were told: If your recipe says to let the dough rise twice, with Fleischmann's Rapid Rise Yeast, once is enough. Our first day's example showed that mathematics and the real world are often quite different.

Here is a set of discussion questions from that first course based on a newspaper article:

Read the New York Times article on China "Stark data on women: 100 million are missing" and answer the following questions:
(a) Suppose that a certain society values sons more than daughters. In this society, a couple will continue bearing children until they produce a son, at which point they will retire from the child-bearing business. Would this family-planning scheme tend to produce more boys or more girls?
(b) Using coin tosses, simulate the generation of twenty families. Make histograms for the number of sons and the number of daughters. Find the average and the standard deviation of the number of sons and the number of daughters. In light of this data, are you inclined to change your answer to the previous question?
(c) What do you think accounts for the missing daughters in China?

The New York Times article was based on research by a Princeton demographer, who provided us with more detailed information about the study. This exchange of information is not uncommon, and local colleagues in other disciplines are often happy to give guest lectures to provide background information for chance issues in the news. A nice example of this collaboration is provided by the researchers from the Center for Disease Control whom Nagambal Shah regularly invites to her Chance course at Spelman College.

In general, we have found that following the news leads naturally to the need to understand various topics, including study design, descriptive statistics (including graphics), probability, correlation, polls and surveys, estimation, and test of hypotheses.

These fundamental statistical ideas and techniques arise in the news in a variety of familiar and meaningful settings. Lotteries are always in the news and provide an interesting introduction to simple counting problems. Medical stories occur regularly and lead naturally to discussions of the difference between randomized clinical trials and epidemiological experiments. Issues of relative and absolute risk arise here as well. Another good source of elementary probability is the daily weather prediction in the newspaper: The weather forecaster predicts "a 30 percent chance of rain," and it rains. What does this mean? Was she right? How does one "score" a weather forecaster? In recent years we have also been able to get a lot of mileage out of El Niño, hurricane and tornado prediction, and global warming (or not!)

Classroom activities provide a dynamic way to elucidate statistical concepts. To illustrate the concept of correlation, we often use a cookie-tasting activity. We provide the students with about ten brands of chocolate chip cookies of varying prices and ask them to design an experiment to determine if there is a correlation between the taste and the price of the cookie.

Classroom activities can also be used to help students understand the concept of a test of hypothesis. For example, we might ask the students in their groups to develop and carry out an experiment to determine if one of their members can tell the difference between Pepsi and Coke. Students often come up with a variety of experiments.

For example, suppose that in one group Mary claims that she has some ability to tell the difference between Pepsi and Coke and she is given 10 trials, with each trial randomized to be Coke or Pepsi. Skeptic John says that Mary must get 8 or
more correct to convince him that she is not just guessing. If Mary is guessing, getting 8 or more correct out of 10 trials would be like getting 8 or more heads in 10 tosses of a coin. A simple counting argument shows that this is $\frac{1+10+45}{1024} \approx 5.4$ percent. So John is happy with this experiment, since if his skepticism is well founded, then with high probability (almost 95 percent) he will be shown to be right.

How does Mary feel about this experiment? She wants an equally high probability of establishing her claim. To be precise, Mary feels that she can tell the difference about three-fourths of the time. Thus her successes should be like the number of heads that turn up when we toss a biased coin with a 75 percent chance of turning up heads. With the biased coin, 8 heads is now about what we would expect, and the probability of 8 or more heads turns out to be 53 percent. So Mary is not very happy with the proposed experiment, because if she does have the ability that she claims, she will have only a 53 percent chance of convincing John.

We then talk about the need to increase the number of trials to make both Mary and John satisfied so that the truth will prevail. For a historical perspective, we tell the students about R. A. Fisher's famous lady-testing-tea experiment.

It is surprising how often the simple coin-tossing model can explain what is going on. Here is an example from a study reported in the New York Times. A large study was carried out to see which of the two drugs t-PA or streptokinase is more effective in preventing death in the period immediately following treatment for a heart attack. In a randomized study, 10,000 patients being treated after a heart attack were given t-PA, and 10,000 were given streptokinase. In the six-month period following the operation, there were 630 deaths for the t-PA group and 740 for the streptokinase group. It was important to know if the differences could be due to chance, since t-PA costs $2,400, while streptokinase costs $240. Also, while the difference between 7.4 percent and 6.3 percent is small, it would save about 2,000 patients a year in the United States if it is real.

To see if this difference is significant, we assume that the two drugs are equally effective. Then since the patients were randomly assigned to the two groups, the 1,370 deaths would be equally likely to have come from each of the two groups. Thus the number of deaths from t-PA can be modeled as the number of heads in 1,370 tosses of a fair coin. The expected number of heads in 1,370 tosses is 685, and the study resulted in a deviation of 55 from this expected value. How likely is it to get a deviation as large or larger than this? The standard deviation for the number of heads is the square root of $1,370 \times \frac{1}{2} \times \frac{1}{2} \approx 18.5$. Thus a deviation of 55 represents more than 3 standard deviations from the expected number, so this outcome would be highly unlikely if the two drugs had the same effect. Thus we conclude that the difference is significant.

Outside of class, students do more traditional homework assignments from a textbook such as Statistics by Freedman, Pisani, and Purvis. They also keep "journals". The journals contain commentaries and answers to further questions related to the articles discussed in class. The course concludes with the "Chance Fair", a one-day extravaganza at which the students give poster presentations of final projects and exercise their newfound statistical skills at the "Chance Casino" by playing blackjack and roulette.

Part of the goal of the Chance Project is to help initiate Chance-like courses at other institutions. One way to facilitate this is to prepare and distribute background material ("profiles") of topics that occur regularly in the news. For example, our lottery profile discusses how large the jackpot needs to be in the well-known "Powerball" lottery in order to make this a favorable bet. Incredibly, the answer turns out to be $270$ million, which happens to be the largest jackpot to date. Our analysis takes into account the effects of differing pay-off schedules, taxes, and the possibility of sharing the prize.

Another way to help teachers is to identify interesting news articles that they can use in their classes. Since both Chance News and the profiles depend on timely information, the Internet is a natural way to distribute the work. Thus, we developed

Illustration by Peter Schles.
a Chance Web site, http://www.dartmouth.edu/~chance, to provide profiles of topics based on our teaching experiences, data sets related to articles we have discussed, activities that we have used, and links to other resources for a Chance course.

Included there are issues of an electronic newsletter, "Chance News", which reviews current articles in the news based on probability or statistical concepts and provides discussion questions for them. It is sent out monthly by e-mail to about 1,500 teachers of probability and statistics. While intended for a Chance course, "Chance News" is also used extensively by teachers wishing to introduce current events in more traditional probability and statistics courses. For example, Joan Garfield does so regularly in her courses, and she was led to call these "Chance-enhanced" courses. The preparation of this newsletter has become a joint effort of Laurie Snell at Dartmouth, Bill Peterson at Middlebury, and Charles Grinstead at Swarthmore. Readers also send suggestions and comments on previous articles.

Most "Chance News" items are based on articles from national newspapers such as the New York Times, the Washington Post, the Boston Globe, the Wall Street Journal, and the Los Angeles Times. It has been estimated that about 80 percent of science articles covered in the news come from a very few journals, including Science, Nature, the New England Journal of Medicine, the Journal of the American Medical Association, and Lancet. Most colleges have these journals and newspapers in their libraries. In addition, all these newspapers and journals have electronic versions. Many libraries have student access to Lexis-Nexis, which provides a much wider variety of newspapers and magazines than listed above. Thus it is easy to find the source of most of the articles discussed in "Chance News".

The most recent addition to the growing treasury of Chance materials are the "Chance Lectures", a video archive of the Chance Lecture Series that we have run the past two years at Dartmouth. Each year we have invited a group of experts in a variety of subjects, ranging from casino gambling to insurance policy redemption, to give one-hour lectures on the way in which probability and/or statistics impacts their work. The lectures are intended for a scientifically literate and interested audience with no more than a "newspaper knowledge" of the subject at hand.

The lectures are videotaped and made publicly available on the Web via streamed video for viewing using the "RealAudio" application. The format of the videos is such that they are accompanied by displays of the speaker's overheads that update automatically as the video proceeds. The Web site contains twenty-six lectures in all, seventeen of which are from the two lecture series. Viewing these requires at least a 58kbs connection and a computer with a clock speed of at least 150 megahertz. To make them easier to use in the classroom, we have made these lectures available on a CD-ROM that requires a browser but not a network connection.

Each lecture is long enough that it would be possible to devote an entire class to the analysis of a single one. When the speaker makes a particularly difficult or controversial remark, the teacher can stop and discuss it with the class before going on. An accompanying indexing scheme also makes it easy to use only segments of a video.

The subject matter runs the gamut, from playing fields to planetary science. For instance, in our first lecture series, Hal Stern, professor of statistics at Iowa State University (and editor of Chance Magazine), gives a beautiful lecture on the probability and statistics which can be found every day in the sports pages. He considers three quite different examples to show how probability and statistical theory, when applied to real sports data, can enhance the understanding of a sport and help determine optimal game strategies. These examples are: the use of Markov chain theory to determine baseball strategies, the use of regression to rate college football teams, and the use of data and the normal distribution to estimate, at a given point during the game, the probability that a particular team wins. This last example sheds light on the folk theory that the final outcome of a basketball game is determined by what happens in the last quarter, and by the first seven innings for a baseball game.

In our second lecture series, Clark Chapman of the Southwest Research Institute speaks on "The risk to civilization from extraterrestrial objects". Chapman, a leading researcher on planetary cratering, discusses the science behind the determination of the rate at which extraterrestrial objects strike the earth, as well as the different types of collisions which can and do occur. He explains the computation of the odds that any individual on Earth will die due to such an event and justifies his claim that "It's as likely that your epitaph will read that you died of an asteroid collision, as by an airplane crash." If the odds of these disasters are the same, then should we devote similar amounts of energy and money to preparing for asteroidal collisions as we do for airline safety? This leads naturally to discussions of the larger topic of risk and resource management.

So, like any good Chance topic or Chance course, Chapman’s lecture is about more than mathematical analysis. It is about framing a question clearly and giving a precise answer; it is about distilling a general principle from a particular example. In short, it is about what we, as mathematicians, try to do every day.
Once Upon a Number: The Hidden Mathematical Logic of Stories
Reviewed by Colin Adams

Once Upon a Number: The Hidden Mathematical Logic of Stories
John Allen Paulos
Basic Books, 1998
224 pages, $23.00

A few years ago I was trying to get a motion passed on the floor of a faculty meeting. I stood up and listed the six reasons, one after the other, that demonstrated that the faculty should vote for the motion. Then I sat down, confident in the irrefutable logic of my arguments. I assumed that the faculty, who are individually intelligent, would certainly see my points when stated in these starkly obvious terms. A nonscience colleague then stood up and, in a long meandering speech, gave one reason why the motion should not be passed. Someone else explained why that point was invalid. My opponent rose again and took another fifteen minutes to make a second point. This also was refuted. But for each refutation he had a fifteen-minute response. By the end, my colleague had held the floor for at least 80 percent of the discussion. When the vote was finally taken, the motion was defeated.

A mathematician's traditional rigorous, concise style of presenting material can be a disaster when utilized on a general audience. It is the drink of water out of a fire hose. The vast majority of people prefer to have a mathematical idea (or any other idea for that matter) explained in a variety of ways and from a variety of viewpoints, with lots of filler to give them time to absorb the idea slowly.

In his best-selling book Innumeracy, John Allen Paulos explained his attempts to grapple with his own tendency toward terseness: "I have a difficult time writing at length about anything. Either my mathematical training or my natural temperament causes me to distill the crucial points and not to dwell (I want to write 'dither') over side issues or contexts or biographical detail. The result, I think, is clean exposition, which can nevertheless be intimidating to people who expect a more leisurely approach."

Paulos is best known for his two books, Innumeracy and A Mathematician Reads the Newspaper. Both of these books are fun reads. And both of these books have great titles. In one and five words respectively, they conjure up the entire content of the books.

Paulos's new book does not have such a title. Once Upon A Number: The Hidden Mathematical Logic of Stories does not explain the book. But as it turns out, this is not an easy book to explain. In some sense it is an expansion of several themes.
that have occurred in Paulos's previous books. Specifically, he is interested in the difference, as he says, between narrative and numbers, between stories and statistics. How do we synthesize the individual anecdotes and the informal discourse with the statistical overview, with the hard cold numbers? That still does not give one much of a sense of where this book is likely to go, since this is not terrain that has been much explored previously.

The book consists of an introduction and five interconnected essays. Each essay investigates a different aspect of the relationships between stories and statistics. Essay does seem the best word to utilize here, as opposed to chapter or treatise, as there is no well-defined thesis that is being argued. Each essay defies easy categorization and works its way over the landscape without a specific goal. Although the landscape is engaging, readers may become frustrated by the apparent lack of forward progress. What follows is a detailed outline of the first essay to give a sense of how the book is written and shorter descriptions of the other essays.

In the first essay, "Between Stories and Statistics", Paulos notes that statistics grew out of informal stories and anecdotes. Concepts such as the mean, mode, variance, correlation, and others had precursors in such everyday words as usual, standard, stereotypical, peculiar, strange, association, and relation. In fact, many of our behaviors are dictated by an intuitive sense of statistics. As he says, "Admit it or not, we are all statisticians, as when we make grand inferences about a person from that tiny sample of behavior known as a first impression."

Unfortunately, we often lose sight of the story that generated the statistics. Paulos derides the use of statistics given out of context and emphasizes the care with which such statistics must be interpreted, a theme that appeared in both of the other books mentioned. He gives several examples where the statistics taken out of context are difficult to interpret, including the "birth effect", the psychological theory which states that the order of birth among siblings plays an important role in subsequent personality development.

Paulos gives the stimulating example (a slight variation of which appeared in Innumeracy) of an individual who sends out letters predicting the outcome of a sporting event, half predicting one result and the other half predicting the opposite. Then when the result is known, he sends another set of letters to those to whom it appeared his first prediction was correct. After repeating this process a few more times, he has a small set of people who believe him a genius or soothsayer. This story, to which Paulos adds various twists and turns, brings him to tree diagrams and their potential use in literature. From here we take a quick ride through correlation and the fact that if the number of traits considered is larger than the number of individuals considered, statistical results will be meaningless. As he does throughout the book with the various mathematical concepts, Paulos asks how this principle might affect us in our daily interactions. In the real world the number of people we know is relatively small and the number of traits we consider is relatively large. Hence we may often see correlations where none exist.

In fact, my favorite aspect of the book is the author's willingness to take a mathematical principle and consider how it might apply in complex systems of interaction amongst people. Although highly speculative, these considerations are always thought-provoking. As he himself says later on, "I am aware that part of what is written here may be dismissed as an unholy mixture of discordant fields; even I think this on Tuesdays and Saturdays. Nevertheless, on the other five days I think it is well worth a scientist's effort to try to explore the borderland between these disparate cultures."

The first essay also includes a discussion of stereotypes and the circumstances under which they are appropriate. This allows Paulos the opportunity to discuss the Op Ed piece he wrote for the New York Times, in which he stated that he had suspected the Unabomber was probably a mathematician, and the brouhaha that resulted from that statement.

The second essay is entitled "Between Subjective Viewpoint and Impersonal Probability". The focus here is on the psychological aspects of our interpretations of the world. The explicit examples are particularly interesting, including a discussion of the Bible Code and the O.J. Simpson trial. This is followed by "Between Informal Discourse and Logic", wherein Paulos considers the informal (intensional) logic of stories and contrasts it with the formal (extensional) logic of mathematics. An appendix on "Humor and Computation" is included, which is based on a talk Paulos gave in 1995 and on his two books Mathematics and Humor and I Think, Therefore I Laugh. Although not clearly relevant, the appendix does have some interesting points to make.

The fourth essay is entitled "Between Meaning and Information". Here is an opportunity to dip into information theory, cryptography, and complexity. Paulos touches on Ramsey's theorem and Smale's horseshoe map and the roles they may play in our day-to-day lives. The final essay is entitled "Bridging the Gap". Paulos discusses how we can over-

1 Well, actually, my very favorite part of the book is the image he describes of himself and his brother traversing the neighborhood in their underwear while throwing darts at trees, with Paulos triumphant in the fact he has swim trunks under his underwear.
come the divide between stories and statistics, but with caveats as to the dangers inherent in such an endeavor.

Paulos ends by saying, "How we can maintain a place for the individual, protected from the overweening claims of religion, society, and science, is an increasingly important unsolved problem. Its solution, I have no doubt, will require simply and pragmatically accepting the indispensability of both stories and statistics and of their nexus, the individual who uses and is shaped by both. The gap between stories and statistics must be filled somehow by us."

Paulos sprinkles the book with quotes and connections and with quips from his favorite comedians. In some cases he is reaching a bit, as for instance when he says that "the word context is obtained by conjoining conte, which means a short tale or adventure, with xt, the most commonly used variables in statistics and mathematics as a bridge between the two worlds." Paulos acknowledges it is a stretch, but he includes it anyway.

Although he can verge on the didactic, most of the time he is eloquent: "In any case, the inexhaustible source of information is the unmediated world out there. By intelligently reducing parts of it to a formal calculi and systems, we tame larger and larger tracts. Still, even when we carry out the reduction thoughtfully, we bring order only to our trim hedgerow in the celestial landscape. Our cognitive homes generally are as unnaturally neat and comfortable as our physical ones."

Unfortunately for anyone who has read Innumeracy and A Mathematician Reads the Newspaper, many of the ideas and the specific examples in this book are repeats from those two books, sometimes with minor variation. These include the soothsayer example, the complexity of a sequence of 0's and 1's, regression to the mean, Type I and II errors in statistics, false identifications of witnesses, and others.

Another flaw is that the serpentine nature of the presentation sometimes causes confusion. For instance, Paulos utilizes Bayes's theorem and conditional probability on page 50 but does not explain them until page 69. He also has a tendency to make up probabilities rather than to search out the actual numbers, as when he guesses the probability that an adult weighs less than 130 pounds or the percent of those people who speak Spanish and who are from Spain. It would be more interesting to know the actual quantities.

The book Innumeracy gave one the feeling of being let loose in a candy store, where the shelves are stacked with bins and each bin contains a new surprising taste treat. One was almost overwhelmed with a surfeit of interesting examples. A Mathematician Reads the Newspaper was more like a stroll down a city block, where one could peer in the windows or enter the variety of unusual stores along the way. Once Upon a Number is more like a canoe ride down a meandering river. The pace is leisurely and the goal is not to reach any particular destination. There are eddies and backwashes, but it is a pleasant ride nonetheless. Paulos has succeeded in slowing down his exposition and decreasing the information-per-number-of-characters ratio. Whether or not that is a benefit will depend on the individual reader.

There are no definitive questions when examining such amorphous topics, and therefore there can be no definitive answers. For mathematicians who expect such, this book will be a disappointment. But one has to respect Paulos for going where mathematicians rarely have the courage to go. He is willing to take statistical and mathematical principles and suggest connections with the complicated systems that make up our everyday world, and though these connections are perhaps tenuous, they are stimulating nonetheless.
Knowing and Teaching Elementary Mathematics

Reviewed by Roger Howe

Notation: The reviewer will refer to the book under review as KTEM.

For all who are concerned with mathematics education (a set which should include nearly everyone receiving the Notices), KTEM is an important book. For those who are skeptical that mathematics education research can say much of value, it can serve as a counterexample. For those interested in improving precollege mathematics education in the U.S., it provides important clues to the nature of the problem. An added bonus is that, despite the somewhat forbidding educationese of its title, the book is quite readable. (You should be getting the idea that I recommend this book!)

Since the publication in 1989 of the Curriculum and Evaluation Standards by the National Council of Teachers of Mathematics [NCTM], there has been a steady increase in discussion and debate about re-forming mathematics education in the U.S., including increased attention from university mathematicians (cf. [Ho]). Many mathematicians who take time to consider precollege education form an intuition that it would help the situation if teachers knew more mathematics. If these mathematicians get more involved in mathematics education, they are likely to be surprised by how little this intuition seems to affect the agenda in mathematics education reform.

Partly this noninterest in mathematical expertise reflects an attitude widespread among educators [Hi] that "facts", and indeed all subject matter, are secondary in importance to a generalized, subject-independent teaching skill and the development of "higher-order thinking". Concerning mathematics in particular, the study [Be] is often cited as evidence for the irrelevance of subject matter knowledge. For this study, college mathematics training, as measured by courses taken, was used as a proxy for a teacher's mathematical knowledge. The correlation of this with student achievement was found to be slightly negative. A similar but less specific method was used in the recent huge Third International Mathematics and Science Study (TIMSS) of comparative mathematics achievement in forty-seven countries. For TIMSS, U.S. students demonstrated adequate (in fourth grade) to poor (in

Roger Howe is professor of mathematics at Yale University. His e-mail address is howe@math.yale.edu.

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How can this intuition—that better grasp of mathematics would produce better teaching—appear to be so wrong? KTEM suggests an answer. It seems that successful completion of college course work is not evidence of thorough understanding of elementary mathematics. Most university mathematicians see much of advanced mathematics as a deepening and broadening, a refinement and clarification, an extension and fulfillment of elementary mathematics. However, it seems that it is possible to take and pass advanced courses without understanding how they illuminate more elementary material, particularly if one’s understanding of that material is superficial. Over the past ten years or so, Deborah Ball and others [B1–3] have interviewed many teachers and prospective teachers, probing their grasp of the principles behind school mathematics. KTEM extends this work to a transnational context. The picture that emerges is highly instructive—and sobering. Mathematicians can be pleased to have at last powerful evidence that mathematical knowledge of teachers does play a vital role in mathematics learning. However, it seems also that the kind of knowledge that is needed is different from what most U.S. teacher preparation schemes provide, and we have currently hardly any institutional structures for fostering the appropriate kind of understanding.

The main body of KTEM (Chapters 1–4) presents the results of interviews with elementary school teachers from the U.S. (23 in all) and China (72 in all). The U.S. teachers were roughly evenly split between experienced teachers and beginners. Ma judged the group as a whole to be “above average”. In particular, although “math anxiety” is rampant among elementary school teachers, this group had positive attitudes about mathematics: they overwhelmingly felt that they could handle basic mathematics and that they could learn advanced mathematics. The Chinese teachers were from schools chosen to represent the range of Chinese teaching experience and expertise: urban schools and rural, stronger schools and weaker.

The teachers’ grasp of mathematics was probed in interviews organized around four questions. In summary form, the questions were as follows:

1) How would you teach subtraction of two-digit numbers when “borrowing” or “regrouping” is needed?

2) In a multiplication problem such as $123 \times 645$, how would you explain what is wrong to a student who performs the calculation as follows?

$$
\begin{array}{r}
  123 \\
  \times 645 \\
  \hline
  615 \\
  1845 \\
  492 \\
  738 \\
  \hline
  1845
\end{array}
$$

(The student has correctly formed the partial products of 123 with the digits of 645, but has not “shifted them to the left”, as required to get a correct answer.)

3) Compute $\frac{11}{2}$. Then make up a story problem which models this computation, that is, for which this computation provides the answer.

4) Suppose you have been studying perimeter and area and a student comes to you excited by a new “theory”: area increases with perimeter. As justification the student provides the example of a $4 \times 4$ square changing to a $4 \times 8$ rectangle: perimeter increases from 16 to 24, while area increases from 16 to 32. How would you respond to this student?

These questions are in order of increasing depth. The first two involve basic issues of place-value decimal notation. The third involves rational numbers and also involves division, the most difficult of the arithmetic operations. It further requires “modeling” or “representation”—connecting a calculation with a “real-world” situation. The last problem, which was originally stated in terms of perimeter and area of a “closed figure”, potentially involves very deep issues. Even if one replaces “closed figure” with “rectangle”, as all the teachers did, one must still compare the behavior of two functions of two real variables.

On sheepskin the American teachers seemed decidedly superior to the Chinese: they all were college graduates, and several had MAs. The Chinese teachers had nine years of regular schooling, and then three years of normal school for teachers—in terms of study time, a high school degree. However, measured in terms of mastery of elementary school mathematics, the Chinese teachers came out better.

The rough summary of the results of the interviews is: the Chinese teachers responded more or
less as one would hope that a mathematics teacher would, while the American teachers revealed disturbing deficiencies. In more detail, on the first two problems, all teachers could perform the calculations correctly and could explain how to do them, that is, describe the correct procedure. However, even on the first problem, fewer than 20% of the U.S. teachers had a conceptual grasp of the regrouping process—decomposing one 10 into 10 ones. By contrast, the Chinese teachers overwhelmingly (86%) understood and could explain this decomposition procedure. On the second problem, about 40% of the U.S. teachers could explain the reason for the correct method of aligning the partial products, while over 90% of the Chinese teachers showed a firm grasp of the place value considerations that prescribe the alignment procedure.

On the third problem, a gap appeared even at the computational level: well under half of the American teachers performed the indicated calculation correctly. Only one came up with a technically acceptable story problem. Even this one was pedagogically questionable, since the units for the answer (3 1/2) persons, which children might expect to come in whole numbers. The Chinese teachers again all did the calculation correctly, and 90% of them could make up a correct story problem. Some suggested multiple problems, illustrating different interpretations of division.

On the fourth problem, the U.S. teachers did exhibit some good teaching instincts, and most, though not all, could state the formulas for area and perimeter of rectangles. However, when it came to analyzing the mathematics, they were lost at sea. Although most wanted to see more examples, over 90% were inclined to believe that the student’s claim was valid. Some proposed to look something up in a book. Only three attempted a mathematical investigation of the claim, and again a lone one found a counterexample. The Chinese teachers also found this problem challenging, and most had to think about it for some time. After consideration, 70% of them arrived at a correct understanding, with valid counterexamples. Of the 30% who did not find the answer, most did think mathematically about the problem, though not sufficiently rigorously to find the defect in the student’s proposal.

The contrast between the performances of the two groups of teachers was even more dramatic than this summary reveals. Some Chinese teachers gave responses that more than answered the question. They sometimes offered multiple solution methods. In the integer arithmetic problems, some indicated that, if the student was having trouble here, it meant that something more fundamental had not been learned properly. These comments point to a deeper layer of teaching culture that simply does not exist in the U.S. For example, American teaching of two-digit subtraction is usually based on “subtraction facts”, the results of subtracting a one-digit number from a one- or two-digit number to get a one-digit number. These are simply to be learned by rote. The Chinese base subtraction on these same facts, but they refer to this topic as “subtraction within 20” and treat it as one to be understood thoroughly, since they regard it as the link between the computational and the conceptual basis for multidigit subtraction. In answering question 3, some Chinese teachers suggested that the given problem was too easy and offered harder ones. Also, the Chinese teachers were comfortable with the algebra that is implicitly involved in performing arithmetic with our standard decimal notation—for example, many explicitly invoked the distributive law when discussing multidigit multiplication. No such awareness of the algebraic backbone of arithmetic was shown by the American teachers.

In these first four chapters, KTEM also discusses issues of teaching methods. Without going into detail about this, I will report that the same limitations that teachers showed in giving a conventional explanation of a topic also prevented them from getting to the conceptual heart of the issue when using teaching aids such as manipulatives.

Thus, KTEM suggests that Chinese teachers have a much better grasp of the mathematics they teach than do American teachers. The hard-nosed might ask for evidence that this extra expertise actually produces better learning. Since Ma’s work did not extend to a simultaneous study of the students of the teachers, KTEM cannot address this question. However, the substantial studies of Stevenson and Stigler [SS] do document superior mathematics achievement in China. (The Stevenson-Stigler project provided part of the motivation for Ma’s work.) KTEM itself also provides some evidence of superior learning in China and of a sort directly related to the knowledge of teachers, as indicated in the interviews. The four interview questions were presented to a group of Chinese ninth-grade students from an unremarkable school in Shanghai. They all (with one quite minor lapse) could do all the calculations correctly and knew the perimeter and area formulas for rectangles. Over 60% found a counterexample to the student’s claim about area and perimeter, and over 40% could make up a story problem for the division of fractions in question 3. These Chinese ninth-grade students demonstrated better understanding of the interview problems than did the American teachers.

One should also entertain the possibility that Ma was overly optimistic in judging her group of American teachers to be “above average”. However, this rating is broadly consistent with evidence from a much larger set of interviews conducted by Deborah Ball [B1-3] and also with the study [PHBL] of
over two hundred teachers in the Midwest. In that
study, for example, only slightly over half the sub-
jects could provide an example of a number be-
tween 3.1 and 3.11. The portion of satisfactory re-
sponses to questions testing pedagogical compe-
tence was considerably smaller. The results of
KTEM are also consistent with massive informal
testimony from serious workers in professional de-
velopment for teachers. The remarkable thing is
that this problem—the failure of our system to pro-
duce teachers with strong subject matter knowl-
edge and the negative impact of this failure—is not
more explicitly recognized. Furthermore, solving
this problem is not a major focus of mathemati-
cal education research and of education policy. I
hope that KTEM will provide impetus for making
it so.

KTEM gives us new perspectives on the problems
involved in improving mathematics education in
the U.S. For example, it strongly suggests that
without a radical change in the state of mathe-
matical preparedness of the American teaching
corps, calls for teaching with or for “understand-
ing”, such as those contained in the NCTM Stan-
ards, are simply doomed. To the extent that they
divert attention from the crucial factor of teacher
preparedness, they may well be counterproductive.
KTEM also indicates that claims that the tradi-
tional curriculum failed are misguided. The tra-
ditional curriculum allowed millions of people to
be taught reliable procedures for finding correct
answers to important problems, without either the
teachers or the students having to understand
why the procedures worked. At the same time,
students with high mathematical aptitude could
learn substantially more mathematics, enough to
support various technical or academic careers.
This has to be counted a major success.

However, times have changed. The success of
the traditional curriculum has fostered a mathemati-
cally based technology, which in turn has cre-
ated conditions in which that curriculum is no
longer appropriate. There are at least two reasons
for this. First, we have cheap calculators that will
do (at least approximately) any calculation of the
elementary curriculum (and much more) with the
push of a couple of buttons. These machines are
typically much faster and more reliable than we are
in doing these calculations. We also have “computer
algebra” systems that will do more kinds of cal-
culations than any single human knows how to do.
It has always been one of the strengths of mathe-
matics to seek reliable and systematic methods of
computation, which has often meant creating al-
gorithms. Anything that has been algorithmized
can be done by a computer. Automation of calcu-
lation means that actually performing a calculation
is no longer a problem working people usually
have to worry about.

At the same time, it means that calculation is
much more prevalent than before. Hence, people
have to spend more time determining what calcula-
tion to do. That is the second reason that mathem-
atics education needs to change. My daughter
was a solid mathematics student but had no en-
thusiasm for the subject and did not expect to
use it in whatever career she might choose. Now
she works in management consulting, and she
finds that her high school algebra comes in handy
in creating spreadsheets. Simply learning computa-
tional procedures without understanding them
will not develop the ability to reason about what
sort of calculations are needed. In short, to func-
tion at work, people now need more understanding
and less procedural virtuosity than they did a
generation ago. (Who knows what they will need
in another generation!)

The good news from KTEM is that there is no
serious conflict between procedural knowledge
and conceptual knowledge: Chinese teachers seem
to be able to develop both in their students. (This
is another intuition of most mathematicians I know
who have been studying educational issues: it
should be the case that procedural ability and con-
ceptual understanding support each other. The
Chinese teachers had a traditional saying to de-
scribe this learning goal: “Know how, and also
know why.”) The bad news is that our current
teaching corps is not capable of delivering this
kind of double understanding: we can only rea-
sonably ask them for procedural facility. Let us be
clear that this is not a matter of teachers lacking
certification or teaching outside their specialty,
which are both frequent problems that aggravate
the situation. The certification procedures, the
teaching methods courses, most college mathe-
matics courses, the recruitment processes, the
conditions of employment, most current teacher
development—none of these is geared to ensuring
that U.S. mathematics teachers have themselves
the understanding needed to teach for understand-
ing. In short, virtually the whole American K-12 math-
ematics education enterprise is out of date.

How might the U.S. create a teaching corps with
capabilities more like those of the Chinese teach-
ers? To begin to answer, we should try to be pre-
cise as to what the differences are between the two
groups. From the evidence of KTEM, I would list
three salient differences:

1. Chinese teachers receive better early training—
good training produces good trainers, in a virtu-
os cycle.

2. Chinese mathematics teachers are specialists.
Making mathematics teaching a specialty can be ex-
pected to increase the mathematical aptitude of the
teaching corps in two ways: it reduces the man-
power requirements for mathematics education
by concentrating it in the hands of the mathe-
matically most qualified teachers, and it raises the incentives for mathematically inclined people to become teachers. Beyond its recruitment implications, it means that Chinese teachers have more time and motivation for developing their understanding of mathematics. This self-improvement is amplified by a social effect: specialization creates a corps of colleagues who can work together to deepen the common teaching culture in mathematics. Thus, making mathematics teaching a specialty works in multiple ways to increase the quality of mathematics education.

3. Chinese teachers have working conditions which favor maturation of understanding. U.S. teachers spend virtually their whole day in front of a class, while the Chinese teachers have time during the school day to study their teaching materials, to work with students who need or merit special attention, and to interact with colleagues. New teachers can learn from more experienced ones. All can study together the key aspects of individual lessons, an activity they engage in systematically. They can also sharpen their skills by discussing mathematical problems. Stevenson and Stigler [SS] have observed that time for self-development is a general feature of mathematics education in East Asia, which, to go by TIMSS [DoEd1-3] as well as [SS], has the most successful systems of mathematics education in the world today.

The combination of training, recruitment, and job conditions that prevail in China helps produce a level of teaching excellence that Ma calls PUFM, "profound understanding of fundamental mathematics". PUFM and how it is attained is the concern of Chapters 5 and 6. It is important to understand that PUFM involves more than subject matter expertise, vital as that is; it also involves how to communicate that subject matter to students. Education involves two fundamental ingredients: subject matter and students. Teaching is the art of getting the students to learn the subject matter. Doing this successfully requires excellent understanding of both. As simple and obvious as this proposition may seem, it is often forgotten in discussions of mathematics education in the U.S., and one of the two core ingredients is emphasized over the other. In K–12 education the tendency is to emphasize knowing students over knowing subject matter, while at the university level the emphasis is frequently the opposite. (This cultural difference may well be part of the reason some university mathematicians have reacted negatively to the NCTM Standards. The emphasis on teaching methods over subject matter is prominent in the recommendations and "vignettes" of this document.) Both these views of teaching are incomplete.

What educational policies in the U.S. might promote the development of a teaching corps in which PUFM were, if not commonplace, at least not ex-

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Getting the Mathematics to the Students

Ma's notion of "profound understanding of fundamental mathematics (PUFM)", involves both expertise in mathematics and an understanding of how to communicate with students. Teacher Mao, one of the teachers Ma identified as possessing PUFM, eloquently expressed the need for both types of understanding:

I always spend more time on preparing a class than on teaching, sometimes three, even four times the latter. I spend the time in studying the teaching materials: what is it that I am going to teach in this lesson? How should I introduce the topic? What concepts or skills have the students learned that I should draw on? Is it a key piece on which other pieces of knowledge will build, or is it built on other knowledge? If it is a key piece of knowledge, how can I teach it so students grasp it solidly enough to support their later learning? If it is not a key piece, what is the concept or the procedure it is built on? How am I going to pull out that knowledge and make sure my students are aware of it and the relation between the old knowledge and the new topic? What kind of review will my students need? How should I present the topic step-by-step? How will students respond after I raise a certain question? Where should I explain it at length, and where should I leave it to students to learn it by themselves? What are the topics that the students will learn which are built directly or indirectly on this topic? How can my lesson set a basis for their learning of the next topic, and for related topics that they will learn in their future? What do I expect the advanced students to learn from this lesson? What do I expect the slow students to learn? How can I achieve these goals? etc. In a word, one thing is to study whom you are teaching, the other thing is to study the knowledge you are teaching. If you can interweave the two things together nicely, you will succeed. We think about these two things over and over in studying teaching materials. Believe me, it seems to be simple when I talk about it, but when you really do it, it is very complicated, subtle, and takes a lot of time. It is easy to be an elementary school teacher, but it is difficult to be a good elementary school teacher.

I would like to highlight the concern in Teacher Wang's statement for the connectedness of mathematics, the desire to make sure that students see mathematics as a coherent whole. This is certainly how mathematicians see it, and to us it is one of the major attractions of the field: mathematics makes sense and helps us make sense of the world. For me, perhaps the most discouraging aspect of working on K–12 educational issues has been confronting the fact that most Americans see mathematics as an arbitrary set of rules with no relation to one another or to other parts of life. Many teachers share this view. A teacher who is blind to the coherence of mathematics cannot help students see it.

—R. H.
tremely rare? This question is discussed in Chapter 7, the final chapter of KTEM. I would like to add my own perspective on the issue. The differences (1), (2), and (3) listed above suggest part of the answer.

Differences (2) and (3) are primarily matters of educational policy. No revolution in American habits is required to create mathematics specialists or to give them opportunity for study and collegial interaction. What is mainly required is political will.

Regarding difference (2), the manpower considerations which favor mathematics specialists beginning in the early grades are much stronger in the U.S. than in China. The U.S. information society has much higher demand for mathematically able people than does the predominantly rural economy of China. Hence, schools face much heavier competition for mathematically competent personnel, and every policy that could lower their manpower requirements or improve their competitive position would benefit mathematics education. The difference in technological level also makes the need for coherent mathematics education greater in the U.S. than in China. Simply partitioning the present cadre of elementary teachers into math specialists and nonmath would already offer the average child a better-qualified (elementary) math teacher while relieving many others of what is now an onerous duty, all without raising overall personnel requirements. Some educators have for some time been calling for mathematics specialists even in the elementary grades [Us]. Perhaps the evidence from KTEM that having teachers who understand mathematics can make a difference already in the second grade (the usual time for two-digit subtraction) can convince education policymakers to heed this call.

Regarding difference (3), testimony from interviews of teachers with PUFM indicates that having time for study and collegial interaction is an important factor in developing PUFM. Such time would be most productive in the context of mathematics specialists—both study and discussion would be more focused on mathematics. Scheduling this time might be more controversial than creating specialists because it requires resources. In fact, in East Asia classes are larger than here, so a given teacher there handles about the same number of students as does a teacher in the U.S.[SS]. The improvement in lessons promoted by study and interaction with colleagues seems to more than make up for larger class size. There is currently in the U.S. a call to reduce class size. On the evidence of KTEM and [SS], I believe that the resources required for such a change would be better spent in eliminating difference (3).

What will be hardest is eliminating difference (1), that is, establishing in the U.S. the virtuous cycle, in which students would already graduate from ninth grade or from high school with a solid conceptual understanding of mathematics, a strong base on which to build teaching excellence. I expect that movement in that direction will, at least at the start, require massive intervention from higher education. New professional development programs, both preservice and in-service, that focus sharply on fostering deep understanding of elementary mathematics in a teaching context will need to be created on a large scale. Current university mathematics courses will not serve; as KTEM makes clear, the needs of teachers at present are of a completely different nature from the needs of professional mathematicians or technical users of mathematics, for whom almost all current offerings were designed.

I would recommend that these programs be joint efforts of education departments and mathematics departments to guarantee that the two poles of teaching, the subject matter and the pedagogy, both get emphasized. These departments have rather different cultures, and developing productive working relationships will not be a simple task; but with sufficient backing from policymakers who understand the current purposes and needs of mathematics education and the shortfall between current capabilities and these needs, some beneficial programs should emerge.

While the greatest need for improvement is probably at the elementary level, middle school and secondary teachers should not be neglected in the new professional development programs. Undoubtedly they know more mathematics than the typical elementary school teacher, but they too must have suffered from the lack of attention to understanding during their early education. Moreover, they need to deal with a larger body of material than do elementary teachers.

There is also the issue of texts. The Chinese teachers have materials, texts, and teaching guides that support their self-study. American texts tend to be lavishly produced but disjointed in presentation [Sc, DoEd1-3], and the teacher's guides do not help much either. Thus, the intervention programs should also work to create materials which will help teachers both learn and transmit a coherent view of mathematics. Eventually, these might be the basis for new texts.

At least at the start, these programs should be multiyear in scope, both so that teachers who do not have the favorable working conditions of Chinese teachers can nevertheless refresh and progressively improve their understanding of mathematics and so that those teachers who do obtain such working conditions can get to the level where self-directed study can be a reliable mode of improvement. One of the most outmoded ideas in education is that a teacher can reasonably be expected to know all that he or she needs to know,
of subject matter or teaching, at the start of work. Continued study, especially of subject matter, since teaching itself will provide plenty of opportunities for learning about children, should become the norm. If a program of this sort is implemented successfully, it should gradually become less necessary. The step-by-step improvement in education provided by teachers with better understanding and the gradual deepening of teaching culture by teachers interacting collegially among themselves should allow elaborate development programs to shrink and eventually disappear or to shift to study of more sophisticated topics, becoming, in subject matter at least, more like standard college mathematics courses. This would constitute truly satisfying progress in our system of mathematics education. However, it will require great effort and resolve to achieve.

In summary, KTEM has lessons for all educational policymakers. Legislators, departments of education, and school boards need to understand the potential value in creating a corps of elementary-grade mathematics specialists who have scheduled time for study and collegial interaction. University educators need to understand teacher training in mathematics as a distinct activity, different from but of comparable value to training scientists, engineers, or generalist teachers. I believe that these mutually supportive changes would give us a fighting chance for successful mathematics education reform.

References


The Clay Mathematics Institute (CMI) was founded in September 1998 as a private philanthropic foundation dedicated to mathematics. Its aim is to increase and disseminate mathematical knowledge and to recognize extraordinary achievements in mathematics by students and researchers. In pursuit of this aim, the CMI will implement a wide variety of projects around the world.

The CMI was established through an endowment by Landon T. Clay, a prominent Boston businessman who served for many years as the chief executive officer and chairman of the mutual fund company Eaton Vance. Arthur Jaffe, whose chair at Harvard University was also endowed by Landon T. Clay, is the president of the CMI Corporation. Jaffe served as president of the AMS during 1997-1998.

Unlike most organizations having the label "mathematics institute", the CMI does not function as a center for conferences or visitors. Rather, the CMI acts as a foundation, employing individuals to create mathematics and sponsoring projects that advance the field. The scope of the CMI is quite broad. For example, it has provided a grant to assist the Independent University of Moscow, a project initiated jointly with the AMS. The CMI also supports individual mathematicians as Clay Prize Fellows. Recently, eighth-grade student Po Ru Loh was selected as the first CMI Olympiad Scholar, a distinction that recognizes the most original solution to a problem in the American Mathematical Olympiad competition.

The latter award demonstrates one of the CMI's most important aims, to honor mathematical achievements and to encourage students in their mathematical pursuits. "One of the goals of the institute is to fundamentally change attitudes toward mathematics and to encourage young people to do mathematics," Jaffe explains. "We also hope to inspire people outside of mathematics to appreciate the importance of the field."

The CMI is run by its five-person board of directors, and several committees of mathematicians provide advice. The initial Scientific Advisory Board consists of Alain Connes of the College de France and Institut des Hautes Etudes Scientifiques, Andrew Wiles of Princeton University, and Edward Witten of the Institute for Advanced Study. This board is supplemented by three liaison committees of mathematicians: one draws on Boston-area institutions, one is at the national level, and one is at the international level. Although located in Cambridge, Massachusetts, the CMI is an independent organization not officially linked to Harvard University, the Massachusetts Institute of Technology, or any other university.

While Jaffe says that he prefers not to speak about the amount of the endowment of the CMI, but rather to focus on CMI's goals, ideas, and projects, he does say that "We are very handsomely endowed." A special event entitled A Celebration...
of the Universality of Mathematical Thinking was held on May 10 to celebrate the opening of the CMI [see sidebar]. The fact that the event featured speakers from five different countries shows that the CMI has already gained a high international profile.

The ambitious and exalted aims of the CMI are well captured in its Statement of Purpose: “The primary objectives and purposes of the Clay Mathematics Institute, Inc., are to increase and disseminate mathematical knowledge, to educate mathematicians and other scientists about new discoveries in the field of mathematics, to encourage gifted students to pursue mathematical careers, and to recognize extraordinary achievements and advances in mathematical research. The Clay Mathematics Institute will further the beauty, power, and universality of mathematical thinking.” Through the establishment of the CMI, the international mathematical community has gained a new source of support for the activities that keep the field thriving.

—Allyn Jackson

Clay Mathematics Institute
1770 Massachusetts Avenue, #618
Cambridge, MA 02140, USA
Telephone: 617-868-8277
Fax: 617-491-1449
E-mail: cmi@claymath.org

CMI Kickoff in Cambridge
The opening of the Clay Mathematics Institute took place on May 10, 1999, in a festive atmosphere. About 450 mathematicians gathered at the Massachusetts Institute of Technology (MIT) for a “happening”, followed by a reception and by dinner in Boston for out-of-town guests. The ceremony excited interest in mathematics, and it received high praise from many persons who were present. CMI founder Landon Clay described the genesis of CMI. Then, mathematician and sculptor Helaman Ferguson unveiled the CMI icon that he had been commissioned to produce. It is a Mongolian granite sculpture named Figure Eight Knot Complement, CMI.

At this point, as a surprise in the program, Mr. Clay brought forward a hand-held bronze miniature of CMI, while Mrs. Clay produced a miniature of its wooden base. Andrew Wiles received the first CMI Award, in the form of the bronze miniature and the base.

The program proceeded with a mini-forum on mathematics and society, moderated by David Gergen of U.S. News & World Report and featuring as speakers Nobel laureate Dudley Herschbach and William Odom, former director of the National Security Agency. The much anticipated keynote address by Wiles followed, with a spectacular, exciting, and witty presentation on “The Future of Number Theory”, aimed at a general audience.

Other speakers at the opening included MIT president Charles Vest, Alain Connes of the Institut des Hautes Études Scientifiques (IHES), Michael Atiyah of the Royal Society, Edward Witten of the Institute for Advanced Study, and Barry Mazur of Harvard University. During the dinner, Rita Colwell, director of the National Science Foundation, spoke positively about mathematics and the CMI. Other dinner speakers included mathematicians Jean-Pierre Bourguignon of IHES, William Browder of Princeton University, David Mumford of Brown University, who represented the International Mathematical Union, and Ludwig Faddeev of the Russian Academy of Sciences. Also speaking at the dinner were Konrad Osterwalder, rector of the Eidgenössisches Technische Hochschule (ETH) in Zürich; and Finn Caspersen, chair of the Knickerbocker Management Corporation, who gave uplifting encouragement to private support of mathematics.

—Arthur Jaffe
In June 1999 the John D. and Catherine T. MacArthur Foundation announced 31 new MacArthur Fellowships presented to 32 individuals. The Fellows will receive stipends ranging from $200,000 to $375,000 over five years, depending on the age of the recipient.

Four of the fellows work in the mathematical sciences: JUAN MARTIN MALDACE NA, PETER SHOR, EVA SILVERSTEIN, and JEFFREY R. WEEKS.

Juan Maldacena
Juan Maldacena was born September 10, 1968, in Buenos Aires, Argentina. He is redefining the boundaries of mathematical physics. He works in the highly abstract field of string theory, which postulates the existence of fundamental constituents of matter too small to detect with current experimental apparatus. He has made key conceptual breakthroughs that have clarified thorny problems in theoretical physics, including the ultimate structure of matter.

In his graduate work, Maldacena showed how radiation from a black hole can be explained within the context of string theory. This work holds important implications for understanding gravity. String theories inherently include an explanation of gravitation consistent with quantum effects. More recently, Maldacena captured the attention of the theoretical physics community by postulating a critical theoretical link between the 4-dimensional structure of quantum chromodynamics (QCD) and a 10-dimensional theory based on strings. (There are only five possible meaningful string theories, each of which represents a limiting case of a single 11-dimensional model known as “M-theory.”) By identifying a plausible method for explaining the earlier QCD theory in the context of the newer but purely theoretical field of string theories, Maldacena’s work holds out the promise of a “grand unification” of all known physical forces.

Maldacena completed his undergraduate studies at the University of Buenos Aires and Universidad de Cuyo, Bariloche, Argentina (1991), and his Ph.D. (1996) at Princeton University. He did a year of postdoctoral work at Rutgers University. Maldacena has been teaching at Harvard University since 1997. His MacArthur Fellowship stipend is $245,000.

Peter Shor
Peter Shor was born August 14, 1959, in New York, New York. He is helping shape the field of quantum computing. Using tools from physics, computation, and information theory, his discoveries offer the possibility of an exponential increase in the speed of an important class of calculations. In so doing, he is breaking limits in computing previously thought to be insurmountable.
It has been known since the 1980s that the superposition of states in quantum mechanics allows, at least in principle, the construction of quantum computers whose computational phase is massively parallel and hence more efficient than classical computers. However, the typical quantum measurement process irrevocably alters a state, and this fact raises obstacles to obtaining the desired output. Shor was the first to show how to design, from start to finish, an algorithm by which a quantum computer could efficiently solve an important practical problem, the factoring of large numbers. Should large quantum computers ever be built, public-key cryptography, whose most popular manifestations rely upon on the supposed difficulty of factoring large integers and computing discrete logarithms, would no longer be secure.

Shor received a B.S. (1981) from the California Institute of Technology and a Ph.D. (1985) from the Massachusetts Institute of Technology. He did postdoctoral work (1985-86) at the Mathematical Sciences Research Institute in Berkeley. He has been at AT&T Labs Research since 1986. In 1998 he received the Nevanlinna Prize [see "Peter Shor Receives Nevanlinna Prize", Notices, November 1998, page 1361]. His MacArthur Fellowship stipend is $290,000.

Eva Silverstein

Eva Silverstein was born October 24, 1970. A theoretical physicist, she questions fundamental assumptions of physics theory. In collaboration with Shamit Kachru, an assistant professor of physics at the University of California, Berkeley, Silverstein is linking recent theories of particle physics and cosmology. She explores the relationship between the cosmological constant (a concept that originated with Einstein's general theory of relativity) and more recent explanations of particle physics based on string theory. These studies provide key insights into the age, structure, dynamics, and eventual fate of the universe.

Kachru and Silverstein have adopted a contrarian strategy for understanding empty space. Beginning with Einstein, physicists have increasingly recognized that explaining the properties of empty space is critical to explaining our observations of mass, gravity, and cosmology. Quantum theory requires any vacuum to be filled with particles and antiparticles, continually created and annihilated. Getting the equations to add up properly requires quantum field theorists to postulate a host of as yet unobserved particles subsumed under a theory known as "supersymmetry". The mathematically desirable properties of this theory have been adopted by string theorists as "superstrings". Against this body of research, Kachru and Silverstein have employed orbifold theory to show how string theory can potentially explain vacua without resorting to postulating a zoo of supersymmetric particles. If successful, this program would greatly reduce the conflict between the cosmological constant and particle physics. In addition to her work on nonsupersymmetric vacua, Silverstein and collaborators have made noteworthy contributions to the development of M-theory, the umbrella theory for string theories.

Silverstein received a B.A. (1992) from Harvard University and a Ph.D. in physics (1996) from Princeton University. She worked for one year as a postdoctoral associate at Rutgers University and has been an assistant professor at the Stanford University Linear Accelerator Center since 1997. Her MacArthur Fellowship stipend is $235,000.

Jeffrey Weeks

Jeffrey Weeks was born December 10, 1956, in Coronado, California. Weeks is a researcher, writer, software developer, and mathematics educator. He has made fundamental contributions to the analysis of knots and collaborates with cosmologists to determine the shape of the universe. His software (available without charge) provides a powerful tool for researchers and for teaching low-dimensional geometry. In addition, Weeks writes texts and articles which are targeted at young adults and nonspecialists and are designed to stimulate interest and skill in thinking about geometry and space.

Weeks's mathematical research centers on describing the topology of knots and hyperbolic structures. He developed a practical computer algorithm for classical knots with hyperbolic complements using a method called "canonical cell decomposition". This algorithm allows mathematicians to quantify permutations of knots delineated by a user-defined set of constraints and then to test and group the topological properties of these knots. On the basis of this work, Weeks developed a general-purpose computer program called SnapPea, which is widely used by mathematicians to explore a large variety of geometrical problems. His book The Shape of Space (Marcel Dekker, 1985) is an approachable introduction to topological analysis. Although Weeks currently holds no academic position, he collaborates with
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1998 Annual Survey of the Mathematical Sciences
(Second Report)

Report on the 1998 Survey of New Doctoral Recipients, Starting Salary Survey of New Doctoral Recipients, Faculty Characteristics, Enrollment Profile, Undergraduate Majors, and Graduate Student Profile

Paul W. Davis, James W. Maxwell, and Kinda M. Remick

This is the Second Report of the 1998 Survey, which includes analysis of data on departmental enrollments, majors, and faculty size, as well as an update of the First Report, which appeared in the Notices of the AMS in February 1999, pages 224-35. It included a report on the 1997-98 new doctoral recipients and salary data on faculty members in four-year colleges and universities.

The 1998 Annual Survey represents the forty-second in an annual series begun in 1957 by the Society. The 1998 Survey was under the direction of the Annual Survey Data Committee, whose members were Paul W. Davis (chair), Lorraine Denby, Malay Ghosh, Mary W. Gray, Alfred W. Hales, Don O. Loftsgaarden, James W. Maxwell (ex officio), Mary Beth Ruskai, Ann K. Stehney, and Ann E. Watkins. Comments or suggestions regarding the Annual Survey may be directed to the Committee.

Highlights
The final count of 1,231 new doctors awarded July 1, 1997, through June 30, 1998, is a slight increase over the previous year's final count of 1,174, continuing last year's gradual increase. The number (and proportion) of 1997-98 doctoral recipients who were female rose slightly to 306 (24.8%) after last year's substantial jump to 298 (25.0%). However, this year's figure of 306 represents the largest number of female recipients ever reported.

The final fall 1998 unemployment rate was 4.9%, an increase from last year's 3.8% but still about half the devastating rates of much of the '90s. As last year, employment in business, industry, and government seemed to account for much of the improvement. These sectors employed 307 individuals (34.8%) of those who found employment in the U.S., comparable to last year's 286 individuals (35.5%).

Using data collected from 539 of the 1997-98 doctoral recipients employed in the U.S., 313 reported obtaining a permanent position and 226 a temporary position. Of the latter, 128 took the position because a suitable permanent one was not available; 129 classified their temporary position as postdoctoral.

Of those who were employed, about three-quarters agreed that their positions were related to their field, professionally challenging, and commensurate with their education. About three-fifths agreed that their position was similar to what they expected at the beginning of their doctoral programs, but one-fifth disagreed, sometimes strongly, with that proposition.

The fall 1998 median starting salary for a 9-10-month appointment, teaching or teaching and research, was $37,000, a very slight increase from the 1997 median of $36,500, itself an increase of only $600 from 1996. Within mathematics departments, the total full-time doctoral faculty increased by only 0.5% over the year. The number of untenured tenure-track doctoral faculty increased by 1.7%, reversing a trend of steady decline. However, the number of non-tenure-track doctoral faculty continued to increase, this year by 6.1%.

This year's 3.8% increase in the number of first-year graduate students enrolled in doctorate-granting mathematics departments continues last year's increase of 4.7%, the first since 1991. Although the total number of full-time female graduate students in these institutions increased by 3.1% (following last year's first-year increase of 8.1%), first-year female enrollments rose only 0.9%. Group VA departments reported substantial drops in almost all categories of graduate enrollment, but response rates were too small to permit reliable prediction for all such departments.
As has been the case for a number of years, much of the data in these reports is presented for departments divided into groups according to several characteristics, the principal one being the highest degree offered in the mathematical sciences. Doctorate-granting departments of mathematics are further subdivided according to their ranking of "scholarly quality of program faculty" as reported in the 1995 publication Research-Doctorate Programs in the United States: Continuity and Change. These rankings update those reported in a previous study published in 1982. Consequently, the departments that now comprise Groups I, II, and III differ significantly from those used in prior surveys. The reader should keep this in mind when attempting to make comparisons by group with previous Annual Survey reports.

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

Brief descriptions of the groupings used for reporting purposes are as follows:

Group I is composed of 48 departments with scores in the 3.00-5.00 range.

Group I Public and Group I Private are Group I departments at public institutions and private institutions respectively.

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

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

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

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

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

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

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

Listings of the departments which comprise Groups I through V are available through the AMS's Web site at www.ams.org/membership/survey.html.


2These findings were published in An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences, edited by Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, National Academy Press, Washington, DC, 1982. The information on mathematics, statistics, and computer science was presented in digest form in the April 1983 issue of the Notices, pages 257-67, and an analysis of the classifications was given in the June 1983 Notices, pages 392-3.

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Paul W. Davis is professor of mathematics at Worcester Polytechnic Institute. James (Jim) W. Maxwell is AMS associate executive director for Professional Programs and Services. Kinda M. Remick is AMS survey specialist.

Introduction

The AMS-IMS-MAA Annual Survey collects information each year about departments, faculties, and students in the mathematical sciences at four-year colleges and universities in the United States. This article reports results from three parts of the 1998 AMS-IMS-MAA Annual Survey. First, we update information about new doctoral recipients reported earlier in the February 1999 issue of the Notices of the American Mathematical Society (see pages 224–35). Second, we present the starting salaries of the new doctoral recipients who responded to a follow-up survey. Third, we present results about the characteristics of faculties and of instructional programs at the undergraduate and graduate levels.

In the interest of continuity in analysis and presentation and to make year-to-year comparisons possible, we report the same kinds of information that were included in last year's Second Report. Details are presented concerning employment patterns for new doctoral recipients, department faculty characteristics, and distribution of enrollments in different types of departments. As explained in the 1997 First Report section "Revised Procedure for Survey of Employment Status" (Notices of the AMS, January 1998, page 33), individual recipients of new doctorates formerly reported their employment status for the upcoming fall during the summer following the academic year in which the degree was awarded. For this year's survey, all doctoral recipients were sent in October the revised and expanded questionnaire Employment Experiences of New Doctoral Recipients. They were asked to report their employment status as of the week of October 12, 1998, and to report additional details on their employment experiences as of that week. In spite of this change in procedure, comparisons with prior years of the key employment indicators remain valid. In addition, use of the survey form and procedures allows the employment experiences of the 1997-98 doctoral recipients in the mathematical sciences to be compared with those of doctoral recipients in a number of other academic disciplines. An initial report on this comparative data is available through Science magazine's Next Wave Web site at www.nextwave.org.

For the Departmental Profile Survey, we follow the procedure started in the 1991 Second Report of reporting projections of survey responses to the entire population of mathematical sciences departments. The projections of survey responses to the entire population are done within strata defined by the survey groups. For example, on the part concerned with faculty, there were 21 usable responses from the twenty-five departments in Group I Public (see Table 3A). The twenty-one responding departments reported 30 full-time faculty to have retired or died, and this tally was multiplied by 25/21 to obtain the projected value of 36 for the group as a whole.

We caution the reader that survey responses and the proportional projections are potentially biased due to (i) selection bias of the responding departments and (ii) inhomogeneity of departments within the survey groups. The responses and projections for total faculty size are slightly affected by this bias. Nonetheless, the problems of a possible selection bias are mitigated by the generally high re-
Table 1A: U.S. New Doctoral Recipients, Fall and Final Counts, 1991-1998

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-1993</td>
<td>1202</td>
<td>1214</td>
</tr>
<tr>
<td>1993-1994</td>
<td>1059</td>
<td>1076</td>
</tr>
<tr>
<td>1994-1995</td>
<td>1226</td>
<td>1237</td>
</tr>
<tr>
<td>1995-1996</td>
<td>1153</td>
<td>1154</td>
</tr>
<tr>
<td>1996-1997</td>
<td>1158</td>
<td>1174</td>
</tr>
<tr>
<td>1997-1998</td>
<td>1216</td>
<td>1231</td>
</tr>
</tbody>
</table>

Table 1B: Trend Chart of Final Count of New Doctoral Recipients, 1986-1998

- Total
- Male
- Female

response rates to the Annual Survey. In groups with lower response rates (e.g., Groups M and B) there is greater risk of biased projections.

Update on the 1998 Survey of New Doctoral Recipients

Information about recipients of doctoral degrees awarded between July 1, 1997, and June 30, 1998, was collected from doctorate-granting departments in late spring 1998 and from a follow-up census of individual degree recipients beginning in October. The “1998 AMS-IMS-MAA Annual Survey First Report” (Notices of the AMS, February 1999, pages 224-35) presents the survey results obtained about new doctoral recipients from the departments. Here we update the earlier figures on the basis of the follow-up census.

The names of the 1997-98 doctoral recipients and their thesis titles were published in “Doctoral Degrees Conferred” (Notices of the AMS, February 1999, pages 246-65). A supplement to this list appears after this report.

The final count of new doctoral recipients (Table 1A) shows a total of 1,231 doctorates in mathematical sciences awarded by U.S. institutions. This number represents an increase of 4.9% from the 1,174 doctorates awarded during 1996-97. Table 1B shows the overall and by-gender trends in the final counts of new doctoral recipients from 1985-86 through 1997-98.

Citizenship status is known for all of the 1,231 new doctoral recipients. The final count of new doctoral recipients who are U.S. citizens is 592. The percentage of 1997-98 new doctoral recipients who are U.S. citizens is 48.1%, up from the reported 44.5% of the past year and up slightly from the previous high of 47.9% of 1994-95. The final count of new doctoral recipients who are non-U.S. citizens decreased slightly from 652 to 639 and was well below the record high of 679 reported in the final count five years ago. Pages 228-30 of the First Report present further information related to the citizenship of the 1997-98 new doctoral recipients.

Of the 592 U.S.-citizen new doctoral recipients, 164 are women and 428 are men. The 164 women new doctoral recipients comprise 27.7% of the U.S. citizen total for 1997-98, a slight increase over last year’s count of 150 (28.7%). The number of U.S. citizen men, 428, increased by 15.1% from 1996-97.

Tables 2A and 2B display updates of employment data for the fall count of 1997-98 doctoral recipients, partitioned by field of thesis research and by the survey group of their degree department. At the time of the Second Report, the fall 1998 employment status of 1,078 of the 1,216 doctoral recipients was known. Of the 1,078, 49.4% assumed academic employment in the U.S. Another 11.0% took academic employment in other countries. Both of these percentages are equivalent to percentages reported last year but are down sharply from their levels of the early 1990s.

Employment of 1997-98 doctoral recipients by U.S. Ph.D.-granting institutions increased by 7.8% from the corresponding figure for 1996-97. Employment of the 1997-98 doctoral recipients by research institutes, government, and business and industry increased by 7.6% (including a slight increase of 3.6% in employment by business and industry).

Among those 1997-98 doctoral recipients taking employment in the U.S., 35.3% took nonacademic employment (government or business and industry). Although this percentage was almost identical to the 1996-97 doctoral recipients, overall there has been a steady growth throughout the 1990s of employment of mathematical scientists in nonacademic positions in the U.S. The corresponding figure for 1990-91 was 21.0%. The fraction of the 1997-98 doctoral recipients taking nonacademic employment varied significantly by field of thesis. Of those whose field of thesis was either algebra/number theory, real or complex analysis, or geometry/topology, 17.4% took nonacademic employment. For probability or statistics the analogous figure is 48.5%; and for applied math, discrete math/combinatorics/logic/computer science, the analogous figure is 34.1%.

Group I departments continued to award the most doctorates. Of the 1,216 doctoral degrees awarded in the mathematical sciences between July 1, 1997, and June 30, 1998, 39.5% (480) were awarded by the Group I departments, while 21.7% (264) by Group II, and 10.6% (132) by Group III.
### Table 2A: Fall 1998 Employment Status of 1997-98 U.S. Doctoral Recipients in the Mathematical Sciences, Updated April 1999

<table>
<thead>
<tr>
<th>TYPE OF EMPLOYER</th>
<th>Column Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Group I (Public)</td>
<td>22</td>
</tr>
<tr>
<td>Group I (Private)</td>
<td>13</td>
</tr>
<tr>
<td>Group II</td>
<td>14</td>
</tr>
<tr>
<td>Group III</td>
<td>3</td>
</tr>
<tr>
<td>Group IV</td>
<td>2</td>
</tr>
<tr>
<td>Group V</td>
<td>1</td>
</tr>
<tr>
<td>Master's</td>
<td>12</td>
</tr>
<tr>
<td>Bachelor's</td>
<td>28</td>
</tr>
<tr>
<td>Two-Year College</td>
<td>1</td>
</tr>
<tr>
<td>Other Academic Dept.</td>
<td>6</td>
</tr>
<tr>
<td>Research Inst./Nonprofit</td>
<td>4</td>
</tr>
<tr>
<td>Government</td>
<td>6</td>
</tr>
<tr>
<td>Business/Industry</td>
<td>18</td>
</tr>
<tr>
<td>Foreign, Academic</td>
<td>26</td>
</tr>
<tr>
<td>Foreign, Nonacademic</td>
<td>1</td>
</tr>
<tr>
<td>Not seeking employment</td>
<td>2</td>
</tr>
<tr>
<td>Still seeking employment</td>
<td>9</td>
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<tr>
<td>Unknown (U.S.)</td>
<td>7</td>
</tr>
<tr>
<td>Unknown (non-U.S.)</td>
<td>10</td>
</tr>
<tr>
<td>Column Total</td>
<td>182</td>
</tr>
</tbody>
</table>

**Note:** Non-U.S. citizens who return to their country of citizenship whose status is reported as "unknown" or "still seeking employment".

### Table 2B: Fall 1998 Employment Status of 1997-98 U.S. Doctoral Recipients by Type of Granting Department, Updated April 1999

<table>
<thead>
<tr>
<th>TYPE OF DOCTORAL DEGREE-GRANTING DEPARTMENT</th>
<th>Row Total</th>
<th>Row Subtotal</th>
</tr>
</thead>
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**Note:** Non-U.S. citizens who return to their country of citizenship whose status is reported as "unknown" or "still seeking employment".
Table 2C: Percentage of New Doctoral Recipients Unemployed, As Reported in the Respective Annual Survey Second Reports, 1978-1998

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The fall 1998 unemployment rate for new doctoral recipients, based on information gathered by the time of the Second Report, increased significantly from 6.7% for fall 1992 to 8.9% for fall 1993 to 10.7% for fall 1994 and fall 1995. Following the last two years' decline to 8.1% in fall 1996 and 3.8% in fall 1997, the fall 1998 unemployment rate made an increase to 4.9%. The counts on which these rates are determined do not include those new doctoral recipients whose fall employment status was unknown at the time of the Second Report.

Table 2C presents the fall 1978 through fall 1998 trend in the final fall unemployment rate of new doctoral recipients.

Out of the 1,216 doctoral recipients reported in the First Report, 1,095 were sent the Employment Experiences of New Doctoral Recipients (EENDR) survey, and 625 (57.1%) individuals responded. The response rates varied considerably among the various subgroups of new doctorates defined by their employment status as reported by departments. Among those reported by the departments as employed in the U.S., the response rate was 58.6%. The response rate was 63.9% for those employed in academia in the U.S., but for those employed in business and industry in the U.S. the response rate dropped to 50.0%. The response rate was 37.5% for the 112 individuals in the U.S. whose employment status was unknown to the department. Females were slightly more likely to respond than males: 54.9% for females versus 50.3% for males. The response rates for U.S. citizens, permanent residents, and temporary residents were 58.5%, 47.9%, and 44.0% respectively.

The EENDR gathered details on employment experiences not available through departments and not gathered in previous Annual Surveys. The rest of this section presents the additional information available on this subset of the 1997-98 doctoral recipients.

Of the 625 total respondents to the EENDR, 539 were employed in the U.S., 68 were employed outside the U.S., and 18 were unemployed in the U.S. as of the week of October 12, 1998. Among those employed in the U.S., 518 were employed full-time and 21 were employed part-time. Of the 21 reporting part-time employment, 10 reported that they were working part-time because a suitable full-time job was not available. Four also reported they were working part-time while they pursued additional education.

Among the 539 employed in the U.S., 313 reported obtaining a permanent position and 226 a temporary position. Of the 226 in temporary positions, 128 (56.6%) reported taking temporary employment because a suitable permanent position was not available and 129 (56.8%) classified their position as postdoctoral. Furthermore, among those in postdoctoral positions, 43.4% responded that they took the position because a suitable permanent position was not available.

Among the 313 who reported obtaining a permanent position in the U.S., 52.3% were employed in academia, 41.2% in business or industry, 4.2% in government, and the remaining 2.2% in other nonprofits or self-employed. Women held 29.7% of the permanent positions.

Among the 226 individuals with temporary employment in the U.S., 83.6% were employed in academia, 3.5% in business or industry, 5.8% in government, and the remaining 6.8% in other nonprofits, typically a research institute. One individual did not respond with a sector.

Among the 68 individuals employed outside the U.S., 72.1% were employed in academia, 17.6% in business or industry, 1.5% in government, and 8.8% in other nonprofits.
Thirteen of those employed outside the U.S. were U.S. citizens, and two were U.S. permanent residents.

The most frequently used job search resources were electronic at 56.6%, publications at 46.8%, faculty advisor at 43.9%, and informal channels (networking with colleagues or friends) at 42.0%. The remaining types of resources are used much less often, each below 23.0%. When asked to indicate the single most effective job search resource, 36.1% chose electronic resources. The next highest was informal channels at 16.7%, followed by publications at 11.7%. Not surprisingly, 76.0% reported using two or more of these methods. The AMS's Web site, e-MATH, was the most frequently mentioned electronic resource. The Notices of the AMS was the most frequently mentioned publication, followed by the Chronicle of Higher Education, Amstat News, and then the publications of other mathematical societies.

Doctoral recipients who found employment were asked to indicate their agreement or disagreement with the following four statements.

1. The position is related to my field.
2. The position is commensurate with my education and training.
3. The position is similar to what I expected to be doing when I began my doctoral program.
4. The position is professionally challenging.

Response options ranged from 5 for "strongly agree" down to 1 for "strongly disagree". The distribution of responses was very similar for statements (1), (2), and (4), and each distribution indicates strong agreement with these three statements. Between 74.0% and 81.0% responded to each with either a 4 or a 5. For statement (3), the response indicated less overall agreement, with 61.0% responding 4 or 5 and 22.6% responding 1 or 2. In summary, the positions obtained were appropriate for the type of education but were not always what was expected at the outset of the doctoral program. This distribution is very similar to last year's.

Table 2D shows the age distribution of new doctoral recipients. The median age was 30, while the mean age was 31.8. The first and third quartiles were 28 and 34 respectively.

### Table 2D: Age Distribution of New Doctoral Recipients

![Histogram showing age distribution]

Starting Salary Survey of New Doctoral Recipients

The salary figures for 1998 were compiled from information gathered on the EENDR questionnaires sent to individuals who received doctoral degrees in the mathematical sciences during the 1997-98 academic year from universities in the United States (see previous section for more details).

The questionnaires were distributed to 1,095 recipients of degrees using addresses provided by the departments granting the degrees; 625 individuals responded between late October and mid-April. Responses with insufficient data or from individuals who indicated they had part-time employment were considered unusable. Numbers of usable responses for each salary category are reported in the following tables.

Readers should be warned that the data in this report are obtained from a self-selected sample, and inferences from them may not be representative of the population.

**Key to Tables.** Salaries are listed in hundreds of dollars. Nine-month salaries are based on 9-10 months' teaching and/or research, not adding extra stipends for summer grants or summer teaching or the equivalent. Years listed refer to the academic year in which the doctorate was received. M and F are male and female respectively. Some persons receiving a doctoral degree had been employed in their present position for several years. Quartile figures are given only in cases where the number of responses is large enough to make them meaningful. All categories of "Teaching or Teaching and Research" and "Research" contain only those recipients employed at academic institutions. In addition, the "Research, 9-10 Month Salaries" table was dropped as of last year because so few recipients responded in this category that the data is not considered meaningful. Starting salaries for those reporting a postdoctoral position are available for a second year on page 902. These salaries are also included within the academic tables and box plots on the following pages 900 and 901.

Note that salaries for teaching or teaching and research have yet to return to their high point of 1970, although considerable progress has been made since 1980.

**Graphs.** The graphs show variants of standard box plots summarizing salary distribution information for the years 1994 through 1998. All values plotted for 1994 through 1997 are converted to 1998 dollars using the implicit price deflator prepared annually by the Bureau of Economic Analysis, U.S. Department of Commerce.

For a given year, the box shows the first and third quartiles and the median salary. The "whiskers" give additional information about the spread of the data, extending to points that are 1.5 interquartile distances from the median. Minimum and maximum salaries are depicted by asterisks or dots outside the whiskers; dots are used to distinguish extreme outliers, i.e., values that are more than 3 interquartile distances from the median.
### Teaching or Teaching and Research

#### 9-10 Month Salaries

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One year or less experience (156 men/52 women)

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#### 11-12 Month Salaries

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One year or less experience (19 men/11 women)

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### Diagrams

#### Teaching or Teaching and Research

- **9-10 Month Salaries**
- **11-12 Month Salaries**

Each dot represents a reported salary, with box plots indicating the distribution of salaries.
### Research 11-12 Month Salaries

(17 men/9 women)

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One year or less experience (15 men/8 women)

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### Government 11-12 Month Salaries

(20 men/4 women)

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One year or less experience (16 men/4 women)

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<th>Q₃</th>
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<tr>
<td>1997M</td>
<td>370</td>
<td>476</td>
<td>573</td>
<td>608</td>
<td>750</td>
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<tr>
<td>1997F</td>
<td>350</td>
<td>465</td>
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<td>1998F</td>
<td>----</td>
<td>----</td>
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</tbody>
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**Research 11-12 Month Salaries**

**Government 11-12 Month Salaries**

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**September 1999**

**NOTICES OF THE AMS**

**901**
Faculty Characteristics

The Departmental Profile Survey, sent in fall 1998 to mathematical sciences departments at four-year colleges and universities as part of the Annual Survey, provided information about faculty and instructional programs. In order that more reliable year-to-year comparisons could be made, data for fall 1997 and fall 1998 were gathered, except for data on retirement, deaths, and faculty recruitment. The annual percent change figures reported in Tables 3F, 3G, 4A, 4D, 5A, 5C, and 5D are based on these two years of data. The First Report presented information collected earlier about faculty salaries (pages 232-5 of the February 1998 issue of the Notices of the AMS).

Table 3A displays losses of full-time mathematical sciences faculty due to retirements or deaths. The fall 1998 mathematical sciences faculty attrition rate for mathematics departments (Groups I, II, III, M & B combined) was 3.1%, compared with fall 1997, 1996, and 1995 figures of 2.4%, 2.3%, and 2.2% respectively. Table 3B depicts the trend in the faculty attrition rates for mathematics departments during the years 1986-98.

Table 3C displays Departmental Profile Survey information on the number of full-time faculty positions under recruitment in mathematical sciences departments in 1997-98. The number of positions under recruitment in mathematics departments increased 23.7% from 1996-97. Table 3D presents the positions under recruitment in mathematics departments for the years 1989-90 through 1997-98, while Table 3E presents the percentage of these positions reported as unfilled. Although there was a steady decrease from 1990 to 1994 and recruitment appeared to have leveled off in the past few years, this year showed the first substantial increase since 1990.

Table 3E indicates that 89.5% of the positions under recruitment by mathematics departments in 1997-98 were available to new doctoral recipients and of these 65.1% were tenured/tenure-track. The number of tenured/tenure-track positions under recruitment by mathematics departments increased by 23.1% from last year's count.

Tables 3F and 3G describe the makeup of faculties by sex, tenure status, and doctoral/nondoctoral degree in the different groups. Table 3E indicates that the total number
of full-time faculty in mathematics departments increased slightly from fall 1997 to fall 1998. After the 1995 reported decrease of 6.5%, the number of non-tenure-track, doctoral full-time faculty in mathematics departments increased by 5.7% in 1996, 12.8% in 1997, and 6.1% in 1998. This increase in non-tenure-track full-time positions continues a disturbing trend reported in "Changes in Mathematics Faculty Composition, Fall 1990 to Fall 1996" (Notices of the AMS, November 1997, pages 1321-3). There was a small overall increase in the untenured tenure-track doctoral faculty in mathematics departments. (Note that Group B accounts for 48.8% of the total of these positions within mathematics departments.) There was an overall increase of 8.1% in part-time faculty in mathematics departments. This increase was due primarily to a 6.5% increase in Group B, which accounts for 55.7% of all the reported part-time faculty in mathematics departments. The number of female non-tenure-track, doctoral full-time faculty increased by only 0.5% in mathematics departments, following the fall 1996 increase of 15.1% and the fall 1997 increase of 11.4%.

### Table 3A: Faculty Attrition*

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>I, II, &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
<th>I, II, III, M &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total faculty who retired or died</td>
<td>36</td>
<td>14</td>
<td>64</td>
<td>58</td>
<td>171</td>
<td>32</td>
<td>5</td>
<td>175</td>
<td>257</td>
<td>604</td>
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<td>1.7</td>
<td>2.9</td>
<td>2.6</td>
<td>2.4</td>
<td>1.8</td>
<td>3.5</td>
<td>3.2</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>21</td>
<td>18</td>
<td>42</td>
<td>57</td>
<td>138</td>
<td>52</td>
<td>6</td>
<td>104</td>
<td>381</td>
<td>623</td>
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</table>

** Usable responses**

<table>
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<th>II</th>
<th>III</th>
<th>I, II, &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
<th>I, II, III, M &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>21</td>
<td>18</td>
<td>42</td>
<td>57</td>
<td>138</td>
<td>52</td>
<td>6</td>
<td>104</td>
<td>381</td>
<td>623</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>84</td>
<td>78</td>
<td>75</td>
<td>78</td>
<td>78</td>
<td>78</td>
<td>63</td>
<td>40</td>
<td>45</td>
<td>38</td>
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</tbody>
</table>

* Number and percentage of full-time faculty who were in the department in fall 1997 but were reported to have retired or died by fall 1998.
** All counts are projected from the survey response to the respective group as a whole. The number of usable responses varies for different sections of the Departmental Profile Survey. The response rates reported here apply to faculty size and recruitment data only.

### Table 3B: Percent of Full-Time Doctoral Faculty Who Retired or Died in Groups I, II, III, M & B Combined

![Graph showing percentage of full-time doctoral faculty who retired or died in groups I, II, III, M & B combined from 1996 to 1998.](image)

### Table 3C: Recruitment of Doctoral Faculty

<table>
<thead>
<tr>
<th>GROUP</th>
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<th>II</th>
<th>III</th>
<th>I, II, &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
<th>I, II, III, M &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open doctoral positions</td>
<td>140</td>
<td>107</td>
<td>141</td>
<td>118</td>
<td>507</td>
<td>126</td>
<td>33</td>
<td>291</td>
<td>730</td>
<td>1528</td>
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<tr>
<td>Total number</td>
<td>67</td>
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<td>72</td>
<td>85</td>
<td>263</td>
<td>98</td>
<td>13</td>
<td>247</td>
<td>496</td>
<td>1006</td>
</tr>
<tr>
<td>Tenured/tenure-track</td>
<td>111</td>
<td>83</td>
<td>111</td>
<td>101</td>
<td>406</td>
<td>110</td>
<td>20</td>
<td>278</td>
<td>685</td>
<td>1368</td>
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<td>Open to new doctoral recipients</td>
<td>40</td>
<td>17</td>
<td>64</td>
<td>69</td>
<td>190</td>
<td>87</td>
<td>3</td>
<td>233</td>
<td>467</td>
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<td>55</td>
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<td>131</td>
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<td>24</td>
<td>3</td>
<td>64</td>
<td>146</td>
<td>274</td>
</tr>
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<td>6</td>
<td>9</td>
<td>0</td>
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<td>0</td>
<td>4</td>
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<td>0</td>
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<td>4</td>
<td>42</td>
<td>51</td>
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<td>Unfilled positions</td>
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<td>80</td>
<td>43</td>
<td>5</td>
<td>82</td>
<td>127</td>
<td>289</td>
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</table>

*Number of full-time doctoral positions under recruitment in 1997-98 to be filled for 1998-99. Subtotals of rounded table values may exhibit rounding errors.
Table 3D: Number of Full-Time Doctoral Positions under Recruitment in Groups I, II, III, M & B Combined

Table 3E: Percentage of Full-Time Doctoral Positions under Recruitment in Groups I, II, III, M & B Combined Reported as Unfilled

Table 3F: Faculty Size, Fall 1998, and Percentage Change in Size, Fall 1997 to Fall 1998

<table>
<thead>
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<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>I, II, &amp; III</th>
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<th>M</th>
<th>B</th>
<th>I, II, III, M &amp; B</th>
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<tr>
<td>Total number</td>
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<td>840</td>
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<td>6751</td>
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<td>285</td>
<td>5015</td>
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<td>1.4</td>
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<td>-1.6</td>
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<td>11.3</td>
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<td>6441</td>
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<td>5.0</td>
<td>11.8</td>
<td>6.5</td>
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</tr>
</tbody>
</table>
The Departmental Profile includes information about mathematical sciences departments.

Table 3G: Female Faculty Size, Fall 1998, and Percentage Change in Size, Fall 1997 to Fall 1998

<table>
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<th>II</th>
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<th>I, II &amp; III</th>
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<th>M</th>
<th>B</th>
<th>I, II, III, M &amp; B</th>
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</thead>
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<td>342</td>
<td>914</td>
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<td>28</td>
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<td></td>
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</tr>
<tr>
<td>Percentage change (%)</td>
<td>3.5</td>
<td>8.8</td>
<td>1.7</td>
<td>1.5</td>
<td>2.6</td>
<td>7.1</td>
<td>0.0</td>
<td>2.3</td>
<td>1.7</td>
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<tr>
<td>Doctoral full-time female faculty</td>
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<td>223</td>
<td>644</td>
<td>238</td>
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<td>806</td>
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<td>7.1</td>
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<td>2.0</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Tenured doctoral full-time female faculty</td>
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<td>110</td>
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<td>77</td>
<td>13</td>
<td>522</td>
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</tr>
<tr>
<td>Percentage change (%)</td>
<td>3.2</td>
<td>0.0</td>
<td>1.4</td>
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<td>73</td>
<td>160</td>
<td>87</td>
<td>8</td>
<td>247</td>
<td>488</td>
<td>895</td>
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<td></td>
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<td>Percentage change (%)</td>
<td>28.6</td>
<td>30.0</td>
<td>0.0</td>
<td>3.6</td>
<td>7.5</td>
<td>19.6</td>
<td>0.0</td>
<td>-5.9</td>
<td>3.7</td>
<td>-2.5</td>
</tr>
<tr>
<td>Non-tenure-track doctoral full-time female faculty</td>
<td>-44</td>
<td>42</td>
<td>53</td>
<td>40</td>
<td>179</td>
<td>74</td>
<td>8</td>
<td>38</td>
<td>133</td>
<td>350</td>
</tr>
<tr>
<td>Total number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-2.6</td>
<td>10.0</td>
<td>0.0</td>
<td>-8.8</td>
<td>-0.7</td>
<td>0.0</td>
<td>0.0</td>
<td>-5.6</td>
<td>4.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Part-time female faculty</td>
<td>71</td>
<td>4</td>
<td>112</td>
<td>222</td>
<td>409</td>
<td>43</td>
<td>25</td>
<td>757</td>
<td>1518</td>
<td>2684</td>
</tr>
<tr>
<td>Total number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-4.8</td>
<td>0.0</td>
<td>1.2</td>
<td>6.8</td>
<td>3.0</td>
<td>17.4</td>
<td>0.0</td>
<td>5.6</td>
<td>6.9</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Enrollment Profile and Undergraduate Majors
The Departmental Profile Survey obtains information about enrollments and distribution of instructional effort in mathematical sciences departments.

Table 4A indicates that undergraduate mathematical sciences course enrollments increased by 3.5% from fall 1997 to fall 1998. In addition, graduate course enrollments increased by 1.0% over the same period. A comparison of this year’s Table 4B with Table 4B from last year’s Second Report (page 1168 of the October 1998 Notices of the AMS) shows a similar pattern of enrollment distributions for mathematics departments.

Table 4D reports that the total number of junior/senior majors in mathematics departments (Groups I, II, III, M & B combined) increased by 1.0% from fall 1997 to fall 1998. The number of female junior/senior majors increased slightly by 0.3% during the same period. Although many groups actually showed declines in female majors, Groups I Public, III, and IV showed sizable increases.

Table 4A: Undergraduate and Graduate Enrollments (thousands), Fall 1998, and Percentage Change in Enrollments, Fall 1997 to Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>I, II, III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate course enrollments</td>
<td>182</td>
<td>43</td>
<td>258</td>
<td>214</td>
<td>697</td>
<td>78</td>
<td>23</td>
<td>585</td>
<td>741</td>
<td>2124</td>
</tr>
<tr>
<td>Total number (thousands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>0.5</td>
<td>3.8</td>
<td>4.0</td>
<td>3.9</td>
<td>3.0</td>
<td>7.0</td>
<td>5.8</td>
<td>3.6</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Graduate course enrollments</td>
<td>7</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>26</td>
<td>18</td>
<td>2</td>
<td>11</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Total number (thousands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>5.9</td>
<td>4.7</td>
<td>-3.6</td>
<td>6.9</td>
<td>2.9</td>
<td>0.1</td>
<td>0.8</td>
<td>-1.9</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Usable responses*</td>
<td>20</td>
<td>17</td>
<td>41</td>
<td>56</td>
<td>134</td>
<td>51</td>
<td>5</td>
<td>103</td>
<td>365</td>
<td>658</td>
</tr>
<tr>
<td>Total number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>80</td>
<td>74</td>
<td>73</td>
<td>78</td>
<td>76</td>
<td>62</td>
<td>39</td>
<td>45</td>
<td>36</td>
<td>44</td>
</tr>
</tbody>
</table>

* The number of usable responses varies for different sections of the Departmental Profile Survey. The response rates reported here apply to Tables 4A through 4C on enrollments only.

All counts are projected from the survey response to the respective group as a whole.
Table 4B: Distribution of Undergraduate Enrollments (thousands), Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>I, II, &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Mathematics*</td>
<td>19</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>22</td>
<td>8</td>
<td>32</td>
<td>15</td>
<td>72</td>
<td>10</td>
</tr>
<tr>
<td>Precalculus</td>
<td>30</td>
<td>17</td>
<td>2</td>
<td>4</td>
<td>59</td>
<td>23</td>
<td>48</td>
<td>23</td>
<td>139</td>
<td>20</td>
</tr>
<tr>
<td>1st-year Calculus (mainstream)</td>
<td>52</td>
<td>28</td>
<td>18</td>
<td>40</td>
<td>51</td>
<td>20</td>
<td>35</td>
<td>17</td>
<td>156</td>
<td>22</td>
</tr>
<tr>
<td>1st-year Calculus (nonmainstream)</td>
<td>20</td>
<td>11</td>
<td>5</td>
<td>11</td>
<td>32</td>
<td>12</td>
<td>20</td>
<td>9</td>
<td>77</td>
<td>11</td>
</tr>
<tr>
<td>Statistics</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>3</td>
<td>17</td>
<td>8</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Computer Science</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Other courses for majors</td>
<td>33</td>
<td>18</td>
<td>7</td>
<td>17</td>
<td>31</td>
<td>12</td>
<td>23</td>
<td>11</td>
<td>94</td>
<td>13</td>
</tr>
<tr>
<td>Other undergraduate courses</td>
<td>23</td>
<td>13</td>
<td>10</td>
<td>23</td>
<td>54</td>
<td>21</td>
<td>33</td>
<td>15</td>
<td>120</td>
<td>17</td>
</tr>
</tbody>
</table>

*Arithmetic, high school algebra, geometry.
**Percentes are "column percents" describing relative enrollments within the respective survey groups of the different types of undergraduate courses.

Table 4C: Undergraduate and Graduate Enrollments per Full-Time Faculty Member, Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate course enrollments per full-time faculty member</td>
<td>109</td>
<td>52</td>
<td>114</td>
<td>108</td>
<td>60</td>
<td>82</td>
<td>117</td>
<td>94</td>
</tr>
<tr>
<td>Graduate course enrollments per full-time faculty member</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>14</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total course enrollments per full-time faculty member</td>
<td>113</td>
<td>56</td>
<td>117</td>
<td>112</td>
<td>74</td>
<td>88</td>
<td>119</td>
<td>94</td>
</tr>
</tbody>
</table>

Table 4D: Undergraduate Junior/Senior Majors and Undergraduate Female Junior/Senior Majors (hundreds), Fall 1998, and Percentage Change in Majors, Fall 1997 to Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>B</th>
<th>I, II, III, M &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior/senior majors</td>
<td>47</td>
<td>15</td>
<td>48</td>
<td>50</td>
<td>7</td>
<td>10</td>
<td>159</td>
<td>261</td>
<td>580</td>
</tr>
<tr>
<td>Total number (hundreds)</td>
<td>8.2</td>
<td>-1.2</td>
<td>-11.1</td>
<td>10.0</td>
<td>7.9</td>
<td>6.1</td>
<td>-3.2</td>
<td>-3.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>18</td>
<td>5</td>
<td>20</td>
<td>22</td>
<td>3</td>
<td>4</td>
<td>75</td>
<td>111</td>
<td>251</td>
</tr>
<tr>
<td>Female junior/senior majors</td>
<td>18</td>
<td>5</td>
<td>20</td>
<td>22</td>
<td>3</td>
<td>4</td>
<td>75</td>
<td>111</td>
<td>251</td>
</tr>
<tr>
<td>Total number (hundreds)</td>
<td>8.0</td>
<td>-0.5</td>
<td>-6.5</td>
<td>7.5</td>
<td>8.1</td>
<td>-7.4</td>
<td>-1.3</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>18</td>
<td>17</td>
<td>37</td>
<td>54</td>
<td>33</td>
<td>5</td>
<td>92</td>
<td>325</td>
<td>543</td>
</tr>
</tbody>
</table>

*The number of usable responses varies for different sections of the Departmental Profile Survey. The response rates reported here apply to undergraduate majors data only. All counts are projected from the survey response to the respective group as a whole.
Graduate Student Profile

Tables 5A, 5C, and 5D summarize population statistics for graduate students gathered by the 1998 Departmental Profile Survey. Table 5A indicates that the total number of full-time graduate students in mathematics departments (Groups I, II, III & M combined) declined by 4.5% from fall 1997 to fall 1998 and declined in every group except Group I Private and IV. Following a five-year decline, the Ph.D.-granting mathematics departments (Groups I, II & III combined) reported an increase for the second year—4.7% in 1997 and 3.8% in 1998—in the number of full-time first-year graduate students. In addition, the number of full-time first-year female graduate students in Ph.D.-granting mathematics departments increased only slightly, by 0.9%. Table 5D also indicates a slight increase of 0.6% in the total number of U.S. citizen full-time first-year mathematics graduate students from fall 1997 to fall 1998 for these same departments. Table 5B presents the trend in annual percentage change of first-year graduate students in Ph.D.-granting mathematics departments during the years 1986 to 1998. For the second year since 1991, the number of first-year graduate students increased.

Table 5A: Full-Time Graduate Students, Fall 1998, and Percentage Change in Graduate Students, Fall 1997 to Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>I, II &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>I, II, III &amp; M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>2462</td>
<td>1035</td>
<td>2575</td>
<td>2114</td>
<td>8186</td>
<td>2895</td>
<td>605</td>
<td>1929</td>
<td>10115</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-6.6</td>
<td>1.6</td>
<td>-6.8</td>
<td>-0.6</td>
<td>-2.2</td>
<td>0.7</td>
<td>-4.5</td>
<td>-12.8</td>
<td>-12.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Total number</th>
<th>Percentage change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-year graduate students</td>
<td>542</td>
<td>293</td>
</tr>
<tr>
<td>Total number</td>
<td>770</td>
<td>743</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-7.5</td>
<td>22.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Total number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable responses*</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Total number</td>
<td>84</td>
<td>78</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>84</td>
<td>78</td>
</tr>
</tbody>
</table>

* The number of usable responses varies for different sections of the Departmental Profile Survey. The response rates reported here apply to Tables 5A through 5C on graduate student enrollments only. All counts are projected from the survey response to the respective group as a whole.

Table 5B: Annual Percentage Change in Full-Time First-Year Graduate Students in Groups I, II & III Combined, 1986 to 1998

[Graph showing annual percentage change from 1986 to 1998.]
### Table 5C: Full-Time Female Graduate Students, Fall 1998, and Percentage Change in Female Graduate Students, Fall 1997 to Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>I, II, &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>I, II, III, &amp; M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time female graduate students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number</td>
<td>649</td>
<td>222</td>
<td>901</td>
<td>795</td>
<td>2568</td>
<td>1306</td>
<td>202</td>
<td>898</td>
<td>3466</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-5.2</td>
<td>5.5</td>
<td>8.0</td>
<td>4.6</td>
<td>3.1</td>
<td>6.4</td>
<td>-3.4</td>
<td>-1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>First-year female graduate students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number</td>
<td>137</td>
<td>61</td>
<td>311</td>
<td>288</td>
<td>798</td>
<td>412</td>
<td>61</td>
<td>376</td>
<td>1174</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-19.0</td>
<td>0.0</td>
<td>-0.4</td>
<td>16.3</td>
<td>8.0</td>
<td>16.5</td>
<td>-5.6</td>
<td>-12.7</td>
<td>-1.8</td>
</tr>
</tbody>
</table>

### Table 5D: Full-Time U.S. Citizen Graduate Students, Fall 1998, and Percentage Change in U.S. Citizen Graduate Students, Fall 1997 to Fall 1998

<table>
<thead>
<tr>
<th>GROUP</th>
<th>I Public</th>
<th>I Private</th>
<th>II</th>
<th>III</th>
<th>I, II, &amp; III</th>
<th>IV</th>
<th>Va</th>
<th>M</th>
<th>I, II, III, &amp; M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time U.S. citizen grad. students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number</td>
<td>1306</td>
<td>478</td>
<td>1528</td>
<td>1163</td>
<td>4475</td>
<td>1467</td>
<td>356</td>
<td>1243</td>
<td>5718</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-6.1</td>
<td>-0.8</td>
<td>-5.3</td>
<td>-0.8</td>
<td>-3.9</td>
<td>-3.6</td>
<td>-5.7</td>
<td>-19.2</td>
<td>-7.7</td>
</tr>
<tr>
<td>First-year U.S. citizen grad. students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number</td>
<td>310</td>
<td>130</td>
<td>438</td>
<td>415</td>
<td>1293</td>
<td>435</td>
<td>94</td>
<td>526</td>
<td>1819</td>
</tr>
<tr>
<td>Percentage change (%)</td>
<td>-4.8</td>
<td>15.9</td>
<td>-15.3</td>
<td>25.7</td>
<td>0.6</td>
<td>6.2</td>
<td>-23.5</td>
<td>-13.3</td>
<td>-3.9</td>
</tr>
</tbody>
</table>

### Bibliography


### Acknowledgments

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

—Paul W. Davis


<table>
<thead>
<tr>
<th>DISTRICT OF COLUMBIA</th>
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</thead>
<tbody>
<tr>
<td><strong>American University</strong> (9)</td>
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<tr>
<td><strong>Mathematics and Statistics</strong></td>
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<tr>
<td>Fofack, Hippolyte, Distribution of parallel market premium under stable alternative modeling.</td>
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<tr>
<td>Foret, Katia, Teaching induction: Historical perspective and current views.</td>
</tr>
<tr>
<td>Jones, Kenneth, The effects of the base of graphing calculation on learning-disabled students' achievement and attitudes in a university finite mathematics course.</td>
</tr>
<tr>
<td>Kpamegan, Elöi, Optimal designs for binary random variables in a bivariate treatment space.</td>
</tr>
<tr>
<td>Merritweather, Michelle, A study of high school mathematics teachers on their attitude towards and use of calculators.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th><strong>NEW YORK</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Columbia University</strong> (4)</td>
</tr>
<tr>
<td><strong>Biostatistics</strong></td>
</tr>
<tr>
<td>Hu, Xiao-Ping, Survival analysis for competing risks model.</td>
</tr>
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<td>Panagiotis, Katherine, Statistics in periodontal research: Interval estimation of the commonly odds ratio under cluster sampling.</td>
</tr>
<tr>
<td>Shi, Qiuju, Simultaneous confidence bounds for hazard data.</td>
</tr>
<tr>
<td>Zhang, Haiying, Nonparametric method for longitudinal studies with dropout.</td>
</tr>
</tbody>
</table>

| **New York University, Courant Institute** (1) |
| **Mathematical Sciences** |
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Yuri Manin Awarded Rolf Schock Prize

The Royal Swedish Academy of Sciences has announced the names of recipients of the Rolf Schock Prizes. These international prizes honor contributions to mathematics, logic and philosophy, visual arts, and music. The prizes, awarded every two years, amount to 400,000 Swedish crowns (approximately US$50,000).

**YURI MANIN** of the Max Planck Institute for Mathematics in Bonn, Germany, has been awarded the 1999 prize in mathematics "for his important work in algebraic geometry and mathematical physics, in particular for those fundamental papers he has recently published about quantum groups and mirror symmetry."

Manin has published mathematical papers covering many fundamental results, including: the proof of a variant of a conjecture by Mordell, counterexamples to the Luroth theorem in higher dimensions, the study of diophantine equations, $p$-adic analysis and modular forms in pure mathematics, the study of solutions of Yang-Mills equations and their relations to 4-dimensional manifolds, the theory of quantum groups, and mirror symmetry in mathematical physics.

Yuri Manin was born in 1937 in Simferopol in the former Soviet Union and is a Russian citizen. He studied mathematics at Moscow University and received his Ph.D. degree in 1960 from the Steklov Institute of Mathematics in Moscow. He was professor of mathematics at Moscow University from 1965 to 1991 and has been at the Max-Planck-Institute für Mathematik in Bonn since 1993.

About Rolf Schock

Rolf Schock was born in France on April 5, 1933. His family had emigrated from Germany in 1931; they later settled in the United States. He studied geology, psychology, and mathematics at the University of New Mexico and then pursued postdoctoral studies in philosophy, first at the University of California, Berkeley, and then at UCLA. After moving to Sweden he received the Fil.Lic. degree in philosophy from Stockholm University in 1964 and a Ph.D. from Uppsala University in 1968. His dissertation, "Logics without Existence Assumptions", was an early work in what is now known as free logic and has often been cited by scholars in the field. Schock wrote many other works in logic and the philosophy of science. He never held a permanent appointment, although he was a lecturer in Sweden for brief periods, and for many years the Royal Institute of Technology provided him with a base. He was also a painter, photographer, and traveler. After his death in an accident on December 5, 1986, it came to light that he had left a considerable fortune, which he had inherited from his father. Schock bequeathed half of the funds for prizes in the arts and sciences.

—From a Royal Swedish Academy of Sciences announcement

Rockafellar Wins von Neumann Prize

R. Tyrrell Rockafellar of the University of Washington has been awarded the 1999 John von Neumann Theory Prize, the highest prize given in the field of operations research and management science.

The $5,000 prize, awarded by the Institute for Operations Research and the Management Sciences, was given to Rockafellar "for his fundamental contributions to the theoretical foundations of optimization, including convex optimization, nonsmooth analysis, and stochastic programming." His principal research interests include de-
velopment of optimization methodology for modeling large-scale problems in decision or control over time, possibly with stochastic elements; numerical techniques for solving such problems; and associated innovations in mathematical analysis. Using the notions of epi- and proto-derivatives, he created a systematic calculus for dealing with nonsmooth functions and, with Roger Wets, promoted epiconvergence as a systematic device for modeling and analyzing the way optimization problems change. He has used this methodology to extend and reshape the theory of differentiation for set-valued functions.

R. Tyrrell Rockafellar received both his bachelor’s degree in 1957 and his Ph.D. in 1963 from Harvard University. During the academic year 1957-58 he held a Fulbright Scholarship at the University of Bonn. He has taught at the University of Texas, Austin (1963-65), and has been at the University of Washington since 1966, where he now teaches jointly in the departments of mathematics and applied mathematics. He has held visiting positions at various institutions, including the Mathematics Institute in Copenhagen, the International Institute of Applied Systems Analysis in Vienna, Princeton University, and the universities of Grenoble, Colorado, Pisa, Paris-Dauphine, and Pau (France).

His numerous honors include the Dantzig Prize, jointly awarded by the Society for Industrial and Applied Mathematics (SIAM) and the Mathematical Programming Society (1982), the von Neumann Lecture Prize of SIAM (1992), and the Lanchester Prize of the Institute for Operations Research and the Management Sciences (1998, shared with Roger Wets).

—Elaine Kehoe

Lebowitz Receives AAAS Scientific Freedom and Responsibility Award

JOEL LEBOWITZ of Rutgers University has been awarded the 1999 Scientific Freedom and Responsibility Award by the American Association for the Advancement of Science (AAAS). The award is given to scientists who have acted to protect the public’s health, safety, or welfare; who have focused public attention on important potential effects of science and technology on society by participating in public policy debates; or who have established important new precedents in carrying out the social responsibilities of defending the professional freedom of scientists and engineers.

Lebowitz was honored “for his tireless devotion to the rights of scientists in oppressive regimes throughout the world and his extraordinary creativity in finding ways to help these scientists survive their ordeal.” In 1979, as president of the New York Academy of Sciences, Lebowitz mounted a strong appeal on behalf of persecuted scientists, particularly in the former Soviet Union. He met with dissident scientists in the Soviet Union on several occasions and provided a written forum for the results of seminars held by the dissidents. He has also advocated for the rights of scientists in Argentina, South Korea, Turkey, and Myanmar.

—From an AAAS announcement

Mathematicians Elected to American Academy of Arts and Sciences

Six mathematicians have been elected to membership in the American Academy of Arts and Sciences in 1999. They are: LEO BREIMAN (University of California, Berkeley), DAVID JERISON (Massachusetts Institute of Technology), HARRY KESTEN (Cornell University), ALAN S. PERELSON (Los Alamos National Laboratory), THOMAS SPENCER (Institute for Advanced Study), and JEAN E. TAYLOR (Rutgers University).

The American Academy of Arts and Sciences was founded in 1780 to foster the development of knowledge as a means of promoting the public interest and social progress. The membership of the academy is elected and represents distinction and achievement in a range of intellectual disciplines: mathematical and physical sciences, biological sciences, social arts and sciences, and humanities and fine arts.

—From an American Academy of Arts and Sciences announcement
AMS Menger Award winners. Back row, left to right: Jack Bewley, Adam Bryant, Jason Loy, Bryce Roberts, John Pope. Front row, left to right: Julian Palmore, chairman of judges' panel, Amit Sabharwal, Andrew Chi, Jennifer Pelka, Jennifer Walk, Heidi Williams, C. Andrew McManus, Ching-Tang Chen.

AMS Menger Awards at the 1999 Intel-International Science and Engineering Fair

The 1999 Intel-International Science and Engineering Fair (ISEF) was held May 2-8 in the Philadelphia Convention Center in Philadelphia, Pennsylvania. This year marked the fiftieth anniversary of the ISEF and saw a return to the origins of the fair in Philadelphia. Student winners were among approximately 1,100 ninth- through twelfth-graders who earned the right to compete by winning top prizes at local, regional, and state fairs in the United States or national science fairs abroad. ISEF Special Award prizes were given by over fifty organizations, including the AMS. These prizes include scholarships, cash awards, T-shirts, magazines, and books.

This was the twelfth year of participation in ISEF by the American Mathematical Society and the tenth year of presentation of the Karl Menger Memorial Awards. The AMS Awards are Special Awards. This year's panel of judges included Loren Argabright (Drexel University), Gisele Goldstein (University of Memphis), Marius Nakashima (University of Alabama, Birmingham), and Julian Palmore, chair (University of Illinois at Urbana-Champaign). The panel of judges reviewed 52 projects, all in mathematics. Each panel member inspected every project, and a panel member interviewed each student. To select the winning projects, the panel conducted several inspections of a student finalist's work. The winners (one first-place award, two second-place awards, and four third-place awards) were given cash prizes, and they and the five honorable mention winners were given copies of What's Happening in the Mathematical Sciences, Vol. 4, by Barry Cipra (published by the AMS) and a short biography of Karl Menger, in whose honor the awards are named. The Karl Menger Memorial prize winners were as follows:

First Place ($1,000): Amit Kumar Sabharwal, Exploration and Generalization of Ring and Localization Properties Associated to GKM Graphs, Senior, Detroit Country Day School, Beverly Hills, Michigan.


Third Place ($250 each): Ching-Tang Chen, Centers, Euler Line, Feuerbach Circle and Conjugate Euler Line of a Triangle, Freshman, Chien-Tai Senior High School, Taiwan, Miao-Li, Republic of China; C. Andrew McManus, Elliptic Curves over Finite Fields, Junior, South Western High School, Hanover, Pennsylvania; Jennifer Rose Walk, Which Factors Affect Noninsulin-Dependent Diabetes Mellitus in China?, Junior, Suncoast High Community School, Riviera Beach, Florida; Heidi Lee Williams, Applying Statistical Language Recognition: Techniques in the Cryptanalysis of Enigma, Senior, Williston Senior High School, Williston, North Dakota.


Within each category the names above were listed alphabetically. It is interesting to note that projects in the mathematics category were awarded prizes by other organizations. For example, Jennifer Pelka was awarded a scholarship from Lehigh University, and C. Andrew McManus was awarded a scholarship from Drexel University for their projects. The titles of the winning projects indicate the breadth and scope of the projects and the wide interests of the participants. The judges were impressed particularly by the enthusiasm of the participants and their interest in mathematics. The Society's participation in the Intel-ISEF is supported in part by income from the Karl Menger Fund, which was established by the family of the late Karl Menger. For more information about this program contact Timothy Goggins, AMS development officer, by e-mail: tjg@ams.org or by telephone: 401-455-4110.

—Julian Palmore
National Academy of Engineering Elections

The National Academy of Engineering has announced the election of eighty new members and eight foreign associates, including three mathematicians: JAMES W. DEMMEL of the University of California, Berkeley, was elected for his contributions to numerical linear algebra and scientific computing; DONALD W. PEACEMAN of Houston, Texas, was elected for contributions to the development and usage of transient three-dimensional multiphase simulators for predicting performance of petroleum reservoirs; and MARTIN GRÖTSCHEL of Konrad-Zuse-Zentrum, Berlin, Germany, was elected a foreign associate for his contributions to combinatorial optimization and its applications.

—From a National Academy of Engineering announcement

USA Mathematical Olympiad

The 28th USA Mathematical Olympiad (USAMO) exam was held April 27, 1999. The students taking the exam were selected on the basis of their performances on the American High School and American Invitational Mathematics Examinations, which involved more than 350,000 students. The USAMO lasts six hours and consists of six challenging questions.

The highest ranking individual on the 1999 USAMO was SASHA SCHWARTZ, an 11th-grader at Radnor High School in Radnor, Pennsylvania. The other seven top scorers were: REID W. BARTON, grade 10, home schooled, Arlington, Massachusetts; GABRIEL D. CARROLL, grade 10, Oakland Technical High School, Oakland, California; LAWRENCE 0. DETLOR, grade 11, Saint Ann's School, Brooklyn, New York; PO-SHEN LOH, grade 11, James Madison Memorial High School, Madison, Wisconsin; STEPHEN E. HAAS, grade 12, Bellarine College Preparatory, San Jose, California; PAUL A. VAIIANT, grade 10, Milton Academy, Milton, Massachusetts; and MELANIE E. WOOD, grade 12, Park Tudor High School, Indianapolis, Indiana. Five of these students—Barton, Carroll, Schwartz, Valiant, and Wood—received top honors in last year's USAMO.

These eight students were honored in June 1999 at a ceremony held at the National Academy of Sciences and at a reception and dinner held at the Department of State. Along with sixteen others who did well on the USAMO, these students are attending the four-week Mathematical Olympiad Summer Program at the University of Nebraska, Lincoln, this summer. This program brings together very promising students who have risen to the top in mathematics contests. It aims to broaden the students' view of mathematics and to prepare them for possible participation on the International Mathematical Olympiad (IMO) team. Six of the eight top USAMO winners—Barton, Carroll, Detlor, Loh, Valiant, and Wood—form the IMO team and are to travel to Romania in July for the 40th International Mathematical Olympiad.

Another form of recognition has come to a USAMO participant. PO RU LOH was named the Clay Mathematics Institute Olympiad Scholar. This award recognizes the most original solution to a problem in the competition.

The examinations are administered by the American Mathematics Competitions, a program of the Mathematical Association of America and jointly sponsored by twelve other mathematical organizations, including the AMS.

—Allyn Jackson

Deaths

HOWARD E. KREHBIEL, professor emeritus of Bluffton College, Bluffton, Ohio, died on March 30, 1999. Born on August 8, 1926, he was a member of the Society for 36 years.

WALTER THOMAS KYNER, professor emeritus of the University of New Mexico, Albuquerque, died on April 10, 1999. Born on January 27, 1926, he was a member of the Society for 44 years.

IVAN NIVEN, professor emeritus of the University of Oregon, Eugene, died on May 9, 1999. Born on October 25, 1915, he was a member of the Society for 62 years.

P. P. SUTTON, of Montréal, Canada, died on May 1, 1993, and was a member of the Society for 48 years.
American Mathematical Society Centennial Fellowships

Invitation for Applications for Awards for 2000–01
Deadline December 1, 1999

The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. Recently, the AMS Council approved changes in the rules for the fellowships. From 1984–96 the fellowship program was aimed at midcareer mathematicians. The changes adopted four years ago redirected the fellowship program toward recent Ph.D.s. The eligibility rules are as follows.

Applicants must: (1) be citizens or permanent residents of a country in North America, (2) have held their doctoral degrees for at least two years at the time of the award, (3) not have permanent tenure, and (4) have held less than two years of research support at the time of the award. (Each year of a full-time teaching appointment with teaching load less than four [respectively, five] courses per year on the semester [respectively, quarter] system will count in this respect as one-half year of research support.) Recipients may not hold the Centennial Fellowship concurrently with other research fellowships (e.g., Sloan Foundation Fellowships or National Science Foundation Postdoctoral Fellowships), they may not use the stipend solely to reduce teaching at the home institution, and they are expected to spend some of the fellowship period at another institution that has a stimulating research environment suited to their research development.

The stipend for fellowships awarded for 2000–01 is expected to be approximately $38,000, with an additional expense allowance of about $1,500. Acceptance of the fellowship cannot be postponed. A fellowship holder may use the stipend as full support for a year or may combine it with half-time teaching and use it as half support over a two-year period.

The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The trustees have arranged a matching program from general funds in such a way that funds for at least one fellowship are guaranteed. Because of the generosity of the AMS membership, it has been possible to award four to five fellowships a year for the past five years. A list of previous fellowship winners can be found at http://www.ams.org/secretary/prizes.html.

Applications should include a short research plan describing both an outline of the research to be pursued and a program for using the fellowship, including institutions at which it will be used and reasons for the choices. The selection committee will base its decision on both the research potential of the applicant, based upon track record and letters of recommendation, and on the quality and feasibility of the research plan.

The deadline for receipt of applications is December 1, 1999. Awards will be announced in February 2000 or earlier if possible.
For application forms, write to the Executive Director, American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248, or send electronic mail to ams@ams.org, or call 401-455-4106. Application forms are also available via the Internet at http://www.ams.org/employment/.

Please note that completed application and reference forms should not be sent to the AMS, but to the address given on the forms.

—AMS announcement

**NSF Mathematical Sciences Postdoctoral Research Fellowships**

The Mathematical Sciences Postdoctoral Research Fellowship program of the Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) awards fellowships each year for research in pure mathematics, applied mathematics and operations research, and statistics. The deadline for this year's applications is **October 16, 1999**. Applications must be submitted via FastLane on the World Wide Web. Go to [http://www.fastlane.nsf.gov/](http://www.fastlane.nsf.gov/), click on "Postdoctoral Fellowship", then on "Postdoctoral Research Fellowships Application Package", and then on "Prepare New Application Package". Information can be found there for the Mathematical Sciences Postdoctoral Research Fellowships, as well as for other NSF Fellowship opportunities. For more information telephone 703-306-1870 or e-mail: msprf@nsf.gov.

—From an NSF announcement

**NSA Grant and Sabbatical Programs**

The Mathematical Sciences Program of the National Security Agency (NSA) provides grants and sabbatical opportunities to support research by academic mathematical scientists.

The grant program offers funding in four categories: the Young Investigators' Grant; the Standard Grant; the Senior Investigators' Grant; and the Conferences, Workshops, and Special Situations Grant. The NSA makes grants to universities and nonprofit institutions to support self-directed research in the following areas of mathematics (including possible computational aspects): algebra, number theory, discrete mathematics, probability, and statistics. In addition, it supports research in the design and analysis of cryptographic algorithms. The deadline for submission of all grant proposals is **October 15, 1999**. Awards are generally made in November of the following year. The principal investigators to be supported by the grant must be U.S. citizens or permanent residents, and students and postdoctoral researchers to be supported must be U.S. citizens or permanent residents who intend to become citizens. Grant proposals must arrive at the NSA on the deadline date; allow at least ten days for mailing. Submit proposals to: NSA Mathematical Sciences Program, National Security Agency, ATTN: R51A, Ft. George G. Meade, MD 20755-6000.

The NSA also accepts proposals for small grants for conferences, workshops, and special academic endeavors. Proposals for these may be submitted at any time and will be reviewed as they are received at NSA. Allow at least eight months for review, negotiation, and processing.

The sabbatical opportunities offered by the NSA provide support for academic mathematical scientists to visit the NSA for periods ranging from 9 to 24 months. The sabbaticals primarily involve cryptography but may also involve algebra, probability, statistics, number theory, and discrete mathematics. NSA provides visiting mathematicians with funds to supplement their university's stipend to at least equal their monthly salaries. A choice is offered between an allowance for moving expenses or a housing supplement. Applicants and their immediate family members must be U.S. citizens and must participate in a thorough, extensive screening process. Further information may be obtained from the NSA's Web site, [http://www.nsa.gov:8080/programs/msp/](http://www.nsa.gov:8080/programs/msp/).

—From an NSA announcement

**AWM Travel Grants for Women**

The National Science Foundation (NSF) and the Association for Women in Mathematics (AWM) sponsor a travel grant program to enable women to attend research conferences in their fields, thereby providing scholars valuable opportunities to advance their research activities and their visibility in the research community. The grants provide full or partial support for travel and subsistence for a meeting or conference in the applicant's field of specialization. Maximum grants of $1,000 for domestic travel and $2,000 for foreign travel are available. For foreign travel, U.S. carriers must be used whenever possible.

These travel grants are provided by the Division of Mathematical Sciences (DMS) of the NSF, and the research conference attended must be in an area supported by DMS. For example, this includes certain areas of statistics but excludes most mathematics education and history of mathematics. An applicant must be a woman holding a doctorate (or equivalent experience) and with a work address in the United States (or home address, in the case of unemployed mathematicians). Anyone who has been awarded an AWM-NSF travel grant in the past two years or who has other sources of external funding, such as any type of NSF grant, is ineligible. Partial support from the applicant's institution or from a nongovernmental agency does not, however, make the applicant ineligible.

The final deadline for the 1999 program is **October 1, 1999**. The deadlines for the 2000 programs are: **February 1, 2000; May 1, 2000; and October 1, 2000**. (Please note
that these deadlines are slightly changed from those for 1999.) Application materials should be sent to the Travel Grant Selection Committee, Association for Women in Mathematics, 4114 Computer and Space Sciences Building, University of Maryland, College Park, MD 20742-2461. For further information and details on applying, see the AWM Web site, http://www.awm-math.org/travelgrants.html, or telephone 301-405-7892, or send e-mail to awm@math.umd.edu. Applications via e-mail or fax are not acceptable.

—From an AWM announcement

NSF Announces Midcareer Methodological Opportunities

The Division of Mathematical Sciences and the Division of Social, Behavioral, and Economic Research of the National Science Foundation (NSF) have announced a joint competition for a limited number of midcareer research fellowships in the social, behavioral, economic, and statistical sciences. The purpose of these fellowships is to facilitate interactions among statisticians and social, behavioral, and economic scientists.

The NSF anticipates supporting no more than four to eight awards per year, depending on the number of applications and availability of funds. Awards will be made for up to a 12-month period. The maximum stipend available for the duration of the award, paid directly to the Fellow, is $50,000.

Proposals must concretely demonstrate how the proposed fellowship activities will further the development of new methods for increased understanding of complex, substantive problems in the social and behavioral sciences. Applicants must be employed at U.S. institutions and must have earned a Ph.D. or equivalent degree in the social, behavioral, economic, or statistical sciences. Although applications may be submitted by researchers at any level beyond the Ph.D., the NSF especially encourages the submission of proposals from senior (posttenure) researchers.

The deadline for submission of proposals is September 15, 1999. Further information on the fellowships and details about application procedures can be found at the NSF Web site, http://www.nsf.gov/.

—From an NSF announcement

AWM Mentoring Travel Grants for Women

The Association for Women in Mathematics (AWM), with the support of the National Science Foundation (NSF), offers a Mentoring Travel Grant Program for Women. The objective of this program is to help junior women to develop long-term working and mentoring relationships with senior mathematicians. This relationship should help the junior mathematician to establish her research program and eventually receive tenure. In 2000, AWM expects to award up to five or six grants in amounts of up to $4,000 each. Each grant would fund travel, subsistence, and other required expenses for an untenured woman mathematician to travel to an institute or a department to do research with a specified individual for one month. Any unexpended funds could be used for further travel to work with the same individual during the following year. (Applicants for mentoring travel grants may in exceptional cases receive up to three such grants throughout their careers, possibly in successive years; each such grant would require a new proposal and would go through the usual competition.)

An applicant must be a women having a doctorate or equivalent experience and with a work address in the United States (or a home address if unemployed). The applicant's research may be in any field that is funded by the Division of Mathematical Sciences of the NSF.

An application consists of the following: a cover letter; a curriculum vitae; a research proposal approximately five pages in length that specifies why the proposed travel would be particularly beneficial; a supporting letter from the proposed mentor (who must promise to be available at the time of the proposed travel and may be either a man or a woman), together with the curriculum vitae of the proposed mentor; an approximate budget; and information about other sources of funding available to the applicant. A final report will be required from each awardee. All awards will be determined on a competitive basis by a selection panel consisting of distinguished mathematicians appointed by the AWM.

Send five complete copies of the application materials (including the cover letter) to: Mentoring Travel Grant Selection Committee, Association for Women in Mathematics, 4114 Computer & Space Sciences Building, University of Maryland, College Park, MD 20742-2461. Applications via e-mail or fax are not acceptable. The deadline for applications is February 1, 2000.

Further information may be obtained by telephone at 301-405-7892 or by e-mail at awm@math.umd.edu.

—From an AWM announcement

Applications for Travel Grants to ICME-9 Are Available

The Ninth International Congress on Mathematical Education (ICME-9) will be held July 30 to August 6, 2000, in Makuhari, Japan. To help make it possible for U.S. mathematics educators to attend, the National Council of Teachers of Mathematics (NCTM) has applied to the National Science Foundation (NSF) for travel funds. If granted, the funds can be used by mathematics teachers, mathematicians, and mathematics educators to supplement travel expenses to ICME-9.

The funds may be used to support air transportation (on U.S. carriers only), hotel accommodations, meal costs, and
conference registration. It is important to note that travel grant awardees under this program may not use other NSF funds to supplement international travel, that is, airfare to Japan or subsistence at ICME-9.

In addition to applying for an ICME-9 travel grant, individuals may apply for participation in an eight-day Post-ICME-9 Seminar Tour to visit with counterparts in Chiba and Yamagata. For this seminar tour, the NSF will fund per diem travel, lodging, and subsistence expenses. A Post-ICME-9 Seminar Tour awardee who does not also receive an NCTM ICME-9 travel grant may use other NSF funds to support travel to ICME-9. Some of the Post-ICME-9 Seminar Tour awardees will be invited and funded to make presentations at the Presidential Awardee Event in Washington, DC, in June 2001.

A selection committee comprised of individuals representing the NCTM, the Mathematical Association of America, the American Mathematical Association of Two-Year Colleges, the Mathematical Sciences Education Board, and the U.S. National Commission on Mathematics Instruction will review the applications and award the grants both for the ICME-9 Travel and the Post-ICME-9 Seminar Tour. Elementary, middle, and high school teachers are strongly encouraged to apply.

The travel grant application and selection criteria are available from the NCTM, Department E, 1906 Association Drive, Reston, VA 20191-1593 (tel. 703-620-9840, ext. 2112); or from the NCTM Web page at http://www.nctm.org/icme9. They are also available from the NCTM Fax-on-demand at 800-220-8483: Follow the voice prompts, select option 2, enter document 525, and when prompted enter the receiving fax number; the system calls your fax machine and delivers your document. The application deadline is November 1, 1999. Notifications will be made by December 15, 1999.

—Frances R. Curcio
New York University
AMS Participates in Capitol Hill Exhibition

The AMS brought in Donald McClure of Brown University as the mathematics exhibitor at this year’s Coalition for National Science Funding Exhibition on Capitol Hill, May 19, 1999. His exhibit was entitled “Mathematical Foundations of Image Analysis and Computational Vision”. About thirty scientists, mathematicians, and engineers presented displays featuring computer demonstrations, videos, and educational material; and talked with Congressional staff, representatives, and senators about their NSF-funded research. The coalition is a network of around fifty scientific, mathematical, and engineering organizations, universities, higher education associations, and industry groups, working together in support of the National Science Foundation (NSF).

—Monica Foulkes, AMS Washington Office

Mathematics Genealogy Project

The Genealogy Project for Mathematicians, located at Minnesota State University, was initiated as a way of understanding and documenting the intellectual history of mathematics by tracing mentor-student relationships. The project coordinators are gathering information on mentor-student relationships for as many current members of the mathematical community as possible. As the information is collected it is being made available on the project’s Web site at http://Hcooncemath.mankato.msus.edu/. There are currently approximately 25,000 names on the site, which will remain under construction for the foreseeable future.

The eventual goal of the project is to make the following information available for each mathematician: name; university and year of terminal degree; title of dissertation; names of advisors; and the mathematician’s own doctoral students, with links to each of these other individuals. The project coordinators are soliciting all possible available data from Ph.D.-granting institutions.

For more information, visit the Web site given above or send e-mail to the project’s director, Harry Coonce, at coonce@mankato.msus.edu.

—Genealogy Project for Mathematicians

About the Cover

The cover image is a detail from a large mathematical still life by Providence, RI, artist John Riedel. The artist describes the painting:

In late 1994, while employed in the graphic arts department of the American Mathematical Society, I accepted a commission to create a large painting involving mathematical elements. As a person with an art, as opposed to a mathematical, background, I approached the problem by collecting images of three-dimensional models and two-dimensional drawings of mathematical figures I found interesting from a visual standpoint. I then tried to place the elements in a coherent manner in the context of an interior space. After working on a small study of one area, I began the final painting with the knowledge that the unity of the light and color relationships were of primary importance to the finished work.

—J. R.

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

Upcoming Deadlines

September 1, 1999: Deadline for receipt of applications for the AWM workshop for women graduate students and postdocs. For more information, contact the Workshop Selection Committee, Association for Women in Mathematics, 4114 Computer & Space Sciences Building, University of Maryland, College Park, MD 20742-2461; telephone 301-405-7892; e-mail: awm@math.umd.edu.

September 15, 1999: Deadline for submission of proposals for the NSF Midcareer Methodological Opportunities fellowships. For more information see "Mathematics Opportunities" in this issue.

October 1, 1999: Deadline for receipt of nominations for the AWM Louise Hay Award. For more information call the AWM at 301-405-7892 or send e-mail to awm@math.umd.edu.

October 1, 1999: Deadline for receipt of nominations for the AWM Alice T. Schafer Mathematics Prize. For more information contact the 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 301-405-7892; e-mail: awm@math.umd.edu.

October 1, 1999: Deadline for applications for NSF/AWM Travel Grants for Women. For more information see the AWM Web site, http://www.awm-math.org/travelgrants.html; or telephone 301-405-7892; or send e-mail to awm@math.umd.edu. Also

Where to Find It

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

AMS e-mail addresses
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AMS Ethical Guidelines
June 1995, p. 694

AMS officers and committee members
October 1998, p. 1209

Board on Mathematical Sciences and Staff
April 1999, p. 479; June/July 1999, p. 696

Bylaws of the American Mathematical Society
November 1997, p. 1339

Classification of degree-granting departments of mathematics
January 1997, p. 48

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Mathematics Research Institutes contact information
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Officers of the Society 1998 and 1999 (Council, Executive Committee, Publications Committees, Board of Trustees)
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see “Mathematics Opportunities” in this issue.

**October 15, 1999:** Deadline for proposals for the National Security Agency Young Investigators' Grants; Standard Grants; Senior Investigators' Grants; and Conferences, Workshops, and Special Situations Grants. For more information see “Mathematics Opportunities” in this issue.

**November 1, 1999:** Deadline for applications for the Fulbright Scholar Program international education and academic administrator seminars. For more information contact the USIA Fulbright Scholar Program, Council for International Exchange of Scholars, 3007 Tilden Street, NW, Suite 5L, Box GNEWS, Washington, DC 20008-3009; telephone 202-686-7877; Worldwide Web: http://www.cies.org/.

**January 1, 2000:** Deadline for applications for the Fulbright Scholar Program NATO advanced research fellowships and institutional grants. For more information contact the USIA Fulbright Scholar Program, Council for International Exchange of Scholars, 3007 Tilden Street, NW, Suite 5L, Box GNEWS, Washington, DC 20008-3009; telephone 202-686-7877; Worldwide Web: http://www.cies.org/.

**January 15, 2000:** Deadline for applications for NIST/NRC Postdoctoral Research Associateship Programs. Further information may be obtained from the NIST Web site at http://www.nist.gov/oiaa/postdoc.htrn by contacting Joy Brooks, Information Specialist, NIST, telephone 301-975-3071; or Jack H. Hsia, Chief of Academic Affairs, NIST, telephone 301-975-3067; or write to the National Research Council, Associateship Programs, TJ2114, 2101 Constitution Avenue, NW, Washington, DC 20418, telephone 202-334-2760.

**February 1, 2000:** Deadline for applications for NSF/AWM Mentoring Travel Grants for Women. For more information see “Mathematics Opportunities” in this issue.

**February 1, May 1, October 1, 2000:** Deadline for applications for NSF/AWM Travel Grants for Women. For more information see “Mathematics Opportunities” in this issue.

**Book List**

The Book List highlights books that have mathematical themes and hold appeal for a wide audience, including mathematicians, students, and a significant portion of 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 the Managing Editor, e-mail: notices@ams.org.


*Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in
Reference and Book List


Why Do Buses Come in Threes?, by Rob Eastaway and Jeremy Wyndham.


# Backlog of Mathematics Research Journals

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1998 Median Time. This information is as reported by the editor of the journal.

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<td>SIAM J. Numer. Anal.</td>
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<td>1980</td>
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<td>SIAM J. Optim.</td>
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<td>Trans. Amer. Math. Soc.</td>
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<td>48</td>
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<td>pdf, ps, dvi</td>
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<td>Electron. J. Differential Equations (ejde.math.swt.edu) (ejde.math.unet.edu) (<a href="http://www.emis.de/journals/EJDE">www.emis.de/journals/EJDE</a>)</td>
<td>36</td>
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### Research Journals Backlog

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<td>ESAIM Proc. (<a href="http://www.emath.fr/proc/">www.emath.fr/proc/</a>)</td>
<td>44</td>
<td>NA</td>
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<td>171</td>
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<tr>
<td>J. Funct. Logic Programming (<a href="http://www.cs.tu-berlin.de/journal/jflp/">www.cs.tu-berlin.de/journal/jflp/</a>)</td>
<td>7</td>
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<td>J. Graph Algorithms Appl. (<a href="http://www.cs.brown.edu/publications/jgaa/">www.cs.brown.edu/publications/jgaa/</a>)</td>
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<td>LMS J. Comput. Math. (<a href="http://www.lms.ac.uk/cm/">www.lms.ac.uk/cm/</a>)</td>
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<td>13</td>
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<tr>
<td>Sem. Lothar. Combin. (cartan.u-strasbg.fr/~slc)</td>
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<td>91</td>
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<td>Sorites (<a href="http://www.ifs.cscis.es/sorites">www.ifs.cscis.es/sorites</a>) (<a href="http://www.filosoficas.unam.mx/sorites/">www.filosoficas.unam.mx/sorites/</a>)</td>
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<td>Southwest J. Pure Appl. Math. (rattler.cameron.edu/swjpam)</td>
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<td>Theory Appl. Categ. (<a href="http://www.tac.mta.ca/tac/">www.tac.mta.ca/tac/</a>)</td>
<td>10</td>
<td>169</td>
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The following electronic-only journals are covered by Mathematical Reviews. No response was received to requests for information: ACM J. Experimental Algorithms (www.jea.acm.org/) and Doc. Math. (www.mathematik.uni-blelefeld.de/documenta/), (www.math.uiuc.edu/documenta/).

NR means no response received.
NA means not available or not applicable.
* From date accepted.
** From date of meeting at which the paper was communicated.
*** Date of receipt or acceptance of manuscript not given in this journal.
† From acceptance to publication in print. Electronic publication will be less.
Northwestern University invites nominations for the Frederic Esser Nemmers Prize in Mathematics, to be awarded during the 1999-2000 academic year. The award includes payment to the recipient of $100,000. Made possible by a generous gift from the late Erwin Plein Nemmers and the late Frederic Esser Nemmers, the award is given every other year.

Previous recipients were Yuri I. Manin (1994), Joseph B. Keller (1996), and John H. Conway (1998).

Candidacy for the Nemmers Prize in Mathematics is open to individuals with careers of outstanding achievement in mathematics, as demonstrated by major contributions to new knowledge or the development of significant new modes of analysis. Individuals of all nationalities and institutional affiliations are eligible, except current or former members of the Northwestern University faculty.

The recipient of the 2000 Nemmers Prize in Mathematics will deliver a public lecture and participate in other scholarly activities at Northwestern University for 10 weeks during the 2000-01 academic year.

Nominations for the Frederic Esser Nemmers Prize in Mathematics will be accepted until December 1, 1999. Nominating letters of no more than three pages should describe the nominee's professional experience, accomplishments, and qualifications for the award. A brief *curriculum vitae* of the nominee is helpful but not required. Nominations from experts in the field are preferred to institutional nominations; direct applications will not be accepted.

Send nominations to:
Secretary
Selection Committee for the Nemmers Prizes
Office of the Provost
Northwestern University
633 Clark Street
Evanston, Illinois 60208-1119
U.S.A.

Northwestern University is an equal opportunity educator and employer.
Election of Officers for 2000

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Dear Colleagues:

Once again members of the Society are invited to vote for candidates for several of the Society's governing bodies. The candidates for election are presented in the material that follows. This information and the official ballot will be sent to you in early September. The choices you make in these elections directly affect the direction that the Society takes. This may not be obvious to the casual member, so let me take a few moments to explain.

The president of the Society (whom you elect every other year) is the most important officer. The president determines, either directly or indirectly, most of the scientific policies of the Society. The direct effect comes through the president's personal interactions, both with members of the Society and outside the organization, for example, in testimony before congressional committees. Indirect influence occurs because the president appoints chairs and members of almost all committees of the Society, including the policy committees. The president sits as a member of all five policy committees, is the chair of the Council's Executive Committee, and serves ex officio as a trustee. The president works closely with all officers and administrators of the Society, especially the executive director and the secretary, to insure the orderly transaction of Society business. Finally, the president nominates candidates for the Nominating Committee and the Editorial Boards Committee. As a consequence, the president has a long-term effect on affairs of the Society.

The vice president and the members at large of the Council you select will serve for three years on the Council of the Society. The Council determines membership on the editorial boards of the Society, appoints the treasurers and the members of the Secretariat, nominates candidates for future elections, creates committees, and determines all scientific policy of the Society. Each of these new members of the Council will serve on one of the Society's policy committees.

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

The candidates presented to you were suggested to the Council either by the Nominating Committee or by petition from members. While the Council has the final nominating responsibility, the groundwork is done by the Nominating Committee. New members of this committee will be elected by you in the forthcoming election. The candidates were nominated by the current president, Felix E. Browder, and the three elected will serve three-year terms. The main work of the Nominating Committee takes place during the annual meeting of the Society, during which it has four sessions of face-to-face meetings, each lasting about three hours. The Committee then reports its suggestions to the Council, which makes the final nominations.

The Editorial Boards Committee is responsible for the operation of the editorial boards of the Society. Members are elected for three-year terms from a list of candidates named by the president. The Editorial Boards Committee makes recommendations for most of the editorial boards of the Society. Editors of those journals named in the by-laws are appointed by the Council, upon recommendation of the Editorial Boards Committee. Associate editors and editors for all other editorial committees are appointed by the president, again upon recommendation of the Editorial Boards Committee.

If past elections are a reliable measure, about 12 percent of you will vote in this election. This is in line with voting patterns in other professional organizations. This is not offered as an excuse for you to throw the ballot in the trash, however; the other officers and members of the
Council join me in urging you to take a few minutes to review the election material, fill out your ballot, and mail it. The Society belongs to its members. You can influence the policy and direction it takes by voting.

Let me urge anyone still reading to consider other ways of participating in Society activities. The Nominating Committee, the Editorial Boards Committee, and the Committee on Committees are always interested in learning of members who are willing to serve the Society in various capacities. Names are always welcome, particularly when accompanied by a few words detailing the person's background and interests. Self-nominations are probably the most useful. Recommendations can be sent to the secretary (e-mail: secretary@ams.org), who will forward them to the cognizant body.

PLEASE VOTE.

We were not able to include the complete list of candidates and biographical information in the September issue. The complete election information will be mailed to all members with the ballot in September.

—Robert J. Daverman
Secretary

<table>
<thead>
<tr>
<th>List of Candidates—1999 Election</th>
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<tbody>
<tr>
<td><strong>President</strong></td>
</tr>
<tr>
<td>(one to be elected)</td>
</tr>
<tr>
<td>Hyman Bass</td>
</tr>
<tr>
<td>Daniel W. Stroock</td>
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<tr>
<td><strong>Vice President</strong></td>
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<tr>
<td>(one to be elected)</td>
</tr>
<tr>
<td>David Eisenbud</td>
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<tr>
<td>Thomas G. Kurtz</td>
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<tr>
<td><strong>Board of Trustees</strong></td>
</tr>
<tr>
<td>(one to be elected)</td>
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<tr>
<td>Eric M. Friedlander</td>
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<tr>
<td>Donald E. McClure</td>
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<tr>
<td><strong>Member at Large of the Council</strong></td>
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<tr>
<td>(five to be elected)</td>
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<tr>
<td>Patricia Bauman</td>
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<tr>
<td>William Fulton</td>
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<tr>
<td>Susan C. Geller</td>
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<tr>
<td>Martin Golubitsky</td>
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<tr>
<td>Ellen E. Kirkman</td>
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<tr>
<td>Jonathan M. Rosenberg</td>
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<tr>
<td>Claude L. Schochet</td>
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<tr>
<td>Ronald J. Stern</td>
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<tr>
<td>Lisa Traynor</td>
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<tr>
<td>William Yslas Velez</td>
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<tr>
<td><strong>Nominating Committee for 2000</strong></td>
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<tr>
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<tr>
<td>Curtis D. Bennett</td>
</tr>
<tr>
<td>Ruth M. Charnley</td>
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<tr>
<td>Ramesh A. Gangolli</td>
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<tr>
<td>Frank Morgan</td>
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<tr>
<td>Donald St. P. Richards</td>
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<tr>
<td><strong>Editorial Boards Committee for 2000</strong></td>
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<tr>
<td>(two to be elected)</td>
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<tr>
<td>Palle E. T. Jorgensen</td>
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<tr>
<td>Gregory F. Lawler</td>
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<tr>
<td>Roger Wiegand</td>
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Election Information

The ballot for election of officers, members of the Council, a trustee, and committee members will be mailed on or shortly after September 10, 1999, in order for members to receive their ballots well in advance of the November 10, 1999, deadline. A list of members of the Council and Board of Trustees serving terms during 1999 will appear in the “AMS Officers and Committee Members” section of the October issue of the Notices (and will be mailed with the election material sent to all members in September).
Replacement Ballots
There has been a small but recurring and distressing problem concerning members who state that they have not received ballots in the annual election. It occurs for several reasons, including failure of local delivery systems on university or corporate properties, failure of members to give timely notice of changes of address to the Providence office, failures of postal services, and other human errors.

To help alleviate this problem, the following replacement procedure has been devised: A member who has not received a ballot by October 10, 1999, or who has received a ballot but has accidentally spoiled it may write after that date to the Secretary of the AMS, P. O. Box 6248, Providence, RI 02940, asking for a second ballot. The request should include the individual’s member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or airmail. It must be returned in an envelope which will be supplied, on the outside of which is the following statement to be signed by the member:

The ballot in this envelope is the only ballot that I am submitting in this election. I understand that if this statement is not correct, then no ballot of mine will be counted.

signature

Although a second ballot will be supplied on request and will be sent by first class or airmail, the deadline for receipt of ballots will not be extended to accommodate these special cases.

Suggestions for 2000 Nominations
Each year the members of the Society are given the opportunity to propose for nomination the names of those individuals they deem both qualified and responsive to their views and needs as part of the mathematical community. Candidates will be nominated by the Council to fill positions on the Council and Board of Trustees to replace those whose terms expire January 31, 2000. See the “AMS Officers and Committee Members” section of the October issue for the list of current members of the Council and Board of Trustees. Members are requested to write their suggestions for such candidates in the appropriate spaces below.

**COUNCIL AND BOARD OF TRUSTEES**

Vice President (1)

Members at Large of the Council (5)

Member of the Board of Trustees (1)

The completed form should be addressed to AMS Nominating Committee, P. O. Box 6248, Providence, RI 02940, to arrive no later than November 10, 1999.
Nominations for President Elect

Nomination for Hyman Bass

by Irving Kaplansky

Let me turn the clock back to the late 1950s at the University of Chicago. The Stone Age was at its peak. (I hope that many young mathematicians will be reading this, and I realize they may not have a clue as to what I am talking about. In brief: In 1946 the late Marshall Stone took over the chairmanship; he promptly made a dazzling array of appointments, and this was promptly followed by the arrival of a dazzling array of graduate students.) Hy Bass was an outstanding graduate student. While still a student he published (Proc. Amer. Math. Soc. (1958)) a dandy paper on algebraic logic. This paper would honor the pen of a mature mathematician: it has motivation, good exposition, and clear and graceful writing.

It is not often that a dissertation introduces a new concept of permanent value. Hy's 1959 thesis added perfect rings to the armory of ring theorists. But let me jump to one of my favorites: "Big projective modules are free" (Illinois J. (1963)), with its entertaining subsection on very big projective modules. If you like projective modules (I do) and infinite algebra (I do), you are going to love theorems such as the following: any nonfinitely generated projective module over a Noetherian domain is free.

Mention "ubiquity" when you are standing near a commutative ring theorist of the homological persuasion. You will get a benign smile of recognition. Just the title is a classic: "On the ubiquity of Gorenstein rings" (Math. Z. (1963)).

I am closing in on the K-theory era. Please forgive me for bringing in a personal angle, dating from the early 1950s. Take the group of invertible \( n \) by \( n \) matrices over a commutative ring. Two subgroups beg for attention: the commutator subgroup and the matrices of determinant 1. Manifestly the former is contained in the latter. Are they equal? Certainly not; look at 2 by 2 matrices over the field of 2 elements. So let us avoid that pitfall by moving up to 3 by 3 matrices. Now are the two subgroups equal? I leaned to the belief that they were. I pestered people with the question. I encouraged a student to try some computations with algebraic integers; the results were inconclusive. But here is an oddity: although at the time I was simultaneously interested in functional analysis, I never thought of trying, say, the ring of continuous real functions on the circle. I believe that if I had done so, a negative answer would have surfaced in 24 hours and algebraic K-theory might have been born a little sooner. A Dyson style "missed opportunity"? Maybe. Anyhow, I was way off base. Not only are the two subgroups unequal, the gap between them spawned a major theory.

Grothendieck gathered projective modules into \( K(0) \), Bass gathered the aforementioned gaps into \( K(1) \). The result: a structure pleasing to topologists, including the inevitable long exact sequence. Soon \( K(2) \) was added, and finally (Quillen) \( K(n) \) for all \( n \). Today we have algebraic K-theory, topological K-theory, the KK-theory of \( C^* \)-algebras, and doubtless scads of \( K(n) \)'s I have never heard of. K-theory has its own journal. And towering benevolently over all is Hy's monumental 762-page treatise.

Irving Kaplansky is the director emeritus at the Mathematical Sciences Research Institute.
In 1975 Bass and Quillen received the AMS's Cole Prize in algebra for their work on $K$-theory.

I move to the congruence subgroup problem. In his 1993 nomination (Notices (1993), 815–6) Milnor described this achievement far better than I can. I hope that at least some readers will take the trouble to hunt it up. In brief: Hy was a member of the 3-person team (Bass, Milnor, Serre—what a team!) that cracked this notable problem.

In 1976 a paper in Comm. Algebra marked Hy's entry into the intriguing world of groups acting on trees. This played an important role in his participation in another remarkable team effort: the proof of the Smith conjecture. This concerns the nature of diffeomorphisms of the 3-sphere. Many people and many methods were assembled, and it is all collected in a book edited by Hy and John Morgan, The Smith Conjecture (Academic Press, 1984). Hy's contribution starts on page 127. I am going to take the space to state his theorem, slightly paraphrased and with the fourth alternative left vague.

Let $G$ be a finitely generated group of invertible complex 2 by 2 matrices. Then at least one of the following four statements must hold: (1) $G$ is conjugate to triangular matrices with roots of unity on the diagonal, (2) $G$ can be thrown by similarity into the ring of algebraic integers, (3) the unipotent matrices of $G$ lie in a normal subgroup with quotient infinite cyclic, (4) $G$ is a certain amalgamated free product.

At a recent conference I heard John Morgan say that Hy was the ideal algebraist for the team. Perhaps I have said enough to establish adequately his mathematical credentials. As is customary in these nominations, I finish by praising his personal and administrative qualifications. I am in an unusually good position to do this, for I had the privilege of working closely with him at MSRI. (There may be a handful of readers who do not recognize this acronym. The NSF-sponsored Mathematical Sciences Research Institute, located on the Berkeley campus, started operations in 1982.) Hy served as chairman of the Board of Trustees from the 1981–2 planning year through 1986, and then as chairman of the Scientific Advisory Council, 1989–92. I believe there is a character in one of Steinbeck's novels who was so good at fixing cars that a car would run better if he just stood next to it. That's how I felt at any meeting with Hy present. His wisdom, his good judgment, his tact, and his wide knowledge of the world of mathematics and mathematicians combined to make him a wonderful colleague. And I still think of it as a miracle that an East Coast mathematician would so unselfishly give so much to an Institute 3,000 miles away. MSRI has just had its funding renewed (in an open competition with new applicants). Thanks in good measure to what Hy gave us, MSRI's future looks promising.

We also worked together at the AMS, especially during my presidential term. I have before me an advance copy of his updated vita; it will accompany this nomination in the election materials. The list of his past services is as long as your arm. Never mind that. Right now he is chairman of the Committee on Education, he is on the Federal Policy Agenda Committee, and he is on the Editorial Board of the Notices.

The Committee on Education brings me to this recent phase of his career. For the past decade he has (again unselfishly) devoted a major part of his energy and talents to the problems we face in mathematical education at all levels, from K–12 to postdoctoral work. I start with the fact that he has chaired the Mathematical Sciences Education Board since 1993. On December 5–6, 1996, there was a conference at MSRI on the future of mathematics education at research universities. Hy was the keynote speaker, and the text of his address leads off the conference proceedings, just published. It is more accessible in the January 1997 Notices, pp. 18–21. If you have any lingering doubts about Hy as AMS president, at least browse it.

By now you will have gathered that I feel that he is ideally qualified to lead the Society into the new millennium.

Nomination for Daniel Stroock

by Raghu Varadhan and Victor Guillemin

These few paragraphs are in support of the nomination of Daniel Wyler Stroock for president of the American Mathematical Society. The part dealing with the scientific aspects of Dan's career was written by Raghu Varadhan, and the one about the administrative aspects of his professional life by Victor Guillemin.

Victor will address Dan's contributions to our profession both at MIT and at the national level. I shall limit myself to the scientific aspects of his career. Dan Stroock has played a very significant role in the development of probability theory and its connections to analysis during the last thirty years. I have known him during this whole period. We met when he was a graduate student of Mark Kac at what used to be then called the Rockefeller Institute and now renamed Rockefeller University. I was a postdoctoral visitor at Courant Institute, in my third year. At that time there was a strong interaction, especially in probability theory between the two centers. We had a joint seminar once a week, that used to alternate between the two institutions.

Dan had found some problem on large deviations that I had worked on to be of interest to him and showed up in my office one day to talk. We found that we had a lot of common interests. He finished his Ph.D. and joined the Courant Institute as a post-doc for a year and then the faculty the following year. I had stayed on the faculty after

Raghu Varadhan is professor of mathematics at the Courant Institute. His e-mail address is varadhan@courant.nyu.edu.

Victor Guillemin is professor of mathematics at the Massachusetts Institute of Technology. His e-mail address is vwg@math.mit.edu.
three years as post-doc. We worked together for nearly six years on various aspects of diffusion processes. The so called martingale formulation did indeed get formulated during this period.

This work, for which we both shared the Steele Prize of the American Mathematical Society, focuses on the measure on path space as the basic object to be studied. This formulation provides a convenient base from which quick connections can be made to other approaches, like partial differential equations, semigroup theory, stochastic differential equations etc. The formulation has also proved very useful in the infinite dimensional context where questions on the nature of the domain of a potential infinitesimal generator hardly ever have decent answers. Over the years this approach has provided the best framework for the study of Markov Processes in diverse contexts.

I personally enjoyed working with him during these six years. We brought slightly different strengths to the partnership. Dan had developed a strong interest in harmonic analysis which he would develop further in future years.

During his twelve years in Boulder, Dan started working on infinite particle systems collaborating with Dick Holley, a colleague at Boulder. Together they did some excellent work in an area that was developing rapidly. This involved connections between stochastic processes and statistical mechanics. It used stochastic dynamics to understand equilibrium behavior of complex statistical ensembles. Holley and Stroock made some of the important contributions to the subject. Their ideas were developed further by Stroock and Zegarlinski. In particular Stroock and Zegarlinski were able to prove for infinite dimensional systems a type of apriori estimate known as logarithmic Sobolev inequality which is more or less the only Sobolev type inequality which can survive the passage to infinite dimensions.

Around that time Paul Malliavin, in Paris, was starting a quiet one man French Revolution all by himself. He was trying to combine Wiener measure with infinite-dimensional differential geometry. Among other things this made possible a dynamical understanding of Hormander’s hypoellipticity condition. Stroock and Kusuoka developed the so called Malliavin Calculus, making it accessible to probabilists. Malliavin Calculus views the solution of a stochastic differential equation as a “smooth” map on the Wiener space. The precise notions of smoothness, nondegeneracy, etc., are quite complex and thanks in part to Kusuoka and Stroock, the material is now familiar to many. Dan has used successfully the tools from Malliavin Calculus to study many problems of probability and analysis.

In fact, an underlying theme in Dan’s work has always been the connection between probability and analysis. I cannot think of anyone who has explored this territory with more success than Dan. In recent years the focus has shifted ever so slightly as he has begun exploring the connections between diffusions and differential geometry.

Dan is also an excellent expositor, having written many books in probability theory. We did a book together way back and since then Dan has several books on Large Deviations, Basic Probability, Diffusions on Manifolds, etc. During his career he has collaborated successfully with many post-docs.

Raghu has given us a vivid mathematical profile of Dan. As Dan’s colleague I would like to discuss another aspect of his life in mathematics: that of “good citizen”. To say that over the years he has taken on his shoulders, selflessly and uncomplainingly, administrative duties that most of us would regard as onerous doesn’t begin to do justice to his role as “good citizen”. More to the point is the fact that he has performed these duties with an unflappable patience and sanity, often in circumstances which would try the patience of a stoic. A few items by way of illustration:

When Dan came to M.I.T. in 1984 much of the activity in his area of probability theory was centered, not in the mathematics department, but in electrical engineering and computer science. Realizing that this presented, not an adversarial situation, but a golden opportunity, he set out to organize seminars, courses and other activities that math and engineering students could participate in together; and though the personal cost in time and effort has been considerable, he has succeeded (with a lot of help from Sanjoy Mitter) in making stochastic processes an intramural field of study at M.I.T. (and creating, into the bargain, an enhanced image of the mathematics department itself as a "good citizen").

The centennial of the birth of Norbert Wiener was celebrated at M.I.T. with considerable pomp and eclat, and, in particular, by a large week-long conference. For the organizers of this conference—Dan, David Jerison, and Isadore Singer—the crises encountered in the course of securing funding, selecting speakers, and commissioning a biography of Wiener to commemorate the occasion were worse than the most pessimistic nay-sayers could have anticipated. Dan’s good common sense was a large factor in weathering these crises and making the conference a success.

Dan served an exemplary two years as chair of the pure mathematics department in spite of the fact that those two years were demanding years for him in terms of duties centered, not at M.I.T., but in Washington (c.f. sopra).

Dan is currently serving as the representative for mathematics in the National Academy of Science, and as such has been very effective in promoting the agenda of mathematics (and getting mathematicians into the academy)!

Most of Dan’s time this year has been taken up with his activities on the Board of Mathematical Sciences. The findings of this board will play an important role in post-millennial funding for mathematics and, in spite of the fact that Dan’s frequent weekend trips to Washington have left him with little time for his favorite extracurricular activity (demolishing his junior colleagues on the squash court) he is upbeat, not unjustifiably I think, about the positive effect of the committee’s recommendations. If he’s right, it will clearly be, in no small part, due to his efforts!

We both hope that we have convinced you about Dan’s exceptional talents as a mathematician as well as his commitment and willingness to serve our profession. We believe that he will make an outstanding president.
Biographies of Candidates 1999

Biographical information about the candidates has been verified by the candidates, although in a few instances prior travel arrangements of the candidate at the time of assembly of the information made communication difficult or impossible. A candidate had the opportunity to make a statement of not more than 200 words on any subject matter without restriction and to list up to five of her or his research papers.

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

Each candidate had the opportunity to supply a photograph to accompany her or his biographical information.

A candidate with an asterisk (*) beside his or her name was nominated in response to a petition.

President Elect

Hyman Bass

Roger Lyndon Collegiate Professor of Mathematics and Professor of Mathematics Education, University of Michigan.

Born: October 5, 1932, Houston, Texas.


Institute for Advanced Study: Member, Board of Trustees, 1992-1997; Oversight Board, Park City/IAS Mathematics Institute, 1993-


Selected Addresses: International Congresses of Mathematicians: Moscow, 1966, and Vancouver, 1974; AMS Invited Address, Cambridge, October 1969; Phillips Lecturer, Haverford College, fall 1970, 1975; Principal Lecturer, CBMS Regional Conference on Algebraic K-Theory, Colorado State University, August, 1973; Invited Address, British Mathematical Colloquium, spring 1973; Colloquium Lectures, Atlanta, January 1978; Barrett Memorial Lecturer, University of Tennessee, March, 1978; Karcher Lecturer, University of Oklahoma, August 1979; Distin-
guished Lecturer, University of Indiana, 1982; Distinguished Lecturer, Kansas State University, 1982; AMS Arnold Ross Lecturer, University of Maryland, April 1996; Knight Lecturer, University of Manitoba, June 1997; AMS Invited Address, Pretoria, June 1997.


Statement: Mathematics is one of the deepest and most powerful expressions of pure human reason and, at the same time, the most fundamental resource for description and analysis of the experiential world. Never before in history have these qualities of our discipline been more evident to us as professionals and more important to society at large.

So it is paradoxical that our field struggles with inadequate resources; with employment crises; with the inability to attract adequate numbers of talented students, especially women and minorities, into our ranks; and with little public perception of appreciation of the pervasive roles of mathematics in contemporary life. The AMS has essential roles to play in addressing these concerns. It should continue, in concert with its sister sciences, as a strong public advocate for the support of fundamental research, as well as interdisciplinary and applied research. And it should foster more effective public communication about the nature and beauty of mathematical ideas and about the human drama of doing mathematics. Some of this can be accomplished in the press and public media. But fundamentally this must be done with our massive and captive audience, our students.

At the graduate level the basic culture of mathematics remains a powerful platform for a multiplicity of professional opportunities, many of them nonacademic. To give our Ph.D.'s this professional versatility, we should not abandon our core disciplinary training, but should seek to enhance it with critical resources that can build professional capacity: auxiliary training in probability and statistics; new computer skills; and, perhaps most important, enhanced ability in communication and teaching. Mathematicians should become better skilled at communicating mathematical ideas to students, to technical users of mathematics, and to the general public. In turn, we must work actively to improve the curriculum and instruction in our undergraduate programs and to accord this responsibility the status and resources it demands. This is a site where our own actions can do much to improve the mathematical preparation of the students who enter and leave our colleges and universities, as well as the mathematical literacy of our work force and citizenry.

Less obvious but nonetheless important is our crucial role in K-12 teacher preparation, for it is in our courses that teachers learn mathematical content and models of teaching. Mathematicians thus have essential contributions to make in education at all levels, to the preparation of technical professionals, and to a public sense of what constitutes mathematical literacy for citizens of a technological democracy like ours.

Daniel W. Stroock

Professor of Mathematics, Massachusetts Institute of Technology.

Born: March 20, 1940, New York, New York.

Ph.D.: Rockefeller University, 1966.


Additional Information: Awards and Affiliations: Steele Prize (with S. R. S. Varadhan), 1997. Member: American Academy of Arts and Sciences; National Academy of Sciences. Other Organizations: Serves on the NRC Board of Mathematical Sciences and on the editorial boards of various other journals.


Statement: Approximately 25,000 of the world’s 6 billion inhabitants belong to the AMS, and approximately 16,000 of these are among the 250 million residents of the United States. Thus, however one figures it, membership in the AMS can be expected to do so? is membership in a rather peculiar and highly specialized organization. In fact, an interest in mathematics is the only compelling reason for joining the AMS. Personally, I find this reality clarifying. Namely, it means to me that the AMS has a well-defined mission: the promotion of mathematics. Thus, if I am elected president of the AMS, I will do my best to mobilize the AMS to maintain and improve the position of mathematics as an integral and essential part of the human endeavor. If the members of the AMS are not ready to undertake and support such activity, who are not among the remaining 99.9936 percent of the American population can be expected to do so?

Vice President
David Eisenbud

Director, Mathematical Sciences Research Institute; Professor of Mathematics, University of California, Berkeley.
Selected Addresses: Invited Lecture, International Congress of Mathematicians, 1974; AMS Invited Address, St. Louis, 1977; Plenary Address, 19th Brazilian Mathematical Colloquium, 1993; Distinguished Lecturer Program, University of New Mexico, Las Cruces, 1996; Emmy Noether Lectures, Bar-Ilan University, 1999.

Statement: The American Mathematical Society, together with its many sister institutions such as SIAM, works to promote research in the mathematical sciences. This research now takes place at an enormous range of different institutions, from traditional research universities to colleges and industrial laboratories. The mathematicians involved are increasingly diverse. As director of MSRI I have worked to encourage this diversity and to serve the whole range of mathematical enterprises. I believe that this is what the AMS should do too.

Mathematicians should be better heard by the public, by the NSF, in Congress, and in the news media. The AMS is one of the primary voices speaking for us. From my MSRI experience I have the background and contacts to help make this communication more effective and more useful to the field.

Keeping the mathematical sciences establishment healthy is important for science, for commercial applications, and for human culture. This is an enormous and highly collaborative enterprise. I am eager for the chance to contribute to it as AMS vice president.

Thomas G. Kurtz

Professor of Mathematics and Statistics, University of Wisconsin-Madison.
Born: July 14, 1941, Kansas City, Missouri.


Statement: The first responsibility of the American Mathematical Society is to ensure the long-term vitality of mathematics as a subject and as a profession. Our success in meeting that responsibility depends on the relationships we build and maintain with the organizations that support our work—the colleges and universities that employ most of us, the federal agencies that supply most of the academic research support, and, increasingly, the industries that provide new opportunities for employment and collaboration—on our ability to foster the development of young mathematicians as future scholars, teachers, and organizational leaders; on our maintaining the intellectual energy and excitement that drives new developments; and on our maintaining a clear view of the unique contributions that mathematics can bring to the interdisciplinary collaborations that now play a central role in our profession.

I believe that I have the necessary experience to contribute to the work of the AMS in all of these directions: leadership within my university, service with national agencies, development of a successful summer program for young faculty in probability, and involvement in a variety of interdisciplinary programs at both the national and local levels. I look forward to the opportunity.

Trustee
Eric M. Friedlander

Henry S. Noyes Professor of Mathematics, Northwestern University.
Born: January 7, 1944, Santurce, Puerto Rico.
Ph.D: Massachusetts Institute of Technology, 1970.


Statement: Over the years the AMS has expanded its role beyond the traditional one of supporting mathematical research through meetings and publications. To mention but three examples: the AMS addresses issues of salary, employment, and diversity which concern its members; the AMS engages in efforts to encourage funding and public support for the profession; and the AMS takes a more active role in issues of mathematical education. The broad scope of these activities requires the AMS to be sensitive to many factors, including the rapid changes occurring in book and journal publication, public and governmental attitudes toward support for mathematics, and demographic trends. If I am elected a trustee of the AMS, I will encourage the diverse activities of the AMS while keeping watch over the financial aspects of the Society.

SEPTEMBER 1999
NOTICES OF THE AMS
937
Donald E. McClure

Professor of Applied Mathematics, Brown University.
Born: October 22, 1944, Portland, Oregon.


Statement: The primary responsibility of the trustees is to exercise sound judgment in management of fiscal affairs and issues that potentially have a far-reaching impact on the financial condition of the Society. I shall approach the responsibilities of the position with the objective of maximizing the ability of the Society to fulfill its primary mission in support of mathematical scholarship and research, as reflected in policies adopted by the Council. I believe that achieving this objective requires prudence and a long-range view towards financial planning. There are still uncertainties in the financial future of the Society linked to its leading role in mathematics publications and to the evolution of modes of scholarly communication. The trustees remain cognizant of these uncertainties.

I shall remain active, as I have been, in efforts of the Society concerned with the status of professions in the mathematical sciences, even though these personal interests are not part of the main job of a trustee. In particular, I shall work to improve and broaden employment opportunities for mathematicians, to address current concerns about fair employment practices in the use of adjunct and part-time faculty, to increase the awareness among mathematicians of areas in technology and science where mathematics is needed, to increase awareness in kindred disciplines of the important role of mathematics, to encourage and enable participation in mathematics by young people truly reflective of the spectrum of our society, to improve the public regard and support of higher education, and to foster support for research in mathematics.

Member at Large of the Council

Patricia Bauman

Professor of Mathematics, Purdue University.

University, West Lafayette, 1998. Associate Editor: SIAM Journal on Mathematical Analysis, 1998-. Member: AMS, AWM, SIAM, SNP.


Statement: The AMS plays a central role in promoting excellence in mathematical research and education. It is also central to the process of dialogue and representation of views on current issues in the mathematical community. In an era of increasing emphasis on industry and product-related research, we must act to preserve the excellence of traditional fundamental research and provide leadership for research in new interdisciplinary areas in mathematics. We must promote the development of young mathematicians and take an active role in facilitating their employment in good academic and nonacademic positions. We must encourage the participation of highly qualified women and minorities in mathematics, and we must promote understanding and appreciation of the role of mathematics in our society.

As a mathematician whose research is in the intersection of pure and applied mathematics, I would appreciate the opportunity to serve the AMS in facing these challenges.

William Fulton

M. S. Keeler Professor of Mathematics, University of Michigan.
Born: August 29, 1939, Boston, Massachusetts.


Statement: The fundamental mission of the AMS is to promote mathematical research of high quality. This requires concern about prospects for young mathematicians and nurturing conditions in our colleges and universities that will attract the best candidates to enter and thrive in our profession. It also requires fostering support for mathematics from the general public.

As a major publisher of mathematics, the AMS should lead in the quality of its journals and books and in assuring that publications are affordable for libraries and individuals. The Council of the AMS should resist the urge to respond to every issue by forming another committee.

Susan C. Geller

Professor of Mathematics, Professor of Veterinary Anatomy and Public Health, Texas A&M University.
Born: October 27, 1948, Newark, New Jersey.


We need to continue to explore all avenues of encouraging mathematical sciences. When organizations work in isolation, the need to educate the legislators and public about the usefulness and necessity of mathematics to help obtain more funding for mathematics at all levels. The research mission is the primary focus of the AMS. We need to open the opportunities for research to a wider diversity of people, including minorities, females, and those working at traditionally nonresearch institutions or in industry.

The teaching mission of the AMS has existed for decades but has rarely been articulated as clearly as the research mission. Yet we are most visible to the public in the area of mathematics education, where we need to not only do a good job but be perceived as doing a good job. Thus, we need to educate the legislators and public about the usefulness and necessity of mathematics to help obtain more funding for mathematics at all levels.

A key component of the service mission is working with other organizations in mathematics and in the mathematical sciences. When organizations work in isolation, the public and legislatures are loath to take their explanations and needs seriously. The AMS should take the lead in coordinating with others.

Martin Golubitsky

Cullen Professor of Mathematics, University of Houston.
Ph.D.: Massachusetts Institute of Technology, 1970.


Statement: The AMS traditionally supports the health of the mathematics profession in the areas of research, teaching, and service. In all these areas we need to break out of insular mode and welcome a diversity of people, places, and organizations.

The research mission is the primary focus of the AMS. We should take the lead in coordinating with others.

Ellen E. Kirkman

Professor of Mathematics, Wake Forest University.
Born: July 28, 1948, St. Paul, Minnesota.
Ph.D.: Michigan State University, 1975.


Statement: Promoting mathematical research should continue as the primary mission of the AMS. While mathematicians continue to solve centuries-old problems and mathematics finds new areas of application, much of the traditional support for research seems to be waning. Nowadays research is pursued at a diverse set of American institutions (where internal support for research is not always ideal), and the uncertainties of the job market present serious problems for young mathematicians. Mathematical research is also affected by perceptions of mathematics and mathematics education held by the public, scientists, and engineers.

The AMS needs Council members representing the diversity of the American research community to develop creative solutions to the problems facing the mathematical community. To improve the support for research, we need to educate not only the policymakers in Washington but also the administrators who make decisions that affect the creation of jobs and the provision of internal resources. The AMS should explore ways to create synergy among all parts of the mathematical community. Working together, different sectors of the research community can find the means to improve support for mathematical research.

Jonathan M. Rosenberg
Professor of Mathematics, University of Maryland.
AMS Committees: Proceedings Editorial Board, 1988–1991; Chair, Committee on Steele Prizes, 1997–; Committee on the Profession, 1999–; Journal of the AMS Editorial Committee (associate editor), 2000–.


Statement: The AMS is the world’s largest and strongest organization for promoting mathematical research, as well as one of the world’s premier mathematical publishers. We must make sure it continues to be successful in the promotion and dissemination of research, but to do so, we must adapt to changing times.

While mathematics plays an increasingly important role in all aspects of society, public appreciation for research mathematics as an enterprise, as well as general understanding of the mathematical profession, is remarkably low. Turning this situation around is a very difficult challenge for the AMS. If elected to the Council, I would work for modernization of mathematics education (to convince the general public that mathematics is a living subject), better recruitment and support of talented young people in mathematics, and improved public relations. The AMS has begun to work on all of these fronts, but much additional work is needed.

Claude L. Schochet
Professor of Mathematics, Wayne State University.
Born: August 5, 1944, Minneapolis, Minnesota.


Additional Information: Wayne State University Board of Governors Faculty Recognition Award, 1983 and 1989.

Member: European Mathematical Union, Israel Mathematical Union, London Mathematical Society, MAA.


Statement: It was once fashionable to view ourselves as a community of scholars. The ivory tower aspect of that world view is now generally obsolete, but what remains should inform and enunciate our actions. Strategies change, but values remain. "Business as usual" is an acceptable strategy for the coming century.

Internally we must promote traditional research and develop new forms of interdisciplinary research. We must support each other—supply excellent teaching, help find jobs, make special efforts to be inclusive of women and minority members—and we must deal ethically with each other.

Externally we must recognize our obligation to the world outside of academic mathematics. It supplies our undergraduates, so we cannot simply ignore K-12 education. It supplies our funding, for which we provide the services of teaching and pure and applied research. Our community must build and maintain bridges to all users of mathematics (from computer science to sociology). These are hard to build and require frequent maintenance, but they are critical to our survival (witness the Rochester affair). I strongly support our national public relations efforts and would encourage off-the-record lobbying; I have learned from COPE that the most effective persuasion occurs in private.

Ronald J. Stern

Professor of Mathematics and Dean, School of Physical Sciences, University of California, Irvine.


Additional Information: University of Utah Distinguished Teaching Award, 1987; Chair, Department of Mathematics, University of California, Irvine, 1990–1994; Secretary, Board of Trustees, MSRI, 1992–1996; President and Chair, Board of Governors, Pacific Journal of Mathematics, 1995–; Dean, School of Physical Sciences, University of California, Irvine, 1998–.


Statement: Historically the primary mission of the AMS has been to encourage and publish mathematical research. The AMS has expanded its role to include a broad array of activities such as representing the mathematical research community to Congress and working together with other professional societies to publicize the importance of mathematic and science in our daily and future lives.

The AMS can further expand its role by providing a meaningful and strong influence on the policies of U.S. funding agencies. Further, the AMS can facilitate discussions between math departments on matters concerning graduate training, undergraduate teaching, support for research, and the important role a math department plays within a university structure. With all these activities the AMS can provide strong leadership for the continued prosperity of
Lisa Traynor

Associate Professor, Mathematics Department, Bryn Mawr College.


Statement: If elected, I would work hard to research issues that come to the attention of the Council. I am particularly interested in issues related to science policy and education. In the process of forming my opinions, I would make efforts to communicate with people involved with mathematics at a variety of levels and employment situations. My motivation to serve the community in this way is my love of and dedication to mathematical research. I believe that excellence in research mathematics, in the application of mathematics to other disciplines, and in the teaching of mathematics are all interdependent and thus all need to be encouraged and supported.

William Yslas Velez

Professor of Mathematics, University Distinguished Professor, University of Arizona.


Additional Information: President, Society for the Advancement of Chicanos and Native Americans in Science, 1994-1997; Director, Southwest Regional Institute in the Mathematical Sciences, 1994-1999; Organizing Committee, Second Joint Meeting of the AMS and the Sociedad Matematica Mexicana (SMM), Guanajuato, November/December 1995; President’s Award for Excellence in Science, Mathematics and Engineering Mentoring, 1997; University Distinguished Professor, 1996--; Council Delegate, Section on Mathematics to AAAS, 1998--; Chair, Human Resources Advisory Committee, Mathematical Sciences Research Institute, Berkeley, 1999--; Governor-at-Large for Minority Interests, MAA, 1999--.


Statement: I sought a Ph.D. in mathematics because I was fascinated by the subject. When I began my career, I thought my entire life would be spent doing research in mathematics. However, since I am one of a very small number of Chicano mathematicians, I have had to redirect my energies in other directions, namely, at encouraging minority students to pursue mathematical studies. These efforts have their own rewards.

As a mathematician I have enjoyed participating in a variety of endeavors. I have created mathematics, I have applied mathematics to solve industrial problems, and I have used mathematics to motivate our children to pursue more quantitative studies. I believe that mathematicians have a rich story to tell. I also believe that we haven’t done a very good job of telling this story, with the effect that students don’t understand the great utility of our subject. As mathematicians we know that our research is behind many of the latest scientific advances. To mimic a recent commercial, our profession can say, “We don’t make the products; we make them possible.” Our children need to know this.
Nominating Committee

Curtis D. Bennett
Associate Professor, Department of Mathematics and Statistics, Bowling Green State University.

Born: July 26, 1963, Madison, Wisconsin.

AMS Committees: Committee on the Profession, 1996-1998; AMS-MAA Committee on Teaching Assistants and Part-Time Instructors, 1998-.


Additional Information: Founding Member and Editor, Young Mathematicians’ Network, 1993-1996; Member, MAA Ohio Section Committee on Student Members, 1995-1997.


Statement: In addition to choosing qualified candidates, the AMS needs to be certain that all of its membership has representation on the Council and other committees. In particular, we need to make an effort to be sure that nominations are made from traditionally underrepresented groups such as women, minorities, mathematicians from smaller schools, junior mathematicians, and mathematicians from industry. As a member of the Nominating Committee, I will endeavor to see that nominees are qualified and represent the diversity of the community.

Ruth M. Charney
Professor, Ohio State University.


Ramesh A. Gangoli
Professor of Mathematics, University of Washington.

Born: February 26, 1935, Bangalore, India.


AMS Committees: Committee to Select Hour Speakers for Far Western Sectional Meetings, 1977, 1984-1985; Committee on Investment, Board of Trustees, 1985-1989; Committee on Corporate Relations, Board of Trustees, 1985-1996 (chair); Committee on Institutional Membership, Board of Trustees, 1987-1997; Agenda and Budget Committee, Board of Trustees (ex officio), 1988; Committee on Long-Range Planning, Board of Trustees (ex officio), 1988; Committee on the Publication Program, Board of Trustees, 1988- (chair, 1991-1992); Ad Hoc Committee on AMS Publications in Applied Mathematics, 1989; Committee on Education, 1991-1993 (chair); AMS-MAA Committee on Cooperation, 1991-1995.


Selected Addresses: Various invited talks at meetings/conferences of the American Mathematical Society.

Ramesh A. Gangoli
Professor of Mathematics, University of Washington.

Born: February 26, 1935, Bangalore, India.


AMS Committees: Committee to Select Hour Speakers for Far Western Sectional Meetings, 1977, 1984-1985; Committee on Investment, Board of Trustees, 1985-1989; Committee on Corporate Relations, Board of Trustees, 1985-1996 (chair); Committee on Institutional Membership, Board of Trustees, 1987-1997; Agenda and Budget Committee, Board of Trustees (ex officio), 1988; Committee on Long-Range Planning, Board of Trustees (ex officio), 1988; Committee on the Publication Program, Board of Trustees, 1988- (chair, 1991-1992); Ad Hoc Committee on AMS Publications in Applied Mathematics, 1989; Committee on Education, 1991-1993 (chair); AMS-MAA Committee on Cooperation, 1991-1995.

Selected Addresses: Various invited talks at meetings/conferences of the American Mathematical Society.


Frank Morgan

*Meenan Third Century Professor of Mathematics, Williams College.*

**Ph.D.:** Princeton University, 1977.

**AMS Offices:** Member at Large of the Council, 1994-1997.

**AMS Committees:** AMS-MAA-SIAM Morgan Prize Committee for Research in Mathematics by an Undergraduate Student, 1995-1997.

**Selected Addresses:** Joint AMS-MAA Invited Address on Compound Soap Bubbles, Shortest Networks, and Minimal Surfaces, San Francisco, January 1991; about 40 other talks a year.


Donald St. P. Richards

*Professor, University of Virginia.*

**Born:** April 4, 1955, Mandeville, Jamaica.

**Ph.D.:** University of the West Indies, 1978.

**AMS Committees:** Southeastern Section Program Committee, 1992-1994 (chair, 1993).

**Selected Addresses:** Invited Address, Tampa, March 1991; Special Session on Harmonic Analysis and Representation Theory, Cincinnati, January 1994; Special Session on Representation Theory, Orlando, January 1996; Special Session on Algebraic Methods in Statistics, Montreal, September 1997; Special Session on Probability Inequalities, Atlanta, October 1998.

**Additional Information:** Member, NAS/NRC Committee on Doctoral and Postdoctoral Study in the United States, 1990-1991; Member, Board on Mathematical Sciences, 1993-1999; Elected Fellow, Institute of Mathematical Statistics, 1999. **Member:** AMS, ASA, IMS.


**Editorial Boards Committee**

Palle E. T. Jorgensen

*Professor of Mathematics, University of Iowa.*

**Born:** October 8, 1947, Copenhagen, Denmark.

**Ph.D.:** Aarhus University, 1973.


**Selected Addresses:** I have been an invited speaker in AMS Special Session lectures at least once a year for the last ten years, and I have been a co-organizer of several Special Sessions. In addition, I have been co-organizer of two CBMS conferences and of several NSF-sponsored conferences.


Statement: The mathematics research journals are the lifeblood of our profession, and with an increasing financial pressure on library budgets the role of the American Mathematical Society grows proportionally. I have served on the library committees of both my department and my university and have learned that there are no magic formulas for solving the difficult problem of availability of journals to researchers. But awareness and pressure helps, and the AMS has done a great job in producing high-quality journals and monographs at moderate prices. It is my ambition to help move this process forward.

Gregory F. Lawler

Professor of Mathematics, Duke University.


Statement: The best way for the AMS to counter the high prices of journals is to continue to produce high-quality, low-cost journals, both print and electronic, and to strive to make these journals among the most prestigious in the mathematics community.

Roger Wiegand

Professor, Department of Mathematics and Statistics, University of Nebraska-Lincoln.
Born: July 22, 1943, Zanesville, Ohio.
AMS Committees: Ad Hoc Committee on Preparing Future Faculty, 1999.

Acknowledgment of Contributions

AMS Mission

The AMS, founded in 1888 to further the interests of mathematical research and scholarship, serves the national and international community through its publications, meetings, advocacy, and other programs, which
• promote mathematical research, its communication and uses,
• encourage and promote the transmission of mathematical understanding and skills,
• support mathematical education at all levels,
• advance the status of the profession of mathematics, encouraging and facilitating full participation of all individuals,
• foster an awareness and appreciation of mathematics and its connections to other disciplines and everyday life.

Thomas S. Fiske Society

The Executive Committee and Board of Trustees have established the Thomas S. Fiske Society to honor those who have made provisions for the AMS in their estate plans. For further information contact Tim Goggins at 800-321-4AMS, or tjg@ams.org.

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The officers and staff of the Society acknowledge with gratitude the following donors whose contributions were received during the past year. The names which follow represent donors who contributed during the period April 1, 1998—March 31, 1999.

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Memorial and commemorative gifts are a distinctive and thoughtful way to memorialize or honor a colleague, friend, or family member, and to support the Society's work to promote mathematical scholarship and research.

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In memory of Albert Calderon
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* In memory of Leo Wene
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* In memory of Leo Wene

In memory of Paul Erdos
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In memory of Robert B. Davis
In memory of Samuel Eilenberg
In memory of Taro Yoshizawa
In memory of Thomas V. Doud
In memory of Veronica Trela

Unspecified

In honor of Detlef Gronoll on his 60th Birthday.
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Rakos, James V.
Reed, Irving S.
Riedel, Marc A.
* Rose, Nicholas J.
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Schubert, Jewell E.
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Taylor, B. A.
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Venema, Gerard A.
Warner, Frank W., III
Weinstein, Steven H.
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Ziebur, Alan D.

* Cai, Joseph M.
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  Cohn, Donald L.
  Cohn, Harvey
  Colagiovanni, Rocco G.
  Cowan, Charles A.
  Cole, George
  Coleman, A. John
  Coleman, Robert
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  Comentes, Daniel
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Frederick, Michael W.
Free, Norman S.
Freder, Rod A.
Freeland, Math S.
Freedman, Robert S.
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Fukuda, Korei
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G.
Fyfe, Alexander
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Gadella, Manuel
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Galazzo, Mariano
Gales, Paul L.
Galiffi, Charles H.
Gallagher, David
Gallagher, Richard C.
Gallagher, William F.
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Gales, Paul L.
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Kleili, H.
Klepikov, Adam
Kleemann, Wolfgang H.
Kline, Richard Ford
Klingsberg, Paul R.
Kneece, Roland R., Jr.
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Knoepf, Peter M.
Knoer, Richard B.
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Kobayashi, Tsuyoshi
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Kuba, Roman K.
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Kuhlmann, Franz Viktor
Kuhlmann, Harald
Kul, H.
Kwok, Don Yu
Kwok, Krista
Kwokwumome, Nathaniel
Kwon, Kil H.
Kyser, Carl T.
Kyzyszewski, Robert P.
Kysa, Quang D.
Kysa, Wladimir
Kysa, Gary D.
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Examples of New Gift Annuity Rates
(Effective March 1, 1997)

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<th>Age</th>
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<tr>
<td>55</td>
<td>6.7%</td>
<td>67</td>
<td>7.4%</td>
<td>79</td>
<td>9.2%</td>
</tr>
<tr>
<td>56</td>
<td>6.7%</td>
<td>68</td>
<td>7.5%</td>
<td>80</td>
<td>9.4%</td>
</tr>
<tr>
<td>57</td>
<td>6.8%</td>
<td>69</td>
<td>7.6%</td>
<td>81</td>
<td>9.6%</td>
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<tr>
<td>58</td>
<td>6.8%</td>
<td>70</td>
<td>7.7%</td>
<td>82</td>
<td>9.8%</td>
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<tr>
<td>59</td>
<td>6.9%</td>
<td>71</td>
<td>7.8%</td>
<td>83</td>
<td>10.0%</td>
</tr>
<tr>
<td>60</td>
<td>6.9%</td>
<td>72</td>
<td>7.9%</td>
<td>84</td>
<td>10.2%</td>
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<tr>
<td>61</td>
<td>7.0%</td>
<td>73</td>
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<td>85</td>
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<td>62</td>
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<td>74</td>
<td>8.2%</td>
<td>86</td>
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<tr>
<td>63</td>
<td>7.1%</td>
<td>75</td>
<td>8.4%</td>
<td>87</td>
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<tr>
<td>64</td>
<td>7.2%</td>
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<td>8.6%</td>
<td>88</td>
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<tr>
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<td>90+</td>
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To determine the size of payments, multiply the rate by the value of the asset used to create the gift annuity. For example, a seventy-five-year-old giving $100,000 receives 8.4 percent, or $8,400, annually for life.
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Officers: J. Persens (President), T. G. Schultz (Vice-President), H. Laurie (Treasurer), R. L. Fray (Secretary).

The Americas

Canadian Mathematical Society
Address for mail: Canadian Mathematical Society, 577 King Edward Ave., Suite 109, Ottawa, Ontario, Canada K1N 6N5; e-mail: office@cms.math.ca; URL: http://cms.math.ca/.
Apply to: Ms. Chantal Stevenson, Membership and Publications Agent, at the above address.
Dues: 50% off applicable rate, payable in US funds to the Canadian Mathematical Society.
Privileges: CMS Notes, access to members section on Web site; reductions in all CMS periodicals, publications, and meeting registration.
Officers: Richard Kane (President), Jonathan Borwein (President-elect), Arthur Sherk (Treasurer), Margaret Battie, Francois Bergeron, Thomas Salisbury, Keith Taylor (Vice-Presidents), Graham P. Wright (Executive Director/Secretary).

The American Mathematical Society has "reciprocity agreements" with a number of mathematical organizations around the world. A current list appears here. These reciprocity agreements provide for reduced dues for members of these organizations who choose to join the AMS and who reside outside of the U.S. and Canada. Reciprocally, members of the AMS who reside in the U.S. or Canada may join these organizations at a reduced rate. Summaries of the privileges available to AMS members who join under the terms of reciprocity agreements are given on the following pages. Members of these organizations who join the AMS as reciprocity members enjoy all the privileges available to ordinary members of the Society. AMS dues for reciprocity members are $66 for 1999 and $66 for 2000. Each organization was asked to review and update its listing in the spring. An asterisk (*) after the name of an organization indicates that no response to this request had been received when the September Notices went to press. A bullet (•) before the name of an organization indicates that application forms for that organization may be obtained by writing the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940-6248.
Reciprocity Agreements

Sociedad Colombiana de Matemáticas
Address for mail: Apartado Aéreo 2521, Santa Fe de Bogotá, Colombia; e-mail: socolmat@matematicas.unal.edu.co; URL: http://www.ucolombia.gov.co/socolmat/

Apply to: Leonardo Rendon, Sociedad Colombiana de Matemáticas, Apartado Aéreo 2521, Santa Fe de Bogotá, Colombia.

Dues: U.S. $27, payable to Sociedad Colombiana de Matemáticas.

Privileges: Free submission to the Society publications (Revista Colombiana de Matemáticas y Lecturas Matemáticas) and discounts for participation in the society activities.

Officers: Leonardo Rendon (President), Carlos Mejía (Vice-President), Campo Elias Velosa (Secretary) Carlos Julio Arrieta (Treasurer).

Sociedad de Matemática de Chile*
Apply to: Sociedad de Matemática de Chile, María Luisa Santander 0363, Providencia, Santiago, Chile, e-mail: socmat@mat.puc.cl; URL: http://www.mat.puc.cl/

Dues: U.S. $50, payable to Sociedad de Matemática de Chile.

Privileges: Receive Gaceta de la Sociedad de Matemática, Notas de la Sociedad de Matemática de Chile.

Officers: Rolando Rebollo (President), Víctor Cortés (Vice-President), Hernán Burgos (Treasurer), Rodrigo Bamón, Sergio Plaza (Secretaries).

Sociedad Matemática de la República Dominicana
Apply to: Isidro Rodríguez, Sociedad Matemática de la República Dominicana, P. O. Box 797-2, Santo Domingo, Dominican Republic.

Dues: U.S. $10, payable to Isidro Rodríguez, Sociedad Matemática de la República Dominicana.

Privileges: Right to receive Notimat (bimonthly newsletter) and Revista Matemática Dominicana (twice a year).

Officers: Isidro Rodríguez (President), Mariana Morales (Vice-President), Amado Reyes (Treasurer), David Castillo (Secretary).

• Sociedad Matemática Mexicana*
Apply to: Rosa Sánchez, Apartado Postal 70-450, 04510-Mexico, D. F. Mexico.

Dues: U.S. $25, payable to Sociedad Matemática Mexicana.

Privileges: To be a regular member paying half of the regular fee for persons living outside of Mexico. Newsletter, Bulletin of the Mexican Mathematical Society, or Miscelanea Matemática.

Officers: José Carlos Gómez-Larrañaga (President), Roberto Martínez (Vice-President), Ernesto Vallejo (Treasurer), Federico Sabina (Executive Secretary), Francisco Mirabal (Secretary), Salvador García-Ferreira and Isabel Puga (Associate Secretaries).

Sociedad Uruguaya de Matemática y Estadística*
Address for mail: IMERL, Facultad de Ingenieria, CP 30, Montevideo, Uruguay.

Apply to: Jorge Blanco, Secretario de SUME, Facultad de Ciencias Económicas y de Administración, Av. G. Ramírez 1926, Montevideo, Uruguay.

Dues: Contact Sociedad Uruguaya de Matemática y Estadística for dues information; payable to: Miguel Galmés, Facultad de Ciencias Económicas y de Administración, Av. G. Ramírez 1926, Montevideo, Uruguay.

Officers: José L. Massera (President), Miguel Galmés (Treasurer), Jorge Blanco (Secretary).

Sociedade Brasileira de Matemática
Apply to: Diretoria da SBM, Estrada Dona Castorina—110, Jardim Botânico, Rio de Janeiro, RJ, Brazil, 22460, e-mail: sbm@imp.i.br.

Dues: U.S. $50, payable to Sociedade Brasileira de Matemática.

Privileges: Revista Matemática Universitária (two issues per year); Ensaios and other publications can be purchased at a 25% discount.

Officers: Paulo D. Cordaro (President), Ruy Exel (Vice-President), Cláudio Possani (Treasurer), F. Michael Forger (Secretary).

• Sociedade Brasileira de Matemática Aplicada e Computacional*
Apply to: Comissão de Admissão da SBMAC, Rua Lauro Müller 455, 22290, Botafogo, Rio de Janeiro, RJ, Brasil.

Dues: U.S. $30, payable to Sociedade Brasileira de Matemática Aplicada e Computacional.

Privileges: SBMAC Bulletin and SBMAC Notices.

Officers: Ricardo S. Kubrusly (President), Cristina Cunha (Vice-President), Jaime M. Rivera (Treasurer), Rolci Cipollati (Secretary).

• Sociedade Paranaense de Matemática*
Apply to: C. Pereira da Silva, Sociedade Paranaense de Matemática, Caixa Postal 1261, 80001-970, Curitiba-PR, Brasil.

Dues: U.S. $12, payable to Sociedade Paranaense de Matemática.

Privileges: Boletim da Sociedade Paranaense de Matemática (two issues per year), Monografías da Sociedade Paranaense de Matemática.

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**Unión Matemática Argentina**

Apply to: Alejandro Neme, IMASL, Ave. Ejercito de los Andes 950, 5700 San Luis, Argentina, e-mail: una@unsl.edu.ar; URL: http://linux0@unsl.edu.ar/uma.

Dues: U.S. $40, payable to Alejandro Neme.

Privileges: Free subscription to Noticiero UMA and one of either Revista de la Unión Matemática Argentina or Revista de Educación Matemática.

Officers: Felipe Zó (President), Jorge Solomin (Vice-President), Alejandro Neme (Treasurer), Hugo Alvarez (Secretary).

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**Asia**

**Allahabad Mathematical Society**

Apply to: Allahabad Mathematical Society, 10, C. S. P. Singh Marg, Allahabad 211001, India.

Dues: U.S. $30 (Category "A"), U.S. $20 (Category "B"), payable to Allahabad Mathematical Society at above address.

Privileges: Category "A": Indian Journal of Mathematics (free of cost); Category "B": Bulletin of the Allahabad Mathematical Society (free of cost).

Officers: D. P. Gupta (President), A. M. Vaidya and P. C. Joshi (Vice-Presidents), Mona Khare (Treasurer), U. K. Saxena (Secretary).

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**Calcutta Mathematical Society**

Apply to: M. R. Adhikari, Secretary, Calcutta Mathematical Society, AE-374, Sector 1, Salt Lake City, Calcutta 700 064, India; telephone: 337-8882, telex: 021-5380 BID IN; fax: (0091) 33-3376290.

Dues: U.S. $40, payable to Secretary, Calcutta Mathematical Society at above address.


Officers: B. K. Lahiri (President); A. P. Baisnab, P. P. Chatterjee, B. H. Lavenda, B. N. Mandal, D. K. Sinha (Vice-Presidents); U. Basu (Treasurer); M. R. Adhikari (Secretary); S. K. Chakraborty (Editorial Secretary).

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**Indian Mathematical Society**

Apply to: S. P. Arya, Administrative Secretary, Indian Mathematical Society, Department of Mathematics, Mai treyi College, Bapu Dham Complex, Chanakyapuri, New Delhi 110021, India.

Dues: U.S. $50, payable to M. K. Singal, Hon. Treasurer, IMS, A-1, Staff Residences, CCS University, Meerut-250005, India.

Privileges: Free copy of the Mathematics Student.

Officers: N. K. Thakare (President), M. K. Singal (Hon. Treasurer), S. P. Arya (Administrative Secretary), H. P. Dikshit (Academic Secretary), H. C. Khare (General Secretary), R. P. Agarwal (Editor, JIMS), V. M. Shah (Editor, Mathematics Student), K. S. Padmanabhan (Hon. Librarian).

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**The Korean Mathematical Society**

Apply to: Ms. Jung Suk Chung, Korean Mathematical Society, The Korea Science and Technology Center 214, 635-4, Yeoksam-dong, Kangnam-ku, Seoul 135-703, Korea; e-mail: kms@kms.or.kr; URL: http://www.kms.or.kr/.

Dues: U.S. $40, payable to The Korean Mathematical Society.

Privileges: Members will receive six volumes of Journal of the KMS and four volumes of Bulletin of the KMS.

Officers: Sung Ki Kim (President), Dong Myung Chung, Young Soo Park (Vice-Presidents), Sun Eun Koh (Treasurer), Seung-Hyeok Kye (Secretary).

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**Malaysian Mathematical Society**

Address for mail: Dept. of Maths., Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia; e-mail: xiripriac.cc.ukm.my; URL: http://www.tmsk.itm.edu.my/persama.

Apply to: Setiausaha Kehormat PERSAMA, Dept. of Maths., Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia.

Dues: U.S. $7.50, payable to Bendahari, PERSAMA, the above address.

Privileges: Warkah Berita PERSAMA (two issues per year), Bulletin of the Malaysian Mathematical Society (two issues per year), Menemui Matematik (two issues per year).

Officers: Shaharir b. Mohamad Zain (President), Abu Osman Md. Tap, Mohd. Ridi (Vice-Presidents), Bachok b. Taib (Treasurer), Maslina Darus (Secretary).

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**Mathematical Society of Japan**

Apply to: Ms. Chikai Obayashi, 25-9-203, Hongo 4 chome, Bunkyo-ku, Tokyo 113-0033, Japan.

Dues: Category I: 9,000 yen; Category II: 10,800 yen, payable to Mathematical Society of Japan, at the above address.


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**Mathematical Society of the Philippines**

Apply to: Membership Committee, Mathematical Society of the Philippines, Department of Mathematics, Ateneo de Manila University, P.O. Box 154, Manila, Philippines.

Reciprocity Agreements

Privileges: Publications and newsletter of the Mathematical Society of the Philippines.

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Address for mail: National Chiao Tung Univ., Dept. of Math., Hsinchu 300, Taiwan, Republic of China; e-mail: mathsoc@math.nctu.edu.tw; URL: http://www.math.nctu.edu.tw/mathsoc/.

Apply to: Tayuan Huang, Secretary, Mathematical Society of the Republic of China, Department of Applied Mathematics, National Chiao Tung University, Hsinchu, Taiwan 300, Republic of China.

Dues: U.S. $45, payable to the Mathematical Society of the Republic of China at the above address.

Officers: Tsang-Hai Kuo (President), Shih-Sen Wang (Treasurer), Tayuan Huang (Secretary).

Mongolian Mathematical Society

Apply to: R. Enhbat, Secretary, Mongolian Mathematical Society, P. O. Box 46/635, Ulaanbaatar, Mongolia.

Dues: U.S. $20; payable to R. Enhbat, at the above address.

Privileges: Right to receive the Journal of MMS for free and to publish in Journal of MMS, participate in activities of MMS.

Officers: Ts. Dashdorj (President), B. Bayasgalan (Vice-President), R. Enhbat (Secretary).

Nepal Mathematical Society

Apply to: S. R. Pant, Secretary, Nepal Mathematical Society, Department of Mathematics, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

Dues: U.S. $20, payable to P. M. Bajracharya (Treasurer), Nepal Mathematical Society, Department of Mathematics, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

Privileges: All privileges enjoyed by an ordinary member, which includes purchasing NMS publications and participation in seminars on concessional rates.

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• Punjab Mathematical Society

Address for mail: Department of Mathematics, University of the Punjab, Quaid-i-Azam Campus, Lahore, Pakistan; e-mail: mathdept@paknet.ptc.pk.

Apply to: Zia ul Haq, Secretary, Punjab Mathematical Society, Department of Maths., University of the Punjab, Lahore, Pakistan.

Dues: U.S. $30 for life membership, payable to Umar Farooq Qureshi, Treasurer, P.M.S.

• Ramanujan Mathematical Society

Address for mail: Professor R. Balakrishnan, Dept. Mathematics, Bharathidasan University, Tiruchirapalli 620 024, India; e-mail: rao@imsc.ernet.in.

Apply to: Professor Geetha S. Rao, Ramanujan Institute for Advanced Study in Mathematics, University of Madras, Chennai 600 005, India.

Dues: U.S. $20 (annual), payable to Professor R. Balakrishnan, Bharathidasan University, Tiruchirapalli 620 024, India.

Officers: R. Sridharan (President); V. P. Saxena (Vice-President); Geetha S. Rao (Secretary), K. S. Harinath (Academic Secretary); C. V. Venkatachalam (Treasurer).

• Singapore Mathematical Society*

Apply to: Secretary, Singapore Mathematical Society, c/o Department of Mathematics, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260, Singapore.

Dues: 10 Singapore dollars, payable to The Honorary Treasurer, Singapore Mathematical Society, National University of Singapore, 10 Kent Ridge Crescent, Singapore 119260, Singapore.

Privileges: Complimentary copy of Mathematical Medley, the Society’s official magazine and discounts on the Society’s publications and activities.

Officers: Lee Seng Luan (President); Tan Eng Chye (Vice-President); Zhao Gongyun (Treasurer); Ling San (Secretary).

• Southeast Asian Mathematical Society*

Apply to: Southeast Asian Mathematical Society, c/o Department of Mathematics, Chinese University of Hong Kong, Shatin, N.T., Hong Kong.

Dues: U.S. $10, payable to Southeast Asian Mathematical Society.


Officers: Mari-Jo P. Ruiz (President), Polly Wee Sy (Treasurer), Luz R. Nochefranca (Secretary).

• Vijñana Parishad of India*

Apply to: H. M. Srivastava, Foreign Secretary, VPI, Department of Mathematics, University of Victoria, Victoria, British Columbia, V8W 2Y2 Canada, or R. C. Singh, Treasurer, Secretary, VPI, Department of Mathematics, D. V. Postgraduate College, Orai-285001, U.P., India.

Privileges: Žmiižba (an interdisciplinary mathematical journal currently published once a year), back volumes available at 25% discount.

Officers: J. N. Kapur (President), B. S. Rajput, M. K. Singal, G. S. Niranjan (Vice-Presidents), R. C. Singh Chandel (Secretary-Treasurer), H. M. Srivastava (Foreign Secretary).

Europe

- **Azerbaijan Mathematical Society**

  Apply to: A. Ali Novruzov, Department of Mechanics and Mathematics, Baku State University, Baku, Azerbaijan, 370145.


  Privileges: All privileges of ordinary members plus 50% discount on all AzMS publications.

  Officers: O. A. Veliev (President), F. A. Abdullaev (Treasurer), V. A. Gasimov (Secretary).

- **Balkan Society of Geometers**

  Apply to: Prof. Dr. Constantin Udriste, Treasurer, Department of Mathematics, Politehnica University of Bucharest, Splaiul Independentei 313, Bucharest 77206, Romania; Fax: (401) 411.53.65; e-mail: udriste@mathem.pub.ro.


  Privileges: Participation in meetings and all other privileges enjoyed by an ordinary member; discounts (at least 10%) on the prices of BSG publications.

  Officers: Radu Miron, Grigoris Tsagas (Presidents), Constantin Udriste, Grosio Stanilov, Mileva Prvanovici (Vice-Presidents), Constantin Udriste (Treasurer), Vasile Iftode (Secretary).

**Berliner Mathematische Gesellschaft**

Address for mail: Fachbereich Mathematik, TU Berlin, MA 8-1, Straße des 17. Juni 136, 10623 Berlin, Germany; e-mail: thiele@math-tu-berlin.de.

Apply to: Prof. Dr. E. J. Thiele, TU Berlin, MA 8-1, Straße des 17. Juni 136, 10623 Berlin, Germany.

Dues: DM 12,00; payable to Prof. Dr. G. Preuss, I. Math. Inst. der FU Berlin, Arminimlee 3, 14195 Berlin, Germany.

Privileges: One free copy of Sitzungsberichte der BMG.

Officers: H. Koch (President), H. G. W. Begehr (Vice-President), G. Preuss (Treasurer), E. J. Thiele (Secretary).

**Croatian Mathematical Society**

Apply to: Aleksandra Čižmešija, Bijenička cesta 30, 10000 Zagreb, Croatia; e-mail: hmd@cromath.math.hr.


Privileges: **Vjesnik HMD** (in Croatian) free of charge; the scientific journal Glasnik Matematicki at the reduced rate of U.S. $15 per volume. All publications of the CMS, and fees for conferences organized by CMS, reduced by at least 25%.

Officers: Sanja Varošanec (President), Zvonimir Šikić (Vice-President), Šime Ungar (Treasurer), Aleksandra Čižmešija (Assistant Secretary).

**Cyprus Mathematical Society**

Address for mail: 36 Stasinou Street, Suite 102, Strovolos 2003, Nicosia, Cyprus; e-mail: cms@cyearn.pl.ac.cy.

Apply to: Gregory Makrides, 36 Stasinou Str. Suite 102, Strovolos 2003, Nicosia, Cyprus.

Dues: U.S. $20, payable to Cyprus Mathematical Society at the above address.

Privileges: Receive the annual periodical *Mathematiko VEMA* in Greek. Invitations to conferences organized in Cyprus, invitations to “Annual Summer Math School” organized in Cyprus the end of June.

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**Dansk Matematikforning**

Apply to: Mogens Esrom Larsen, Treasurer, Dansk Matematikforning, Universitetsparken 5, 2100 København Ø, Denmark.

Dues: DKK 50, payable to Treasurer.

Privileges: *Mathematica Scandinavica* (DKR. 267.50 per volume), *Nord. Mat. Tidss. (Normat)* (NKR. 220 per volume). (Members of the American Mathematical Society do not have to join Dansk Matematikforning to obtain the journals. Subscription orders should be sent directly to the journals: *Normat*, Universitetsforlaget, Avd. for tidsskrifter, Postbox 2959 Tøyen, Oslo 6, Norway; *Mathematica Scandinavica*, Matematik Institut, Aarhus Universitet, 8000 Aarhus C, Denmark.)

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**Deutsche Mathematiker-Vereinigung (DMV)**

Apply to: Mrs. Berthold, DMV, c/o WIAS, Mohrenstr. 39, D 10117 Berlin, Germany.

Dues: DM 30, payable to Volksbank Freiburg 6955002 (BLZ 680 900 00).

Reciprocity Agreements

Officers: K. H. Hoffman (President), I. Kersten (Vice-President), J. Brüening (Treasurer), F. Behrends (Secretary).

- Edinburgh Mathematical Society

Apply to: The Honorary Secretary, Edinburgh Mathematical Society, James Clerk Maxwell Building, King's Buildings, Mayfield Road, Edinburgh, EH9 3JZ, Scotland.

Dues: U.S. $12 (preferably £5 sterling), payable to the Honorary Secretary.

Privileges: Proceedings at reduced rate of U.S. $20 (preferably £9 sterling) per annum.

Officers: Tim Howie (President), C. Maclachlan (Vice-President), N. K. Dickson (Treasurer), P. Heywood, C. J. Smyth (Secretaries).

Gesellschaft für Angewandte Mathematik und Mechanik e.v. (GAMM)*

Address for mail: V. Ulbricht, Institut für Festkörpermechanik, Technische Universität Dresden, D-01062 Dresden, Germany.

Apply to: L. Gaul, Institut für Mechanik, Universität Stuttgart, Pfaffenwaldring 9, D-70550 Stuttgart, Germany.

Dues: DM 100, payable to G. Alefeld, Institut für Angewandte Mathematik, Universität Karlsruhe, Englerstr. 2, D-76131 Karlsruhe, Germany.

Privileges: Regular publications of GAMM and participation in scientific meetings at a reduced rate.

Officers: F. Ziegler (President), R. Mennicken (Vice-President), G. Alefeld (Treasurer), V. Ulbricht (Secretary).

Glasgow Mathematical Association

Address for mail: Department of Mathematics, University Gardens, University of Glasgow, Glasgow G12 8QQ, Scotland; e-mail: fmg@maths.gla.ac.uk; URL: http://www.maths.gla.ac.uk/links/gma/.

Apply to: F. H. Goldman, Glasgow Mathematical Association, Department of Mathematics, University of Glasgow, 15 University Gardens, Glasgow G12 8QW, Scotland.

Dues: £2.50, payable to Glasgow Mathematical Association.

Privileges: Glasgow Mathematical Journal at reduced rate (£35).

Officers: Philip Moon (President), George Robertson (Vice-President), F. H. Goldman (Treasurer), R. Payne (Secretary).

Hellenic (Greek) Mathematical Society*

Apply to: Maria Georgoudi, Hellenic Mathematical Society, 34 Panepistimiou Street, GR-10679 Athens, Greece.

Dues: U.S. $20, payable to Hellenic Mathematical Society at above address.

Privileges: The Bulletin of HMT, News-Bulletin (Enimerosi), discounts which are available to all members.

Officers: T. S. Bolis (President), G. Dimakos (Vice-President), A. Angelis (Treasurer), I. Tirlis (Secretary).

Icelandic Mathematical Society

Address for mail: Icelandic Mathematical Society, Raunvisindastofnun Haskolans, Dunhaga 3, IS-107 Reykjavik, Iceland; e-mail: benedikt@talnakonunn.is; URL: http://www.raunvishi.is/is/.

Apply to: Dr. Benedikt Johannesson, Icelandic Mathematical Society, Dunhaga 3, IS-107 Reykjavik, Iceland.

Dues: U.S. $10, payable to Dr. Geir Agnarsson, at the above address.

Privileges: Reduced subscription rate on Mathematica Scandinavica and Nordisk matematisk Tidsskrift (Normat); subscription orders should be sent directly to the journals.

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Irish Mathematical Society

Address for mail: The Secretary of the IMS, c/o Department of Mathematics, University College Dublin, Belfield, Dublin 4, Ireland; e-mail: russell.higgs@ucd.ie; URL: http://www.maths.tcd.ie/pub/ims/.

Apply to: Kevin Hutchinson, Treasurer, Department of Mathematics, University College Dublin, Belfield, Dublin 4, Ireland.

Dues: U.S. $10, payable to K. Hutchinson, Treasurer, IMS, at the above address.

Privileges: Free copy of the Bulletin of the Irish Mathematical Society (two times per year), free registration at IMS annual conference (September).

Officers: D. Armitage (President), E. Gath (Vice-President), K. Hutchinson (Treasurer), R. Higgs (Secretary).

János Bolyai Mathematical Society

Apply to: Executive Director, Cecília Kulcsár, János Bolyai Mathematical Society, Budapest, Fő utca 68, Hungary H-1027; e-mail: bjmt@math-inst.hu.

Dues: Are voluntary but should minimally cover duplication and mailing costs; for reciprocity members (residing outside Hungary) suggested fee is 1/8 of one percent of the member's net income; sponsoring members pay at least U.S. $180 or equivalent per year.

Privileges: Upon request, Matematikai Lapok (twice a year), Középiskola Matematikai Lapok (monthly). If sufficient interest is expressed, a bulletin in English will be available. In addition, the JBMS is negotiating to obtain discounts for its reciprocity and sponsoring members on several serial publications and periodicals appearing in Hungary. Contact the JBMS secretary for more information regarding this and other privileges of membership.

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**Address for mail:** Union of Czech Math & Phys., Žitná 25, 117 10 Praha 1, Czech Republic, e-mail: jcmf@math.cas.cz.

**Dues:** U.S. $20, payable to Jednota českých matematiků a fyziků.

**Privileges:** (i) A discount of 20% in the conference fees for conferences, symposia, summer schools, and similar events organized (or co-organized) by the JCMF; (ii) newsletter.

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**• Jednota slovenských matematikov a fyzikov (JSMF) (Union of Slovak Mathematicians and Physicists)**

**Apply to:** Hilda Draškovičová, Sekretariát JSMF, MFF UK, Mlynská dolina, 842 15 Bratislava, Slovakia.

**Dues:** U.S. $20, payable to Slovenská sporiteľňa, Štúrova ul., 800 00 Bratislava, Slovakia, č.: 101848-019/0900 UČO: 178705.

**Privileges:** A discount of 20% in conference fees for conferences, symposia, summer schools, and similar events organized by the Society JSMF.

**Officers:** Peter Lukáč (President), Stanislav Jendrlova (Vice-President), Hilda Draškovičová (Treasurer), Hilda Draškovičová (Secretary).

**London Mathematical Society**

**Address for mail:** London Mathematical Society, De Morgan House, 57-58 Russell Square. London WC1B 4HP, United Kingdom, e-mail: lms@lms.ac.uk; URL: http://www.lms.ac.uk.

**Apply to:** Miss Susan M. Oakes, at the address above.

**Dues:** £9.50, U.S. $19.00, payable to London Mathematical Society.

**Privileges:** LMS Newsletter; reduced rates for the Bulletin, Journal, and Proceedings of the LMS; Nonlinearity; Journal of Applied Probability; Mathematical Proceedings of the Cambridge Philosophical Society; Quarterly Journal of Mathematics; Glasgow Mathematical Journal; LMS Lecture Notes; LMS Student Texts; LMS Monographs. (Please write to the LMS for complete details.)

**Officers:** M. J. Taylor (President), K. A. Brown, J. W. Bruce (Vice-President), A. O. Morris (Treasurer), D. J. H. Garling (Executive Secretary).

**Mathematical Society of Serbia**

**Apply to:** Mathematical Society of Serbia, Knez Mihailova 35/IV, p.p. 791, 11000 Belgrade, Yugoslavia.


**Privileges:** Matematicki Vesnik, Teaching Mathematics

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Apply to: Peter Legiša, FMF, Jadranska 19, P.P. 2964, 1001 Ljubljana, Slovenia.

Dues: U.S. $30, payable to SKB banka, Ajdovscina 4, 1000 Ljubljana, Slovenia, ekbas12x.

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  Privileges: *Bulletin of the Iranian Mathematical Society* (in English), *Farhang va Andishe Reiazi* (in Farsi), and reduced rate for participation in the conferences and seminars organized by IMS.
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Apply to: John A. Shanks, Department of Mathematics and Statistics, University of Otago, P. O. Box 56, Dunedin, New Zealand.

Dues: NZ $16, payable to John A. Shanks, Department of Mathematics and Statistics, University of Otago, P. O. Box 56, Dunedin, New Zealand.

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Reciprocity Agreements

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NEUTROSOPHIC: NEUTROSOPHIC PROBABILITY, SET, AND LOGIC

by Florentin Smarandache, American Research Press (Rehoboth, Box 141, NM 87322, USA, M_L_Perez@yahoo.com), ISBN 1-879585-63-4, 105 pages, 1998, in five chapters:

1. The Neutrosophy is a new branch of philosophy which studies the origin, nature, and scope of neutralities, as well as their interactions with different idealistic spectras. Let's note by $<A>$ an idea (or proposition, theory, event, concept, entity), by $<\text{Non-A}>$ what is not $<A>$, and by $<\text{Anti-A}>$ the opposite of $<A>$. Also, $<\text{Neut-A}>$ means what is neither $<A>$ nor $<\text{Anti-A}>$, i.e. neutrality in between the two extremes.

The Fundamental Thesis: Any idea $<A>$ is $t\%$ true, $i\%$ indeterminate, and $f\%$ false, where $t+i+f=100$ and $t,i,f\in[0,100]$.

The Fundamental Theory: Every idea $<A>$ tends to be neutralized, diminished, balanced by $<\text{Non-A}>$ ideas (not only $<\text{Anti-A}>$ as Hegel asserted) - as a state of equilibrium. In between $<A>$ and $<\text{Anti-A}>$ there are infinitely many $<\text{Neut-A}>$ ideas, which may balance $<A>$ without necessarily $<\text{Anti-A}>$ versions.

To neuter an idea one must discover all its three sides: of sense (truth), of nonsense (falsity), and of undecidability (indeterminacy) - then reverse/combine them. Afterwards, the idea will be classified as neutrality.

http://www.gallup.unm.edu/~smarandache/NeutSo.txt

2. TransDisciplinarity (Multi-Space, Multi-Structure), a neutrosophic method.

http://www.gallup.unm.edu/~smarandache/TransDis.txt

3. Neutrosophic Probability (as a generalization of the classical probability) studies the chance that a particular event $<A>$ will occur, that chance is represented by three coordinates (variables): $t\%$ true, $i\%$ indeterminate, and $f\%$ false, where $t+i+f=100$ and $t,i,f\in[0,100]$.

Neutrosophic Statistics is the analysis of such events.

http://www.gallup.unm.edu/~smarandache/NeutProb.txt

4. Neutrosophic Set (as a generalization of the fuzzy set) is a set such that an element belongs to the set with a neutrosophic probability, i.e. $t\%$ is true that the element is in the set, $f\%$ false, and $i\%$ indeterminate.

If a proposition $<A>$ is $t\%$ true, doesn't necessarily mean it is $(100-t)\%$ false as in fuzzy logic. There should also be a percent of indeterminacy on the logical values of $<A>$. A better approach is $(t\%, t\%$ false, and $i\%$ indeterminate, where $t+i+f=100$ and $t,i,f\in[0,100]$, called neutrosophic logical value of $<A>$, and noted by $n(A) = (t,i,f)$.

http://www.gallup.unm.edu/~smarandache/NeutSet.txt

5. Neutrosophic Logic (as a generalization of the fuzzy logic) means the study of neutrosophic logical values of the propositions. There exist for each individual one, PRO parameters, CONTRA parameters, and NEUTER parameters which influence the above values.

Indeterminacy results from any hazard which may occur, from unknown parameters, or from new arising conditions. This resulted from practice.

http://www.gallup.unm.edu/~smarandache/NeutLog.txt

Applications:

Neutrosophic logic is useful in artificial intelligence, neural networks, evolutionary programming, neutrosophic dynamic systems, and quantum theory.

Can be ordered from the University of Microfilm International, 300 North Zeib Road, PO Box 1346, Ann Arbor, Michigan 48106-1346, USA, Tel.: 1-800-521-0600, for $33.50.
Add this Cover Sheet to all of your Academic Job Applications

How to use this form

1. Using the facing page or a photocopy, (or a TeX version which can be downloaded from the e-math "Employment Information" menu, http://www.ams.org/employment/), fill in the answers which apply to all of your academic applications. Make photocopies.

2. As you mail each application, fill in the remaining questions neatly on one cover sheet and include it on top of your application materials.

The Joint Committee on Employment Opportunities has adopted the cover sheet on the facing page as an aid to job applicants and prospective employers. The form is now available on e-math in a TeX format which can be downloaded and edited. The purpose of the cover form is to aid department staff in tracking and responding to each application.

Mathematics Departments in Bachelor's, Master's and Doctorate granting institutions have been contacted and are expecting to receive the form from each applicant, along with any other application materials they require. Obviously, not all departments will utilize the cover form in the same manner. Please direct all general questions and comments about the form to: emp-info@ams.org or call the Professional Programs and Services Department, AMS, at 800-321-4267 extension 4105.

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(1) Acknowledge receipt of the application—immediately; and
(2) Provide information as to the current status of the application, as soon as possible.

The JCEO recommends a triage-based response, informing the applicant that he/she
(a) is not being considered further;
(b) is not among the top candidates; or
(c) is a strong match for the position.
Title: Academic Employment in Mathematics

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| <strong>Ph.D. Advisor</strong> |  |
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| <strong>Indicate the mathematical subject area(s) in which you have done research using, if applicable, the 1991 Mathematics Subject Classification printed on the back of this form. If listing more than one number, list first the one number which best describes your current primary interest.</strong> |  |
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| <strong>Secondary Interests</strong> |  |
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| <strong>Give a brief synopsis of your current research interests (e.g. finite group actions on four-manifolds). Avoid special mathematical symbols and please do not write outside of the boxed area.</strong> |  |
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| <strong>Most recent, if any, position held post Ph.D.</strong> |  |
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<td>Information and communication, circuits</td>
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NEW TITLES IN OPTIMIZATION
THE HANDBOOK OF COMBINATORIAL OPTIMIZATION
Edited by: Ding-Zhu Du and Panos M. Pardalos

Up until now there was an unfulfilled need in Combinatorial Optimization for a complete reference work concerning all applications and areas in which combinatorial (or discrete) optimization problems arise. In cooperation with the contributors, we have filled this need with The Handbook of Combinatorial Optimization. This three volume set deals with a wide range of applications:

- Communication network design
- VLSI design
- Machine vision
- Airline crew scheduling
- Corporate planning
- Linear and integer programming
- Graph theory, artificial intelligence and number theory.

In the handbooks the accent is on recent developments in Combinatorial Optimization. We have included the historical perspective by including linear programming and the design efficient integer programming, software, and the availability of parallel computers. The Handbook, Volumes 1-3 is addressed not only to researchers in discrete optimization, but to all scientists who use combinatorial optimization methods to model and solve problems. Experts in the field as well as non-specialists will find the material stimulating and helpful.

Hardbound Set only of 3 vols.
ISBN 0-7923-5019-7
$1325.00

OPTIMIZATION AND ENGINEERING
International Multidisciplinary Journal to Promote Optimization Theory and Applications in Engineering Science

Editor-in-Chief: Tamás Terlaky, Delft University of Technology.

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L. Vandenberghe, Electrical Engineering, Control, & Automation, UCLA.
Y. Ye, Mathematical Programming, University of Iowa.

Scope
The primary goal of this journal is to promote the application of optimization methods in the general area of engineering sciences. The journal provides a forum in which engineering scientists obtain information about recent advances in optimization sciences, and researchers in mathematical optimization learn about the needs of engineering sciences and successful applications of optimization methods. Its aim is to close the gap between optimization theory and the practice of engineering.

All optimization methods of relevance to applications in engineering sciences will be considered: deterministic and stochastic, continuous, mixed integer and discrete, when they are relevant for application in engineering sciences. The journal also strives to publish successful applications of optimization in various engineering areas.

Editorial Policy
- The journal publishes high quality, original research papers in the broad area of engineering and optimization sciences with special emphasis on successful applications of optimization in engineering. Survey articles and expository papers are published regularly.
- The Editorial Board aims to provide prompt turn-around of refereeing and prompt publication.
- The refereeing process adheres to the rigorous standards of high-quality international journals.

Subscription Information:
2000, Vol. 1 (4 issues), ISSN 1389-4420
Institutional and individual subscription rates To Be Announced,
Mathematics Calendar

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

September 1999

September-May National Mathematics Honor Society Pi Mu Epsilon's Kansas Gamma Chapter, 50th Anniversary, Wichita State University, Wichita, Kansas. (May 1999, p. 594)

1-3 First International Conference on the Integration of Dynamics, Monitoring and Control (DYMAC 99), Manchester, United Kingdom. (Sept. 1998, p. 1053)

1-3 Symposium on Operations Research 1999 (SOR'99), Magdeburg, Germany. (May 1999, p. 594)

1-10 Geometry, Integrability and Quantization, St. Constantine resort (near Varna), Bulgaria. (May 1999, p. 595)

5-8 Conference Moshe Flato-Advances and Prospects in Physical Mathematics, Université de Bourgogne, Dijon, France.


Information: http://www.u-bourgogne.fr/monga/cmfr/e-mail: cmfr@u-bourgogne.fr

5-11 XX International Seminar on Stability Problems for Stochastic Models, Maria Curie-Skłodowska University, Lublin, Poland. (Jan. 1999, p. 70)

6-10 Second Meeting on Quaternionic Structures in Mathematics and Physics, Univ. di Roma "La Sapienza", Univ. Roma Tre, Rome, Italy. (May 1999, p. 595)

6-10 Some Trends in Algebra 1999, Czech Agricultural University, Prague, Czech Republic. (Jun/Jul. 1999, p. 709)

6-24 School on Modern Statistical Methods in Medical Research (in conjunction with ICMS, Edinburgh, Scotland, UK), The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy. (Mar. 1999, p. 379)


8-15 European Summer Courses 1999, CIM: Direct and Inverse Methods in Solving Nonlinear Evolution Equations, Cetraro (Cosenza), Italy. (May 1999, p. 595)

9-11 IX Congress for the learning and teaching of Mathematics (JAEI), Lugo (Galicia), Spain. (Mar. 1999, p. 380)

13-18 International Conference on Arithmetic Algebraic Geometry, Venice, Italy. (May 1999, p. 595)


14-18 International Conference on Analytic Methods of Analysis and Differential Equations (AMADE), Minsk, Belarus. (Jan. 1999, p. 70)

15-19 GD'99—Seventh International Symposium on Graph Drawing, Strin Castle, Prague, Czech Republic. (Jan. 1999, p. 71)


20-24 The 10th Biennial Computational

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), deadline for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the Notices in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.

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

The complete listing of the Mathematics Calendar will be published only in the September issue of the Notices. The March, June, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.

The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through e-MATH on the World Wide Web. To access e-MATH, use the URL http://e-math.ams.org/ (or http://www.ams.org/). For those with VT100-type terminals or for those without WWW browsing software, connect to e-MATH via Telnet (telnet e-math.ams.org; login and password e-math) and use the lynx option from the main menu.)
Techniques and Applications Conference and Workshops (CTAC99), Australian National University, Canberra, Australia. (Feb. 1999, p. 278)


20-26 International Symposium on Classical Analysis, Kazimierz Dolny, Poland. (Jun./Jul. 1999, p. 709)

23-24 IMA Tutorial: Low-Speed Combustion, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 595)


27-October 1 IMA Workshop: Low-Speed Combustion, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 595)

October 1999


29 49th Algebra Day, Carleton University, Ottawa, Canada. (Oct. 1999, p. 71)


11-13 IMA Workshop: Fires, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 595)

11-15 MSRI Workshop on Galois Actions and Geometry, MSRI, Berkeley, California. (Jun./Jul. 1999, p. 710)

12-14 Mathematical Decision Making Under Uncertainty and Ambiguity, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. (Jun./Jul. 1999, p. 710)

12-16 Conference on Analysis, The Ohio State University, Columbus, Ohio. (Jun./Jul. 1999, p. 710)

13-15 Research in General and Geometric Topology, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. (Jun./Jul. 1999, p. 710)

8-10 AMS Central Sectional Meeting, University of Texas, Austin. (Sept. 1997, p. 1031) Information: W. Drady, e-mail: wsd@ams.org.

9-11 Fiftieth Anniversary Celebration of the Postdoctoral Instructorship Program in Mathematics, MIT, Cambridge, Massachusetts. Focus: A conference on the occasion of the 50th anniversary of the C.F. Moore Instructorship, featuring mathematical talks and non-technical discussions in celebration of the impact of the Postdoctoral Instructorships at MIT on the wider academic and mathematical communities.


10-14 National Conference on Algebra VIII, Beijing Normal Univ., Beijing, China. (May 1999, p. 595)

15-17 AMS Southeastern Section Meeting, University of North Carolina, Charlotte, North Carolina. (Nov. 1998, p. 1378) Information: Information will appear on the meetings pages on e-MATH.

16-17 West Coast Operator Algebra Symposium, University of Victoria, Victoria, British Columbia. (Jun./Jul. 1999, p. 710)


21-26 Workshop on Stochastic and Quantum Physics, University of Aarhus, Aarhus, Denmark. (Jun./Jul. 1999, p. 710)

22-23 19th Annual Southeastern-Atlantic Regional Conference on Differential Equations, University of Richmond, Richmond, Virginia. (Jun./Jul. 1999, p. 711)

22-24 MSRI “Hot Topics” Workshop: Scattering Phenomena in Communication Networks, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 595)


27-29 Algorithm Engineering as a New Paradigm, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: H. Nagamochi, Graduate School of Informatics, Kyoto Univ., Sakyo-ku, Kyoto 606-8501. Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

November 1999

1-3 Probabilistic Analysis of Algorithms for Hard Problems, DIMACS Center, Rutgers University, Piscataway, New Jersey. Organizers: M. Dyer (Univ. of Leeds), and A. Frieze (Carnegie Mellon Univ.). Aim: A variety of research goals will be explored: to extend average case analysis to new problems, to explore the effect of distributional assumptions on the behavior of algorithms, to identify distributions that are especially hard for particular problems. This workshop aims to bring together...
Mathematics Calendar

researchers interested in all of these approaches.

Information: A. Frieze, Carnegie Mellon University, alan@random.math.cmu.edu. Local arrangements: P. Pravato, DIMACS Center, pravato@dimacs.rutgers.edu; 732-445-5929; http://dimacs.rutgers.edu/

Workshops/index.html.

1-5 MSRI Workshop on The Mathematics of Imaging, MSRI, Berkeley, California. (Jun/Jul. 1999, p. 711)

2-5 Workshop on Hilbert's 10th Problem, Relations to Arithmetic and Algebraic Geometry, University of Gent, Gent, Belgium. (Jun/Jul. 1999, p. 711)

* 4-5 Microlocal Analysis for Schrodinger Equations and Related Topics, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: S. Fujii, Math. Univ. of Tokohu, Aoba-ku, Sendai City, Miyagi Pref. 980-8578.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

5 IMA Tutorial: High-Speed Combustion, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 596)


* 8-10 Statistical Nature of Turbulence and Its Dynamical Description Based on Coherent Structures, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: S. Toh, Graduate School of Science, Kyoto Univ., Saky-o-ku, Kyoto 606-8501.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

8-12 IMA Workshop: High-Speed Combustion in Gaseous and Condensed-Phase Energetic Materials, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 596)

* 8-12 Mathematical Models in Functional Equations, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: S. Sakata, Osaka Electro-Communication Univ., Hatsu-cho, Neyagawa City, Osaka Pref. 572-8530.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 9-12 DIMACS Workshop on Codes and Association Schemes, DIMACS Center, Rutgers University, Piscataway, New Jersey. Organizers: A. Barg (Bell Labs, Lucent Technologies) and S. Litsyn (Tel Aviv Univ.).


Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 10-12 DIMACS Workshop on Codes and Association Schemes, DIMACS Center, Rutgers University, Piscataway, New Jersey. Organizers: A. Barg (Bell Labs, Lucent Technologies) and S. Litsyn (Tel Aviv Univ.).

* 10-12 Mathematical Models in Functional Equations, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: S. Sakata, Osaka Electro-Communication Univ., Hatsu-cho, Neyagawa City, Osaka Pref. 572-8530.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.


Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 24-26 Analytic Function Spaces and Operators on These Spaces, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: K. Izuhi, Fac. of Sci., Nihara Univ., Igarashino-cho, Nihara City, Nihara Pref. 950-2181.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 29-December 3 Analytic Number Theory and Related Areas, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: K. Matsumoto, Graduate School of Math., Nagoya Univ., Furo-cho, Chikusa-ku, Nagoya, Aichi Pref. 464-8602.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 29-December 3 Group Theory and Computation, University of Sydney, Sydney, Australia. (May 1999, p. 596)

* 29-December 3 Hyperbolic Spaces and Related Topics II, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan. Organizer: S. Kamiya, Okayama Univ. of Science, Rida-cho, Okayama City, Okayama Pref. 700-0005.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

December 1999

2-4 Computational and Mathematical Methods in Music, Vienna, Austria. (Jun/Jul. 1999, p. 712)

* 3-4 Tenth Costa Rican Symposium on Mathematics, Sciences and Society: Paradigms and Methods in Mathematical Education, Instituto Tecnol6gico de Costa Rica, Sede de Santa Clara, San Carlos, Costa Rica. Focus: The principal themes of the symposium will be, firstly, paradigms, models and theory in mathematical education, and, secondly, the use of modern technology in mathematical education.

Program: There will be plenary sessions, workshops, roundtables, contributed papers, and exhibits. All activities will take place in Spanish.

Contributed Papers: Contributed papers should be submitted before August 13, 1999.

Information: Orietta Protti, Escuela de Matemática, 2060 Universidad de Costa Rica, San José, Costa Rica; tel: (506) 207-5742; e-mail: protti@carriari.ucr.ac.cr, Web: http://carriari.ucr.ac.cr/cism/documen/sipmo.html.

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Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.

Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 6-8 Spectral and Scattering Theory and its Related Topics, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 6-9 Microlocal Analysis and Related Topics, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.


* 13-17 International Conference, 100 Years After Sophus Lie, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

* 13-18 Second International Conference on Intersection Theory, Dipartimento di Matematica, Universita' di Bologna, Italy.
Scientific Committee: G. Ellingsrud (Univ. of Oslo), S. Kleiman (M.I.T.), A. Vistoli (Univ. of Bologna).
Organizing Committee: R. Achilles (Univ. of Bologna), M. Manaresi (Univ. of Bologna), A. Vistoli (Univ. of Bologna).

* 14-18 Second International Conference on Intersection Theory, Dipartimento di Matematica, Universita' di Bologna, Italy.
Scientific Committee: G. Ellingsrud (Univ. of Oslo), S. Kleiman (M.I.T.), A. Vistoli (Univ. of Bologna).
Organizing Committee: R. Achilles (Univ. of Bologna), M. Manaresi (Univ. of Bologna), A. Vistoli (Univ. of Bologna).

Information: More information about accommodations, financial support, etc., will be given in later announcements. For questions, contact, preferably by e-mail: R. Achilles, Dipartimento di Matematica, Universita' di Bologna, 40127 Bologna, Italy; e-mail: intersect@dm.unibo.it.

* 20-22 Analytical Approaches to Quantum Information and Their Related Fields, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Organizer: M. Oya, Science Univ. of Tokyo, Yamazaki, Noda City, 278-8510.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

20-22 Seventh IMA International Conference on Cryptography and Coding, Royal Agricultural College, Cirencester, United Kingdom. (May 1999, p. 596)
31-January 3 Golden Jubilee International Conference on Mathematics (GJCM), Lucknow, India. (Jun/Jul. 1999, p. 712)

January 2000

3-7 Fifth International Conference on Difference Equations and Applications, Univ. del Frontera, Temuco, Chile. (Jun/Jul. 1999, p. 712)

* 5-7 Sixth International Symposium on Artificial Intelligence and Mathematics, Fort Lauderdale, Florida.
Objective: The objective of the symposium is to foster interactions between mathematics, theoretical CS, and artificial intelligence. Traditionally, the symposium attracts around 100 participants from a variety of disciplines, thereby providing a unique forum for active scientific exchange. Submission: Authors must e-mail a short abstract (up to 200 words) in plain text format to anni@rutcor.rutgers.edu by September 23, 1999, and either e-mail PostScript files or TeX/LaTeX source files (including all necessary macros) of their extended abstracts (up to 10 double-spaced pages) to anni@rutcor.rutgers.edu or send five hard copies to B. Selman, Dept. of Computer Science, 4130 Upson Hall, Cornell Univ., Ithaca, NY 14853-7501, to be received by September 30, 1999.
Sponsors: The symposium is partially supported by the Annals of Math and AI and Florida Atlantic University.
Organizers: M. Golumbic (Bar-Ilan Univ., Ramat Gan), F. Hoffman (Florida Atlantic Univ.), A. Kogan (Rutgers Univ.), B. Nebel (Albert-Ludwigs-Univ., Freiburg), B. Selman (Cornell Univ.).
Information: Further information and future announcements can be obtained from the conference Web site, http://rutcor.rutgers.edu/ani/ or by e-mail to hoffman@acc.fau.edu, or F. Hoffman, Florida Atlantic Univ., Dept. of Math., P.O. Box 3091, Boca Raton, FL 33431.

* 6-7 Operator Inequality and Related Area, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Organizer: M. Cho, Fac. of Engineering, Kanagawa Univ., Kanagawa-ku, Yokohama City, Kanagawa Pref. 221-8686.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

10-14 MSRI Workshop on Combinatorial Algebra, MSRI, Berkeley, California.

* 17-20 Finite Group Theory and Algebraic Combinatorics, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

17-22 Workshop on Computational Stochastics, University of Aarhus, Denmark. (Jun Jul. 1999, p. 713)

* 24-26 7th DIMACS Implementation Challenge: Semidefinite and Related Optimization Problems, DIMACS Center, Rutgers University, Piscataway, New Jersey. (Jun/Jul. 1999, p. 713)

Focus: In the past few years much has been learned about the kinds of problem classes that SDP can tackle, the best SDP algorithms for the various classes, and the various limits of the current approaches to solving SDP's. Similar to, and indeed an extension of, semidefinite programming, a great deal is known about optimization with convex quadratic constraints as well as the limitation of current methods. This workshop attempts to distill and expand upon accumulated knowledge. We have collected a variety of interesting and challenging SDP instances whose solution would expand our knowledge on the applicability of SDP.
Deadlines: September 15, 1999: Preliminary proposals due for comment and feedback; November 15, 1999: Extended ab-
Mathematics Calendar

abstracts due for consideration for the workshop. All proposals and abstracts should be sent to the conference e-mail address: challenge@dimec.rutgers.edu.

Information: F. Alzadeh, Rutgers Univ., challenge@dimec.rutgers.edu. Local arrangements: P. Pravato, DIMACS Center, pravato@dimacs.rutgers.edu; tel: 732-445-5929; http://dimacs.rutgers.edu/Workshops/index.html.

*24-28 Algebraic Number Theory and Related Topics, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Organizer: Y. Ihara, Research Institute for Mathematical Sciences, Kyoto Univ., Sakyo-ku, Kyoto 606-8502.
Information: http://www.kurims.kyo­to-u.ac.jp/workshop-e.html.

26-30 IMA Workshop: Confinement and Remediation of Environmental Hazards, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 596)

*31-February 2 Foundations of Computer Science, Research Institute for Mathematical Sciences, Kyoto University, Kyoto, Japan.
Organizer: O. Watanabe, Tokyo Inst. of Tech., Oh-okayama, Meguro-ku, Tokyo 152-8550.
Information: http://www.kurims.kyoto-u.ac.jp/workshop-e.html.

February 2000

7-11 MSRI Workshop on The Mathematics of Quantum Computation, MSRI, Berkeley, California. (Jun./Jul. 1999, p. 713)

*8-12 ANZIAM 2000, Copthorne Resort, Waitangi, New Zealand.
Aim: ANZIAM is an established gathering of applied mathematicians, scientists and engineers, and students. It provides an interactive and traditionally informal forum for presentation and discussion of research on applied and industrial problems derived in many scientific fields.
Invited Speakers: J. Filar (Univ. of South Australia), D. Goring (National Institute of Water and Atmospheric Research), P. Hunter (Univ. of Auckland), P. Jackson (Univ. of Auckland), N. Kopell (Boston Univ.), M. Wright (Bell Labs).
Special Sessions: In addition to the invited addresses there will be a number of specially organized sessions devoted to the areas of: biomathematics, applied probability and statistics, operations research, Antarctite research, inverse problems, numerical methods in continuum mechanics, numerical methods of ODEs.
Organizer: The conference is organized by the Dept. of Engineering Science at the School of Engineering of the Univ. of Auckland.
Call for Papers: A formal call for papers will be made in October. Papers are invited in all areas of applied mathematics. Not just the mentioned specialty areas. If you intend to present a paper, please e-mail: anziam2000@unilakc. ac. nz. This will ensure that a place is reserved for you in the program, but does not commit you in any way.
Information: More information can be found at our Web page: http://www.esc. auckland. ac.nz/Organisations/anziam2000. Registration will be available on the Web later this year, and a second announcement will be made once this is put in place.


25-26 XV SIDIM (Inter-university Mathematics Research Seminar), University of Puerto Rico, Mayaguez Campus, Mayaguez, Puerto Rico.
Topic: Mathematical Sciences and Research in Mathematical Education.

Call for Papers: Participants are invited to present a 20-minute research talk. To this end, please submit a title and a short abstract of at most 1 page no later than January 1, 2000, to the Scientific Committee via the email address: llwww.math.nus.edu.sglicfsl.

Visit the Web page at http://math. u.osu. edu/sidim. html, or contact L. F. Caceres, lfcaceres@math. u.osu. edu, or M. Ramos, m_ramos@ramos. u.osu. edu; tel: 709-826-1848 or 709-826-4040, ext. 3308, fax: 709-826-5454; mail address: XV SIDIM, Department of Mathematics, RUM, P.O. Box 9018, Mayaguez, Puerto Rico 00681-9018.

Information: Visit the Web page at http://math. u.osu. edu/sidim. html, or contact L. F. Caceres, lfcaceres@math. u.osu. edu, or M. Ramos, m_ramos@ramos. u.osu. edu; tel: 709-826-1848 or 709-826-4040, ext. 3308, fax: 709-826-5454; mail address: XV SIDIM, Department of Mathematics, RUM, P.O. Box 9018, Mayaguez, Puerto Rico 00681-9018.

*28-March 3 Eighth International Conference on Hyperbolic Problems, Otto-von-Guericke University, Magdeburg, Germany.
Subject: Theory, numerics and applications of hyperbolic conservation laws and related fields.
Organizers: H. Freistühler and G. Warnecke.

Plenary Speakers: Y. Brenier (Paris), T. Hou (Pasadena), S. Kawashima (Fukuoka), I. Mueller (Berlin), A. Quarteroni (Lausanne), P. Roe (Ann Arbor), G. Russo (L'Aquila), S. Schochet (Tel Aviv), J. Smoller (Ann Arbor), M. Struwe (Zurich), K. Zumbrun (Bloomington).
Invited Speakers: J. F. Bouchut (Orleans), S. Canic (Houston), D. Cendelin, J. Feireisl (Prague), D. Hoff (Bloomington), S. Jin (Taipei), K. H. Lin (Bremen), C. M. Münch (Stuttgart), B. Piccoli (Bologna), S. Pott (Potsdam), T. Tang (Hong Kong), E. Toro (Manchester), C.-C. W. Wu (Los Angeles), T. Yang (Hong Kong), S.-H. Yu (Osaka).

Information: Details can be found on the conference Web page, http://www.math.uni-magdeburg.de/~hyp2000. Alternatively, send e-mail to hyp2000@mathematik.uni-magdeburg.de or a letter to HYP-2000, c/o Institut für Analysis und Numerik, Otto-von-Guericke-Universität Magdeburg, PF 4120, D-39106 Magdeburg, Germany, in order to have all information sent to you by e-mail, fax, or regular mail.

March 2000

6-17 Homogenization and Effective Media Theories, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 1999, p. 1053)

*13-17 International Conference on Fundamental Sciences: Mathematics and Theoretical Physics, Singapore, China.
Organizers: Faculty of Science, National University of Singapore & Isaac Newton Institute for Mathematical Sciences.

15-19 IMA Workshop: Air Quality Engineering, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 596)


20-31 Superconvergence in Finite Element Methods, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 1999, p. 1053)

April 2000

1-2 AMS Eastern Section Meeting, University of Massachusetts, Lowell, Massachusetts.
Information: Information will be posted to the meetings pages in e-MATH.

7-9 AMS Central Sectional Meeting, University of Notre Dame, Notre Dame, Indiana. (Sept. 1999, p. 1031)
Information: W. Drady, e-mail: wsd@ams.org.

9-16 The Klee-Grunbaum Festival of Geometry, Ein Gev, Israel. (Jun./Jul. 1999, p. 713)
20-25 Aims: To stimulate cooperation between researchers working in harmonic maps and those working in submanifold theory.


Information: J. C. Wood, School of Mathematics, Univ. of Leeds, Leeds LS2 9JT, Great Britain; e-mail: j.c.wood@leeds.ac.uk; Web page: http://www.amsta.leeds.ac.uk/pure/geometry/leeds2000.html.

14-16 AMS Southeastern Section Meeting, University of Southern Western Louisiana, Lafayette, Louisiana. (Mar. 1999, p. 380)

Information: See the AMS Meetings & Conferences pages on e-MATH, or contact Donna Salter, dl@ams.org.


May 2000

1-5 IMA Workshop: Dispersive Corrections to Transport Equations, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 596)

10-12 ICNPAA 2000, Third International Conference on Nonlinear Problems in Aviation and Aerospace (Methods and Software), Daytona Beach, Florida. (Jun./Jul. 1999, p. 714)

17-20 Trends in Approximation Theory, An International Symposium Celebrating the 60th Birthday of Larry L. Schumaker, held in conjunction with the 15th Annual Shanks Lecture, Vanderbilt University, Nashville, Tennessee. (May 1999, p. 596)

18-19 IMA Tutorial: Simulation of Transport in Transition Regimes, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 597)

18-21 Year 2000 International Conference on Dynamical Systems and Differential Equations, Kennesaw State University, Kennesaw, Georgia. (Jun./Jul. 1999, p. 714)

20-25 Summer School on Stereology and Geometric Tomography, Sandbjerg Manor, Denmark.

Focus: Stereology is the area of stochastics dealing with statistical inference about spatial structures from geometric samples of the structure such as two-dimensional sections and one-dimensional probes. The development of stereological methods involves the use of advanced mathematical tools, especially from geometric measure theory and integral geometry. Stereology is now in worldwide use in many areas of biology and medicine, most importantly in neuroscience and cancer grading. Other areas of application are geology, metallurgy, and mineralogy. Geometric tomography is closely related to stereology, as is apparent from its definition: "Geometric tomography is the area of mathematics dealing with the retrieval of information about a geometric object from data about its sections, or projections, or both." Geometric tomography has connections with convex geometry, geometric probing in robotics, computerized tomography, and other areas.

Organizer: E. B. V. Jensen (Univ. of Aarhus).

Speakers: The teaching team includes: A. Baddeley (Univ. of Western Australia), R. Gardner (Western Washington Univ.), H. J. Gundersen (Univ. of Aarhus), E. B. V. Jensen (Univ. of Aarhus), K. Kie (Institut National de la Recherche Agronomique, Versailles). Lectures by invited researchers in related fields such as convex geometry, stochastic geometry, and spatial statistics are also planned, as well as lectures by the participants of the summer school.

Deadlines: The number of participants is limited to 50. Participation will therefore be by application only. To apply for participation, fill out the registration form on the course home page. The deadline for application is March 1, 2000.

Information: More information can be obtained from the course home page located at http://www.maphysto.dk/events/S-landTR2000/.


22-26 IMA Workshop: Simulation of Transport in Transition Regimes, IMA, University of Minnesota, Minneapolis, Minnesota. (May 1999, p. 597)

23-27 Summer Symposium in Real Analysis, University of North Texas, Denton, Texas.

Speakers: Z. Buczolich (Budapest), K. Falconer (St. Andrews), J. P. Kahane (Paris), A. Kniffki (Paderborn), M. Misuriwickz (Indiana), Y. Peres (Berkeley).

Information: For online preregistration materials visit http://www.stolaf.edu/people/analysis/.

24-26 Advances in Fluid Mechanics, Montreal, Canada. (Aug. 1999, p. 813)


29-June 9 Foliations: Geometry and Dynamics Revisited, Banach Center, Warsaw, Poland. (Jun./Jul. 1999, p. 714)
July 2000
3-7 ANTS IV (Algorithmic Number Theory Symposium IV), Korteweg-de Vries Institute for Mathematics, University of Amsterdam, The Netherlands. (Oct. 1998, p. 1230)
3-7 Sixth International Conference on p-Adic Analysis, Ioannina, Greece. (Jun/Jul. 1999, p. 715)
9-15 AGRAM Conference on Abelian Groups, Rings and Modules, The University of Western Australia, Perth, Australia. (Jun. 1999, p. 715)
Sponsors: The Fibonacci Association, Institut Supérieur de Technologie, Luxembourg.
Purpose: The purpose of the conference is to bring together people from all branches of mathematics and science who are interested in Fibonacci numbers, their applications and generalizations, and other special number sequences.
Organizer: F. T. Howard, Wake Forest Univ., Box 7388 Reynolds Station, Winston-Salem, NC 27109; e-mail: howard@mathcse.vwu.edu.
Local Committee: R. Andre-Jeannin, J. Lahr (chair), M. Malvetti, C. Mollitor-Braun, M. Obergews, P. Schroeder. J. Lahr’s address: Institut Supérieur de Technologie, 6, rue R. Coudeville-Kalergi, L-1359 Luxembourg; e-mail: joseph.lake1@isist.lu.
International Committee: M. Bucknell-Johnson (USA), C. Cooper (USA), F. Filipponi (Italy), H. Harborth (Germany), A. Horadam (Australia), Y. Horibe (Japan), P. Kiss (Hungary), A. Philippou (Cyprus), G. Phillips (Scotland), J. Turner (New Zealand), M. Waddell (USA).
Abstracts: Abstracts of one page or less should be submitted in duplicate to F. T. Howard before June 1, 2000. New results are especially desirable, but abstracts on work in progress or on work already accepted for publication will be considered. Manuscripts should not be submitted. If an abstract is accepted, the author will be allotted twenty-five minutes on the conference program.
Information: For more information contact F. T. Howard or J. Lahr at the above addresses.
17-22 International Congress on Mathematical Physics, Imperial College, London, United Kingdom. (Nov. 1998, p. 1378)
19-26 The Third World Congress of Nonlinear Analysts (WCNA-2000), Catania, Italy. (Feb. 1998, p. 296)
31-August 3 Third Conference of Balkan Society of Geometers, Univ. Politehnica of Bucharest, Bucharest, Romania. (Jun/Jul. 1999, p. 715)
*August 2000
August-December MSRI Program in Algorithmic Number Theory, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 1998, p. 1054)
August-May MSRI Program in Operator Algebras, Mathematical Sciences Research Institute, Berkeley, California. (Sept. 1998, p. 1054)
7-12 Mathematical Challenges of the 21st Century, UCLA, Los Angeles, California. (Mar. 1999, p. 381)
7-12 Nevanlinna Colloquium, University of Helsinki, Helsinki, Finland. (May 1998, p. 642)
22-24 The Fifth Iranian Statistics Conference, Isfahan University of Technology, Isfahan, Iran. (Jun/Jul. 1999, p. 715)
September 2000
*11-15 IWOTA-Portugal 2000, Faro, Portugal.
18-22 International Data Analysis Conference, Innsbruck, Austria. (Mar. 1999, p. 381)
*18-23 International Congress on Differential Geometry, in Memory of Alfred Gray 1939-1998, Bilbao, Spain.
Scientific Committee: T. Bancroft (Brown Univ.), J. P. Bourguignon (IHES, France), S. Donaldson (Imperial College London, UK), J. Eells (Cambridge Univ., England), S. Gindikin (Rutgers Univ.), M. Gromov (IHES, France), O. Kowalski (Charles Univ., Prague, Czech Republic), M. Mezzino (Univ. of Houston-Clear Lake), S. Novikov (Maryland Univ.), P. Pansky (Northwestern Univ.), A. Ros (Univ. de Granada, Spain), S. Salamon (Oxford Univ., England), L. Vanhecke (Katholieke Univ. Leuven, Belgium), J. Wolf (Univ. of California-Berkeley). The Scientific Committee reserves the right to select contributions for oral presentation.
Organizing Committee: L. C. de Andrés (Univ. del País Vasco, Spain), L. A. Cordero (Univ. de Santiago de Compostela, Spain), M. Fernández (chair, Univ. del País Vasco, Spain), A. Ferrandez (Univ. de Murcia, Spain), R. Ibáñez (Univ. del País Vasco, Spain), M. de León (C.S.I.C., Spain), M. Macho-Stadler (Univ. del País Vasco, Spain), A. Martinez Naveira (Univ. de Valencia, Spain), L. Ugarte (Univ. de Zaragoza, Spain).
Program: The International Congress will include various invited talks, several short communications, a poster session, a roundtable discussion, and a session with Mathematica.
Fees: Participation fee is 15,000 pesetas or US$100.
Deadline: The deadline for preregistration is September 30, 1999.
Information: R. Ibáñez or M. Macho-Stadler, Departamento de Matemáticas, Facultad de Ciencias, Apartado 644, 48080 Bilbao, Spain; tel: 34-946015358 and 34-946015352; fax: 34-946015216; e-mail: gray@bgu.ub.es. Further information about registration, conference fees, lodging, submission of abstracts, program of the conference, proceedings, social activities, etc., will be distributed in the second announcement before November 1999. All information will also be available on the Web page http://www.ub.es/Gray/.
22-24 AMS Central Section Meeting, University of Toronto, Toronto, Ontario, Canada. (Nov. 1998, p. 1378)
Information: Information will be posted on the meetings pages of e-MATH.

November 2000
3-5 AMS Northeastern Section Meeting, Columbia University, New York, New York. (Nov. 1998, p. 1378)
Information: Information will be posted on the meetings pages of e-MATH.

January 2001

March 2001
16-18 AMS Southeastern Section Meeting, University of South Carolina, Columbia, South Carolina. (Jan. 1998, p. 113)
Information: W. Drady, wad@ams.org.

April 2001
28-29 AMS Northeastern Section Meeting, Stevens Institute of Technology, Hoboken, New Jersey. (Nov. 1998, p. 1378)

September 2001
1-5 May 31 MIT-Mittag-Leffler Call for Proposals, Djursholm, Sweden.

October 2001
Information: W. Drady, wad@ams.org.

January 2002
6-9 Joint Mathematics Meetings, San Diego Convention Center, San Diego, California. (Nov. 1998, p. 1378)
New Publications Offered by the AMS

New Series from the AMS!

We are pleased to announce an important new book series: The SMF/AMS Texts and Monographs series will be co-published by the Société Mathématique de France (SMF) and the AMS.

The collection consists of English translations of select books originally published in French by the SMF in their outstanding Cours Spécialisés and other series, including the well-known Astérisque, Panoramas et Synthèses, and Mémoires. These high-quality works will be distributed worldwide by the AMS. AMS and SMF members will receive AMS member discounts on the titles in the series. The books published in the series are suitable for honors courses, upper-division seminars, reading courses or self-study.

Algebra and Algebraic Geometry

Selected Papers of E. B. Dynkin with Commentary

A. A. Yushkevich, University of North Carolina, Charlotte,
G. M. Seitz, University of Oregon, Eugene, and
A. L. Onishchik, Yaroslavl State University, Russia, Editors

Eugene Dynkin is a rare example of a contemporary mathematician who has achieved outstanding results in two quite different areas of research: algebra and probability. In both areas, his ideas constitute an essential part of modern mathematical knowledge and form a basis for further development. Although his last work in algebra was published in 1955, his contributions continue to influence current research in algebra and in the physics of elementary particles. His work in probability is part of both the historical and the modern development of the topic.

This volume presents Dynkin's scientific contributions in both areas. Included are Commentary by recognized experts in the corresponding fields who describe the time, place, role, and impact of Dynkin's research and achievements. Biographical notes and the recollections of his students are also featured. This item will also be of interest to those working in probability. This book is jointly published by the AMS and the International Press.

New Publications Offered by the AMS

E. B. Dynkin and S. E. Kuznetsov, Determining functions of Markov processes and corresponding dual regular classes;
E. B. Dynkin, Economic equilibrium under uncertainty;
I. V. Evstigneev, Comments on economic equilibrium under uncertainty;
E. B. Dynkin, Markov process es and random fields; E. B. Dynkin, Green's and Dirichlet spaces associated with fine Markov processes; E. B. Dynkin, Markov processes as a tool in field theory; E. B. Dynkin and A. Mandelbaum, Symmetrized statistics, Poisson point processes, and multiple Wiener integrals; E. B. Dynkin, Gaussian and non-Gaussian random fields associated with Markov processes; E. B. Dynkin, Author's correction to Gaussian and non-Gaussian random fields associated with Markov processes; E. B. Dynkin, An application of flows to time shift and time reversal in stochastic processes; E. B. Dynkin, Author's comments on an application of flows to time shift and time reversal in stochastic processes; E. B. Dynkin, Representation for functionals of superprocesses by multiple stochastic integrals, with applications to self-intersection local times; E. B. Dynkin, A probabilistic approach to one class of nonlinear differential equations; E. B. Dynkin, Superdiffusions and parabolic nonlinear differential equations; S. E. Kuznetsov, Comments on Superdiffusions and parabolic nonlinear differential equations; P. A. Meyer, Dynkin and the theory of Markov processes; A. A. Yushkevich, To the history of strong Markov property; M. A. Olshansky, On compactifications of symmetric spaces; J.-F. Le Gall, Dynkin's contributions to superprocesses and partial differential equations; I. V. Evstigneev, Dynkin's work in mathematical economics; Acknowledgments.

Collected Works, Volume 14


Algebraic Geometry: Hirzebruch 70

Piotr Pragacz, Institute Mathematics PAN, Torun, Poland, Michal Szurek, Warsaw, Poland, and Jaroslaw Wiśniewski, University of Warsaw, Poland, Editors

This book presents the proceedings from the conference on algebraic geometry in honor of Professor Friedrich Hirzebruch's 70th Birthday. The event was held at the Stefan Banach International Mathematical Center in Warsaw (Poland). Topics covered in the book include intersection theory, singularities, low-dimensional manifolds, moduli spaces, number theory, and interactions between mathematical physics and geometry. Also included are articles from notes of two special lectures. The first, by Professor Atiyah, describes the important contributions to the field of geometry by Professor Hirzebruch. The second article contains notes from the talk delivered at the conference by Professor Hirzebruch. Contributors to the volume are leading researchers in the field.


Contemporary Mathematics, Volume 241


Algebraic Methods and $q$-Special Functions

Jan Felipe van Diejen, Universidad de Chile, Santiago, and Luc Vinet, Université de Montréal, Québec, Canada, Editors

There has been revived interest in recent years in the study of special functions. Many of the latest advances in the field were inspired by the works of R. A. Askey and colleagues on basic hypergeometric series and I. G. Macdonald on orthogonal polynomials related to root systems. Significant progress was made by the use of algebraic techniques involving quantum groups, Hecke algebras, and combinatorial methods.

The CRM organized a workshop for key researchers in the field to present an overview of current trends. This volume consists of the contributions to that workshop. Topics include basic hypergeometric functions, algebraic and representation-theoretic methods, combinatorics of symmetric functions, root systems, and the connections with integrable systems.

This item will also be of interest to those working in analysis.

Contents: F. Bergeron and A. M. Garsia, Science fiction and Macdonald's polynomials; R. Chouikha, On the expansion of elliptic functions and applications; D. V. Chudnovsky and G. V. Chudnovsky, Generalized hypergeometric functions—Classification of identities and explicit rational approximations; W. S. Chung, E. G. Kalnins, and W. Miller, Jr., Tensor products of $q$-superalgebras and $q$-series identities; J. F. van Diejen and J. V. Stokman, $q$-Racah polynomials for $BC$ type root systems;
Non-Euclidean Geometry in the Theory of Automorphic Functions

Jacques Hadamard, and Jeremy J. Gray, Open University, Milton Keynes, UK, and Abe Shenitzer (Editors), York University, Toronto, ON, Canada

This is the English translation of a volume originally published only in Russian and now out of print. The book was written by Jacques Hadamard on the work of Poincaré.

Poincaré's creation of a theory of automorphic functions in the early 1880s was one of the most significant mathematical achievements of the nineteenth century. It directly inspired the uniformization theorem, led to a class of functions adequate to solve all linear ordinary differential equations, and focused attention on a large new class of discrete groups. It was the first significant application of non-Euclidean geometry. The implications of these discoveries continue to be important to this day in numerous different areas of mathematics.

Hadamard begins with hyperbolic geometry, which he compares with plane and spherical geometry. He discusses the corresponding isometry groups, introduces the idea of discrete subgroups, and shows that the corresponding quotient spaces are manifolds. In Chapter 2 he presents the appropriate automorphic functions, in particular, Fuchsian functions. He shows how to represent Fuchsian functions as quotients, and how Fuchsian functions invariant under the same group are related, and indicates how these functions can be used to solve differential equations. Chapter 4 is devoted to the outlines of the more complicated Kleinian case. Chapter 5 discusses algebraic functions and linear algebraic differential equations, and the last chapter sketches the theory of Fuchsian groups and geodesics.

This unique exposition by Hadamard offers a fascinating and intuitive introduction to the subject of automorphic functions and illuminates its connection to differential equations, a connection not often found in other texts.

This book is the second in an informal sequence of works called "History of Mathematics, Sources", to be included within the History of Mathematics series, co-published by the AMS and the London Mathematical Society. Volumes to be published within this subset are classical mathematical works that served as cornerstones for modern mathematical thought. (For another historical translation on this topic, see Sources of Hyperbolic Geometry, volume 10, in the History of Mathematics series.)

Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners.

Contents: Historical introduction; A brief history of automorphic function theory, 1890-1930; The group of motions of the hyperbolic plane and its properly discontinuous subgroups;
Discontinuous groups in three geometries. Fuchsian functions; Fuchsian functions; Kleinian groups and functions; Algebraic functions and linear algebraic differential equations; Fuchsian groups and geodesics; References; Additional references.

**History of Mathematics, Volume 17**

October 1999, approximately 102 pages, Softcover, ISBN 0-8218-2030-3, LC 99-31709, 1991 Mathematics Subject Classification: 01-XX, 01A55, 01A60; 30-03, 30F35, 34A20, 51-03. All AMS members $15, List $19, Order code HMAH/17N

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**Differential Equations**

**Geometric Aspects of Partial Differential Equations**

Bernhelm Booss-Bavnbek, Roskilde University, Denmark, and Krzysztof Wojciechowski, Indiana University-Purdue University, Indianapolis, Editors

This collection of papers by leading researchers gives a broad picture of current research directions in geometric aspects of partial differential equations. Based on lectures presented at a Minisymposium on Spectral Invariants - Heat Equation Approach, held in September 1998 at Roskilde University in Denmark, the book provides both a careful exposition of new perspectives in classical index theory and an introduction to currently active areas of the field.

Presented here are new index theorems as well as new calculations of the eta-invariant, of the spectral flow, of the Maslov index, of Seiberg-Witten monopoles, heat kernels, determinants, non-commutative residues, and of the Ray-Singer torsion. New types of boundary value problems for operators of Dirac type and generalizations to manifolds with cuspidal ends, to non-compact and to infinite-dimensional manifolds are also discussed. Throughout the book, the use of advanced analysis methods for gaining geometric insight emerges as a central theme. Aimed at graduate students and researchers, this book would be suitable as a text for an advanced graduate topics course on geometric aspects of partial differential equations and spectral invariants.

This item will also be of interest to those working in geometry and topology.


**Contemporary Mathematics, Volume 242**


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**General and Interdisciplinary**

**John von Neumann**

The Scientific Genius Who Pioneered the Modern Computer, Game Theory, Nuclear Deterrence, and Much More

Norman Macrae

I always thought [von Neumann's] brain indicated that he belonged to a new species, an evolution beyond man. Macrae shows us in a lively way how this brain was nurtured and then left its great imprint on the world.

—Hans A. Bethe, Cornell University

The book makes for utterly captivating reading. Von Neumann was, of course, one of this century's geniuses, and it is surprising that we have had to wait so long ... for a fully fleshed and sympathetic biography of the man. But now, happily, we have one.

Macrae nicely delineates the cultural, familial, and educational environment from which von Neumann sprang and sketches the mathematical and scientific environment in which he flourished. It's no small task to render a genius like von Neumann in ordinary language, yet, Macrae manages the trick, providing more than a glimpse of what von Neumann accomplished intellectually without expecting the reader to have a Ph.D. in mathematics. Beyond that, he captures von Neumann's qualities of temperament, mind, and personality, including his effortless wit and humor. And [Macrae] frames and accounts for von Neumann's politics in ways that even critics of them, among whom I include myself, will find provocative and illuminating.

—Daniel J. Kevles, California Institute of Technology

A lively portrait of the hugely consequential mathematician-physicist-er al., whose genius has left an enduring impress[on] on our thought, technology, society, and culture. A double salute...
Riemannian Geometry During the Second Half of the Twentieth Century

Marcel Berger, Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France

The article is masterfully written and delightful to read. In addition to the numerous digressions for newly introduced concepts, the author adds to the value of the survey by providing fertile opinions, some of them his, others of his close colleagues and of M. Gromov in particular. The wonderful effort of the author is shown partially by the long bibliography of thirty pages, with references updated right to the very end of the century. A person who wants to learn more about Riemannian geometry will certainly do him/herself a good service by reading Berger's work.

—Mathematical Reviews

During its first hundred years, Riemannian geometry enjoyed steady, but undistinguished growth as a field of mathematics. In the last fifty years of the twentieth century, however, it has exploded with activity. Berger marks the start of this period with Rauch's pioneering paper of 1951, which contains the first real pinching theorem and an amazing leap in the depth of the connection between geometry and topology. Since then, the field has become so rich that it is almost impossible for the uninitiated to find their way through it. Textbooks on the subject invariably must choose a particular approach, thus narrowing the path. In this book, Berger provides a truly remarkable survey of the main developments in Riemannian geometry in the second half of the last fifty years.

One of the most powerful features of Riemannian manifolds is that they have invariants of (at least) three different kinds. There are the geometric invariants: topology, the metric, various notions of curvature, and relationships among these. There are analytic invariants: eigenvalues of the Laplacian, wave equations, Schrödinger equations. There are the invariants that come from Hamiltonian mechanics: geodesic flow, ergodic properties, periodic geodesics. Finally, there are important results relating different types of invariants. To keep the size of this survey manageable, Berger focuses on five areas of Riemannian geometry: Curvature and topology; the construction of and the classification of space forms; distinguished metrics, especially Einstein metrics; eigenvalues and eigenfunctions of the Laplacian; the study of periodic geodesics and the geodesic flow. Other topics are treated in less detail in a separate section.

While Berger's survey is not intended for the complete beginner (one should already be familiar with notions of curvature and geodesics), he provides a detailed map to the major developments of Riemannian geometry from 1950 to 1999. Important threads are highlighted, with brief descriptions of the results that make up that thread. This supremely scholarly account is remarkable for its careful citations and voluminous bibliography. If you wish to learn about the results that have defined Riemannian geometry in the last half century, start with this book.

Reprint arranged with the approval of the publisher B.G. Teubner, Stuttgart and Leipzig.

Contents: Introduction; Riemannian geometry up to 1950; Comments on the main topics I, II, III, IV, V under consideration; Curvature and topology; The geometrical hierarchy of Riemannian manifolds: Space forms; The set of Riemannian structures on a given compact manifold: Is there a best metric? The spectrum, the eigenfunctions; Periodic geodesics, the geodesic flow; Some other Riemannian geometric topics of interest; Bibliography; Subject and notation index; Name index.

University Lecture Series


Supplementary Reading

Riemannian Geometry During the Second Half of the Twentieth Century

Marcel Berger, Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France

The article is masterfully written and delightful to read. In addition to the numerous digressions for newly introduced concepts, the author adds to the value of the survey by providing fertile opinions, some of them his, others of his close colleagues and of M. Gromov in particular. The wonderful effort of the author is shown partially by the long bibliography of thirty pages, with references updated right to the very end of the century. A person who wants to learn more about Riemannian geometry will certainly do him/herself a good service by reading Berger's work.

—Robert K. Merton, Columbia University

This volume is the reprinted edition of the first full-scale biography of the man widely regarded as the greatest scientist of the century after Einstein.

Born in Budapest in 1903, John von Neumann grew up in one of the most extraordinary of scientific communities. From his arrival in America in the mid-1930s—with bases in Boston, Princeton, Washington, and Los Alamos—von Neumann pioneered and participated in the major scientific and political dramas of the next three decades, leaving his mark on more fields of scientific endeavor than any other scientist. Von Neumann's work in areas such as game theory, mathematics, physics, and meteorology formed the building blocks for the most important discoveries of the century: the modern computer, game theory, the atom bomb, radar, and artificial intelligence, to name just a few.

From the laboratory to the highest levels of government, this definitive biography gives us a behind-the-scenes look at the politics and personalities involved in these world-changing discoveries. Written more than 30 years after von Neumann's untimely death at age 58, it was prepared with the cooperation of his family and includes information gained from interviewing countless sources across Europe and America. Norman Macrae paints a highly readable, humanizing portrait of a man whose legacy still influences and shapes modern science and knowledge.

Contents: The cheapest way to make the world richer; A silver spoon in Budapest, 1903-14; At the Lutheran Gymnasium, 1914-21; An undergraduate with lion's claws, 1921-26; Rigor becomes more relaxed, 1926-32; Sturm und Drang, marriage, emigration, 1927-31; Depression at Princeton, 1931-37; The calculating exploder, 1937-43; Los Alamos to Trinity, 1943-45; In the domain of economics; The computers at Philadelphia, 1944-46; The computers from Princeton, 1946-52; And then the H-bomb; With astonishing influence, 1950-56; Acknowledgments; Permissions acknowledgments; Notes; Bibliography; Index; Macrae on Macrae.

New Publications Offered by the AMS

Espaces de Modules des Courbes, Groupes Modulaires et Théorie des Champs
Xavier Buff, Jérôme Fehrenbach, Pierre Lochack, Leila Schneps, and Pierre Vogel
A publication of Société Mathématique de France.

This volume comprises the proceedings of a three-day workshop on the following topics: moduli spaces of curves, mapping class groups, and quantum field theory. Chapter 1 presents an introduction to Teichmüller spaces, containing full proofs of many useful results not easily found in the literature. Also presented is an introduction to moduli spaces of curves, with a detailed description of the genus zero case, in particular of the part at infinity. Chapter 2 addresses the genus-zero moduli spaces and gives a complete description of their fundamental groupoids, based at tangential base points neighboring the part at infinity. The description relies on identifying these groupoids with certain canonical subgroupoids of a free braided tensor category. The section concludes with a study of the canonical Galois action on the fundamental groupoids, computed using Grothendieck-Teichmüller theory. Chapter 3 studies strict ribbon categories, which are closely related to braided tensor categories. Here they are used to construct invariants of 3-manifolds which give rise to quantum field theories.

Distributed by the AMS in the United States, Canada, and Mexico. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: X. Buff, J. Fehrenbach, and P. Lochak, Éléments de géométrie des espaces de modules des courbes; L. Schneps, Groupoides fondamentaux des espaces de modules en genre 0 et catégories tensorielles tressées; P. Vogel, Invariants de Witten-Reshetikhin-Turaev et théories quantiques des champs.

Panoramas et Synthèses, Number 7
Mathematics Subject Classification: 32G15, 20F34, 57A10, 11R32, 20F36, 81Exx, Individual member $23, List $26, Order code PASY/7N

Logic and Foundations

Principles of Mathematical Logic
D. Hilbert and W. Ackermann

David Hilbert was particularly interested in the foundations of mathematics. Among many other things, he is famous for his attempt to axiomatize mathematics. This now classic text is his treatment of symbolic logic. It lays the groundwork for his later work with Bernays.

This translation is based on the second German edition, and has been modified according to the criticisms of Church and Quine. In particular, the authors' original formulation of Gödel's completeness proof for the predicate calculus has been updated.

In the first half of the twentieth century, an important debate on the foundations of mathematics took place. Principles of Mathematical Logic represents one of Hilbert's important contributions to that debate. Although symbolic logic has grown considerably in the subsequent decades, this book remains a classic.

Contents: The sentential calculus; The calculus of classes (monadic predicate calculus); The restricted predicate calculus; The extended predicate calculus; Editor's notes; Bibliography; Index.

AMS Chelsea Publishing

Number Theory

Collected Papers of Srinivasa Ramanujan
G. H. Hardy, P. V. Sheshu Aiyar, and B. M. Wilson, with commentary by Bruce Berndt, University of Illinois, Urbana, IL, Editors

The influence of Ramanujan on number theory is without parallel in mathematics. His papers, problems and letters have spawned a remarkable number of later results by many different mathematicians. Here, his 37 published papers, most of his first two and last letters to Hardy, the famous 58 problems submitted to the Journal of the Indian Mathematical Society, and the commentary of the original editors (Hardy, Seshu Aiyar and Wilson) are reprinted again, after having been unavailable for some time.

In this, the third printing of Ramanujan's collected papers, Bruce Berndt provides an annotated guide to Ramanujan's work and to the mathematics it inspired over the last three-quarters of a century. The historical development of ideas is traced in the commentary and by citations to the copious references. The editor has done the mathematical world a tremendous service that few others would be qualified to do.

Contents: Some properties of Bernoulli's numbers; On Question 330 of Prof. Sanjana; Note on a set of simultaneous equations; Irregular numbers; Squaring the circle; Modular equations and approximations to π; On the integral ∫₀⁺₀⁻¹ dt; On the number of divisors of a number; On the sum of the square roots of the first n natural numbers; On the product Π₁ⁿ⁻¹ (1 + (x/j)²); Some definite integrals; Some definite integrals connected with Gauss's sums; Summation of a certain series; New expressions for Riemann's functions ξ(s) and Ξ(t); Highly composite numbers; On certain infinite series; Some formulae in the analytic theory of numbers; On certain arithmetical functions; A series for Euler's constant γ; On the expression of a number in the form ax² + by² + cz² + du²; On certain trigonometrical sums and their applications in the theory of numbers; Some definite integrals; Some definite inte-
Ramanujan
Twelve Lectures on Subjects Suggested by His Life and Work
G. H. Hardy

From the fact that practically all topics of analytic number theory are mentioned, briefly or extensively, in this book in connection with one or the other of Ramanujan’s ideas, theorems, conjectures, we realize the far-reaching influence which his work has had on present-day mathematics ... the book is not only an homage to Ramanujan’s genius; it is a survey of many modern problems of modular arithmetic and analysis and, altogether, a book which makes fascinating reading.
—Hans Rademacher, Mathematical Reviews

Ramanujan occupies a unique place in analytic number theory. His formulas, identities and calculations are still amazing three-quarters of a century after his death. Many of his discoveries seem to have appeared as if from the ether. His mentor and primary collaborator was the famous G. H. Hardy. Here, Hardy collects twelve of his own lectures on topics stemming from Ramanujan’s life and work. The topics include: partitions, hypergeometric series, Ramanujan’s \( \tau \)-function and round numbers.

Hardy was the first to recognize the brilliance of Ramanujan’s ideas. As one of the great mathematicians of the time, it is fascinating to read Hardy’s accounts of their importance and influence.

Contents: The Indian mathematician Ramanujan; Ramanujan and the theory of prime numbers; Round numbers; Some more problems of the analytic theory of numbers; A lattice-point problem; Ramanujan’s work on partitions; Hypergeometric series; Asymptotic theory of partitions; The representation of numbers as sums of squares; Ramanujan’s function \( \tau(n) \); Definite integrals; Elliptic and modular functions; Bibliography.

AMS Chelsea Publishing

Previously Announced Publications

Cohomologie, Stabilisation et Changement de Base
Jean-Pierre Labesse, Université Paris 7, France

A publication of Société Mathématique de France.
In this volume, the concept of a “crossed set” (a generalization of crossed modules) is introduced; the author studies Galois cohomology of these objects. This is the key to the stabilization of all elliptic terms for the twisted trace formula. Labesse then proves the existence of the stable transfer for cyclic base change, and from a conditional stabilization of the twisted trace formula, the existence of weak base change in some cases is deduced, in particular for automorphic representations on simply connected semi-simple groups which are Steinberg at two places. In an appendix, Labesse and Clozel study certain unitary groups. In a second appendix, L. Breen rephrases crossed sets in the framework of simplicial algebra. Text is in French.

Previously Announced Publications

Pioneers of Representation Theory: Frobenius, Burnside, Schur, and Brauer
Charles W. Curtis, University of Oregon, Eugene

The year 1897 was marked by two important mathematical events: the publication of the first paper on representations of finite groups by Ferdinand Georg Frobenius (1849-1917) and the appearance of the first treatise in English on the theory of finite groups by William Burnside (1852-1927). Burnside soon developed his own approach to representations of finite groups. In the next few years, working independently, Frobenius and Burnside explored the new subject and its applications to finite group theory.

They were soon joined in this enterprise by Issai Schur (1875-1941) and some years later, by Richard Brauer (1901-1977). These mathematicians’ pioneering research is the subject of this book. It presents an account of the early history of representation theory through an analysis of the published
work of the principals and others with whom the principals’ work was interwoven. Also included are biographical sketches and enough mathematics to enable readers to follow the development of the subject. An introductory chapter contains some of the results involving characters of finite abelian groups by Lagrange, Gauss, and Dirichlet, which were part of the mathematical tradition from which Frobenius drew his inspiration.

This book presents the early history of an active branch of mathematics. It includes enough detail to enable readers to learn the mathematics along with the history. The volume would be a suitable text for a course on representations of finite groups, particularly one emphasizing an historical point of view.

Co-published with the London Mathematical Society. Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners.

History of Mathematics, Volume 15


An Introduction to the Mathematical Theory of Waves

Roger Knobel, University of Texas-Pan American, Edinburg

This book is based on an undergraduate course taught at the IAS/Park City Mathematics Institute, on linear and nonlinear waves. The first part of the text overviews the concept of a wave, describes one-dimensional waves using functions of two variables, provides an introduction to partial differential equations, and discusses computer-aided visualization techniques.

The second part of the book discusses traveling waves, leading to a description of solitary waves and soliton solutions of the Klein-Gordon and Korteweg-deVries equations. The wave equation is derived to model the small vibrations of a taut string, and solutions are constructed via d’Alembert’s formula and Fourier series.

The last part of the book discusses waves arising from conservation laws. After deriving and discussing the scalar conservation law, its solution is described using the method of characteristics, leading to the formation of shock and rarefaction waves. Applications of these concepts are then given for models of traffic flow.

The intent of this book is to create a text suitable for independent study by undergraduate students in mathematics, engineering, and science. The content of the book is meant to be self-contained, requiring no special reference material. Access to computer software such as Mathematica®, MATLAB®, or Maple® is recommended, but not necessary. Scripts for MATLAB applications will be available via a Web site. Exercises are given within the text to allow further practice with selected topics.

* Wolfram Research, Inc., Champaign IL
* The Math Works, Inc., Natick, MA
* Waterloo Maple, Inc., Ontario, Canada.

Student Mathematical Library, Volume 3


Lectures on Contemporary Probability

Gregory F. Lawler, Duke University, Durham, NC, and Lester N. Coyle, Loyola College, Baltimore, MD

This volume is based on classes in probability for advanced undergraduates held at the IAS/Park City Mathematics Institute. It is derived from both lectures (Chapters 1-10) and computer simulations (Chapters 11-13) that were held during the program. The material is coordinated so that some of the major computer simulations relate to topics covered in the first ten chapters. The goal is to present topics that are accessible to advanced undergraduates, yet are areas of current research in probability. The combination of the lucid yet informal style of the lectures and the hands-on nature of the simulations allows readers to become familiar with some interesting and active areas of probability.

The first four chapters discuss random walks and the continuous limit of random walks: Brownian motion. Chapters 5 and 6 consider the fascinating mathematics of card shuffles, including the notions of random walks on a symmetric group and the general idea of random permutations.

Chapters 7 and 8 discuss Markov chains, beginning with a standard introduction to the theory. Chapter 8 addresses the recent important application of Markov chains to simulations of random systems on a large finite set: Markov Chain Monte Carlo. Random walks and electrical networks are covered in Chapter 9. Uniform spanning trees, as connected to probability and random walks, are treated in Chapter 10.

The final three chapters of the book present simulations. Chapter 11 discusses simulations for random walks. Chapter 12 covers simulation topics such as sampling from continuous distributions, random permutations, and estimating the number of matrices with certain conditions using Markov Chain Monte Carlo. Chapter 13 presents simulations of stochastic differential equations for applications in finance. (The simulations do not require one particular piece of software. They can be done in symbolic computation packages or via programming languages such as C.)

The volume concludes with a number of problems ranging from routine to very difficult. Of particular note are problems that are typical of simulation problems given to students by the authors when teaching undergraduate probability.

Student Mathematical Library, Volume 2


Foundations of $p$-adic Teichmüller Theory

Shinichi Mochizuki, Research Institute for the Mathematical Sciences, Kyoto, Japan

This book lays the foundation for a theory of uniformization of $p$-adic hyperbolic curves and their moduli. On one hand, this theory generalizes the Fuchsian and Bers uniformizations of complex hyperbolic curves and their moduli to nonarchimedean places. That is why in this book, the theory is referred to as $p$-adic Teichmüller theory, for short. On the other hand, the theory may be regarded as a fairly precise hyperbolic analog of the Serre-Tate theory of ordinary abelian varieties and their moduli.
The theory of uniformization of \( p \)-adic hyperbolic curves and their moduli was initiated in a previous work by Mochizuki. And in some sense, this book is a continuation and generalization of that work. This book aims to bridge the gap between the approach presented and the classical uniformization of a hyperbolic Riemann surface that is studied in undergraduate complex analysis.

**Features:**
- Presents a systematic treatment of the moduli space of curves from the point of view of \( p \)-adic Galois representations.
- Treats the analog of Serre-Tate theory for hyperbolic curves.
- Develops a \( p \)-adic analog of Fuchsian and Bers uniformization theories.
- Gives a systematic treatment of a "nonabelian example" of \( p \)-adic Hodge theory.

Titles in this series are co-published with International Press, Cambridge, MA.

**AMS/IPS Studies in Advanced Mathematics, Volume 11**

**Miles of Tiles**
Charles Radin, University of Texas, Austin

*In this book, we try to display the value (and joy!) of starting from a mathematically amorphous problem and combining ideas from diverse sources to produce new and significant mathematics—mathematics unforeseen from the motivating problem ...*

—from the Preface

The common thread throughout this book is aperiodic tilings; the best-known example is the "kite and dart" tiling. This tiling has been widely discussed, particularly since 1984 when it was adopted to model quasicrystals. The presentation uses many different areas of mathematics and physics to analyze the new features of such tilings. Although many people are aware of the existence of aperiodic tilings, and maybe even their origin in a question in logic, not everyone is familiar with their subtleties and the underlying rich mathematical theory. For the interested reader, this book fills that gap.

Understanding this new type of tiling requires an unusual variety of specialties, including ergodic theory, functional analysis, group theory and ring theory from mathematics, and statistical mechanics and wave diffraction from physics. This interdisciplinary approach also leads to new mathematics seemingly unrelated to the tilings. Included are many worked examples and a large number of figures. The book's multidisciplinary approach and extensive use of illustrations make it useful for a broad mathematical audience.

**Student Mathematical Library, Volume 1**

**Advance Notice**

**Prime Numbers and Their Distribution**
Gérald Tenenbaum, Université Henri Poincaré, Nancy I, France, and Michel Mendès Franc, Université Bordeaux I, France

From reviews for the French edition ...

This is a short introductory book on analytic number theory. The prerequisites are quite modest, but it still contains an impressive amount of information. A multitude of results is included, some of which were proved just recently ... this book is very well written. It is fun to read and at the same time presents most of the fundamental concepts and ideas in analytic number theory.

—Mathematical Reviews

The reviewer recommends it to all interested readers.

—Zentralblatt für Mathematik

We have been curious about numbers—and prime numbers—since antiquity. One notable new direction this century in the study of primes has been the influx of ideas from probability. The goal of this book is to provide insights into the prime numbers and to describe how a sequence so tautly determined can incorporate such a striking amount of randomness.

There are two ways in which the book is exceptional. First, some familiar topics are covered with refreshing insight and/or from new points of view. Second, interesting recent developments and ideas are presented that shed new light on the prime numbers and their distribution among the rest of the integers.

The book begins with a chapter covering some classic topics, such as quadratic residues and the Sieve of Eratosthenes. Also discussed are other sieves, primes in cryptography, twin primes, and more.

Two separate chapters address the asymptotic distribution of prime numbers. In the first of these, the familiar link between \( \xi(s) \) and the distribution of primes is covered with remarkable efficiency and intuition. The later chapter presents a walk through an elementary proof of the Prime Number Theorem. To help the novice understand the "why" of the proof, connections are made along the way with more familiar results such as Stirling's formula.

A most distinctive chapter covers the stochastic properties of prime numbers. The authors present a wonderfully clever interpretation of primes in arithmetic progressions as a phenomenon in probability. They also describe Cramér's model, which provides a probabilistic intuition for formulating conjectures that have a habit of being true. In this context, they address interesting questions about equipartition modulo 1 for sequences involving prime numbers. The final section of the chapter compares geometric visualizations of random sequences with the visualizations for similar sequences derived from the primes. The resulting pictures are striking and illuminating. The book concludes with a chapter on the outstanding big conjectures about prime numbers.

This book is suitable for anyone who has had a little number theory and some advanced calculus involving estimates. Its engaging style and invigorating point of view will make refreshing reading for advanced undergraduates through research mathematicians. This book is the English translation of the French edition.

**Student Mathematical Library**
PUBLICATIONS of CONTINUING INTEREST

Tittles of General Interest

The AMS is pleased to bring you these bestselling titles in the General Interest category. The selections are suitable for a wide audience, including high school students, undergraduates, and educators. Many of the books make fine texts for course adoption. They offer vital and informative historical, biographical, and educational perspectives on mathematics. For more recommended textbooks, search the AMS Bookstore at www.ams.org/bookstore/. To request an exam copy, contact the AMS.

What's Happening in the Mathematical Sciences, Volume 4
Barry Cipra
Praise for volumes 1, 2, and 3 of What's Happening...
Stylish format...largely accessible to laymen...This publication is one of the snappier examples of a growing genre from scientific societies seeking to increase public understanding of their work and its societal value.
—Science & Government Report

Another choice of new exciting developments in mathematics. These volumes really deserve a large audience, students as well as researchers will be fascinated by the insights and overviews presented.
—Zentralblatt für Mathematik

The topics chosen and the lively writing fill a notorious gap—to make the ideas, concepts and beauty of mathematics more visible for the general public...well-illustrated...Congratulations to Barry Cipra.
—Zentralblatt für Mathematik

Cover picture, detail of “Wave-Particle Duality”, was created and provided by artist Mel Fisher. Reproduced with permission.

How to Teach Mathematics
Second Edition
Steven G. Krantz, Washington University, St. Louis, MO
Praise for the First Edition...
An original contribution to the educational literature on teaching mathematics at the post-secondary level. The book itself is an explicit proof of the author's claim “teaching can be rewarding, useful, and fun.”
—Zentralblatt für Mathematik

1999; ISBN 0-8218-1398-6; 307 pages; Softcover; All AMS members $19, List $24, Order Code HTM/2CT99

Jacques Hadamard, A Universal Mathematician
Vladimir Maz'ya and Tatyana Shaposhnikova, Linköping University, Sweden

The authors describe Hadamard’s life with numerous interesting details contained in the references of those close to him and give many illustrations of the wide-ranging mathematical impact of this “living legend.” Furthermore, the authors enhance the utility of their text as a research tool by organizing and listing hundreds of references to other pertinent materials about the life and works of Hadamard.

—MAA Online

The reviewer recommends the book highly for both enjoyment and information. The authors have a masterful grasp of both the mathematics and the biography, and they tell the story in a very interesting way.
—Mathematical Reviews

An account of one of the great mathematicians of all time. Thoroughly researched biography plus summary of contributions to analytic function theory, number theory, geometry, calculus of variations, mathematical physics, PDEs, and other other subjects.
—American Mathematical Monthly

Some mathematicians are well remembered without being well acknowledged; the name circulates, but the contributions which caused the fame are largely forgotten or at least not distinguished from others’. An outstanding case for this century is Jacques Hadamard...All the more reason to welcome this fine and exhaustive book, which treats in detail both his exceptionally long life and comparably important work...
—Bulletin of the American Mathematical Society

Co-published with the London Mathematical Society. Members of the AMS may order directly from the AMS at the member price. The LMS is registered with the Charity Commissioners.


Prospects in Mathematics
Invited Talks on the Occasion of the 250th Anniversary of Princeton University
Hugo Rossi, Mathematical Sciences Research Institute, Berkeley, CA, Editor

Cover picture of Old Fine Hall at Princeton University courtesy of Robert P. Matthews, Communications Department, Princeton University.

Research in Collegiate Mathematics Education. III
Alan H. Schoenfeld, University of California, Berkeley, Jim Kaput, University of Massachusetts, Dartmouth, and Ed Dubinsky, Georgia State University, Atlanta, Editors

This volume presents state-of-the-art research on understanding, teaching, and learning mathematics. Included is information on methodology and research concentrating on these areas of student learning: problem solving, understanding concepts, and understanding proofs.

This series is published in cooperation with the Mathematical Association of America.

CBMS Issues in Mathematics Education, Volume 7; 1998; ISBN 0-8218-0882-6; 319 pages; Softcover; All Individuals $24, List $40, Order Code CBMATH/7CT99

A Gentle Introduction to Game Theory
Saul Stahl, University of Kansas, Lawrence

Mathematical World, Volume 13; 1999; ISBN 0-8218-1339-0; 176 pages; Softcover; All AMS members $20, List $26, Order Code MAWRLD/13CT99

AMERICAN MATHEMATICAL SOCIETY
NOTICES OF THE AMS
VOLUME 46, NUMBER 8
992
is expected to encourage and sustain excellence in teaching.

The University of
California, Berkeley, is
looking for the F. Burton Jones Chair in Topology. The university seeks a distinguished scholar recognized for outstanding research in topology. The selected individual is expected to encourage and sustain research and scholarly studies in topology and have a strong commitment to excellence in teaching. It is hoped to have the position filled by July 1, 2000. It is expected that the appointment will be with tenure at the rank of full professor and that the appointee will perform all the duties thereof. Established criteria of the University of California determine rank and salary. Initial review of applications will begin on October 1, 1999, and will continue until the position is filled.

Please send nominations, applications (curriculum vitae, publications list, and the names of at least five references), and supporting materials to:

Professor Xiao-Song Lin
Chair, Selection Committee
F. Burton Jones Chair
Department of Mathematics
University of California
Riverside, CA 92521-0135

The University of California, Riverside, is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF CALIFORNIA AT BERKELEY
Department of Mathematics
Berkeley, CA 94720

Tenured or Tenure-Track Position

Pending budget approval, we invite applications for one or more positions effective July 1, 2000, at either the tenure-track (assistant professor) or tenured (associate or full 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 should send a resume, reprint or preprints, and/or dissertation abstract, and three letters of evaluation to the Vice Chair for Faculty Affairs at the address above. It is the responsibility of the tenure-track applicants to make sure 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/ by clicking on "People", then "Faculty Positions at Berkeley").

Tenure applicants are expected to demonstrate leadership in research and should send a curriculum vitae, list of publications, a few selected reprints or preprints, and the names and address of three references to the Vice Chair for Faculty Affairs at the above address. The applicant should indicate whether they are applying for an associate professor or a full professor position. The department will assume responsibility to solicit letters of evaluation and will provide evaluators with a copy of the summary of policies on confidentiality of letters of evaluation.

All applicants are requested 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, which is available courtesy of the American Mathematical Society.

We should receive material for both tenure-track and tenure applications no later than November 1, 1999. Applications postmarked after the deadline will not be considered. The University of California is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF CALIFORNIA AT BERKELEY
Department of Mathematics
Berkeley, CA 94720
Charles B. Morrey Jr.
Assistant Professorships

We invite applications for these special (non-tenure-track) positions effective July 1, 2000. The terms of these appointments...
may range from two to three years. Applicants should have a recent Ph.D., or the equivalent, in an area of pure or applied mathematics. Applicants should send a résumé, reprints, preprints, and/or dissertation abstract, and three 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 on our home page (http://math.berkeley.edu/ by clicking on "People", and then "Faculty Positions at Berkeley"). 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, which is available courtesy of the American Mathematical Society.

We should receive this material no later than December 1, 1999. Applications postmarked after the deadline will not be considered. The University of California is an Equal Opportunity/Affirmative Action Employer.

**UNIVERSITY OF CALIFORNIA AT BERKELEY**

Department of Mathematics
Berkeley, CA 94720

Temporary Postdoctoral Positions

Several temporary positions beginning in fall 2000 are anticipated for new and recent Ph.D.s of any age in any area of pure or applied mathematics. The terms of these appointments may range from one to three years. Applicants for NSF or other postdoctoral fellowships are encouraged to apply for these positions. Mathematicians whose research interests are close to those of regular department members will be given some preference. Applicants should send a résumé, reprints, preprints, and/or dissertation abstract, and three 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 on our home page (http://math.berkeley.edu/ by clicking on "People", and then "Faculty Positions at Berkeley"). 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, which is available courtesy of the American Mathematical Society.

We should receive this material no later than December 1, 1999. The University of California is an Equal Opportunity/Affirmative Action Employer.

**DELAWARE**

UNIVERSITY OF DELAWARE

Department of Mathematical Sciences

The Department of Mathematical Sciences at the University of Delaware invites applications for tenure-track positions to begin September 1, 2000. The position is in applied mathematics at the assistant or associate professor level. Applications are invited for one or more positions. Mathematicians whose research interests are close to those of the faculty will be given preference.

The successful candidate will show excellent promise in research with a strong potential for external funding. An interest in establishing and mentoring links with industry and other academic disciplines will weigh heavily in the candidate's favor. Expertise in any of the areas of wave propagation, fluid dynamics, material science, scientific computation, and inverse problems is a plus. Evidence of effective teaching is essential.

Applicants should send a curriculum vitae (including funding history), reprints and/or preprints, and three letters of recommendation to:

Applied Mathematics Search Committee
Department of Mathematical Sciences
University of Delaware
Newark, DE 19716

Applications must be received by November 15, 1999.

The University of Delaware is an Equal Opportunity Employer which encourages applications from qualified minority group members and women.

**ILLINOIS**

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Department of Mathematics

Tenured Position

Applications are invited for one or more full-time tenured faculty positions to commence August 21, 2000. Those faculty will be expected to pursue an outstanding research program and to teach graduate as well as undergraduate students. The department will consider applicants in all fields of mathematics, but we intend to show preference in applied mathematics, computational mathematics, mathematical physics, partial differential equations and global analysis, probability theory, algebraic geometry, and number theory. Salary and teaching load are competitive.

Applicants should have completed the Ph.D. (or equivalent) by the time the appointment begins and are expected to present evidence of excellence in research and teaching. Applicants should send a letter of application, a curriculum vitae and publication list, and three letters of reference to the address below. It is the responsibility of the tenure-track applicants to make sure that letters of recommendation are sent.

Joseph Rosenblatt, Chair
Department of Mathematics
University of Illinois at Urbana-Champaign
1409 West Green Street
Urbana, IL 61801
tel. (217) 333-3352
e-mail: tenure@math.uiuc.edu

For full consideration, all materials, including letters of reference, should be received by November 30, 1998; however, applications will be accepted and interviews conducted until the positions are filled. We encourage use of the application cover sheet provided by the American Mathematical Society. Applications from women and minority candidates are especially encouraged. The University of Illinois is an affirmative action/equal opportunity employer.
encouraged. The University of Illinois is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Department of Mathematics
Postdoctoral Positions as J. L. Doob Research Assistant Professor

The Department of Mathematics of the University of Illinois at Urbana-Champaign is soliciting applications for postdoctoral positions. Three appointments will be made starting August 21, 2000; each appointment is for three years and is not renewable. These positions are for recent Ph.D. recipients (with a strong preference for those not more than one year past the Ph.D. degree). The Department of Mathematics will provide an excellent scientific environment to pursue research in pure and applied mathematics. The position carries a salary of $41,000 per year.

Applications should send a letter of application, a curriculum vitae and publication list (please provide hard copies of your application and supporting documents), and three letters of reference to the address below. It is the responsibility of the applicants to make sure that letters of recommendation are sent.

Postdoctoral Search Committee
Department of Mathematics
University of Illinois at Urbana-Champaign
1409 West Green Street
Urbana, IL 61801-2975
e-mail: postdocs@math.uiuc.edu

To ensure full consideration, all materials, including letters of reference, should be received by November 30, 1999. We will review later applications until the search is closed. We encourage use of the application cover sheet provided by the American Mathematical Society and the indication of the subject area using the AMS subject classification numbers. Applications from women and minority candidates are especially encouraged. The University of Illinois is an Affirmative Action/Equal Opportunity Employer.

INDIANA
UNIVERSITY OF NOTRE DAME
Department of Mathematics
Notre Dame, IN 46556
Regular Positions in Pure and Applied Mathematics

The Department of Mathematics of the University of Notre Dame invites applications for two positions starting on August 26, 2000. The fields of interest are applied partial differential equations, complex differential geometry and related areas, and harmonic analysis. Outstanding candidates in any field connected with the research interests of the department are also strongly encouraged to apply. The positions are at the tenure-track level, although higher-level appointments are possible for exceptional candidates. The teaching load is one course one semester and two courses the other semester. Salaries are competitive. Applications, including a curriculum vitae, a letter of application, and a completed AMS Standard Cover Sheet, should be sent to: Alexander J. Hahn, 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 teach artifically and effectively. Notre Dame is an Equal Opportunity Employer and encourages applications from women and minority candidates. The evaluation of candidates will begin November 15. Information about the department is available via http://www.math.nd.edu/.

MICHIGAN
UNIVERSITY OF MICHIGAN
College Park
Department of Mathematics

Applications are invited for tenured and tenure-track positions in the Department of Mathematics. Strong preference will be given to candidates in (1) applied analysis, (2) applied and computational statistics, and (3) representation theory, but candidates from all areas will be considered.

Candidates at all levels will be considered. Priority will be given to applications received by November 1, 1999. Appointments will commence in fall 2000. The University of Michigan is an Equal Opportunity and Affirmative Action Employer that strongly encourages applications from female and minority candidates.

Please send a curriculum vitae, AMS Standard Cover Sheet, and three letters of recommendation to:

The Hiring Committee
Department of Mathematics
University of Michigan
College Park, MD 20742

MARYLAND
UNIVERSITY OF MARYLAND
COLLEGE PARK
Department of Mathematics

Applications are invited for tenured and tenure-track positions in the Department of Mathematics. Strong preference will be given to candidates in (1) applied analysis, (2) applied and computational statistics, and (3) representation theory, but candidates from all areas will be considered.

Candidates at all levels will be considered. Priority will be given to applications received by November 1, 1999. Appointments will commence in fall 2000. The University of Maryland is an Equal Opportunity and Affirmative Action Employer that strongly encourages applications from female and minority candidates.

Please send a curriculum vitae, AMS Standard Cover Sheet, and three letters of recommendation to:

The Hiring Committee
Department of Mathematics
University of Maryland
College Park, MD 20742

WISCONSIN
UNIVERSITY OF WISCONSIN - MADISON

The Department of Mathematics anticipates openings for one or more positions to begin August 23, 2000, at either the tenure-track (assistant professor) or tenured (associate/full professor) level. Preference will be given to hiring at the assistant and associate professor level. Applications are invited in all areas of mathematics. Areas in which the department wishes to hire in the near future include: real and harmonic analysis, partial differential equations, numerical analysis, probability, and algebraic geometry/number theory. Candidates should exhibit evidence of outstanding research potential, normally including significant contributions beyond the doctoral dissertation. A strong commitment to excellence in instruction is also expected. Additional departmental information is available on our Web site, 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 53706-1109

Applicants should also arrange to have sent to the above address three to four letters of recommendation, at least one of which addresses the applicant’s teaching experiences and capabilities. Completed applications received by November 1, 1999, will be assured full consideration. Additional letters will be solicited by the department for candidates who are finalists for a tenure position.

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.

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**SWITZERLAND**

**UNIVERSITY OF BASEL**

**Professor of Numerical Analysis and Computational Mathematics**

In connection with the new program of computational sciences at the Faculty of Sciences, the Mathematical Institute of the University of Basel is seeking applicants for a position in numerical analysis and computational mathematics.

The successful candidate is expected to teach numerical analysis and computational mathematics at the Mathematical Institute and at the Faculty of Sciences and to develop a research program in this field.

Candidates should have a strong commitment to excellence in teaching as well as in research in numerical analysis and computational mathematics. Also required is a habilitation or equivalent qualification. The University of Basel would like to increase the number of female staff, and women are encouraged to apply. The level of the position (full, associate, or assistant professor) will depend on the qualification.

Applicants should provide a curriculum vitae; a list of publications; copies of five important papers; reports on past teaching experience and, if possible, interdisciplinary projects; a statement describing their plans for future projects; and the names and addresses of three referees. Applications should be sent before September 30, 1999, to Dekanat der Philosophisch-Naturwissenschaftlichen Fakultät Universität Basel Prof. S. Schmid Missionsstrasse 64 CH-4055 BASEL, Switzerland

For additional information contact: Collier Brown or Kirsten Berg @ Powell's Technical Bks., Portland, OR. Call 800-225-6911, fax 503-228-0505, or e-mail kirsten@technical.powells.com.

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**THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY**

The Swiss Federal Institute of Technology in Zurich (ETHZ) invites applications for a professorship in mathematics. Duties of this position include teaching and research in mathematics. Together with the other members of the department, the new professor will be responsible for undergraduate and graduate courses for students of mathematics, natural sciences, and engineering.

We are seeking candidates with strong research records and proven ability to direct research of high quality. Willingness to teach at all university levels and to collaborate with colleagues is expected.

Qualified candidates from all areas of mathematics are encouraged to apply.

Applications with curriculum vitae and a list of publications should be submitted to the president of ETH Zurich, Prof. Dr. O. Kuebler, ETH Zentrum, CH-8092 Zurich, no later than November 15, 1999. The ETHZ specifically encourages female candidates to apply, with a view towards increasing the proportion of female professors.

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**PUBLICATIONS WANTED**

**MATHEMATICS BOOKS PURCHASED**

Pure & appl. adv. & research level, any age, usable cond. Reprints OK. One box to whole libraries sought. Contact: Collier Brown or Kirsten Berg @ Powell's Technical Bks., Portland, OR. Call 800-225-6911, fax 503-228-0505, or e-mail kirsten@technical.powells.com.
AMERICAN MATHEMATICAL SOCIETY

Please read the "Membership Categories" section of this form to determine the membership category for which you are eligible. Then fill out this application and return it as soon as possible.

Family Name First Middle

Place of Birth

Date of Birth

Day Month Year

If formerly a member of AMS, please indicate dates

Check here if you are now a member of either MAA or SIAM

Degrees, with institutions and dates

Present position

Firm or institution

City State Zip/Country

Primary fields of interest (choose five from the list at right)

Secondary fields of interest (choose from the list at right)

Address for all mail

Telephone number(s)

Electronic address

Signature

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Meetings & Conferences of the AMS

IMPORTANT NEW PROGRAM INFORMATION: In order that AMS meeting programs include the most timely information for each speaker, abstract deadlines have been moved to dates much closer to the meeting. As a result, Sectional Meeting programs have been appearing in the Notices after the meeting takes place. The Secretariat of the AMS has observed that this arrangement does not provide an adequate service to the reader. So, beginning with the Gainesville meeting (March 12-13, 1999), AMS Sectional Meeting programs will no longer appear in the print version of the Notices. However, prior to the meeting date, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on e-MATH. See http://www.ams.org/meetings/.

Programs and abstracts will continue to be displayed on e-MATH in the Meetings and Conferences section until about three weeks after the meeting is over. Final programs for Sectional Meetings will be archived on e-MATH in the next electronic issue of the Notices which follows the meeting. See the entry “Program issue of electronic Notices” listed below for each meeting to identify the specific issue.

Salt Lake City, Utah
University of Utah
September 25-26, 1999

Meeting #946
Western Section
Associate secretary: Bernard Russo
Announcement issue of Notices: June 1999
Program first available on e-MATH: August 19, 1999
Program issue of electronic Notices: December 1999
Issue of Abstracts: Volume 20, Issue 4

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

Invited Addresses
Robert Burton, Oregon State University, Title to be announced.
Michael Kapovich, University of Utah, Monodromy of Schwarzian differential equations, holomorphic bundles over Riemann surfaces and dynamics on character varieties of surface groups.
Richard Wentworth, University of California, Irvine, Title to be announced.
Maciej Zworski, University of California, Berkeley, Resonances in chaotic scattering.

Special Sessions
Arithmetical Algebraic Geometry, Minhyong Kim, University of Arizona, and Wieslawa Niziol, University of Utah.
Commutative Algebra, Paul Roberts, University of Utah, and Roger Wiegand, University of Nebraska.
Complex Variables and Operator Theory, Siqi Fu, Farhad Jafari, and Peter Polyakov, University of Wyoming.
Ergodic and Number Theory, Robert Burton and Thomas Schmidt, Oregon State University.
Ergodic Theory of Stochastic Processes, Stewart N. Ethier and Davar Khoshnevisan, University of Utah.
Microlocal Analysis and Applications, Gunther Uhlmann, University of Washington, and Maciej Zworski, University of California, Berkeley.

Providence, Rhode Island
Providence College
October 2-3, 1999

Meeting #947
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: August 1999
Meetings & Conferences

Program first available on e-MATH: August 25, 1999
Program issue of electronic Notices: December 1999
Issue of Abstracts: Volume 20, Issue 4

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: August 11, 1999

Invited Addresses
Dan M. Barbasch, Cornell University, Unipotent representations and unitarity.
Henri Berestycki, Université Paris VI and École Normale Superieure, Title to be announced.
David Mumford, Brown University, What is the right mathematical/statistical model for natural images?
Guoliang Yu, University of Colorado, The Novikov conjecture and geometry of groups.

Special Sessions
Algebraic and Geometric Combinatorics (Code: AMS SS A1), Vesselin N. Gasharov, Cornell University, and Ira M. Gessel, Brandeis University.
Difference Equations and Applications (Code: AMS SS E1), Gerasimos Ladas, University of Rhode Island, and Jeffrey T. Hoag, Providence College.
Geometric Properties of Nonlinear Elliptic PDEs (Code: AMS SS K1), Henri Berestycki, Université Paris VI and École Normale Superieure, and Yanyan Li, Rutgers University.
Geometry and Representation Theory of Algebraic Groups (Code: AMS SS C1), James E. Humphreys and Ivan Mirkovic, University of Massachusetts.
The History of Mathematics (Code: AMS SS F1), Daniel Otero, Xavier University, and C. Edward Sandifer, Western Connecticut State University.
Number Theory (Code: AMS SS J1), Michael I. Rosen and Siman Wong, Brown University.
Representation Theory of Reductive Groups (Code: AMS SS B1), Dan M. Barbasch and Birgit Speh, Cornell University.

Austin, Texas
University of Texas, Austin
October 8–10, 1999

Meeting #948
Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: June 1999
Program first available on e-MATH: August 25, 1999
Program issue of electronic Notices: December 1999
Issue of Abstracts: Volume 20, Issue 4

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: August 11, 1999

Invited Addresses
Mikhail Kapranov, Northwestern University, Title to be announced.
John Roe, Oxford and Pennsylvania State University, Large scale geometric invariants of elliptic operators.
Catherine Sulem, University of Toronto, The nonlinear Schrodinger equation: Self-focusing and wave collapse.
Tatiana Toro, University of Washington, Characterization of non-smooth domains via potential theory.

Special Sessions
Aperiodic Tiling (Code: AMS SS D1), Charles Radin and Lorenzo Sadun, University of Texas, Austin.
Banach and Operator Spaces: Isomorphic and Geometric Structure (Code: AMS SS E1), Edward Odell and Haskell P. Rosenthal, University of Texas, Austin.
DNA Topology (Code: AMS SS J1), Isabel K. Darcy, University of Texas, Austin, and Makkuni Jayaram, University of Texas, Austin.
Dehn Surgery and Kleinian Groups (Code: AMS SS L1), John Luecke and Alan Reid, University of Texas, Austin.
The Development of Topology in the Americas (Code: AMS SS A1), Cameron Gordon, University of Texas, Austin, and Joan Mackenzie James, University of Oxford.
The Diverse Mathematical Legacy of Jean Leray (Code: AMS SS N1), Eric M. Friedlander, Northwestern University, and Susan J. Friedlander, University of Illinois, Chicago.
Dynamical Systems (Code: AMS SS S1), David Delatte, R. Daniel Mauldin, Mariusz Urbanski, and Luca Quardo Zamboni, University of North Texas.
Free Surface Interfaces and PDEs (Code: AMS SS K1), Kirk Lancaster, Wichita State University, and Thomas Vogel, Texas A&M University.
Harmonic Analysis and PDEs (Code: AMS SS C1), William Beckner and Luis A. Caffarelli, University of Texas, Austin,
Toti Daskalopoulos, University of California, Irvine, and Tatiana Toro, University of Washington.

Interconnections among Diophantine Geometry, Algebraic Geometry, and Value Distribution Theory (Code: AMS SS Q1), William Cherry, University of North Texas, Min Ru, University of Houston, and Felipe Voloch, University of Texas, Austin.

Mathematical and Computational Finance (Code: AMS SS H1), Stathis Tompaidis, University of Texas, Austin.

Mathematical Problems in Transport Phenomena (Code: AMS SS M1), Jose Antonio Carrillo and Irene M. Gamba, University of Texas, Austin.

Nonlinear Dynamics (Code: AMS SS G1), Robert J. McCann and Catherine Sulem, University of Toronto.

Recent Developments in Index Theory (Code: AMS SS F1), Daniel S. Freed, University of Texas, Austin, and John Roe, Pennsylvania State University.

Theoretical, Computational and Experimental Aspects of Mechanics (Code: AMS SS P1), Jerry Bona, Steven Levandosky, and Jiaihong Wu, University of Texas, Austin.

Topology of Continua (Code: AMS SS R1), Wayne Lewis and Carl Seaquist, Texas Tech University.

Wavelets and Approximation Theory (Code: AMS SS B1), Don Hong, Eastern Tennessee State University, and Michael Prophet, Murray State University.

Yakov Sinai, Princeton University, Recent results in mathematical and statistical hydrodynamics.

Special Sessions

Algebraic Geometry (Code: AMS SS K1), Valery Alexeev, William Graham, Roy C. Smith, and Robert Varley, University of Georgia.

Applied Probabilistic Combinatorics (Code: AMS SS N1), Bela Bollobas, University of Memphis, and Gregory Sorkin, IBM T. J. Watson Research Center.

Commutative Algebra (Code: AMS SS B1), Sarah Glaz, University of Connecticut, and Evan G. Houston and Thomas G. Lucas, University of North Carolina, Charlotte.

Contemporary Methods in Dynamics and Differential Equations (Code: AMS SS J1), Robert W. Ghrist and Konstantin M. Mischaikow, Georgia Institute of Technology.


Geometric Function Theory (Code: AMS SS H1), David A. Herron, University of Cincinnati, and Shanshuang Yang, Emory University.


Operator Theory, Including Applications in Operator Algebras and Wavelets (Code: AMS SS F1), Alan L. Lambert and Xingde Dai, University of North Carolina, Charlotte.

Optimal Control and Computational Optimization (Code: AMS SS D1), Mohammed A. Kazemi, University of North Carolina, Charlotte, and Gamal N. Elnagar, University of South Carolina, Spartanburg.

Set-Theoretic Topology (Code: AMS SS G1), Ronald F. Levy.


Stochastic PDEs and Turbulence (Code: AMS SS E1), Weinan E, Courant Institute, New York University.

Stochastic Processes and Control (Code: AMS SS M1), Volker Wihstutz and Alexander A. Yushkevich, University of North Carolina, Charlotte.

Charlotte, North Carolina

University of North Carolina, Charlotte

October 15-17, 1999

Meeting #949

Southeastern Section

Associate secretary: John L. Bryant
Announcement issue of Notices: August 1999
Program first available on e-MATH: September 1, 1999
Program issue on electronic Notices: December 1999
Issue of Abstracts: Volume 20, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: August 18, 1999

Invited Addresses

Valery Alexeev, University of Georgia, Title to be announced.

Bela Bollobas, University of Memphis and Cambridge University, Title to be announced.

Konstantin M. Mischaikow, Georgia Institute of Technology, From time series to symbolic dynamics: An algebraic topological approach.

Washington, District of Columbia

Marriott Wardman Park Hotel and Omni Shoreham Hotel

January 19-22, 2000

Note: This is a World Math Year 2000 (WMY2000) event.

Meeting #950

Joint Mathematics Meetings, including the 106th Annual Meeting of the AMS, 83rd Meeting of the Mathematical Association of America (MAA), with minisymposia and other special events contributed by the Society for Industrial and
Applied Mathematics (SIAM), the annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM).

Announcement issue of Notices: October 1999
Program first available on e-MATH: November 1, 1999
Program issue of electronic Notices: January 2000
Issue of Abstracts: Volume 21, Issue 1

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: August 10, 1999
For abstracts: October 5, 1999
For summaries of papers to MAA organizers: September 9, 1999

Joint Mathematics Meetings

January 19-22, 2000
Washington, D.C.

Note: This is a World Math Year 2000 (WMY2000) event.

Joint Invited Addresses

Brian Greene, Columbia University, Title to be announced (AMS-MAA).

George C. Papanicolaou, Stanford University, Title to be announced (AMS-MAA-SIAM).

Joint Special Sessions

The History of Mathematics (Code: AMS SS E1), Karen H. Parshall, University of Virginia, and David E. Zitarelli, Temple University. (AMS-MAA)

Innovative Development Programs for Teaching Assistants and Part-Time Instructors (Code: AMS SS D1), Suzanne M. Lenhart, University of Tennessee. (AMS-MAA)

Linear Algebra and Optimization (Code: AMS SS C1), Dianne P. O'Leary, University of Maryland, College Park, and Margaret H. Wright, Bell Laboratories. (AMS-AWM-SIAM)

Mathematics and Education Reform (Code: AMS SS P1), William H. Barker, Bowdoin College, Jerry L. Bona, University of Texas, Austin, Naomi Fisher, University of Illinois, Chicago, and Kenneth C. Millett, University of California, Santa Barbara. (AMS-MAA-MER)

AMS Invited Addresses

Sun-Yung Alice Chang, University of California, Los Angeles, Title to be announced.

Thomas C. Hales, University of Michigan, Ann Arbor, Title to be announced.

Alexander R. Its, Indiana University-Purdue University, Indianapolis, Title to be announced.

Arthur M. Jaffe, Harvard University, Title to be announced (AMS Retirement Presidential Address).

M. Lyubich, State University of New York at Stony Brook, Title to be announced.

Curtis T. McMullen, Harvard University, Title to be announced (AMS Colloquium Lectures).

Roger Penrose, Oxford University, Title to be announced (AMS Josiah Willard Gibbs Lecture).

AMS Special Sessions

Algebraic Geometry and Commutative Algebra (Code: AMS SS AA1), Irena Peeva, Cornell University, and Hema Srinivasan, University of Missouri, Columbia.

Beautiful Graph Theory (Code: AMS SS J1), Gary Chartrand, Western Michigan University, and Frank Harary, New Mexico State University.

Complex Hyperbolic Geometry and Conformal Geometry of the Heisenberg Group (Code: AMS SS K1), William M. Goldman, University of Maryland, Hanna M. Sandler, American University, and Richard Schwartz, University of Maryland.

Control Theory for Partial Differential Equations (Code: AMS SS EE1), Robert Triggiani, University of Virginia.

Difference Equations and Their Applications in Social and Natural Sciences (Code: AMS SS V1), Hassan Sedaghat, Virginia Commonwealth University, Abdul Aziz Yakubu, Howard University, Gerry Ladas, University of Rhode Island, and Saber Elaydi, Trinity University.

Effective Methods and Commutative Algebra (Code: AMS SS BB1), Anna Guerrieri, Universita Degli Studi dell’Aquila, and Irene Swanson, New Mexico State University.

Ergodic Theory and Topological Dynamics of Zd and Rd Actions (Code: AMS SS R1), E. Arthur Robinson, George Washington University, and Ayşe A. Şahin, North Dakota State University.

The Feynman Integral and Applications (Code: AMS SS A1), Michel L. Lapidus, University of California, Riverside, and Gerald W. Johnson, University of Nebraska.

Geometric Analysis (Code: AMS SS G1), Paul C. Yang, University of Southern California, and Matthew J. Gursky, Indiana University.

The History of Topology (in honor of Ralph H. Feaster) (Code: AMS SS T1), Jack Morava, Johns Hopkins University.

Homotopy Theory (Code: AMS SS Q1), W. Stephen Wilson and Jack Morava, Johns Hopkins University.


Integral Equations and Applications (Code: AMS SS U1), Constantin Costabile, University of Texas, Arlington, and Mehran Mahdavi, Bowie State University.

Invariants of Knots and 3-Manifolds (Code: AMS SS L1), Dubravko Ivanusic, George Washington University, Mark E. Kidwell, U.S. Naval Academy, Jozef H. Przytycki and
Santa Barbara, California
University of California, Santa Barbara

March 11–12, 2000

Meeting #951
Western Section
Associate secretary: Bernard Russo
Announcement issue of Notices: January 2000

Program first available on e-MATH: January 1, 2000
Program issue of electronic Notices: May 2000
Issue of Abstracts: Volume 21, Issue 2

Lowell, Massachusetts
University of Massachusetts, Lowell
April 1–2, 2000

Meeting #952
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: February 2000
Program first available on e-MATH: February 24, 2000
Program issue of electronic Notices: June 2000
Issue of Abstracts: Volume 21, Issue 2

Deadlines
For organizers: August 11, 1999
For consideration of contributed papers in Special Sessions: November 23, 1999
For abstracts: January 18, 2000

Special Sessions
History of Mathematics (Code: AMS SS A1), James Tattersall, Providence College.

Invited Addresses
Walter Craig, Brown University, Title to be announced.
Erwin Lutwak, Polytechnic University, Title to be announced.
Alexander Nabutovsky, Courant Institute, New York University, Title to be announced.
Mary Beth Ruskai, University of Massachusetts, Lowell, Title to be announced.

Special Sessions
Combustion Theory (Code: AMS SS D1), James Graham-Eagle, University of Massachusetts, Lowell, and Daniel A. Schult, Colgate University.
Ergodic Theory and Dynamical Systems (Code: AMS SS C1), Stanley J. Eigen, Northeastern University, and Vidhu S. Prasad, University of Massachusetts, Lowell.
Invariance in Convex Geometry (Code: AMS SS A1), Daniel A. Klain, Georgia Institute of Technology, and Elisabeth Werner, Case Western Reserve University.
Meetings & Conferences

**Quantum Information Theory** (Code: AMS SS B1), Mary Beth Ruskai, University of Massachusetts, Lowell, and Christopher K. King, Northeastern University.

*Syzgies* (Code: AMS SS E1), Irena Peeva, Cornell University.

**Vorticity in Fluid Flows: Analysis and Methods** (Code: AMS SS F1), Louis F. Rossi, University of Massachusetts, Lowell, and Richard B. Pelz, Rutgers University.

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**Notre Dame, Indiana**

*University of Notre Dame*

**April 7-9, 2000**

**Meeting #953**

Central Section

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: February 2000

Program first available on e-MATH: February 24, 2000

Program issue of electronic *Notices*: June 2000

Issue of *Abstracts*: Volume 21, Issue 2

**Deadlines**

For organizers: September 7, 1999

For consideration of contributed papers in Special Sessions: December 21, 1999

For abstracts: February 15, 2000

**Invited Addresses**

Peter Bates, Brigham Young University, *Title to be announced.*

Andras Nemethi, Ohio State University, *Title to be announced.*

Charles Radin, University of Texas, Austin, *Title to be announced.*

David Sattinger, University of Minnesota, *Title to be announced.*

**Special Sessions**

*Algebraic Coding Theory* (Code: AMS SS K1), Judy Walker, University of Nebraska, and Jay Wood, Purdue University, Calument.

*Algebraic Geometry* (Code: AMS SS F1), Karen Chandler and Scott Nollet, University of Notre Dame.

*Applications of Invariant Manifold Theory* (Code: AMS SS M1), Peter Bates, Brigham Young University.

*Commutative Algebra* (Code: AMS SS A1), Juan Migliore, University of Notre Dame, and Chris Peterson, Washington University.

*Differential Geometry and Its Applications* (Code: AMS SS B1), Jianqiu Cao, Brian Smyth, and Frederico Xavier, University of Notre Dame.

*Homotopy Theory* (Code: AMS SS H1), William G. Dwyer, University of Notre Dame, and Michele Intermont, Kalamazoo College.

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**Integrable Systems and Nonlinear Waves** (Code: AMS SS E1), Mark S. Alber and Gerard Misiolek, University of Notre Dame.

**Microlocal Analysis and Partial Differential Equations** (Code: AMS SS D1), Nicholas Hanges, City University of New York, Lehman College, and Alex Himonas, University of Notre Dame.

**Nonlinear Partial Differential Equations** (Code: AMS SS J1), Qing Han and Bei Hu, University of Notre Dame, and Hong-Ming Yin, Washington State University.

**Optimization and Numerical Analysis** (Code: AMS SS C1), Leonid Faybusovitch, University of Notre Dame.

**Several Complex Variables** (Code: AMS SS G1), Jeffrey Diller and Nancy Stanton, University of Notre Dame.

**Singularities in Algebraic Geometry** (Code: AMS SS L1), Sandor Kovacs, University of Chicago, and Andras Nemethi, Ohio State University.

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**Lafayette, Louisiana**

*University of Southwestern Louisiana*

**April 14-16, 2000**

**Meeting #954**

Southeastern Section

Associate secretary: John L. Bryant

Announcement issue of *Notices*: February 2000

Program first available on e-MATH: March 2, 2000

Program issue of electronic *Notices*: June 2000

Issue of *Abstracts*: Volume 21, Issue 2

**Deadlines**

For organizers: September 14, 1999

For consideration of contributed papers in Special Sessions: December 28, 1999

For abstracts: February 22, 2000

**Special Sessions**

*Mathematical Models in the Biological and Physical Sciences* (Code: AMS SS B1), Lan Ke, Robert D. Sidman, and Azmy Sinaan Ackleh, University of Southwestern Louisiana.

*Nonlinear Differential Equations and Their Applications* (Code: AMS SS C1), C. Y. Chan, Keng Deng, and A. S. Vatsala, University of Southwestern Louisiana.

*Quantum Topology* (Code: AMS SS E1), Patrick M. Gilmer, Louisiana State University.

*Rings and Their Generalizations* (Code: AMS SS A1), Gary F. Birkenmeier and Henry E. Heatherly, University of Southwestern Louisiana.

*Scientific Computing* (Code: AMS SS D1), R. Baker Kearfott, Qin Sheng, and Christo Christov, University of Southwestern Louisiana.
Odense, Denmark
Odense University
June 13–16, 2000
Meeting #955
Associate secretary: Robert M. Fossum
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Invited Addresses
Tobias Colding, Courant Institute, New York University, Title to be announced.
Nigel J. Hitchin, University of Oxford, Title to be announced.
Pertti Mattila, University of Jyväskylä, Title to be announced.
Curtis T. McMullen, Harvard University, Title to be announced.
Alexei N. Rudakov, Norwegian University of Science & Technology, Title to be announced.
Dan Voiculescu, University of California, Berkeley, Title to be announced.

Special Sessions
Algebraic Groups and Representation Theory, Henning Haahr Andersen and Niels Lauritzen, Aarhus University.
Differential Geometry, Claude R. LeBrun, State University of New York at Stony Brook, and Peter Petersen, University of California, Los Angeles.
Discrete Mathematics, Iiro S. Honkala, University of Turku, and Carsten Thomassen, Technical University of Denmark.
Dynamical Systems, Michael Benedicks, Royal Institute of Science, Stockholm, and Carsten Lunde Petersen, Roskilde.
Geometric Analysis/PDE, Gerd Grubb, University of Copenhagen, and Bent Orsted, Odense University.
K-Theory and Operator Algebras, Søren Eilers, University of Copenhagen, and Nigel D. Higson, Pennsylvania State University.
Mathematical Physics, Bergfinnur Durhuus, University of Copenhagen.

Stochastic DE and Financial Mathematics, Tomas Björk, University of Stockholm, and Bernt Oksendal, University of Oslo.

Los Angeles, California
University of California, Los Angeles
August 7–12, 2000

Note: This is a World Math Year 2000 (WMY2000) event.

Meeting #956
Associate secretary: Robert J. Daverman
Announcement issue of Notices: May 2000
Program first available on e-MATH: May 24, 2000
Program issue of electronic Notices: October 2000
Issue of Abstracts: Volume 21, Issue 3

Deadlines
For abstracts: May 10, 2000

Joint Invited Address
Ronald L. Graham, AT&T Labs, will speak on a subject to be announced (AMS-MAA Presidents' Lecture).

Invited Addresses
James G. Arthur, University of Toronto, will speak on automorphic forms and the Langlands program.
Alexander A. Beilinson, University of Chicago, will speak on the geometric Langlands conjecture.
Michael V. Berry, H. H. Wills Physics Laboratory, will speak on waves, geometry, and arithmetic.
Haim Brezis, University of Paris XI and Rutgers University, will speak on nonlinear partial differential equations.
Alain Connes, College de France, will speak on noncommutative geometry.
David L. Donoho, Stanford University, will speak on interactions among harmonic analysis, statistical analysis, and information theory.
Charles L. Fefferman, Princeton University, will speak on a subject to be announced.
Helmut H. W. Hofer, Courant Institute, New York University, will speak on symplectic geometry/dynamical systems.
Richard M. Karp, University of Washington, will speak on computational molecular biology.
Meetings & Conferences

Sergiu Klainerman, Princeton University, will speak on partial differential equations.

Peter D. Lax, Courant Institute, New York University, will speak on mathematics and computing.

László Lovász, Yale University, will speak on discrete mathematics and algorithms.

David Mumford, Brown University, will speak on models of perception and inference.

Peter Sarnak, Princeton University, will speak on a subject to be announced.

Peter W. Shor, AT&T Labs, will speak on quantum computing/quantum information theory.

Yakov G. Sinai, Princeton University, will speak on dynamical systems.

Richard P. Stanley, Massachusetts Institute of Technology, will speak on algebraic combinatorics.

Clifford Taubes, Harvard University, will speak on geometry and topology of the future.

Karen Uhlenbeck, University of Texas, Austin, will speak on a subject to be announced.

S. R. S. Varadhan, Courant Institute, New York University, will speak on a subject to be announced.

Edward Witten, Institute for Advanced Study, will speak on the mathematical impact of quantum fields and strings.

Shing-Tung Yau, Harvard University, will speak on geometry and its relation to physics.

San Francisco, California
San Francisco State University

October 21–22, 2000

Meeting #958
Western Section
Associate secretary: Bernard Russo
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: March 21, 2000
For consideration of contributed papers in Special Sessions: June 21, 2000
For abstracts: August 29, 2000

New York, New York
Columbia University

November 3–5, 2000

Meeting #959
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: September 2000
Program first available on e-MATH: September 28, 2000
Program issue of electronic Notices: To be announced
Issue of Abstracts: Volume 21, Issue 4

Deadlines
For organizers: April 3, 2000
For consideration of contributed papers in Special Sessions: July 18, 2000
For abstracts: September 12, 2000

Invited Addresses
Paula Cohen, Université des Sciences et Technologies de Lille, France, will speak on geometry and its relation to physics.

Sergey Novikov, University of Maryland, College Park and Landau Institute for Theoretical Physics, Title to be announced.

Alexander I. Suciu, Northeastern University, Title to be announced.

Toronto, Ontario, Canada
University of Toronto

September 22–24, 2000

Meeting #957
Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: August 2000
Program first available on e-MATH: August 10, 2000
Program issue of electronic Notices: November 2000
Issue of Abstracts: Volume 21, Issue 3

Deadlines
For organizers: February 2, 2000
For consideration of contributed papers in Special Sessions: June 6, 2000
For abstracts: August 1, 2000
Birmingham, Alabama
University of Alabama, Birmingham

November 10-12, 2000

Meeting #960
Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of Notices: September 2000
Program first available on e-MATH: October 5, 2000
Program issue of electronic Notices: To be announced
Issue of Abstracts: Volume 21, Issue 4

Deadlines
For organizers: April 10, 2000
For consideration of contributed papers in Special Sessions: July 25, 2000
For abstracts: September 19, 2000

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 10-13, 2001

Joint Mathematics Meetings, including the 107th Annual Meeting of the AMS, 84th 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).
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: October 2000
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: Volume 22, Issue 1

Deadlines
For organizers: April 11, 2000
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

Columbia, South Carolina
University of South Carolina

March 16-18, 2001
Southeastern Section

Associate secretary: John L. Bryant
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: August 15, 2000
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Lawrence, Kansas
University of Kansas

March 30-31, 2001
Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: June 28, 2000
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Hoboken, New Jersey
Stevens Institute of Technology

April 28-29, 2001
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: September 28, 2000
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Lyon, France

July 17-20, 2001
First Joint International Meeting between the AMS and the Société Mathématique de France.
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Meetings & Conferences

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

Williamstown, Massachusetts
Williams College
October 13–14, 2001
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

San Diego, California
San Diego Convention Center
January 6–9, 2002
Joint Mathematics Meetings, including the 108th Annual Meeting of the AMS and 85th Meeting of the Mathematical Association of America (MAA).
Associate secretary: John L. Bryant
Announcement issue of Notices: To be announced
Program first available on e-MATH: To be announced
Program issue of electronic Notices: To be announced
Issue of Abstracts: To be announced

Deadlines
For organizers: April 4, 2001
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
Overview of the Employment Center

Beginning in 2000, the "Employment Register" has been renamed; it will be the "Employment Center" to more accurately reflect the variety of offerings. It will function not as one program but as a meeting place and information center for all employers and Ph.D.-level jobseekers attending the Joint Meetings. The new Employment Center will allow everyone to choose a comfortable level of participation.

The Mathematical Sciences Employment Center is held each January at the Joint Mathematics Meetings. It is an interviewing program for Ph.D.-level mathematicians seeking employment and for employers, mainly academic, who wish to conduct brief, 15-minute interviews with them. Many employers at the Employment Center are looking for well-rounded candidates for teaching positions. A few jobs are open to those with a master's degree in mathematics. A few employers from business and government also participate.

The Employment Center is a three-day program which takes place on the Wednesday, Thursday, and Friday (and one segment continues through Saturday) of the Joint Meetings. Most participants register in advance (by the November 8 deadline) and their brief résumé or job description is printed in a booklet which is mailed to participants.

The Employment Center has grown in recent years to house three services: the computer-scheduled interviews (the Scheduled Employment Register), the employer-scheduled interview tables (the Interview Center), and the employer information booths, where employers speak informally with walk-up applicants. Use of the Center overall by employers has gone up. At the 1999 Employment Register, 355 candidates and 104 employers participated, giving an overall applicant-to-employer ratio of 3.4:1 (compared with 394 applicants and 86 employers in 1998, a ratio of 4.6:1). The number of interviews in the Interview Center is unknown, but probably averages between 4 and 5, for a total of 8 or 9 interviews. Each employer conducted approximately 30–40 interviews. Last year an additional option was added for employers: the use of an "Information Booth" table in the high-traffic lobby of the Employment Center where employers can distribute information and speak with walk-up candidates about open positions.
At the January 2000 Employment Center, job candidates will be able to choose how to participate. Two forms of participation will be available:

All Employment Center services (computer-scheduling 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 employer-scheduled 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 November 8, 1999) can be printed in the Winter List which will be distributed to employers.

The regular Employment Center computer-scheduled tables work as follows: participants must appear at the Employment Center desk on Wednesday and submit an interview request form, indicating their choices for possible interviews. A program is run overnight to produce schedules for all participants, which are distributed Thursday morning. Interviews are conducted according to the schedule on Thursday and Friday. In recent years the imbalance of employers and applicants has meant that employers have had the advantage of obtaining all of the interviews they requested. Applicants typically receive an average of around five interviews. Applicants can optimize their experience at the Employment Center by submitting their brief résumé by the November deadline, providing as much information about their abilities as possible, and indicating in all correspondence with employers in the fall that they will be present at the Joint Meetings.

Employers who use the employer-scheduled interview tables only will not take part in the automated interviewing-scheduling program. They will make some appointments with applicants ahead of time and make some appointments on-site using the Message Center. The Employment Message Center will provide individual folders or boxes for each registered applicant or employer. Anyone is welcome to leave messages in the Message Center; however, only those registered will have folders to receive them.

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 more of these tables:

- Computer-scheduled Employment Register table
- Employer-scheduled Interview Center table
- Centrally located “Information Booth” table

The Employment Register Computer-Scheduling System

Employers register in advance by the November 8 deadline, and their job listings (“Employer Forms”) are printed and distributed in late December to applicants. Employers receive the book of brief, numbered applicant résumés. Participants decide on Wednesday, January 19, 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. They are assured of those requests being filled by the scheduling algorithm, provided the applicants are present. 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, every 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. For follow-up interviews, the scheduled tables will also be available for use until 7:30 p.m. on Thursday and Friday.

This year 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 sessions—for instance, between 4:40 p.m. and 7:30 p.m. Thursday or Friday—or during sessions which they left unscheduled.

Employers should bring school catalogs, corporate reports, or more lengthy job descriptions to the Employment Center desk early on Wednesday for perusal by applicants prior to interviews. If an employer brings enough copies of the complete job description, staff will undertake to place them in the folders of the applicants who appear on the schedule. This will happen Thursday morning.

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 19, 2000, 9:30 a.m.-5:00 p.m.
- Thursday, January 20, 2000, 8:00 a.m.-7:30 p.m.
- Friday, January 21, 2000, 8:00 a.m.-7:30 p.m.
- Saturday, January 22, 2000, 9:00 a.m.-2:00 p.m.

The fee for use of this area is the same as the normal employer fee. This year 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.

Employers should indicate at the bottom of the form that they are using an Interview Center table. 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 Washington, 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.

**Information Booth Tables for Informal Discussions**

Some employers need to distribute information about open positions during the Joint Meetings and are willing to speak with walk-up applicants in an informal way. The Information Booth tables, located in the high-traffic lobby of the Employment Center, provide a perfect setting for this. Normal table fees are charged. Keep in mind, however, that only a table, chairs, and small sign will be provided. No shipping or receiving services, no electrical connections, and no sales of any kind are allowed. Those requiring such services should utilize Joint Meetings exhibit space. Small banners are allowed at Information Booths.

**Try a Combination of Tables**

Employers often benefit most from reserving two different tables. For instance, an employer could use a Scheduled Employment Register table for Thursday and Friday morning and conduct follow-up interviews at an Interview Center table (keeping in mind that Interview Center tables are available for use on Wednesday also). Or some employers may wish to speak with a number of walk-up applicants at an Information Booth table and then follow up some of these contacts with real interviews in the Interview Center.

The cost of reserving two tables is only $50 more than reserving one table. Be sure to indicate which types of tables are needed on both the registration form and the Employer Form.

**About the Winter List of Applicants**

This booklet contains hundreds of résumés of applicants registered by November 8 for the Employment Center. It will be mailed to all employers who register by November 8 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 display a job description. 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). If the form is received in the Providence office (with payment or purchase order) by the November 8 deadline, it will appear in the Winter List of Employers. Forms received in the Providence office after that deadline will be displayed at the meeting.

**Employers: How to Register**

The interviewer should register and pay for the Joint Mathematics Meetings by:

- Indicating on the Joint Meetings registration form (available electronically at [www.ams.org/amsmtgs/2026_intro.html](http://www.ams.org/amsmtgs/2026_intro.html), 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.

- Submitting an Employer (job listing) Form electronically at [www.ams.org/emp-reg/](http://www.ams.org/emp-reg/), or using 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's important to register by the November 8 deadline, in order for your form to be included in the Winter List of Employers. However, registration will be accepted up to December 18 for the normal fees or on site in Washington at the on-site rates. Call 800-321-4267, ext. 4105, with any questions or deadline problems.

Any number of interviewers can sit at a table together or in shifts, and their names should be listed on the Employer form as a reference point for the applicants. However, Employment Center fees should be paid only for each table required.

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 $200 for the first table and $50 for each additional table. Onsite registration fees (any registrations after 12/18/99) are $250 for the first table and $75 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 18 may register on site in Washington 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 19, 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 2000, applicants will finally 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 employer-scheduled Interview Center, BUT NOT use of the computer-scheduling system). This option is available at a slightly lower price.

Applicants who participate in the 2000 Employment Center will find themselves talking with employers in three different settings:

1. A computer-scheduling program sets 15-minute interviews in the Employment Register numbered tables. This is the choice that has now become optional for applicants. Applicants do not have to hand in a computer-scheduling 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.

3. The third method of employer participation is an information booth area, where employers distribute information about open positions and chat with the candidates who approach the table. There were five such tables in 1999.

**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.

**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 a minimum of 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 Registers 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.

**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 with their Joint Meetings materials. If time permits, they should apply for suitable open positions they notice in the Winter List of Employers after they receive it in December. Applicants are advised to bring a number of copies of their 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.

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 November 8 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.

Applicants: Advance Registration Is Important

Applicants will be registered when they have completed the following steps:

Register and pay for the Joint Mathematics Meetings (see form in the back of the October issue of the Notices or the electronic information at www.ams.org/amsmtgs/2026_intro.html).

Mark one of the two "Employment Center Applicant fee" boxes on the Joint Meetings registration form and pay the appropriate fee. If you choose "Message Center and Winter List only" you will not receive, or turn in, an Interview Request/Availability 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. Each Applicant Form will be reproduced in a booklet, the Winter List of Applicants, and distributed to all registered employers. Applicant Forms received after November 8, 1999, cannot be included in the booklet. The booklet allows employers more time to examine each candidate's qualifications in advance.

Advance registration fees for applicants using the full Employment Center services are $40 plus Joint Meetings registration fee, vs. $75 on-site registration fee plus Joint Meetings registration fee. This year the new applicant "Message Center and Winter List only" registration is $20 in advance or on site. However, those registering for this service after November 8 will have missed the opportunity to appear in the Winter List.

Advance registration for the Employment Center will continue after the November 8 deadline until the final registration deadline of December 18, 1999. However, the Applicant Form will NOT be included in the Winter List, but will be posted on site at the Employment Center (a serious disadvantage). Those who do not register by December 18 must register on site at the Joint Meetings Registration Desk and pay the higher fees.

Applications registered by November 8 will receive their badges, programs, and Employment Center materials two to three weeks in advance of the meeting, unless they request otherwise. The package will include the complete job announcements received from employers registered by November 8.

Don't forget, all participants in the scheduled section of the 2000 Employment Center must submit their Interview Request/Availability Forms in person between 9:30 a.m. and 4:00 p.m. on Wednesday, January 19, 2000, or they will not be included when the interview-scheduling program runs Wednesday night. Should unexpected delays occur while travelling, contact the Employment Center by telephone at 401-455-4107 (or 800-321-4267, ext. 4107) before 4:00 p.m. EST on Wednesday, January 19.

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 computer-scheduled 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. This year registering on site for a mailbox only is possible, at the $20 rate, on Wednesday and Thursday.
Instructions for Applicant and Employer Forms

Applicant forms submitted for the Employment Center by the November 8 deadline will be reproduced in a booklet titled Winter List of Applicants. Employer forms submitted by the November 8 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 e-MATH.

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 November 8, 1999, in order to appear in the Winter List. If you are attending the meeting, the Advance Registration/Housing Form printed in this issue should accompany the form.

00 General
01 History and biography
03 Mathematical logic and foundations
04 Set theory
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
39 Finite differences 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
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
73 Mechanics of 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 Economics, operations research, programming, games
92 Biology and other natural sciences, behavioral sciences
93 Systems theory, control
94 Information and communication, circuits
97 Mathematics education
1. Forms should be accessed and submitted electronically if possible. The URL for accessing Employment Center 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 November 8 (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.

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<td>Code</td>
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<td>Department</td>
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<td>Mailing address</td>
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<td>E-mail address (one only)</td>
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<td>URL (or other contact info)</td>
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<td>Name(s) of Interviewer(s) 1.</td>
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<td>2.</td>
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<td>4.</td>
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Specialties sought

Title(s) of position(s)__________________________________________

Number of positions_________

Starting date _______ / _______ Term of appointment _______ / _______

Renewal

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<th>Possible</th>
<th>Impossible</th>
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<td>[ ] Yes</td>
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Tenure-track position

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<th>Teaching hours per week</th>
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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: [ ] Yes [ ] No

THE EMPLOYER PLANS TO USE THE FOLLOWING SERVICES (check all that apply):

[ ] One or more computer-scheduled Interview Tables
[ ] One or more self-scheduled Interview Tables
[ ] Information Booth table
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Geometric Models for Noncommutative Algebras
Ana Cannas da Silva and Alan Weinstein, University of California, Berkeley

The volume is based on a course, “Geometric Models for Noncommutative Algebras” taught by Professor Weinstein at Berkeley. Noncommutative geometry is the study of noncommutative algebras as if they were algebras of functions on spaces, for example, the commutative models associated to affine algebraic varieties, differentiable manifolds, topological spaces, and measure spaces. In this work, the authors discuss several types of geometric objects (in the usual sense of sets with structure) that are closely related to noncommutative algebras. Central to the discussion are symplectic and Poisson manifolds, which arise when noncommutative algebras are obtained by deformations of commutative algebras. The authors also give a detailed study of groupoids whose role in noncommutative geometry has been stressed by Connes as well as of Lie algebroids, the infinitesimal approximations to differentiable groupoids.

The Classification of the Finite Simple Groups, Number 4
Part II, Chapters 1–4: Uniqueness Theorems
Daniel Gorenstein, Richard Lyons, Rutgers University, New Brunswick, NJ, and Ronald Solomon, Ohio State University, Columbus

After three introductory volumes on the classification of the finite simple groups, (Mathematical Surveys and Monographs, Volumes 40.1, 40.2, and 40.3), the authors now start the proof of the classification theorem: They begin the analysis of a minimal counterexample $G'$ to the theorem. Two fundamental and powerful theorems in finite group theory are examined: the Bender-Suzuki theorem on strongly embedded subgroups (for which the non-character-theoretic part of the proof is provided) and Aschbacher's Component theorem. Included are new generalizations of Aschbacher's theorem which treat components of centralizers of involutions and $p$-components of centralizers of elements of order $p$ for arbitrary primes $p$.

This book, with background from sections of the previous volumes, presents in an approachable manner critical aspects of the classification of finite simple groups. Mathematical Surveys and Monographs, Volume 40; 1999; 341 pages; Hardcover; ISBN 0-8218-0952-0; List $75; Individual member $45; Order code SURV/40/NA

A Survey of the Hodge Conjecture
Second Edition
James D. Lewis, University of Alberta, Edmonton, Canada

The book is a self-contained presentation, completely devoted to the Hodge conjecture and related topics. It includes many examples, and most results are completely proven or sketched. The motivation behind many of the results and background material is provided. This comprehensive approach to the book gives it a “user-friendly” style. Readers need not search elsewhere for various results. The book is suitable for use as a text for a topics course in algebraic geometry; includes an appendix by B. Brent Gordon.

Recommended Text

Algebraic Geometry I From Algebraic Varieties to Schemes
Kenji Ueno, Kyoto University, Japan

This is the first of three volumes on algebraic geometry. The book begins with a description of the standard theory of algebraic varieties. Then, sheaves are introduced and studied, using as few prerequisites as possible. Once sheaf theory has been well understood, the next step is to see that an affine scheme can be defined in terms of a sheaf over the prime spectrum of a ring. By studying algebraic varieties over a field, Ueno demonstrates how the notion of schemes is necessary in algebraic geometry.

Ueno's book is a self-contained introduction to this important circle of ideas, assuming only a knowledge of basic notions from abstract algebra (such as prime ideals). It is suitable as a text for an introductory course on algebraic geometry.

Invariant Measures
John von Neumann

In 1940–1941 von Neumann lectured on invariant measures at the Institute for Advanced Study at Princeton. This book is essentially a written version of those lectures.

The lectures began with general measure theory and went on to Haar measure and some of its generalizations. Shizuo Kakutani was at the Institute that year, and he and von Neumann had many conversations on the subject. The conversations revealed facts and produced proofs. Quite a bit of the content of the course, especially toward the end, was discovered a few weeks before it appeared on the blackboard. The original version of these notes was prepared by Paul Halmos, von Neumann’s assistant that year. Von Neumann read the handwritten version before it went to the typeset and sometimes scribbled comments on the margins; he rewrote most of Chapter 6. This book is the first published version of the original notes.

In 1999; 134 pages; Softcover; ISBN 0-8218-0562-1; List $39; All AMS members $31; Order code INMEASNA
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| References (Name and Institution only) | |
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The following perspectives may serve as guidelines:

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Manuscripts intended for submission should ideally contain problems either within the body of the text or at the end of each chapter or section. Connections to current research are encouraged. This could take the form of reports on recent results and/or lists of open problems of continuing interest.

For more information contact:
Sergei Gelfand, Director of Acquisitions (sgx@ams.org) or Edward Dunne, Editor for the Book Program (egd@ams.org), at the American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248, U.S.A.; telephone 1-800-321-4267 (U.S. and Canada) or 1-401-455-4000 (worldwide); fax 1-401-331-3842.

Titles currently published in this series ...

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Roger A. Knobel, University of Texas-Pan American, Edinburg
Volume 1; 2000; ISBN 0-8218-2039-7; approximately 200 pages; Softcover; All AMS members $18, List $23, Order Code STML/3NA

Lectures on Contemporary Probability
Gregory F. Lawler, Duke University, Durham, NC, and Lester N. Coyle, Loyola College, Baltimore, MD
Volume 2; 1999; ISBN 0-8218-2029-X; 95 pages; Softcover; All AMS members $14, List $17, Order Code STML/2NA

Miles of Tiles
Charles Radin, University of Texas, Austin
Volume 1; 1999; ISBN 0-8218-1893-X; 120 pages; Softcover; All AMS members $13, List $16, Order Code STML/1NA

Prime Numbers and Their Distribution
Gerald Tenenbaum, Université Henri Poincaré, Nancy I, France, and Michel Mendès France, Université Bordeaux I, France
2000; ISBN 0-8218-1647-2; approximately 190 pages; Softcover; All AMS members $14, List $17, Order Code STML/TENENBAUMA

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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 is available on the World Wide Web at www.ams.org/meetings/.

Meetings:

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Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 106 in the January 1999 issue of the Notices for general information regarding participation in AMS meetings and conferences.

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Several options are available for speakers submitting abstracts, including an easy-to-use interactive Web form. No knowledge of LaTeX is necessary to submit an electronic form, although those who use LaTeX or AMS-LaTeX may submit abstracts with such coding. 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, and descriptions and instructions on how to get the template of your choice will be emailed to you.

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