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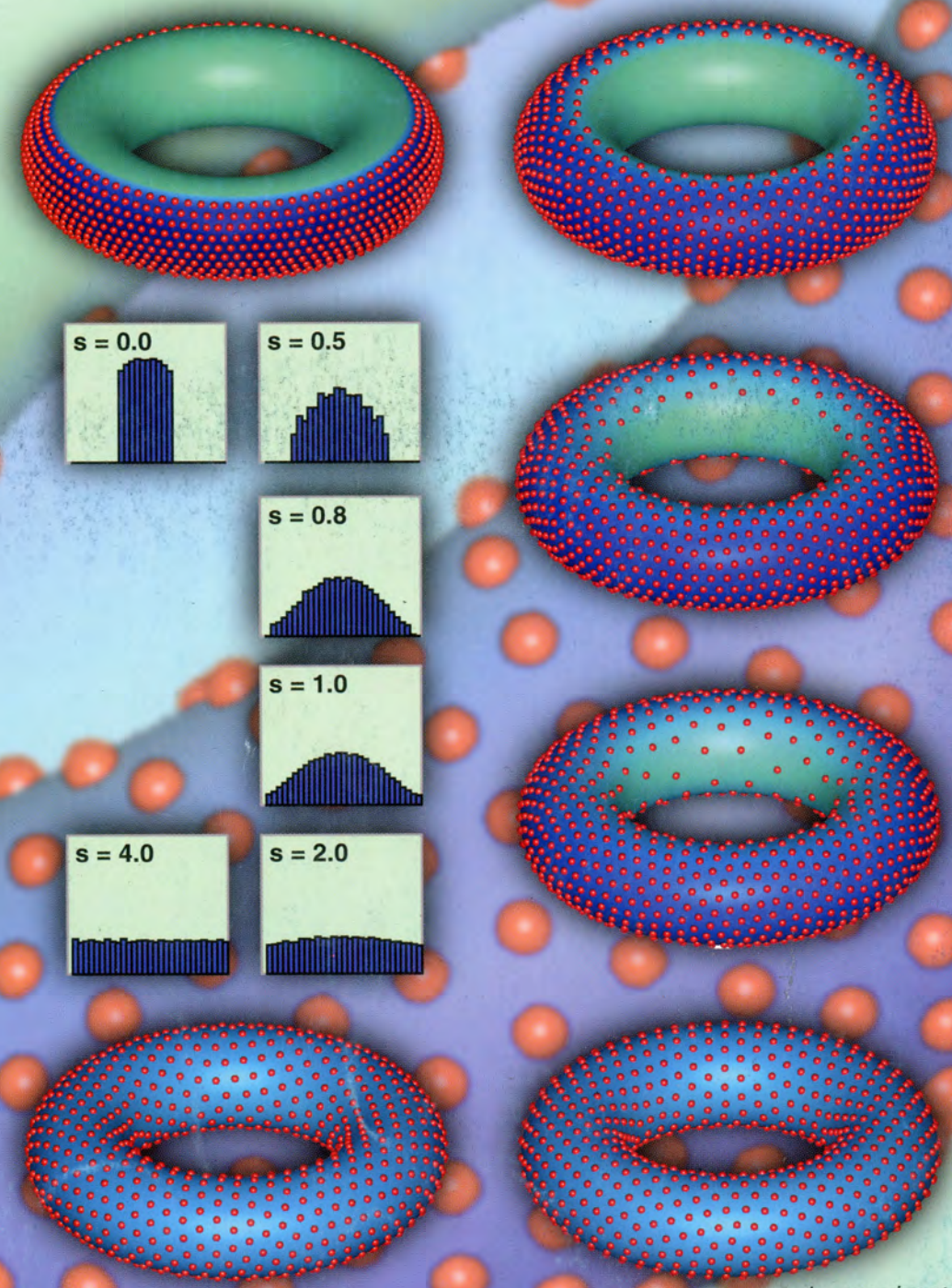
November 2004 Volume 51, Number 10



Approximating minimal Riesz configurations (see page 1194)

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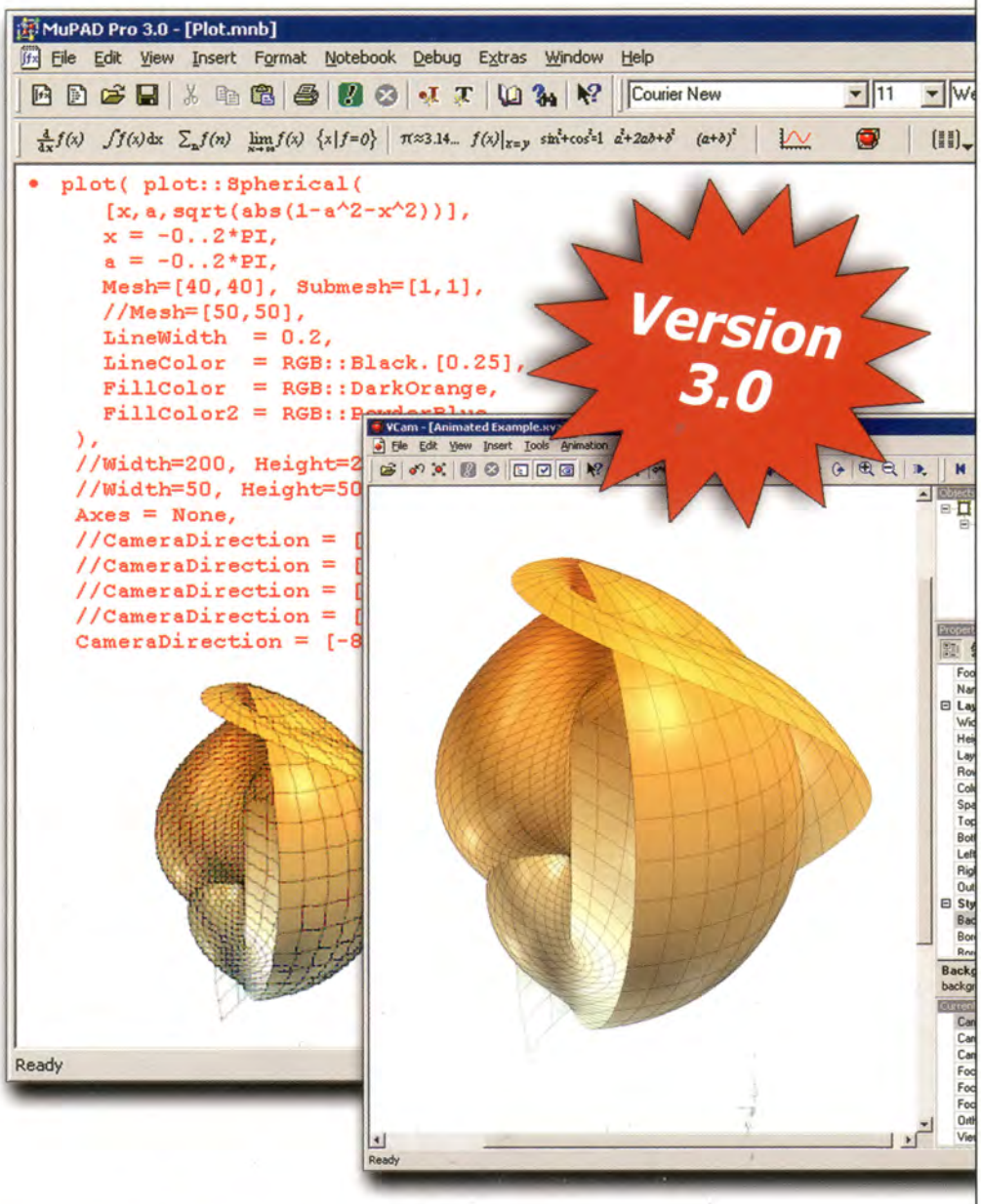

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November 2004

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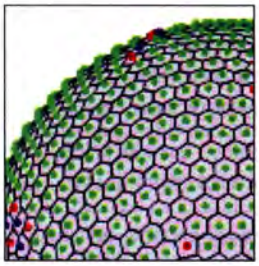

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Departments

From the AMS Secretary

Mathematics and the Public

Like most U.S. states, Oklahoma, where I live, allows car owners to purchase license plates for their vehicles with alphanumeric strings selected by the purchaser, provided, of course, that no one else has ordered the same string. Mine says "GALOIS". I like to joke that this makes me the only licensed Galois theorist in the state. (For the record, I note that character limits precluded ordering a plate saying "Differential Galois Theorist".) Most people who read or have to record my car tag, such as tow truck operators or highway patrol officers, do so without comment or even accurate pronunciation. But on occasion it does provoke welcome conversation. For example, a fellow customer stopped me recently in the parking garage of an upscale Dallas shopping center to inquire if I knew that the name on my license plate was that of a famous mathematician. This fellow turned out to be a computer engineer with a mathematics background, and a pleasant chat ensued.

I would contrast that encounter with the typical exchange one often has with strangers when it comes up that one is a mathematician. We are so commonly told in these situations that our interlocutors are functionally innumerate ("I can't even balance my checkbook," for example) that we tend to miss the force of that admission. Presumably the same individuals are not going to tell newly met English professors that they "can't even read a newspaper" or make similar confessions of functional illiteracy.

In fact they are no more likely to be innumerate than illiterate. One reasonable explanation goes as follows: the general public in the United States, because of their school experience, tends to identify mathematics with arithmetic computation and therefore to assume that what mathematicians do is some elaborate and high-powered form of arithmetic computation. Thus their polite denigration of their own arithmetic skills via clearly false claims of incompetence should be instead viewed as compliments being paid to the putative vastly superior arithmetic skills of mathematicians.

Presumably all mathematicians agree that this social convention is a pity. But suppose our casual conversation partners spoke directly from their assumptions, not mentioning the unbalanced checkbook but saying something like "So you're a mathematician. I'll bet you're really great at dividing fractions (or long division, or mental multiplication of multidigit numbers)". Whether your answer would be yes or no, what one would really like is to explain some of what mathematics really is and some of what mathematicians do.

A lay explanation of the latter is the subject of a communication in this issue by Martin Krieger ("Some of what mathematicians do", p. 1226). This is a bit of a departure from our standard expository mathematical articles. Members of the American Mathematical Society certainly know what mathematics is and what mathematicians do. Our information for authors of *Notices* mathematics articles instructs that "all [*Notices*] readers may be assumed to be interested in mathematics research". But larger publics have been considered as well: when the transition to the current *Notices* format was under discussion a decade ago, there was even thought of possible newsstand sales.

The *Notices* will not be trying that any time in the near future. But we will occasionally try to have articles that can be a resource for mathematicians who want to explain what they do to the general public.

Professor Krieger's article is drawn from his recent book, *Doing Mathematics* (World Scientific, 2003), written for a general audience. As the proliferation of titles in your local general bookstore reveals, publishers believe there is a substantial market for books about mathematics for the lay reader. The *Notices* reviews a few of these, and we try to keep mathematicians informed about a somewhat larger number in our Book List section. We do not list research monographs or textbooks, but rather books that have potential to appeal to the general public, as well as to mathematicians. We remind readers that there is no implicit or explicit endorsement when a book is put into the Book List. Its purpose is not to recommend books but to give an overview of what's currently "out there" in the way of popular books on mathematics. As with the rest of the *Notices*, readers' suggestions for the Book List are welcome.

Finally, I noted above the misunderstanding of the nature of the mathematical enterprise that may be the unwelcome result of the American school mathematics curriculum. As Lynn Steen pointed out in this space last month ("How Mathematicians Can Contribute to K–12 Education"), there are ways mathematicians can help improve this situation. Some mathematicians have been doing this over the years. Future *Notices* articles will report on their experiences and successes. Readers who would like to share their personal stories as mathematicians involved in K–12 education are invited to submit brief accounts for this series.

—*Andy Magid*

Letters to the Editor

Reply to Hastrev

In response to Professor Hastrev's letter about "Mathematicians and Mathematics Educators Must Be Political!" (*Notices*, June/July 2004, page 607), there is a definite need for mathematical people to support political advocacy for mathematics education regardless of the No Child Left Behind Act. I do advocate for NCTM's [National Council of Teachers of Mathematics] program for advocacy and no other, because I am not aware of another mathematics organization having such a program. Note that the program is not specific to NCTM but is a program that could be embraced by other organizations and by the entire mathematics community.

Though there are threats to mathematics, I sincerely hope that we have not reached the ultimate threat he suggested. If we are and there is a slippery slope, I do not believe that it is one I described. In addition, Professor Hastrev chose to separate mathematics and mathematics education; it is more likely that this contined separation may be an ultimate threat. Virtually no one outside the mathematics community either knows about or understands this separation; perhaps we would all be better off if this particular sea were allowed to close.

Finally, effective advocacy is much more than helping to increase funding for various mathematics efforts. It's educating policymakers, proving us expert and valuable contributors to the process, earning credibility as expert resources, and more. Many efforts cannot be made without funding, but I did not imply that more money was the answer to all issues surrounding mathematics.

As to the boycott suggested by Professor Hastrev, whether I agree or disagree is irrelevant to political advocacy.

—Johnny W. Lott
jlott@nctm.org

(Received July 27, 2004)

Reply to Bharali

My thanks to Gautam Bharali for his question, as well as for his undeserved compliment (*Notices*, October 2004, page 1022). Though I would hate to believe Mr. Chicken was purely a fictional creation, it is indeed hard not to see him as an avatar of the animal discussed by Russell in the following passage:

> "The man who has fed the chicken every day throughout its life at last wrings its neck instead, showing that more refined views as to the uniformity of nature would have been useful to the chicken."

(B. Russell, *The Problems of Philosophy*, 1912, paperback edition of 1977, Oxford University Press, p. 63.)

My review didn't mention this parable (nor the chicken's more recent, and mysterious, incarnation in the literature as an "inductivist turkey") for the simple reason that I was unaware of it before reading Bharali's letter. Which goes to show that one should be no less wary of mathematicians writing about philosophy than of novelists writing about mathematics.

—Michael Harris
Université Paris 7

(Received August 12, 2004)

Revive the Queries Column

In the 1970s and 1980s the *Notices* carried a regular column called Queries, which ran a page or a page and a half. Its long-time editor, Hans Samelson, introduced each column with the statement:

"QUESTIONS ARE WELCOMED from AMS members regarding mathematical matters such as details of, or references to vaguely remembered theorems, sources of exposition of folk theorems, or the state of current knowledge concerning published or unpublished conjectures...REPLIES from readers will, when appropriate, be edited into a composite answer and published in a subsequent column. All answers received will be forwarded to the questioner."

Since the column's demise, we have the Internet and a new generation of mathematicians. From time to time, a question arises and we know that the answer—or enlightenment—is "out there"—somewhere, but where? and to whom do we write? The Internet sometimes helps, but not as directly or fully as would a column designed for such questions.

I write to ask if the editor and the readership of the *Notices* would be interested in reviving a Queries column.

—Seymour Kass
University of Massachusetts Boston
seymour.kass@umb.edu

(Received August 14, 2004)

Discretizing Manifolds via Minimum Energy Points

D. P. Hardin and E. B. Saff

There are a variety of needs for the discretization of a manifold—statistical sampling, quadrature rules, starting points for Newton's method, computer-aided design, interpolation schemes, finite element tessellations—to name but a few. So let us assume we are given a d-dimensional manifold A in the Euclidean space $\mathbb{R}^{d'}$ and wish to determine, say, 5,000 points that "represent A". How can we go about this if A is described by some geometric property or by some parametrization of the unit cube $U^d := [0,1]^d$ in $\mathbb{R}^d$? Naturally, we must be guided by the particular application in mind.

For a historical perspective as well as a brief motivational journey, let us look at the simple case when A is the interval $[-1,1] \subset \mathbb{R}$. One obvious choice for N points that discretize A is the set of equally spaced points

$$x_{k,N} = -1 + \frac{2k}{N-1}, \qquad N \geq 2,\ k = 0, \ldots, N-1.$$

These points also enjoy the property of solving the "best-packing" problem on $[-1,1]$; in general, a set of distinct points $\omega_N^* = \{x_1^*, \ldots, x_N^*\} \subset A$ solves the *N-point best-packing problem* on a compact set A if

$$\min_{i \neq j} |x_i^* - x_j^*| = \max_{\omega_N \subset A} \min_{i \neq j} |x_i - x_j|,$$

where the maximum is taken over all N-point subsets $\omega_N = \{x_i\}_1^N$ of A. But suppose our interest is in selecting N points for quadrature or for polynomial interpolation of a smooth function $f(x)$ on $[-1,1]$. Then, as shown by Runge, the choice of equally spaced points (or, indeed, any asymptotically uniformly distributed sets of points) can be disastrous (in fact, the norm of the polynomial interpolation operator grows *geometrically* large with N). Rather, choosing N points of $[-1,1]$ that asymptotically (as $N \to \infty$) have the arcsine distribution $(1/\pi)dx/\sqrt{1-x^2}$ (such as the zeros of the classical Chebyshev polynomials $T_N(x) = \cos(N \arccos x)$ shown in Figure 1) does a much better job—one can achieve polynomial interpolation operator norm $\mathcal{O}(\log N)$.

The connection between efficient univariate polynomial interpolation (or Gaussian quadrature) and the arcsine distribution becomes clearer on observing that any monic polynomial $p_N(x) = \prod_{i=1}^N (x - x_i)$ satisfies

$$(1) \qquad \frac{1}{N} \log \frac{1}{|p_N(x)|} = \int \log \frac{1}{|x-t|}\, d\nu_N(t),$$

where ν_N is the normalized counting measure

$$\nu_N := \frac{1}{N} \sum_{i=1}^N \delta_{x_i}$$

with δ_x denoting the unit point mass at x. In other words, $(1/N)\log(1/|p_N(x)|)$ is a logarithmic potential

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for a discrete probability measure. Classical potential theory shows that the energy integral

$$I_0[\mu] := \iint \log \frac{1}{|x-t|}\, d\mu(x)\, d\mu(t), \tag{2}$$

where μ is any probability measure (normalized, positive, Radon measure) supported on $[-1,1]$, attains its minimum when $d\mu$ is the arcsine distribution, which is called the *equilibrium measure* or *Robin measure* for $A = [-1,1]$.

It was M. Fekete who explored the connection between polynomial interpolation and the discretized version of (2), which, for given N, consists in finding an N-point set $\omega_N^F = \{x_{k,N}^F\}_1^N \subset A$ that minimizes the logarithmic energy

$$E_0(\omega_N) := \sum_{i \neq j} \log \frac{1}{|x_i - x_j|} = 2 \sum_{1 \le i < j \le N} \log \frac{1}{|x_i - x_j|} \tag{3}$$

over all N-point subsets $\omega_N = \{x_i\}_1^N$ of A. (For $A = [-1,1]$, such points are the zeros of the Jacobi polynomial $P_{N-2}^{(1,1)}(x)$ together with $x = \pm 1$.) Provided that a compact set $A \subset \mathbb{R}^2$ has positive logarithmic capacity, the sequence of normalized counting measures for the *Fekete point sets* $\{\omega_N^F\}$ converges in the weak-star topology (as $N \to \infty$) to the unique measure μ_A that minimizes the energy integral (2) over all probability measures supported on A (cf. [17]); moreover,

$$\lim_{N\to\infty} \frac{E_0(\omega_N^F)}{N^2} = I_0[\mu_A]\,.$$

(So, in particular, the Fekete point sets for $A = [-1,1]$ asymptotically have the arcsine distribution.) The condition that A have positive logarithmic capacity simply means that there is at least one probability measure μ on A for which the energy integral is finite. This condition will play a crucial role as we discuss point sets that minimize other energy functionals.

Both the equally spaced points and the Fekete points for $A = [-1,1]$ can be regarded as limiting cases of point sets that minimize the discrete Riesz energy. For a fixed parameter $s > 0$, the **Riesz s-energy** of a set $\omega_N = \{x_i\}_1^N$ of N distinct points in $\mathbb{R}^{d'}$ is given by

$$E_s(\omega_N) := \sum_{i \neq j} \frac{1}{|x_i - x_j|^s}\,, \tag{4}$$

where $|\cdot|$ denotes Euclidean distance. For $s = 0$, we use the definition in (3). Given a compact set $A \subset \mathbb{R}^{d'}$ with infinitely many points, we denote the **N-point minimal s-energy over** A by

$$\mathcal{E}_s(A,N) := \inf_{\omega_N \subset A} E_s(\omega_N). \tag{5}$$

Notice that as $s \to \infty$, with N fixed, the s-energy (5) is increasingly dominated by the term(s) involving the smallest of pairwise distances and, in this sense, leads to the best-packing problem on A. On the other hand, as $s \to 0$, it is easily verified that for each $N \ge 2$,

$$\frac{\mathcal{E}_s(A,N) - N(N-1)}{s} \to \mathcal{E}_0(A,N).$$

So natural questions that arise are:

Q1: *How are minimal s-energy configurations for A distributed for large N?*

Q2: *How does the asymptotic behavior of $\mathcal{E}_s(A,N)$ in (5) depend on A and s?*

For $A = [-1,1]$ and $0 \le s < 1$, explicit answers can be found in [11], where it is shown using potential theoretic arguments that optimal s-energy points have the limit distribution (as $N \to \infty$)

$$d\lambda_s = \frac{c_s}{(1-x^2)^{(1-s)/2}}\, dx, \quad x \in (-1,1), \tag{6}$$

where c_s is a normalizing constant. Furthermore,

$$\lim_{N\to\infty} \frac{\mathcal{E}_s([-1,1],N)}{N^2} = \frac{\sqrt{\pi}\,\Gamma(1+s/2)}{\cos(\pi s/2)\Gamma((1+s)/2)}, \quad 0 < s < 1. \tag{7}$$

The potential theoretic argument proceeds as in the case of Fekete points by showing that any limit distribution of optimal s-energy points minimizes the energy integral

$$I_s[\mu] := \iint \frac{1}{|x-y|^s} d\mu(x) d\mu(y) \tag{8}$$

over all probability measures μ supported on $[-1,1]$ and then appealing to the fact that such a measure is unique and given by (6). The limit in (7) is simply $I_s[\lambda_s]$.

But What If $s \ge 1$? In this case we have $I_s[\mu] = \infty$ for all probability measures μ on $[-1,1]$, and so the preceding argument fails. Yet a glance at the distribution (6) reveals that as s increases from 0 to 1, the equilibrium distributions λ_s transform from the arcsine to the uniform (normalized Lebesgue) distribution, which is the distribution of the best-packing points corresponding to $s = \infty$. Thus we might expect that for *every* fixed $s \ge 1$, optimal s-energy points are uniformly distributed in the

$$\lim_{N\to\infty} \frac{1}{N} \sum f(x_i) = \lim_{N\to\infty} \frac{1}{N} \sum f(\cos\theta_i)$$
$$= \frac{1}{\pi} \int_0^\pi f(\cos\theta)\, d\theta$$
$$= \frac{1}{\pi} \int_{-1}^1 f(x)\, \frac{dx}{\sqrt{1-x^2}}$$

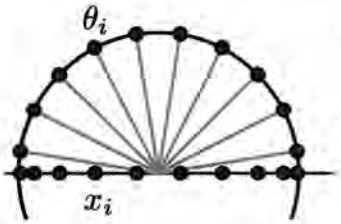

Figure 1. Chebyshev polynomial zeroes (blue dots) have arcsine limit distribution.

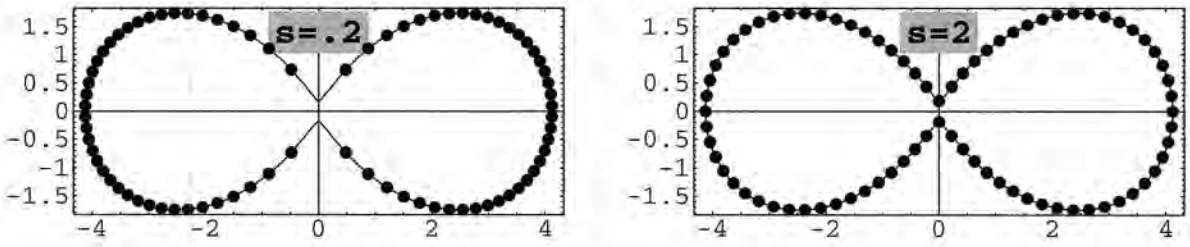

Figure 2. Near optimal energy configurations for $s = 0.2$ (left) and for $s = 2$ (right) with 100 points for the affinely scaled Cassinian oval given by (11).

limit, and this turns out to be true in a much more general context that we describe below. The predicted analog of (7) is, however, less obvious.

Minimal Energy Points on Curves. For the case when A is a rectifiable Jordan arc or curve in $\mathbb{R}^d$, answers to Q1 and Q2 are given by A. Martinez-Finkelshtein et al. [12]. They show that for $s = 1$

$$\lim_{N\to\infty} \frac{\mathcal{E}_1(A,N)}{N^2 \log N} = \frac{2}{L} \tag{9}$$

and for $s > 1$

$$\lim_{N\to\infty} \frac{\mathcal{E}_s(A,N)}{N^{1+s}} = \frac{2\zeta(s)}{L^s}, \tag{10}$$

where L is the arclength of A and $\zeta(s)$ denotes the classical Riemann zeta function. Moreover, for each $s \geq 1$, the limit distribution of asymptotically optimal s-energy configurations for A is uniform with respect to arclength measure on A. The situation for $0 \leq s < 1$ on such curves is treated, as above, via potential theory; the limit distribution of asymptotically optimal points is the unique measure $\lambda_{A,s}$ that minimizes the energy integral $I_s[\mu]$ in (8) (or (2)) over all probability measures μ supported on A, and the energy $\mathcal{E}_s(A,N)$ grows like N^2 (more precisely, $\mathcal{E}_s(A,N)/N^2 \to I_s[\lambda_{A,s}]$ as $N \to \infty$). Hence as s increases from zero, the minimum energy growth switches from order N^2 to order N^{1+s}, with the transition occurring at $s = 1$ where the energy growth is of order $N^2 \log N$. This transition is signaling a change from global to local effects, with the influence of nearby neighbors becoming more and more dominant as s increases beyond 1 (indeed, at $s = \infty$, *only* the nearest neighbors are significant).

The (curious) appearance of the zeta function in (10) arises from the following observation: For any set of points $\omega_N = \{x_k\}_1^N$ that are listed in consecutive order along a Jordan arc A, we can get a lower bound for $E_s(\omega_N)$ by setting $d_{i,j}$ equal to the length of the subarc from x_i to x_j and noting that

$$E_s(\omega_N) \geq \sum_{k=1}^{N-1} \hat{E}_k, \text{ where } \hat{E}_k := \sum_{|i-j|=k} \frac{1}{d_{i,j}^s}.$$

From the convexity of x^s for $s \geq 1$, together with the harmonic-arithmetic mean inequality, we deduce that

$$\begin{aligned}\hat{E}_k &= 2\sum_{j=1}^{N-k} \frac{1}{d_{j,j+k}^s} \geq 2(N-k)^{1-s}\left(\sum_{j=1}^{N-k} \frac{1}{d_{j,j+k}}\right)^s \\ &\geq \frac{2(N-k)^{1+s}}{\left(\sum_{j=1}^{N-k} d_{j,j+k}\right)^s} \geq \frac{2(N-k)^{1+s}}{(kL)^s}.\end{aligned}$$

Adding these lower estimates, dividing by N^{1+s}, and letting $N \to \infty$ give rise to $\sum_{k=1}^{\infty} k^{-s} = \zeta(s)$. In the case of a piecewise smooth Jordan curve without cusps, equally spaced points along A provide an asymptotically sharp upper bound. (The upper bound for general Jordan curves requires finer analysis.)

By way of illustration, consider the (affinely scaled) Cassinian oval A given parametrically by

$$(x(t), y(t)) := r(t)(2\cos t, 3\sin t) \quad (0 \leq t \leq 2\pi), \tag{11}$$

where $r(t) := \cos(2t) + \sqrt{a^4 + \cos^2(2t)}$ and $a = 0.6$. Figure 2 shows numerically computed optimal s-energy configurations for A with $N = 100$ points for $s = 0.2$ and $s = 2$, demonstrating the dependence of the limit distribution on s. The case $s = 2$ clearly indicates nearly uniformly distributed points on A as is expected for any $s \geq 1$. In contrast, the configuration for $s = 0.2$ is distributed according to the (nonuniform) equilibrium measure for the corresponding Riesz energy integral.

Moving to Higher-Dimensional Manifolds. Here a canonical choice for the manifold A is the sphere $S^d = \{x \in \mathbb{R}^{d+1} : |x| = 1\}$, for which optimal point configurations have been the subject of considerable investigation. Indeed, the case $s = \infty$ of best-packing is the famous *Tammes's problem* or *hard-spheres problem*, which has its origin in a botanist's attempt to describe patterns of pores on spherical pollen grains (optimal configurations for this problem are known explicitly only for a handful of integers N). The case $s = 0$, which is the same as maximizing the product of pairwise distances $\prod_{i\neq j} |x_i - x_j|$ over all N-point sets $\omega_N \subset S^d$,

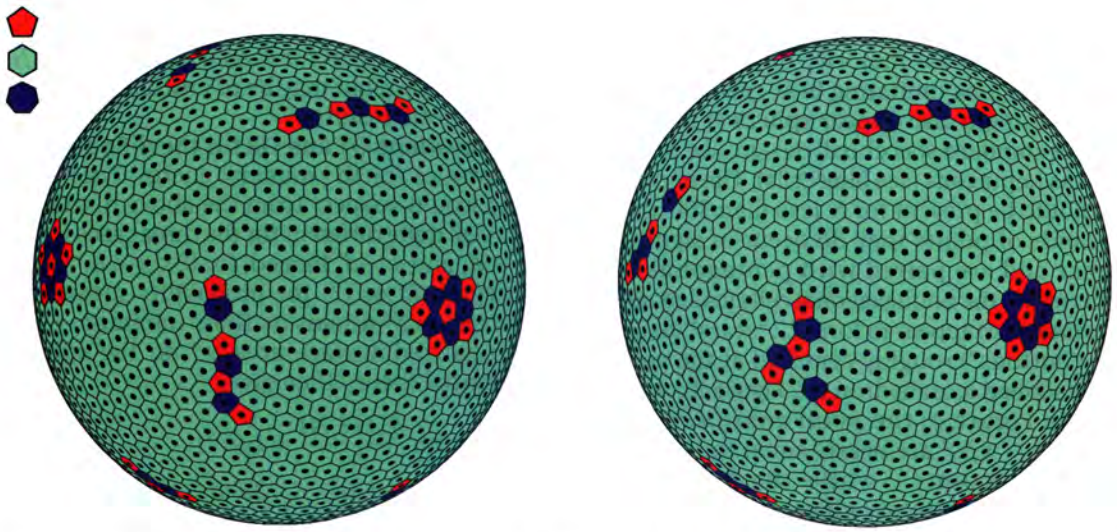

Figure 3. Near optimal s-energy configurations for $s = 1$ (left) and $s = 4$ (right) with 1,600 points on the sphere S^2.

arises, for example, in the study of computational complexity, where M. Shub and S. Smale [18] investigate good starting points for Newton's method on the sphere. Smale, in his list [19] of problems for the current century, states as Problem #7 the challenge to design a fast algorithm for generating "nearly optimal" logarithmic energy points: namely, to compute (in polynomial time with respect to N) an N-point set $\omega_N \subset S^2$ so that

$$(12)\quad E_0(\omega_N) \le \mathcal{E}_0(S^2, N) + C \log N\,, \quad N = 2, 3, \ldots,$$

for some positive constant C. While far from meeting this challenge, a variety of fast methods have been devised (see, e.g., the algorithms for "spiral points" in [14], [16] and for "equal area points" in [14], [20], the latter being downloadable from `http://math.vanderbilt.edu/~esaff/sphere_points.html` and recently extended to S^d for arbitrary d by I. Sloan, R. Womersley, and P. Leopardi).

We further note that for $s = 1$ and $A = S^2$, the minimization in (5) is the classical *Thomson problem* of electrons restricted to the sphere and interacting through the Coulomb potential (see, e.g., [7], [4]), which is relevant not only in electrostatics but also in molecular modeling (crystallography, stable carbon molecules, fullerenes) as well as in the study of certain viral structures. Extensive computations of optimal configurations appear in a number of articles spanning the physics, chemistry, and mathematics literature. A particularly convenient listing is provided by Hardin, Sloane, and Smith, whose findings are accessible via the Internet address `http://www.research.att.com/~njas/electrons/` (see also [15]).

For large N the numerical determination of minimum energy points is a difficult constrained optimization problem. Indeed, it appears (cf. [7], [15]) that the number of relative minima (ignoring rotations and reflections) grows exponentially with N (at least for certain subsequences of integers). Beyond a few hundred points, finding a global minimum of energy is always accompanied with some uncertainty. Yet ad hoc numerical methods devised by Alar Toomre and others for N in the thousands have generated configurations on the sphere that reveal rather startling features. Figure 3 provided by R. Womersley shows (near) optimal s-energy configurations for $N = 1,600$ points when $s = 1$ and $s = 4$. These illustrations display the tessellations

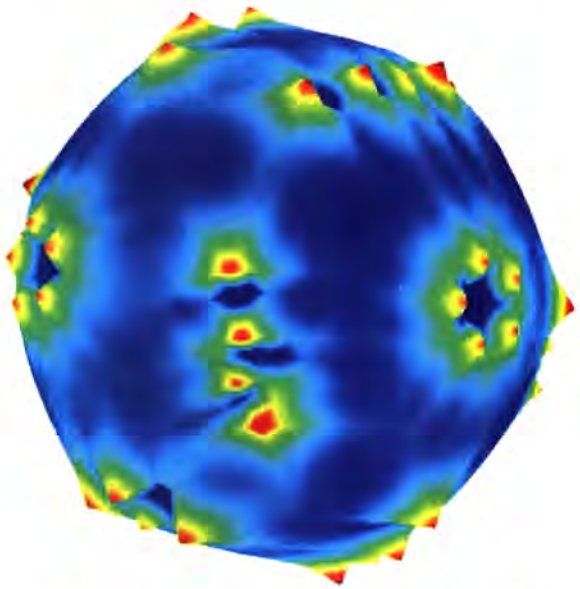

Figure 4. The point energies for the near optimal 1-energy configuration shown in Figure 3.

of the sphere created by the Voronoi cells ("school districts") corresponding to these optimal points. Notice that the vast majority of cells are nearly regular hexagons (imitating best coverings of the plane). But there also appear spherical pentagons (as in the standard soccer ball design; see red cells) as well as heptagons (see blue cells). The heptagons seem not to be present for N less than 300, but for thousands of points they do occur in significant number and are paired with pentagonal cells. Furthermore, the nonhexagonal cells (called *defects* or *disclinations*) appear to form 12 "scars" (or sometimes "buttons") roughly centered at the vertices of an inscribed icosahedron (cf. Figure 3). As illustrated in Figure 4, the *point energies* $E_s(x_i) := \sum_{j=1,\ j\neq i}^{N} |x_i - x_j|^{-s}$ are nearly equal for the sea of "hexagonal points", while the "pentagonal points" have relatively elevated energies and the "heptagonal points" have relatively lower energies.

The appearance of nonhexagonal cells is no surprise, since an Euler characteristic computation readily implies that the sphere cannot be covered by hexagons alone. But what is fascinating is that the twelve formations of these five and seven nearest neighbor points appear to be independent of the ground potential (e.g. independent of the parameter s for the Riesz potential). These observations by Bowick et al. [4] have also been confirmed by laboratory experiments in which polystyrene beads (one micron in diameter) attach themselves to a water droplet suspended in an oily mixture (cf. [2]). Focusing on these twelve scars has the considerable advantage of reducing the number of variables in the optimization problem and may in the future lead to fast generation of nearly optimal configurations for N in the thousands. Whether such scars persist for even larger orders of N is as yet unknown but may be of crucial importance for asymptotic results.

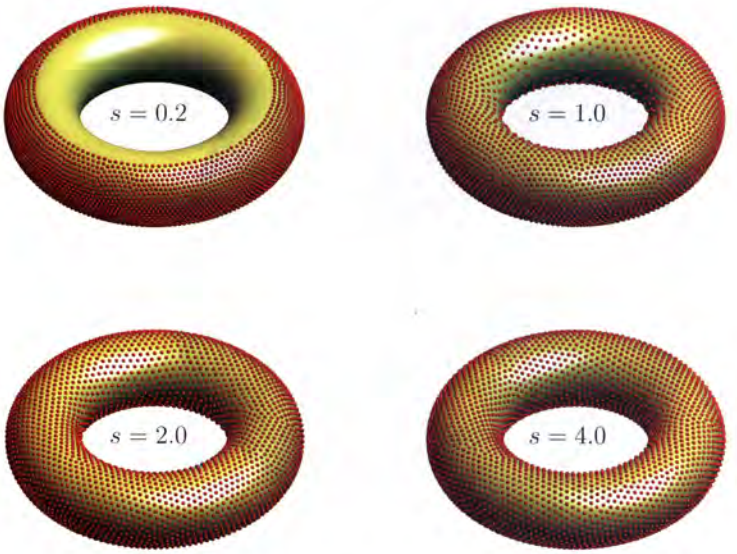

Figure 5. Near optimal s-energy configurations for $s = 0.2$, $s = 1$, $s = 2$, and $s = 4$ with 4,000 points for a torus in $\mathbb{R}^3$.

Questions Q1 and Q2 for the d-Sphere. The asymptotics for the minimal energy $\mathcal{E}_s(S^d, N)$ is (as one would suspect from the above discussion for curves) quite different for the three cases $0 \le s < d$, $s = d$, and $s > d$. Indeed, for $0 \le s < d$, the energy integral (8) or (2) for probability measures supported on S^d attains its finite minimum when μ is normalized surface area σ^d on the sphere and potential theory then gives

$$\lim_{N\to\infty} \frac{\mathcal{E}_s(S^d, N)}{N^2} = I_s(\sigma^d) = \frac{\Gamma((d+1)/2)\Gamma(d-s)}{\Gamma((d-s+1)/2)\Gamma(d-s/2)}, \quad 0 < s < d, \tag{13}$$

as well as the fact that optimal s-energy configurations are asymptotically uniformly distributed with respect to σ^d. For $s \ge d$, however, $I_s(\mu) = +\infty$ for all probability measures on S^d and different methods are needed for analysis. Using spherical harmonics and positivity results, it is shown by Kuijlaars and Saff [10] that for $s = d$

$$\lim_{N\to\infty} \frac{\mathcal{E}_d(S^d, N)}{N^2 \log N} = \frac{\Gamma((d+1)/2)}{d\sqrt{\pi}\,\Gamma(d/2)} = \frac{\mathrm{Vol}(\mathcal{B}^d)}{\mathrm{Area}(S^d)},$$

where $\mathcal{B}^d$ is the unit ball in $\mathbb{R}^d$, from which it follows that d-optimal configurations are asymptotically uniformly distributed. For $s > d$, it is not difficult to show that the order of growth of the minimal energy becomes $N^{1+s/d}$, again signaling the increasing dominance of local interactions. Yet more precise limit formulas such as the analogue of (13) as well as a rigorous proof that optimal configurations for $s > d$ are asympotically uniformly distributed (as symmetry would tend to dictate) require a completely different approach that we will describe below. Unlike the simple case $d = 1$ for a rectifiable curve where we can consider points in the systematic order described earlier, handling nearest neighbors in higher dimensions can present quite a challenge. What is fortuitous is that attempts to deal with the sphere for $s > d$ have led to a general argument that resolves questions Q1 and Q2 for a large class of d-manifolds in $\mathbb{R}^{d'}$.

A General Result. For an arbitrary compact set $A \subset \mathbb{R}^{d'}$ with Hausdorff dimension d_H, potential theory provides answers to Q1 and Q2 for $0 \le s < d_H$ via the s-energy equilibrium measure $\lambda_{A,s}$ that minimizes (8) over all probability measures supported on A (cf. [11] and [13]). For $s \ge d_H$, the following recent result applies to rectifiable manifolds A.

Recall that a mapping $\phi : B \to \mathbb{R}^{d'}$ is said to be *bi-Lipschitz on $B \subset \mathbb{R}^d$ with constant $L > 0$* if

$$(1/L)|x-y| \le |\phi(x)-\phi(y)| \le L|x-y|,\ x,y \in B.$$

We say that $A \subset \mathbb{R}^{d'}$ is a *d-rectifiable manifold* if it is a compact subset of a finite union of bi-Lipschitz images of open sets in $\mathbb{R}^d$.

Theorem 1 *([9]). Suppose $s \ge d$ and $A \subset \mathbb{R}^{d'}$ is a d-rectifiable manifold. When $s = d$ we further assume A is a subset of a d-dimensional C^1 manifold. Let $\mathcal{H}_d$ denote d-dimensional Hausdorff measure on $\mathbb{R}^{d'}$. Then for $s = d$ we have*

$$\lim_{N\to\infty} \frac{\mathcal{E}_d(A,N)}{N^2 \log N} = \frac{\mathcal{H}_d(\mathcal{B}^d)}{\mathcal{H}_d(A)}, \tag{14}$$

while for $s > d$, the limit $\lim_{N\to\infty} \mathcal{E}_s(A,N)/N^{1+s/d}$ exists and is given by

$$\lim_{N\to\infty} \frac{\mathcal{E}_s(A,N)}{N^{1+s/d}} = \frac{C_{s,d}}{\mathcal{H}_d(A)^{s/d}}, \tag{15}$$

where $C_{s,d}$ is a finite positive constant independent of A and d'.

If $\mathcal{H}_d(A) > 0$, then for each $s \ge d$, any sequence of optimal (or asymptotically optimal) s-energy configurations ω_N is uniformly distributed (as $N \to \infty$) with respect to d-dimensional Hausdorff measure restricted to A.

In particular, the theorem holds for any compact subset A of $\mathbb{R}^d$ as well as any compact subset of a smooth d-dimensional manifold. It is interesting to note that the limit (14) is simply $1/\rho^d$ when A is a ball in $\mathbb{R}^d$ with radius ρ.

The constant $C_{s,d}$ in (15) certainly depends on the normalization for Hausdorff measure. Here we choose $\mathcal{H}_d$ on $\mathbb{R}^{d'}$ normalized so that any isometric image of the unit cube $U^d := [0,1]^d$ in $\mathbb{R}^{d'}$ has $\mathcal{H}_d$-measure 1. Then, for $s > d$,

$$C_{s,d} = \lim_{N\to\infty} \frac{\mathcal{E}_s(U^d,N)}{N^{1+s/d}}. \tag{16}$$

For $d = 1$ we deduce from (10) that $C_{s,1} = 2\zeta(s)$ for $s > 1$; however, for $d \ge 2$, the determination of the constant $C_{s,d}$ for $s > d$ remains an open problem. For $d = 2$ (as seen for the sphere) the hexagonal lattice $L \subset \mathbb{R}^2$ consisting of points of the form $m(1,0) + n(1/2, \sqrt{3}/2)$ for $m, n \in \mathbb{Z}$ appears to play the central role in determining $C_{s,2}$. Assuming that most points in optimal configurations live in the "hexagonal sea" and are centers of regular hexagons with area $\approx \mathcal{H}_2(A)/N$, it is natural to conjecture that the constant $C_{s,2}$ is given by $(\sqrt{3}/2)^{s/2}\,\zeta_L(s)$, where $\zeta_L(s) := \sum_{X\in L, X\neq 0} |X|^{-s}$ is the zeta function for the lattice L. It is shown in [10] that for the sphere S^2

$$\limsup_{N\to\infty} \frac{\mathcal{E}_s(S^2,N)}{N^{1+s/2}} \le \left(\frac{\sqrt{3}}{8\pi}\right)^{s/2} \zeta_L(s),\ (s > 2), \tag{17}$$

which implies that $(\sqrt{3}/2)^{s/2}\,\zeta_L(s)$ is an upper bound for $C_{s,2}$.

Theorem 1 provides the order of growth of $\mathcal{E}_s(A,N)$ and the limit distribution of optimal configurations for a d-rectifiable manifold A only if $\mathcal{H}_d(A) > 0$. If $\mathcal{H}_d(A) = 0$, then the right-hand side of (15) is understood to be ∞, and, in this case, Theorem 1 provides only a lower bound on the order of growth of $\mathcal{E}_s(A,N)$. When $0 < \mathcal{H}_d(A) < \infty$, we observe, as with the sphere S^d, that the minimum energy experiences a transition in order of growth as s increases from values less than d to values greater than d (that is, from N^2 to $N^{1+s/d}$ with the transition value of $s = d$ giving growth of order $N^2 \log N$). Moreover, as s increases, the limit distribution of optimal (or near optimal) points becomes and remains the uniform distribution when $s \ge d$. The latter is particularly significant with regard to applications that involve integration with respect to Hausdorff (Lebesgue) measure.

For example, let A be the torus in $\mathbb{R}^3$ obtained by revolving about the z-axis the circle in the xz-plane of radius 1 centered at (3,0,0). Figure 5 shows near optimal s-energy configurations for A with $s = 0.2$, $s = 1$, $s = 2$, and $s = 4$ with $N = 4000$ points. In contrast to the case of the sphere, the equilibrium measure $\lambda_{A,s}$ for $s < 2$ is no longer uniform, and thus we find qualitatively different s-energy configurations for $s < 2$ (points are distributed more densely around the outer ring) from those for $s \ge 2$ (points are distributed uniformly on A in accordance with Theorem 1). The pictures in Figure 4, together with animations prepared by R. Womersley showing near optimal s-energy configurations for the torus A, are available at the Internet address `http://www.maths.unsw.edu.au/~rsw/Torus/`.[1] Because the Euler characteristic for a torus is 0, nonhexagonal "defects" are not required as they are for the sphere. In [5] Bowick et al. investigate configurations on the torus with long-range bond-orientational order. For such "hexatic" phase configurations they predict that pentagonal and heptagonal defects should be present in optimal configurations when N is below a critical value N_c depending on the "aspect ratio" and that there should be no defects when $N > N_c$. For the torus A with aspect ratio 3, they predict $N_c \approx 10^4$.

So how does one go about proving Theorem 1, given that our potential theoretic tools are no longer available when $s \ge d$? Here we focus our discussion on the $s > d$ case, since the $s = d$ case is more technical, relying on the previously

[1] *A natural question suggested by the configurations shown in Figure 5 (and even more so by the animations of Womersley) is whether $s^* = 1$ is the critical value of s such that for $s < s^*$ the support of the equilibrium measure $\lambda_{A,s}$ is a proper subset of A.*

mentioned result for the d-sphere. The first step in the proof is to show the existence of the limit (15) for the cube.

The Argument for the Unit Cube U^d. We begin with an optimal arrangement ω_N^* minimizing the s-energy of N points in U^d and use it to obtain an upper bound for the minimal energy of m^dN points of U^d. So let $m \in \mathbb{N}$ and set $\mathbb{Z}_m^d := \{0, 1, \ldots, m-1\}^d$. For $0 < \gamma < 1$ and $\mathbf{i} = (i_1, \ldots, i_d) \in \mathbb{Z}_m^d$, consider the m^d disjoint subcubes

$$U_{\mathbf{i}} = \frac{1}{m}(\gamma U + \mathbf{i}) = \left[\frac{1}{m}i_1, \frac{1}{m}(i_1+\gamma)\right] \times \cdots \times \left[\frac{1}{m}i_d, \frac{1}{m}(i_d+\gamma)\right].$$

Then we obtain m^dN points of U^d by scaling and translating ω_N^* to each $U_{\mathbf{i}}$ (see Figure 6), yielding

$$\omega_{m^dN} := \bigcup_{\mathbf{i}\in\mathbb{Z}_m^d} \frac{1}{m}(\gamma\omega_N^* + \mathbf{i}),$$

and we note that $\frac{1}{m}(\gamma\omega_N^* + \mathbf{i})$ is an optimal N-point configuration for $U_{\mathbf{i}}$. To estimate $E_s(\omega_{m^dN})$, we separate the energy terms arising from pairs of points in the same subcube (the terms involving interactions between distinct subcubes will turn out to be relatively negligible):

$$(18)\quad \mathcal{E}_s(U^d, m^dN) \le E_s(\omega_{m^dN}) \le \sum_{\mathbf{i}\in\mathbb{Z}_m^d} \Big\{\mathcal{E}_s(U_{\mathbf{i}}, N) + \sum_{\mathbf{j}\in\mathbb{Z}_m^d,\ \mathbf{j}\neq\mathbf{i}} N^2 \operatorname{dist}(U_{\mathbf{i}}, U_{\mathbf{j}})^{-s}\Big\}.$$

Next, from the translation invariance and scaling properties of the Riesz s-energy we can write $\mathcal{E}_s(U_{\mathbf{i}}, N) = m^s\gamma^{-s}\mathcal{E}_s(U^d, N)$, which we use along with the inequality $\operatorname{dist}(U_{\mathbf{i}}, U_{\mathbf{j}}) \ge \frac{1-\gamma}{m}|\mathbf{i}-\mathbf{j}|$ to deduce from (18) the estimate

$$(19)\quad \mathcal{E}_s(U^d, m^dN) \le m^{s+d}\{\gamma^{-s}\mathcal{E}_s(U^d, N) + K(1-\gamma)^{-s}N^2\},$$

where $K := \sum_{\mathbf{k}\in\mathbb{Z}^d, \mathbf{k}\neq 0} |\mathbf{k}|^{-s} < \infty$ for $s > d$.

Let L_t denote a subsequence for which

$$\overline{g}_{s,d} := \limsup_{N\to\infty} \mathcal{E}_s(U^d, N)/N^{1+s/d} = \lim_{t\to\infty} \mathcal{E}_s(U^d, L_t)/L_t^{1+s/d}$$

and choose N_* so that

$$(20)\quad N_*^{1-s/d} < (1-\gamma)^{2s} \quad \text{and} \quad \mathcal{E}_s(U^d, N_*)/N_*^{1+s/d} \le \underline{g}_{s,d} + (1-\gamma),$$

where $\underline{g}_{s,d} := \liminf_{N\to\infty} \mathcal{E}_s(U^d, N)/N^{1+s/d}$. Selecting m_t so that $(m_t-1)^dN_* < L_t \le m_t^dN_*$, we have from (19) and (20) that

$$\begin{aligned}\overline{g}_{s,d} &= \lim_{t\to\infty} \frac{\mathcal{E}_s(U^d, L_t)}{L_t^{1+s/d}} \le \limsup_{t\to\infty} \frac{\mathcal{E}_s(U^d, m_t^dN_*)}{[(m_t^*-1)^dN_*]^{1+s/d}} \\ &\le \limsup_{t\to\infty} \left(\frac{m_t}{m_t-1}\right)^{s+d} \left(\gamma^{-s}\frac{\mathcal{E}_s(U^d, N_*)}{N_*^{1+s/d}} + K(1-\gamma)^{-s}N_*^{1-s/d}\right) \\ &\le \gamma^{-s}[\underline{g}_{s,d} + (1-\gamma)] + K(1-\gamma)^s.\end{aligned}$$

Taking $\gamma \to 1$ gives $\overline{g}_{s,d} \le \underline{g}_{s,d}$, proving the existence of the limit (15) for $A = U^d$.

It remains to show that the limit $g_{s,d} := \overline{g}_{s,d} = \underline{g}_{s,d}$ is positive and finite. This follows for the upper estimate by considering the configurations $\omega_{m^d} = \frac{1}{m}Z_m^d$, $m = 2, 3, \ldots$, and for the lower

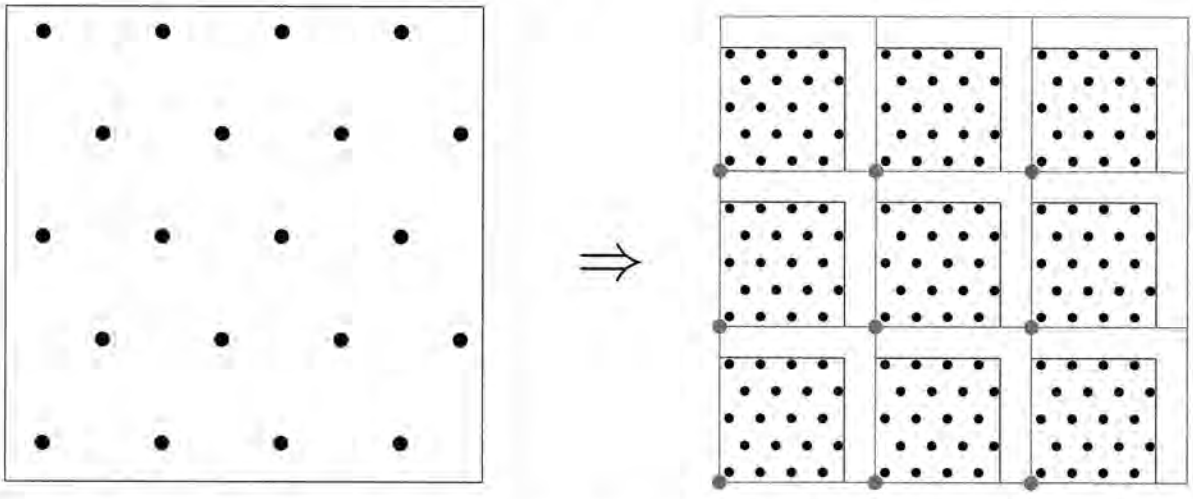

Figure 6. Scaling an optimal configuration of N points in the unit cube U^d to disjoint subcubes provides bounds for the minimal Riesz s-energy for m^dN points in terms of the minimal Riesz s-energy for N points.

estimate by using the convexity of $f(r) = r^{s/d}$ and the arithmetic-harmonic mean inequality.

From the Unit Cube to Compact Sets in $\mathbb{R}^d$. For $s > d$, we define

$$g_{s,d}(A) := \lim_{N\to\infty} \mathcal{E}_s(A, N)/N^{1+s/d}$$

for any compact set A for which the limit exists. As we have seen, for $s > d$ it is the near neighbor terms that dominate the Riesz s-energy. If B and C are disjoint compact sets such that both $g_{s,d}(B)$ and $g_{s,d}(C)$ exist and $A = B \cup C$, then by neglecting terms in $\mathcal{E}_s(A, N)$ involving pairs of points $x \in B$ and $y \in C$ and considering optimal s-energy configurations for B and C separately, one can show that $g_{s,d}(A)$ exists and satisfies

$$g_{s,d}(A)^{-d/s} = g_{s,d}(B)^{-d/s} + g_{s,d}(C)^{-d/s}. \tag{21}$$

For an arbitrary compact set $A \subset \mathbb{R}^d$ we use finite unions of cubes with pairwise disjoint interiors to approximate A to show that $g_{s,d}(A)$ exists and satisfies $g_{s,d}(A) = g_{s,d}(U^d)\mathcal{H}_d(A)^{-s/d}$ (the latter equation clearly holding for arbitrary cubes). The Besicovitch Covering Theorem and the Lebesgue Density Theorem play key roles in this argument. Letting $C_{s,d} = g_{s,d}(U^d)$ gives (15) in the case A is a compact set in $\mathbb{R}^d$.

From Compact Sets in $\mathbb{R}^d$ to d-Rectifiable Manifolds in $\mathbb{R}^{d'}$. Clearly, if $A \subset \mathbb{R}^{d'}$ is *exactly* the isometric image of some compact set $B \subset \mathbb{R}^d$, then $g_{s,d}(A)$ exists and equals

$$g_{s,d}(B) = C_{s,d}\mathcal{H}_d(B)^{-s/d} = C_{s,d}\mathcal{H}_d(A)^{-s/d}.$$

Moreover, if A is the union of a finite collection of pairwise disjoint compact sets $\{K_i\}_{i=1}^L$ where each K_i is the isometric image of some compact set $B_i \subset \mathbb{R}^d$, then using (21) (which also holds when $d < d'$), one may conclude that $g_{s,d}(A)$ exists and

$$g_{s,d}(A) = C_{s,d}\left(\sum_{i=1}^{L} \mathcal{H}_d(K_i)\right)^{-s/d} = C_{s,d}\mathcal{H}_d(A)^{-s/d}.$$

Finally, we appeal to a basic result of Federer [8] that for every d-rectifiable manifold A, $\mathcal{H}_d$-almost all of A can be covered by a countable union of pairwise disjoint images of bi-Lipschitz mappings of compact sets in $\mathbb{R}^d$ with bi-Lipschitz constants uniformly close to 1. This completes an outline of the proof of Theorem 1.

Other Energy Functions. Although the Riesz s-energy is relevant to a variety of physical and mathematical problem areas, there are many other energy functionals that have significant application. For example, Benedetto and Fickus [3] show how to generate finite normalized tight frames by minimizing the energy

$$\sum_{i\neq j} f(|x_i - x_j|), \tag{22}$$

for N points on the sphere S^d, where $f(t) = t^4/4 - t^2$. J. Brauchart has shown that for a suitable function f depending on N, the minimum energy points on the sphere give spherical designs for cubature. A further recent example arises in the work of M. Atiyah and P. Sutcliffe [1], where the energy is minimized over $\mathbb{R}^3$ for a function of the form $\log 1/|D|$, where $D : C_N(\mathbb{R}^3) \to \mathbb{C}$ is a smooth function on the space of N distinct unordered points in $\mathbb{R}^3$. Du, Gunzburger, and Ju [6] consider point sets on a surface A obtained by minimizing the energy function

$$\sum_{i=1}^{N} \int_{x\in V_i} \rho(x)|x - x_i|^2\, dx,$$

where V_i denotes the Voronoi regions on A generated by $\{x_1, \ldots, x_N\} \subset A$ and ρ is a weight function. Many of these energy functionals provide fertile ground for asymptotic analysis.

A natural generalization that is currently being investigated is that of the *weighted* Riesz s-energy problem:

$$\min_{\{x_i\}_{i=1}^N \subset A} \sum_{i\neq j} \frac{\rho(x_i, x_j)}{|x_i - x_j|^s},$$

where $\rho(x, y)$ is a given weight function on a d-dimensional manifold A. The methods described above can be adapted to show that under suitable conditions on the weight and manifold, the limit density (with respect to $\mathcal{H}_d$) for optimal s-energy configurations is a multiple of $\rho(x, x)^{-d/s}$ when $s > d$.

Acknowledgments. We thank R. Womersley for providing the images for Figures 3–5, M. Bowick for helpful discussions, and S. Borodachov for his useful comments.

Added in proof: The authors, together with S. Borodachov, have recently shown that Theorem 1 holds for a more general class of rectifiable sets.

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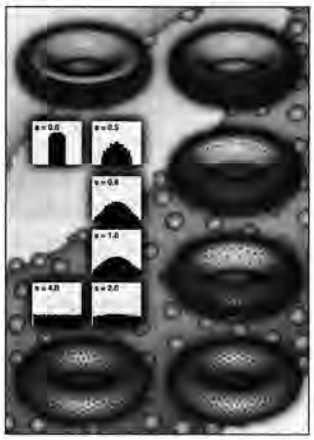
About the Cover

Approximating minimal Riesz

This month's cover originated with the article by Doug Hardin and Ed Saff in this issue. It shows 1,000 points on a torus distributed so as to minimize the total energy determined by an interaction through Riesz potentials $-\log r$ (labeled $s = 0$) as well as $1/r^s$ for 0.5, 0.8, 1, 2, and 4. As explained in the article, the limit distribution as the number of points becomes infinite is, remarkably, just the uniform distribution for all values of $s \ge 2$ (the dimension of the torus). This is also shown by the histograms on the cover, displaying the distribution in somewhat carefully selected radial bands. If the uniformity for $s = 2$ doesn't seem to be quite valid in the figure, that's because convergence to the equilibrium is very slow at the transitional s-value.



The data for all images, and indeed the actual images of all those blue & green bagels with red poppy seeds (as Saff refers to them), were produced by Rob Womersley of the University of New South Wales. Asked how he produced the pictures, Womersley said it had been "by a combination of local and global large-scale optimization techniques running on a Linux cluster to find close to minimum energy point sets, as well as visualization using Matlab." He added, "Numerical experiments such as these help illustrate theoretical results, but also suggest new results waiting to be proved."

—Bill Casselman
Graphics Editor
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Comme Appelé du Néant— As If Summoned from the Void: The Life of Alexandre Grothendieck

Allyn Jackson

This is the second part of a two-part article about the life of Alexandre Grothendieck. The first part of the article appeared in the October 2004 issue of the *Notices*.

A Different Way of Thinking

> Dans le travail de découverte, cette attention intense, cette sollicitude ardente sont une force essentielle, tout comme la chaleur du soleil pour l'obscure gestation des semences enfouies dans la terre nourricière, et pour leur humble et miraculeuse éclosion à la lumière du jour.
>
> In the work of discovery, this intense attention, this ardent solicitude, are an essential force, just like the warmth of the sun for the obscure gestation of seeds covered in nourishing soil, and for their humble and miraculous blossoming in the light of day.
>
> —*Récoltes et Semailles*, page P49

Grothendieck had a mathematical style all his own. As Michael Artin of the Massachusetts Institute of Technology commented, in the late 1950s and 1960s "the world needed to get used to him, to his power of abstraction." Nowadays Grothendieck's point of view has been so thoroughly absorbed into algebraic geometry that it is standard fare for graduate students starting in the field, many of whom do not realize that things were once quite different. Nicholas Katz of Princeton University said that when as a young mathematician he first encountered Grothendieck's way of thinking, it seemed completely different and new. But it is hard to articulate what the difference was. As Katz put it, the change in point of view was so fundamental and profound and, once adopted, so completely natural "that it's sort of hard to imagine the time before you thought that way."

Although Grothendieck approached problems from a very general point of view, he did so not for generality's sake but because he was able to use generality in a very fruitful way. "It's a kind of approach that in less gifted hands just leads to what most people would say are sterile generalities," Katz commented. "He somehow knew what general things to think about." Grothendieck always sought the precise level of generality that would provide precisely the right leverage to gain insight into a problem. "He seemed to have the knack, time after time, of stripping away just enough so that it wasn't a special case, but it wasn't a vacuum either," commented John Tate of the University of Texas at Austin. "It's streamlined; there is no baggage. It's just right."

One striking characteristic of Grothendieck's mode of thinking is that it seemed to rely so little on examples. This can be seen in the legend of the so-called "Grothendieck prime". In a mathematical conversation, someone suggested to Grothendieck that they should consider a particular prime number. "You mean an actual number?" Grothendieck asked. The other person replied, yes, an actual prime number. Grothendieck suggested, "All right, take 57."

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But Grothendieck must have known that 57 is not prime, right? Absolutely not, said David Mumford of Brown University. "He doesn't think concretely." Consider by contrast the Indian mathematician Ramanujan, who was intimately familiar with properties of many numbers, some of them huge. That way of thinking represents a world antipodal to that of Grothendieck. "He really never worked on examples," Mumford observed. "I only understand things through examples and then gradually make them more abstract. I don't think it helped Grothendieck in the least to look at an example. He really got control of the situation by thinking of it in absolutely the most abstract possible way. It's just very strange. That's the way his mind worked." Norbert A'Campo of the University of Basel once asked Grothendieck about something related to the Platonic solids. Grothendieck advised caution. The Platonic solids are so beautiful and so exceptional, he said, that one cannot assume such exceptional beauty will hold in more general situations.

One thing Grothendieck said was that one should never try to prove anything that is not almost obvious. This does not mean that one should not be ambitious in choosing things to work on. Rather, "if you don't see that what you are working on is almost obvious, then you are not ready to work on that yet," explained Arthur Ogus of the University of California at Berkeley. "Prepare the way. And that was his approach to mathematics, that everything should be so natural that it just seems completely straightforward." Many mathematicians will choose a well-formulated problem and knock away at it, an approach that Grothendieck disliked. In a well-known passage of *Récoltes et Semailles*, he describes this approach as being comparable to cracking a nut with a hammer and chisel. What he prefers to do is to soften the shell slowly in water, or to leave it in the sun and the rain, and wait for the right moment when the nut opens naturally (pages 552–553). "So a lot of what Grothendieck did looks like the natural landscape of things, because it looks like it grew, as if on its own," Ogus noted.

Grothendieck had a flair for choosing striking, evocative names for new concepts; indeed, he saw the act of naming mathematical objects as an integral part of their discovery, as a way to grasp them even before they have been entirely understood (*R&S*, page P24). One such term is *étale*, which in French is used to describe the sea at slack tide, that is, when the tide is neither going in nor out. At slack tide, the surface of the sea looks like a sheet, which evokes the notion of a covering space. As Grothendieck explained in *Récoltes et Semailles*, he chose the word *topos*, which means "place" in Greek, to suggest the idea of "the 'object *par excellence*' to which topological intuition applies" (pages 40–41). Matching the concept, the word *topos* suggests the most fundamental, primordial notion of space. The term *motif* ("motive" in English) is intended to evoke both meanings of the word: a recurrent theme and something that causes action.

Grothendieck lecturing at the IHÉS.

Grothendieck's attention to choosing names meant that he loathed terminology that seemed unsuitable: In *Récoltes et Semailles*, he said he felt an "internal recoiling" upon hearing for the first time the term *perverse sheaf*. "What an idea to give such a name to a mathematical thing!" he wrote. "Or to any other thing or living being, except in sternness towards a person—for it is evident that of all the 'things' in the universe, we humans are the only ones to whom this term could ever apply" (page 293).

Although Grothendieck possessed great technical power, it was always secondary; it was a means for carrying out his larger vision. He is known for certain results and for developing certain tools, but it is his creation of a new viewpoint on mathematics that is his greatest legacy. In this regard, Grothendieck resembles Evariste Galois; indeed, in various places in *Récoltes et Semailles* Grothendieck wrote that he strongly identified with Galois. He also mentioned that as a young man he read a biography of Galois by Leopold Infeld [Infeld] (page P63).

Ultimately, the wellspring of Grothendieck's achievement in mathematics is something quite humble: his love for the mathematical objects he studied.

A Spirit in Stagnation

> [P]endant vingt-cinq ans, entre 1945 (quand j'avais dix-sept ans) et 1969 (quand j'allais sur les quarante-deux), j'ai investi pratiquement la totalité de

mon énergie dans la recherche mathématique. Investissement démesuré, certes. Je l'ai payé par une longue stagnation spirituelle, par un "épaississement" progressif, que j'aurai plus d'une fois l'occasion d'évoquer dans les pages de *Récoltes et Semailles*.

[F]or twenty-five years, between 1945 (when I was seventeen years old) and 1969 (when I reached forty-two), I invested practically my entire energy into mathematical research. An excessive investment, certainly. I paid for it with a long spiritual stagnation, with a progressive "dulling", that I have more than once found occasion to evoke in the pages of *Récoltes et Semailles*.

—*Récoltes et Semailles*, page P17

During the 1960s, Barry Mazur of Harvard University visited the Institut des Hautes Études Scientifiques (IHÉS) with his wife. Although by that time Grothendieck had a family and a house of his own, he also kept an apartment in the same building where the Mazurs were living and frequently worked there late into the night. Because the apartment keys did not open the outside doors, which were locked at 11:00 p.m., one might have trouble getting into the building after an evening in Paris. But "I remember we never had any problems," Mazur recalled. "We would take the last train back, absolutely certain that there would be Grothendieck working, his desk by the window. We would throw some gravel at his window and he would open the outside door for us." Grothendieck's apartment was sparely furnished; Mazur remembered a wire sculpture in the outline of a goat and an urn filled with Spanish olives.

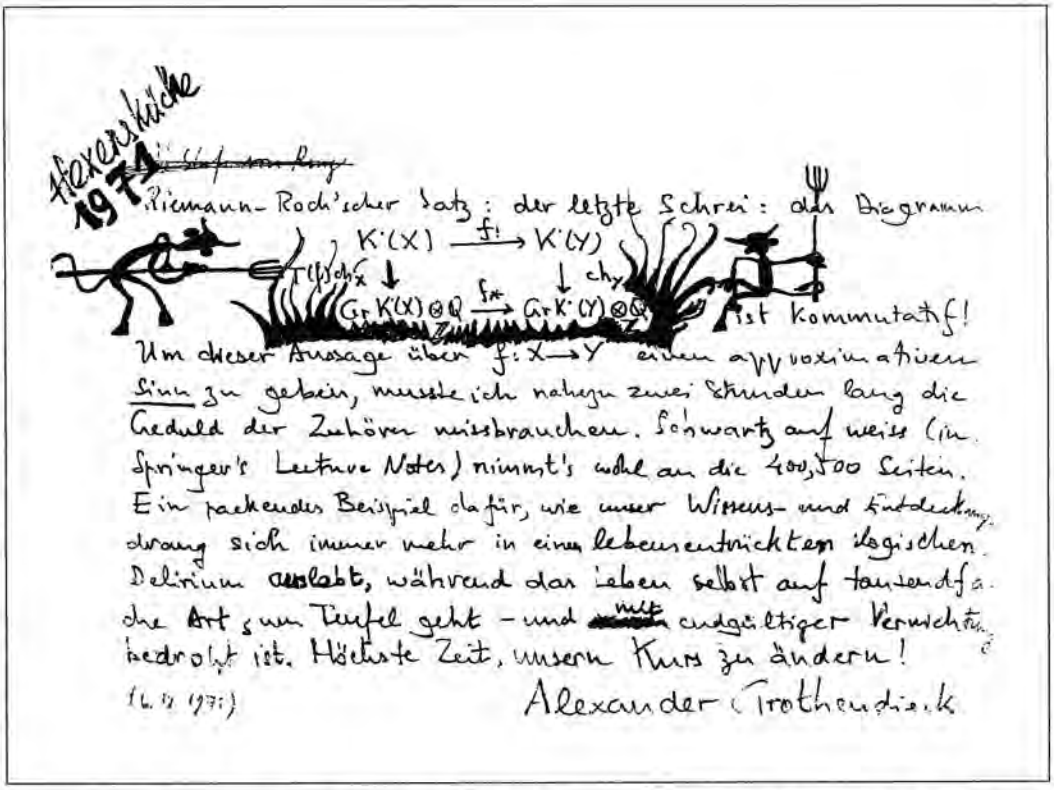
This somewhat lonely image of Grothendieck working away into the night in a spartan apartment captures one aspect of his life during the 1960s. At this time he did mathematics nonstop. He was talking to colleagues, advising students, lecturing, carrying on extensive correspondence with mathematicians outside of France, and writing the seemingly endless volumes of *EGA* and *SGA*. It is no exaggeration to say that he was single-handedly leading a large and thriving segment of worldwide research in algebraic geometry. He seemed to have few interests outside of mathematics; colleagues have said that he never read a newspaper. Even among mathematicians, who tend to be single-minded and highly devoted to their work, Grothendieck was an extreme case. "Grothendieck was working on the foundations of algebraic geometry seven days a week, twelve hours a day, for ten years," noted his IHÉS colleague David Ruelle. "He had achieved level -1 and was working on level 0 of something that must be 10 levels high....At a certain age it becomes clear you will never be able to finish the building."

The extremity of Grothendieck's focus on mathematics is one reason for the "spiritual stagnation" he referred to in *Récoltes et Semailles*, which in turn is one of the reasons behind his departure, in 1970, from the world of mathematics in which he had been a leading figure. One step toward that departure was a crisis within the IHÉS, which led to his resignation. Starting in late 1969, Grothendieck became embroiled in a conflict with the founder and director of the IHÉS, Léon Motchane, over military funding for the institute. As historian of science David Aubin explained [Aubin], during the 1960s, the IHÉS finances were rather precarious, and in some years the institute received a small portion of its budget, never more than about 5 percent, from sources within the French military. All of the permanent IHÉS professors had misgivings about military funding, and in late 1969 they insisted that Motchane quit accepting such funding. Motchane agreed, but, as Aubin noted, he went back on his word just a few months later, when the IHÉS budget was stretched thin and he accepted a grant from the minister of the army. Outraged, Grothendieck tried in vain to persuade the other professors to resign along with him, but none did. Less than a year earlier, Pierre Deligne had joined the IHÉS faculty as a permanent professor, largely on the recommendation of Grothendieck, who now pressed his newly appointed colleague to join him in resigning. Deligne too refused. "Because I was very close to him mathematically, Grothendieck was surprised and deeply disappointed that this closeness of ideas did not extend outside of mathematics," Deligne recalled. Grothendieck's letter of resignation was dated May 25, 1970.

His rupture with the IHÉS was the most visible sign of a profound shift taking place in Grothendieck's life. Toward the end of the 1960s there were other signs as well. Some were small. Mazur recalled that when he was visiting the IHÉS in 1968, Grothendieck told him he had gone to the movies—for the first time in perhaps a decade. Other signs were larger. In 1966, when he was to receive the Fields Medal at the International Congress of Mathematicians (ICM) in Moscow, Grothendieck refused to attend as a protest against the Soviet government. In 1967 Grothendieck made a three-week trip to Vietnam, which clearly left an impression on him. His written account of the trip [Vietnam] described the many air raid alerts and a bombing that left two mathematics teachers dead, as well as the valiant efforts of the Vietnamese to cultivate a mathematical life in their country. A friendship with a Romanian physician named Mircea Dumitrescu led Grothendieck to make

in the late 1960s a fairly serious foray into learning some biology. He also discussed physics with Ruelle.

The events of the extraordinary year of 1968 must also have had an impact on Grothendieck. That year saw student protests and social upheavals all over the world, as well as the Soviet Union's brutal crushing of the "Prague Spring". In France the boiling point came in May 1968, when students objecting to university and government policies carried out massive protests that soon turned into riots. In Paris hundreds of thousands of students, teachers, and workers took to the streets to protest police brutality, and the French government, fearing revolution, stationed tanks around the perimeter of the city. Millions of workers went on strike, paralyzing the nation for about two weeks. Karin Tate, who was living in Paris with her husband at the time, John Tate, recalled the chaos that reigned. "Paving stones, batons, and any other missiles that were handy flew through the air," she said. "Soon the entire country was at a standstill. There was no gasoline (truckers were on strike), there were no trains (train workers were on strike), garbage was piling up in Paris (sanitation workers were on strike), there was very little food on the shelves." She and John fled to Bures-sur-Yvette, where her brother, Michael Artin, was visiting the IHÉS. Many Parisian mathematicians took the side of the students in the conflict. Karin Tate said the protests dominated conversations among the mathematicians she knew, though she did not remember discussing the topic with Grothendieck.



Grothendieck wrote this abstract into the colloquium book at the Universität Bielefeld when he spoke there in 1971. The abstract says: "Witch's Kitchen 1971. Riemann-Roch Theorem: The 'dernier cri': The diagram [displayed] is commutative! To give an approximate sense to the statement about $f : X \to Y$, I had to abuse the listeners' patience for almost two hours. Black on white (in Springer Lecture Notes) it probably takes about 400, 500 pages. A gripping example of how our thirst for knowledge and discovery indulges itself more and more in a logical delirium far removed from life, while life itself is going to Hell in a thousand ways—and is under the threat of final extermination. High time to change our course!"

Shortly after his resignation from the IHÉS, Grothendieck plunged into a world completely new to him, the world of protest politics. In a June 26, 1970, lecture at the Université de Paris in Orsay, he spoke not about mathematics but about the threat of nuclear proliferation to the survival of humankind and called upon scientists and mathematicians not to collaborate in any way with the military. Nicholas Katz, who had recently arrived for a visit at the IHÉS and was surprised to hear of Grothendieck's resignation, attended the lecture, which he said drew an audience of hundreds in a very crowded lecture hall. Katz remembered that in the lecture Grothendieck went so far as to say that doing mathematical research was actually "harmful" (*"nuisible"*), given the impending threats to the human race.

A written version of the lecture, "Responsabilité du savant dans le monde d'aujourd'hui: Le savant et l'appareil militaire" ("The responsibility of the scholar in today's world: The scholar and the military apparatus"), circulated as an unpublished manuscript. An appendix described the hostile reactions of the students who attended the lecture and who handed out flyers mocking Grothendieck. One of the flyers is reproduced in the appendix; a typical slogan: "Réussissez, ossifiez-vous, détruisez-vous vous-mêmes: devenez un petit schéma télécommandé par Grothendieck" ("Succeed, ossify, self-destruct: become a little scheme remote-controlled by Grothendieck"). He was clearly seen as a detested member of the establishment.

In another appendix in this manuscript, Grothendieck called for the founding of a group to fight

Tata Institute International Colloquium in 1968. Grothendieck (standing, left) and Armand Borel (seated, facing camera).

for the survival of the human race against environmental degradation and the dangers of military conflict. This group, called "Survival" ("Survivre et Vivre" in French) came into being in July 1970 when Grothendieck delivered his Orsay lecture a second time, at a summer school on algebraic geometry at the University of Montreal. The main activity of Survival was the publication of a newsletter by the same name, the first issue of which was written in English by Grothendieck and is dated August 1970. The newsletter describes an ambitious agenda of publication of books on science, organization of public courses on science aimed at nonexperts, and boycotts of scientific institutions that accept military funds.

That first issue carried a list of the names, professions, and addresses of the group's members, who numbered twenty-five at the time. On the list were several mathematicians, Grothendieck's mother-in-law, and his son Serge. The directors of the group were Grothendieck and three other mathematicians: Claude Chevalley, Denis Guedj, and Pierre Samuel (*R&S*, page 758). Survival was one of many leftist groups that emerged in the wake of the tumultuous 1960s; a similar organization in the United States was the Mathematics Action Group. Too small and diffuse to accumulate much influence, Survival was more active in Paris than in the United States and Canada, due mostly to Grothendieck's presence. When he moved out of Paris in 1973, the group petered out.

At the ICM in Nice in the summer of 1970, Grothendieck tried to recruit members for Survival. He wrote, "I expected massive enrollments—there were (if I remember correctly) two or three" (*R&S*, page 758). Nevertheless, his proselytizing drew a good deal of attention. "First of all, he was one of the world stars in mathematics at that time," said Pierre Cartier of the IHÉS, who attended the congress. "Also, you have to remember the political climate at the time." Many mathematicians opposed the Vietnam War and sympathized with Survival's antimilitary stance. During the congress, Cartier said, Grothendieck sneaked a table in between two publishers' booths in the exhibit area and, assisted by his son Serge, began to hand out the Survival newsletter. This caused a heated row between him and his old colleague and friend, Jean Dieudonné, who had become the first dean of the science faculty at the Université de Nice when it was founded in 1964 and who was responsible for the ICM being held there. Cartier said that he and others tried unsuccessfully to persuade Dieudonné to permit this "unofficial booth". Eventually Grothendieck took the table out to the street in front of the hall in which the congress was being held. But another problem loomed: in delicate negotiations with the mayor of Nice, the congress organizers had promised there would be no street demonstrations. Police officers began to question Grothendieck, and finally the chief of police showed up. Grothendieck was asked to move his table just a few yards back so that it was off the sidewalk. "But he refused," Cartier recalled. "He wanted to be put in jail. He really wanted to be put in jail!" Finally, Cartier said, he and some others moved the table back sufficiently to satisfy the police.

Although Grothendieck's plunge into politics was sudden, he was by no means alone. His good friend Cartier has a long history of political activism. For example, he was among the mathematicians who used the holding of the ICM in Warsaw in 1983 to negotiate the release of one hundred fifty political prisoners in Poland. Cartier traces his activism to the example set by his teacher and mentor, Laurent Schwartz, who was one of the most politically vocal and active academics in France. Schwartz was the thesis adviser of Grothendieck. Another mathematician Grothendieck knew well, Pierre Samuel, is one of the founders of the French Green Party. Outside of France, many mathematicians were politically active. Among the best-known examples in North America are Chandler Davis and Stephen Smale, who were deeply involved in protests against the Vietnam War.

But despite his strong convictions, Grothendieck was never effective in the real world of politics. "He was always an anarchist at heart," Cartier observed. "On many issues, my basic positions are not very far from his positions. But he was so naive that it was totally impossible to do anything with him politically." He was also rather ignorant. Cartier recalled that, after an inconclusive presidential election in France in 1965, the newspapers carried

headlines saying that de Gaulle had not been elected. Grothendieck asked if this meant that France would no longer have a president. Cartier had to explain to him what a runoff election is. "Grothendieck was politically illiterate," Cartier said. But he did want to help people: it was not unusual for Grothendieck to give shelter for a few weeks to homeless people or others in need. "He was very generous, he has always been very generous," Cartier said. "He remembered his youth, his difficult youth, when his mother had nothing, and he was always ready to help—but in a nonpolitical way."

The Wild '70s

> [In 1970 J]'ai alors quitté un milieu pour entrer dans un autre—le milieu des gens "des premiers rangs" pour le "marais"; soudain, la plupart de mes nouveaux amis étaient de ceux justement qu'un an avant encore j'aurais tacitement situés dans cette contrée sans nom et sans contours. Le soi-disant marais soudain s'animait et prenait vie par les visages d'amis liés à moi par une aventure commune—une autre aventure!
>
> [In 1970] I left one milieu to enter another—the milieu of people "of the first rank" for the "swamp"; suddenly, the majority of my new friends were those who just a year before I had tacitly situated in this region without name and without shape. The so-called swamp suddenly moved around and took on life through the faces of friends tied to me by a common adventure—another adventure!
>
> —*Récoltes et Semailles*, page 38

"Légion d'Honneur! Légion d'Honneur!" Grothendieck was shouting from the back of the auditorium, waving a paper facsimile of the Légion d'Honneur cross, a distinction conferred by the French government. The scene was the opening day of a summer school on modular functions, held in Antwerp in the summer of 1972 and supported by the North Atlantic Treaty Organization (NATO). Grothendieck's longtime friend Jean-Pierre Serre of the Collège de France, who had recently received the Légion d'Honneur, was presenting the opening speech. Grothendieck approached Serre and asked, "Do you mind if I go to the blackboard and say something?" Serre replied, "Yes, I mind" and left the room. Grothendieck then mounted the podium and began speaking against NATO support for the conference. Other mathematicians sympathized with this view: One example was Roger Godement,

Grothendieck, center, University of Montreal, around 1970.

who in April 1971 wrote an open letter explaining his reasons for refusing to attend the conference.

Unbeknownst to Grothendieck, Cartier and some other mathematicians who were uncomfortable about the NATO support had conducted extensive negotiations to have a NATO representative come to the conference for a public debate. Cartier and others eased Grothendieck off the podium, but the damage had been done: Cartier soon received an angry phone call from the NATO representative, who had heard about the outburst and refused to come, believing that conditions for an orderly debate had been ruined. "To me, it was sad, because from what I remember, I think that the audience was mostly on Grothendieck's political side," Cartier noted. "Even people who were close to his political views or his social views were antagonized by his behavior....He behaved like a wild teenager."

By the time of the Antwerp meeting, Grothendieck had cut many of the ties that had bound him to an orderly life focused on mathematics. For one thing, he no longer had a permanent position. After he left the IHÉS in 1970, Serre arranged for him to have a visiting position at the Collège de France for two years. This elite institution operates differently from other universities in France (or anywhere else for that matter). Each professor at the Collège must submit for approval by the assembly of all the professors a program of the lectures he or she plans to deliver during the year. Serre recalled that Grothendieck offered two possible programs: one on mathematics and one on the political themes that occupied the Survival group. The committee approved the mathematical program and rejected the other one. So Grothendieck presented mathematical lectures prefaced by long discourses about politics. After two years he applied for a permanent position at the Collège de France, a position that had become vacant with the retirement of Szolem Mandelbrojt. The curriculum vitae

A. Grothendieck with children Serge (left) and Johanna in 1960.

Grothendieck submitted plainly showed that he intended to give up mathematics to focus on tasks he believed to be far more urgent: "the imperatives of survival and the promotion of a stable and humane order on our planet." How could the Collège appoint to a position in mathematics someone who had declared that he would no longer do any mathematics? "He was rightly refused," Serre said.

It was also during the period just after he left the IHÉS that Grothendieck's family life crumbled and he and his wife separated. In the two years after he left the IHÉS, Grothendieck spent a fair amount of time lecturing in mathematics departments in North America. He spread the gospel of Survival by insisting he would give a mathematics lecture only if arrangements were made for him also to give a political lecture. On one such trip in May 1972, he visited Rutgers University and met Justine Bumby (Skalba), then a graduate student of Daniel Gorenstein. Captivated by Grothendieck's charismatic personality, Bumby left behind her life as a graduate student to follow him, first on the remainder of his trip in the United States, and then on to France, where she lived with him for two years. "He's the most intelligent person I've ever met," she said. "I was very much in awe of him."

Their life together was in some ways emblematic of the counterculture years of the 1970s. Once, at a peaceful demonstration in Avignon, the police intervened, harassing and pushing away the demonstrators. Grothendieck got angry when they started pestering him, Bumby recalled. "He was a good boxer, so he was very fast," she said. "We see the policemen approaching us, and we are all scared, and then the next thing we know, the two policemen are on the ground." Grothendieck had singlehandedly decked two police officers. After some other officers had subdued him, Bumby and Grothendieck were bundled into a wagon and taken to the police station. When his identification papers revealed that he was a professor at the Collège de France, the two were taken in to see the chief of police, who spoke to them in English, as Bumby spoke no French. After a short conversation, in which the police chief expressed his desire to avoid trouble between police and professors, the two were released and no charges were brought.

Shortly after Bumby came to France with Grothendieck, he started a commune in a large house he had rented just south of Paris in Chatenay-Malabry, and they lived there together. She said he sold organically grown vegetables and sea salt out of the basement of the house. The commune was a bustling place: Bumby said that Grothendieck held meetings, which might attract up to a hundred people, about the issues raised in the Survival group, and these attracted considerable media attention. However, the commune dissolved fairly rapidly as a result of complicated personal relationships among the members. It was around this time that Grothendieck's position ended at the Collège de France, and in the fall of 1972 he took a temporary position teaching for one year at the Université de Paris in Orsay. After that, Grothendieck obtained a position called *professeur à titre personnel*, which is attached to a single individual and can be taken to any university in France. Grothendieck took his to the Université de Montpellier, where he was to remain until his retirement in 1988.

In early 1973 he and Bumby moved to Olmet-le-sec, a rural village in the south of France. This area was at the time a magnet for hippies and others in the counterculture movement who wanted to return to a simpler lifestyle close to the land. Here Grothendieck again attempted to start up a commune, but personality conflicts led to its collapse. At various times three of Grothendieck's children came to live in the Paris commune and in the one in Olmet. After the latter commune dissolved, he moved with Bumby and his children to Villecun, a short distance away. Bumby noted that Grothendieck had a hard time adjusting to the ways of the people attracted to the counterculture movement. "His students in mathematics had been very serious, and they were very disciplined, very hardworking people," she said. "In the counterculture he was meeting people who would loaf around all day listening to music." Having been an undisputed leader in mathematics, Grothendieck now found himself in a very different milieu, in which his views were not always taken seriously. "He was used to people agreeing with his opinions when he was doing algebraic geometry," Bumby remarked. "When he switched to politics all the people who would have agreed with him before suddenly disagreed with him.... It was something he wasn't used to."

Although most of the time Grothendieck was very warm and affectionate, Bumby said, he

sometimes had violent outbursts followed by periods of silent withdrawal. There were also disturbing episodes in which he would launch into a monologue in German, even though she understood no German. "He would just go on as if I wasn't there," she said. "It was kind of scary." He was frugal, sometimes compulsively so: one time, to avoid throwing away three quarts of leftover coffee, he drank it—with the predictable result that he got quite sick afterward. Bumby said she believes that his speaking German and his extreme frugality may have been connected psychologically to the hardships he endured as a child, especially the time when he lived with his mother in the internment camps.

Grothendieck may have been experiencing some kind of psychological breakdown, and Bumby today wonders whether she should have sought treatment for him. Whether he would have submitted to such treatment is unclear. They parted ways not long after their son, John, was born in the fall of 1973. After spending some time in Paris, Bumby moved back to the United States. She married a mathematician who was a widower, Richard Bumby of Rutgers University, and they raised John and Richard's two daughters. John exhibited a good deal of mathematical talent and was a mathematics major at Harvard University. He recently finished his Ph.D. in statistics at Rutgers. Grothendieck has had no contact with this son.

During the early 1970s, Grothendieck's interests were very far from those of the mathematical world he had left behind. But that world intruded in a major way in the summer of 1973, when, at a conference in honor of W. V. D. Hodge in Cambridge, England, Pierre Deligne presented a series of lectures about his proof of the last and most stubborn of the Weil conjectures. Grothendieck's former student Luc Illusie was at the conference and wrote to him with the news. Wanting to know more, Grothendieck, accompanied by Bumby, visited the IHÉS in July 1973.

In 1959 Bernard Dwork proved by p-adic methods the first Weil conjecture (which says that the zeta function of a variety over a finite field is a rational function). Grothendieck's 1964 l-adic proof of this conjecture was more general and introduced his "formalism of the six operations." In the 1960s Grothendieck also proved the second Weil conjecture (which says that the zeta function of a variety satisfies a functional equation). Finding a way to prove the last Weil conjecture (sometimes called the "congruence Riemann Hypothesis") was a major inspiration for much of his work. He formulated what he called the "standard conjectures," which, if they could be proved, would imply all of the Weil conjectures. The standard conjectures were also formulated independently around the same time by Enrico Bombieri. To this day, the standard conjectures remain inaccessible. Deligne found a clever way to circumvent them when he proved the last Weil conjecture. One of the key ideas he used came from a paper by R. A. Rankin [Rankin], which is about the classical theory of modular forms and of which Grothendieck was unaware. As John Tate put it, "For the proof of the last Weil conjecture, you needed another ingredient that was more classical. That was Grothendieck's blind spot."

When Bumby and Grothendieck turned up at the IHÉS that summer, among the visitors was William Messing of the University of Minnesota. Messing first met Grothendieck in 1966, when as a graduate student at Princeton he attended a series of lectures Grothendieck gave at Haverford College. These lectures made a deep impression on Messing, and Grothendieck became his informal thesis adviser. In 1970 Messing joined the Survival group at the Montreal meeting at which it was founded. The following year, while Grothendieck was visiting Kingston University in Ontario, he and Messing made a car trip to visit Alex Jameson, an Indian activist living on a reservation near Buffalo, New York. Grothendieck was pursuing a quixotic hope of helping the Indians resolve a dispute over a land treaty.

In the summer of 1973 Messing was living in a small studio in the Ormaille, the housing complex for IHÉS visitors. Excitement was bubbling among the mathematicians over Deligne's breakthrough. "Grothendieck was with Justine," Messing recalled. "They came for dinner, and Katz and I spent the evening explaining to Grothendieck the main new and different things in Deligne's proof of the last of the Weil conjectures. He was pretty excited." At the same time, Grothendieck expressed disappointment that the proof bypassed the question of whether or not the standard conjectures were true. "I think he certainly would have been very happy to have proven [all the Weil conjectures] himself," Katz remarked. "But in his mind, the Weil conjectures were important because they were the tip of the iceberg reflecting some fundamental structures in mathematics that he wanted to discover and develop." A proof of the standard conjectures would reveal that structure in a much deeper way.

Later during that visit Grothendieck also met with Deligne to discuss the proof. Deligne recalled that Grothendieck was not as interested in the proof as he would have been had it used the theory of motives. "If I had done it using motives, he would have been very interested, because it would have meant the theory of motives had been developed," Deligne remarked. "Since the proof used a trick, he did not care." In trying to develop the theory of motives, Grothendieck had run into a major technical difficulty. "The most serious problem was that, for his idea of motives to work, one had to be able to construct enough algebraic cycles," Deligne explained. "I think he tried very hard and

he failed. And since then nobody has been able to succeed." According to Deligne, this technical obstacle to developing the theory of motives was probably far more frustrating to Grothendieck than his inability to prove the last Weil conjecture.

A Distant Voice

> [J]'ai quitté "le grand monde" mathématique en 1970....Après quelques années de militantisme anti-militariste et écologique, style "révolution culturelle", dont tu as sans doute eu quelque écho ici et là, je disparais pratiquement de la circulation, perdu dans une université de province Dieu sait où. La rumeur dit que je passe mon temps à garder des moutons et à forer des puits. La vérité est qu'à part beaucoup d'autres occupations, j'allais bravement, comme tout le monde, faire mes cours à la Fac (c'était là mon peu original gagne-pain, et ça l'est encore aujourd'hui).
>
> I left "the great world" of mathematics in 1970....After several years of anti-military and ecological militancy, "cultural revolution"-style, of which you have no doubt heard an echo here and there, I just about disappeared from circulation, lost in a university in some province, God knows where. Rumor has it that I pass my time tending sheep and drilling wells. The truth is that apart from many other occupations, I bravely went, like everyone else, to teach my courses in the Department (this was the way I originally earned my bread, and it's the same today).
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> —*Récoltes et Semailles*, page L3

When Grothendieck came to the Université de Montpellier in 1973, Yves Ladegaillerie, then twenty-five years old, was a *maître des conferences* there, having finished his doctorate at the Institut Henri Poincaré in Paris three years earlier. Grothendieck proposed that Ladegaillerie do a *thèse d'état* with him in topology and spent a great deal of time initiating the younger mathematician into his vision and methods. In a brief memoir about Grothendieck, Ladegaillerie wrote: "I had had as professors in Paris some of the great mathematicians of the day, from Schwartz to Cartan, but Grothendieck was completely different, an extra-terrestrial. Rather than translating things into another language, he thought and spoke directly in the language of modern structural mathematics, to whose creation he had contributed greatly" [Ladegaillerie]. Once, in order to verify a certain algebraic computation involving braids, Ladegaillerie made a little model using some string and a small plank with holes. This made Grothendieck laugh out of sheer delight: "At that moment, he was like a child before a wizard who performed a trick, and he told me: 'I would never have thought of doing that'."

Grothendieck lived an ascetic, unconventional life in an old house without electricity in Villecun, about thirty-five miles outside of Montpellier. Ladegaillerie remembered seeing Justine Bumby and her baby there, though she soon was gone. Many friends, acquaintances, and students went to visit Grothendieck, including people from the ecology movement. In 1974 the leader of a group of Buddhist missionaries from Japan came to visit Grothendieck, and after that many other adherents of Buddhism passed through his home (*R&S*, page 759). Once, after being host to a Buddhist monk whose travel documents were not in order, Grothendieck became the first person in France ever to be charged under an obscure 1949 law against "gratuitously lodging and feeding a stranger in an irregular situation" (*R&S*, page 53). As someone who had been stateless all his life, Grothendieck was outraged at the charge and tried to launch a campaign against it. He even traveled to Paris to speak about it at a Bourbaki seminar. His campaign made headlines in French national newspapers. Ultimately he paid a fine and received a suspended sentence.

It was around this time that Grothendieck learned to drive. He had an ancient Citroën of a model called 2CV and known informally as a *deux chevaux*. One of his students, Jean Malgoire, now a *maître des conferences* at Montpellier, recalled a terrifying journey through a torrential rainstorm with Grothendieck at the wheel. In addition to being a poor driver, Grothendieck was far more occupied with the discourse he was presenting to his passengers than with the condition of the road. "I was sure we would never get there alive!" Malgoire said. "I understood then that Alexandre had a very special relationship with reality.... Rather than adapting to what was real, he believed that reality would adapt itself to him." One time, while driving a moped, Grothendieck collided head-on with an automobile. According to Ladegaillerie, he had turned his eyes from the road to get an apricot out of a bag that was behind him. Although he had a leg fracture serious enough to require surgery, he requested acupuncture as the only anesthetic. He agreed to take antibiotics only when the surgeon told him that the alternative was to amputate the broken leg.

At the Université de Montpellier, Grothendieck had a regular faculty position and taught at all levels. Although the students were not as strong as the ones he had had in Paris, he nevertheless poured a great deal of energy, enthusiasm, and patience into

his teaching. He had an unconventional teaching style. For an examination involving polyhedra, he had students submit paper-and-glue models, much to the dismay of those who had to shepherd the exam papers through the grading process. One person who took undergraduate courses from him at Montpellier is Susan Holmes, now a statistician at Stanford University. "I found him very inspiring, as he was both unconventional and kind to the students, who really didn't understand at all that he was a great mathematician," she recalled. He showed up in the worn-out attire of a hippie and distributed his homegrown organic apples in class. "He definitely did not explain in a linear fashion suited to undergraduates, but his teaching was very inspiring, and one got the impression of some wonderful mysterious 'big picture'," Holmes said.

Grothendieck was never one for reading as a way to learn about and understand mathematics. Talking to others had always been his primary way of finding out what was going on in the field. His departure from the intense, stimulating atmosphere of the IHÉS, where oral exchanges were his primary mode of communication about mathematics, was an enormous change for him. Compared with the pace he kept during the 1960s, Grothendieck's later mathematical work was sporadic. Although he had several Ph.D. students at Montpellier, he did not establish anything like the thriving school he had headed at the IHÉS. Some of Grothendieck's former students and colleagues from his Paris days traveled to Montpellier to visit him. The most frequent of these visitors was Deligne, who during the 1970s was the main person keeping Grothendieck aware of new developments.

At Montpellier, Grothendieck did not have a seminar that met consistently. He formed a small working group with Ladegaillerie, Malgoire, and some of his other students, but according to Ladegaillerie it never really got off the ground. During 1980–81, he ran a seminar, whose sole attendee was Malgoire, on relations between Galois groups and fundamental groups. This is the subject of his 1,300-page manuscript *La Longue Marche à Travers la Théorie de Galois* (*The Long March through Galois Theory*), completed in 1981. Grothendieck did not publish *La Longue Marche*, but through Malgoire's efforts part of it was published in 1995 by the Université de Montpellier [Marche]. There was also a small working seminar in which Ladegaillerie gave some lectures on William Thurston's work on Teichmüller spaces, which stimulated Grothendieck's interest in this subject.

By the 1980s Grothendieck felt he had done all he could in trying to motivate the less-than-enthusiastic students at Montpellier and decided to apply for a position as a researcher in the Centre National de la Recherche Scientifique (CNRS). The CNRS, an agency of the French government, employs mathematicians and scientists to do research. Based at universities or research institutions, CNRS positions usually entail no teaching. In the 1950s, before he went to the IHÉS, Grothendieck had held a CNRS position. In the 1970s he applied to reenter the CNRS but was turned down. At that time, Michel Raynaud of the Université de Paris-Orsay was on the committee of mathematicians that reviewed CNRS applications. Raynaud said the CNRS administration had been hesitant to take Grothendieck on, arguing that it was unclear whether he would continue doing mathematics. The committee could not contradict this argument, and the application was turned down.

When Grothendieck reapplied to the CNRS in 1984, his application was once again controversial. Jean-Pierre Bourguignon, now director of the IHÉS, chaired the committee in charge of reviewing applications in mathematics, among which was Grothendieck's. According to Bourguignon, in the handwritten letter required for the application, Grothendieck listed several tasks he would not perform, such as supervising research students. Because CNRS contracts obligate researchers to perform some of these tasks, this letter was viewed by the CNRS administration as proof of Grothendieck's ineligibility. Bourguignon said he tried to get Grothendieck to amend his application so that it did not state explicitly all the tasks he refused to carry out, but Grothendieck would not budge. After considerable effort on the part of several people, Grothendieck was eventually put on a special kind of position, called a *position asterisquée*, that was acceptable to him and to the CNRS. The CNRS did not actually hire him but was in charge only of paying his salary, and he retained his university affiliation. So for his last few years at Montpellier before his retirement in 1988, Grothendieck did not teach and spent less and less time at the university.

The mathematical part of Grothendieck's 1984 application to the CNRS was the now-famous manuscript *Esquisse d'un Programme*. In it he outlines, in a somewhat mysterious but nevertheless penetrating and visionary fashion, a new area that he called "anabelian algebraic geometry". He also muses on the inadequacy of general topology and presents ideas for a renewal in the form of what he called "tame topology". The *Esquisse* also contains his ideas about *dessins d'enfants*, which he originally developed in order to have a simple way of explaining to students some notions in algebraic geometry and which have since spawned a good deal of research. Grothendieck sent the *Esquisse* to mathematicians who he thought might take an interest in it, and the manuscript circulated unpublished for several years.

Leila Schneps of the Université de Paris VI read the *Esquisse* in 1991. Before that she had identified

Grothendieck with the foundational works of *EGA* and *SGA*, and she found that the *Esquisse* was completely different. "It was a wild expression of mathematical imagination," she recalled. "I loved it. I was bowled over, and I wanted to start working on it right away." She became an enthusiastic evangelist for the research program described in the *Esquisse*, and she and others have made a good deal of progress on it. She said, "Some of it doesn't even seem to make sense at first, but then you work for two years, and you go back and look at it, and you say, 'He *knew* this'." She edited a book on *dessins d'enfants*, which appeared in 1994 [Schneps1], and in 1995 she and Pierre Lochak, also of the Université de Paris VI, organized a conference around the *Esquisse*. The *Esquisse* appeared for the first time in print in the proceedings of that conference [Schneps2].

Aside from the *Esquisse* and *La Longue Marche*, Grothendieck wrote at least one other mathematical work during the 1980s. *À la Poursuite des Champs* (*Pursuing Stacks*), which runs 1,500 pages, began as a letter to Daniel Quillen of the University of Oxford. Completed in 1983, it sketches Grothendieck's vision of a synthesis of homotopical algebra, homological algebra, and topos theory. *À la Poursuite des Champs* circulated widely among mathematicians but was never published. Although its topic is mathematics, the style of *À la Poursuite des Champs* is completely different from the style of his earlier mathematical writings. It was written as a sort of "log book" on a mathematical voyage of discovery, which includes all the false starts, wrong turns, and sudden inspirations that characterize mathematical discovery but that are typically omitted from written mathematical works. When nonmathematical matters drew his attention, they become part of the log book too: for example, *À la Poursuite des Champs* contains a digression about the birth of one of his grandchildren. During the 1990s he wrote a 2,000-page mathematical work on the foundations of homotopy theory called *Les Dérivateurs*, which he gave to Malgoire in 1995 and which is now being made available on the Web [Deriv].

While he was at Montpellier, Grothendieck's uncompromising, "anti-establishment" bent seems to have become more pronounced. After Ladegaillerie's thesis was finished, Grothendieck wrote to Springer-Verlag to suggest that it be published in the Lecture Notes series. He was outraged when he received the reply that the series no longer published theses. The thesis was submitted for publication anyway, with the predictable result that it was rejected. According to Ladegaillerie, Grothendieck wrote letters about this to colleagues, in an effort to build a campaign against Springer. Ladegaillerie decided to publish his thesis in the form of several papers rather than as a whole, and the main part appeared in *Topology*. Grothendieck reproached him for having cut the work into publishable pieces. As Ladegaillerie put it, Grothendieck tried to enlist him in his "fight against the establishment," but Ladegaillerie resisted, believing that such a fight was unreasonable and unjustified.

"Despite such disagreements, we have stayed friends, with highs and lows," Ladegaillerie said. Of his work with Grothendieck, Ladegaillerie said, "It was fascinating to work with a genius. I don't like this word, but for Grothendieck there is no other word possible....It was fascinating, but it was also frightening, because the man was not ordinary." Memories of working on mathematics with Grothendieck long into the night, by the light of a kerosene lamp, are "the greatest memories of my life as a mathematician."

Reaping and Sowing

> Il y a beaucoup de choses dans *Récoltes et Semailles*, et les uns et les autres y verront sans doute beaucoup de choses différentes: un *voyage* à la découverte d'un passé; une *méditation* sur l'existence; un *tableau de moeurs* d'un milieu et d'une époque (ou le tableau du glissement insidieux et implacable d'une époque à une autre...); une *enquête* (quasiment policière par moments, et en d'autres frisant le roman de cape et d'épée dans les bas-fonds de la mégapolis mathématique...); une vaste *divagation mathématique* (qui sèmera plus d'un...); un traité pratique de psychanalyse appliquée (ou, au choix, un livre de *"psychanalyse-fiction"*); une panégyrique de la *connaissance de soi*; "Mes *confessions*"; un *journal* intime; une psychologie de la *découverte et de la création*; un *réquisitoire* (impitoyable, comme il se doit...), voire un *règlement de comptes* dans "le beau monde mathématique" (et sans faire de cadeaux).
>
> There are many things in *Récoltes et Semailles*, and different people will no doubt see in it many different things: a *voyage* to the discovery of a past; a *meditation* on existence; a *portrait of the morals* of a milieu and of an era (or the portrait of an insidious and relentless sliding of one era into another...); an *inquest* (almost detective-style at times, and at others bordering on cloak-and-dagger fiction set in the underbelly of the mathematical megapolis); a vast *mathematical ramble* (which will leave more than one reader in the dust...); a practical treatise on applied psychology (or, if you like, a book of

"psychoanalytic-fiction"); a panegyric on *self-knowledge*; "My *confessions*"; a private *diary*; a psychology of *discovery and creation*; an indictment (pitiless, as is fitting), even a *settling of scores* in "the world of elite mathematics" (and without any gifts).

—*Récoltes et Semailles*, page L2

Between June 1983 and February 1986, Grothendieck wrote *Récoltes et Semailles: Réflexions et témoignage sur un passé de mathématicien* (*Reapings and Sowings: Reflections and testimony about the past of a mathematician*). It is a work that defies categorization. The title suggests a memoir, but *Récoltes et Semailles* is something more and less than a memoir. It is more, in that it contains not only memories of events in his life but also analyses, often quite deep and minute, of the moral and psychological significance of those events and his attempts to reconcile their meaning with his view of himself and the world. These analyses lead him into philosophical musings about the role of discovery and creativity in mathematics and in life more generally. At the same time, *Récoltes et Semailles* is something less than a memoir, in that it does not attempt a systematic and comprehensive account of events in Grothendieck's life. He is not writing for future biographers or historians, but primarily for himself. *Récoltes et Semailles* is a probing examination of matters closest to his heart. He brings to this work the searching curiosity, the same drive to get to the very bottom of things, that he brought to his mathematics. The result is a dense, multilayered work that reveals a great and sometimes terrifying mind carrying out the difficult work of trying to understand itself and the world.

Needless to say, *Récoltes et Semailles* is not an easy read, and Grothendieck makes a lot of demands on his readers. Much of it has a quotidian feel, and in some parts he is obviously setting down his thoughts as they evolve from one day to the next. As a result, within the space of a page there can be sudden and sometimes disconcerting changes in mood and topic. The organization is complex. The main text is divided into numbered sections, each with its own carefully chosen and evocative title. Within each section there are cross-references to other sections, as well as numerous footnotes, some quite long and substantial, and sometimes even footnotes to the footnotes. The wide-ranging vocabulary presents special challenges for those whose native language is not French, as does his penchant for using colloquialisms, some of them rather vulgar. Through it all Grothendieck writes with great care, insight, and clarity, in a pungent and arresting style. He often succeeds at describing things that at first glance would seem quite ineffable.

One of the reasons for the complexity of the structure of *Récoltes et Semailles*, and for its spontaneity, is that Grothendieck wrote it without a definite plan in mind. He started writing it as an introduction to *À la Poursuite des Champs*, which was to mark his return to making a serious investment of time and energy in doing and publishing mathematics. The introduction was intended to explain the new spirit of his research, which would not focus on the precise and exhaustive foundation-building of his earlier work, but would take readers on a "voyage of discovery" of new mathematical worlds. Grothendieck envisioned *Récoltes et Semailles* as the first volume of a series called *Réflexions*, which would contain his thoughts and reflections on things mathematical and otherwise. The second volume was to have been *À la Poursuite des Champs*, and *La Longue Marche à Travers la Théorie de Galois* and *Esquisse d'un Programme* were also to have been included.

In the first part of *Récoltes et Semailles*, which he called "Fatuité et Renouvellement" ("Complacency and Renewal"), Grothendieck does a lot of soul-searching about the mathematical community in which he worked. The welcoming atmosphere he encountered upon joining that community as a newcomer in 1948 began to disappear, he says, as mathematicians came to use their reputations to set themselves in a superior position. Mathematics became a way to gain power, and the elite mathematicians of the day became smug, feared figures who used that power to discourage and disdain when it served their interests. He ruefully recounts some instances in which he himself displayed attitudes of conceit and haughtiness and realizes that these attitudes had coalesced into a "sportive" or competitive approach to mathematics that had begun to hamper his ability to open himself to the beauty of mathematical things.

It was after writing "Fatuité et Renouvellement" that he was suddenly struck by "the insidious reality of a *Burial* of my oeuvre and at the same time of my person, which suddenly imposed itself on me, with an irresistible force and with this very name, 'The Burial', on [April 19, 1984]." (*R&S*, page L8). On that date he began writing what eventually became a three-part series called "L'Enterrement" ("The Burial"), comprising more than one thousand pages. In it he strongly attacks some of his former students and colleagues, whom he believes tried to "bury" his work and his style of mathematics by pilfering his ideas and not according proper credit to him. He also champions the work of Zoghman Mebkhout, who during the 1970s developed some of Grothendieck's ideas and whose work Grothendieck believes was unfairly marginalized and ignored. "L'Enterrement" presents six mathematical areas, or "construction sites" (*"chantiers"*), that he says were abandoned when

he left the IHÉS in 1970 and that he believes his students should have developed. Throughout "L'Enterrement" he closely analyzes his relationship with Pierre Deligne, the most brilliant of all of his students and the one with whom he had the closest mathematical affinity.

"L'Enterrement (II) ou La Clef du Yin et du Yang" ("The Burial (II) or the Key to Yin and Yang") is rather different from the other two parts of "L'Enterrement" in being less directly concerned with the investigation of the "burial". This second part, which Grothendieck notes is the most personal and deepest part of *Récoltes et Semailles*, constitutes a wide-ranging meditation on diverse themes such as creativity, intuition, violence, conflict, and the self. He uses the "yin-yang" dialectic to analyze different styles of doing mathematics, concluding that his own style is fundamentally "yin", or feminine. This style is captured in one especially evocative section called "La mer qui monte..." ("The rising sea..."). He likens his approach to mathematics to a sea: "The sea advances imperceptibly and without sound, nothing seems to happen and nothing is disturbed, the water is so far off one hardly hears it. But it ends up surrounding the stubborn substance, which little by little becomes a peninsula, then an island, then an islet, which itself is submerged, as if dissolved by the ocean stretching away as far as the eye can see" (*R&S*, page 553).

Grothendieck in a photograph from the 1950s.

In "L'Enterrement" he pursues some of the themes established in "Fatuité et Renouvellement" concerning the competitive, snobbish attitudes of the upper crust of the mathematical world. For example, he notes that much of his work in mathematics was marked by an "attitude of service": service to the mathematical community of writing clear and complete expositions that make fundamental and foundational ideas widely accessible. Although he candidly admits that his own conceit sometimes led him into elitist attitudes, he says that he never lost this spontaneous sense of service, "service to all those who leaped with me into a common adventure" (*R&S*, page 630, (*)). He believes that the mathematical community lost this sense of service as personal aggrandizement and the development of an exclusionary elite became the order of the day. He also decries the devaluation of vision and intuition in favor of technical mastery.

Apart from "Fatuité et Renouvellement" and the three parts that make up "L'Enterrement", *Récoltes et Semailles* has two introductory volumes, as well as an appendix to "La Clef du Yin et du Yang". About two hundred copies were sent out to his mathematical colleagues. Despite Grothendieck's intention to publish it, the original French-language version of *Récoltes et Semailles* has never appeared in print, as the strong attacks it contains could be deemed libelous. Nevertheless, it has circulated widely. Copies can be found on bookshelves in mathematicians' offices all over the world, especially in France, and in some libraries in universities and mathematics institutes. Historian of science Alain Herreman of the Université de Rennes has undertaken an effort to post on the Web html files containing the entire French original, and partial translations into English, Russian, and Spanish have appeared there too [*R&S*]. A Japanese translation of a large portion of *Récoltes et Semailles* was prepared by Yūichi Tsuji, who knew Grothendieck through the Survival group, and was published in the 1990s by Gendaisūgakusha, a mathematics publisher. According to Michel Waldschmidt of the Université de Paris VI, who was president of the Société Mathématique de France (SMF) during 2001–04, the society considered, during his presidency, the question of whether to publish *Récoltes et Semailles*. The question raised strong opinions both for and against, Waldschmidt said, and ultimately the SMF decided against publication.

Many mathematicians, especially some of Grothendieck's former students, were shocked and hurt by the accusations in *Récoltes et Semailles*. One of them, Luc Illusie of the Université de Paris-Orsay, recalled that he talked to another former student, Jean-Louis Verdier, about whether they should try to discuss the accusations with Grothendieck. According to Illusie, Verdier, who died in 1989, felt that Grothendieck's state of mind was such that there was no sound basis for discussion. But, Illusie said, "I thought, 'It is not possible that Grothendieck has become like that. I will try to reason and to discuss with him. Maybe I will agree with him on some points that he is right and on others he is not right.' Eventually, we settled the material points, but nothing really emerged, and he remained convinced that everyone was against him."

In *Récoltes et Semailles* Grothendieck says that, after he left the mathematical world in 1970, his style of doing mathematics was held in contempt and that many of the paths he had broken went undeveloped. It is true that after that time, research in algebraic geometry began to shift, mixing the highly general approach that characterized his work with investigation of specific problems. Deligne's proof of the Weil conjecture, which was

very much in the spirit of Grothendieck but which also incorporated many new ideas, was one of the great advances of the 1970s. Along with developments in the theory of D-modules and Deligne's mixed Hodge theory, greater attention began to be paid to more specific problems, such as the classification theory of varieties and questions about low-dimensional varieties. Also, after the Antwerp meeting of 1972, collaborations grew between algebraic geometry and representation theory, leading to advances in the theory of automorphic forms and the Langlands program. As Illusie put it, all these developments show that there has been "quite a natural balance between general theory and the study of specific examples at great length, to enrich the theory itself."

Récoltes et Semailles also contains the accusation that Grothendieck's work was not always properly credited. Indeed, his work was so well known and fundamental that credit was not always specifically accorded to him. "It is true that everybody knew he had invented motives, for instance, or l-adic cohomology, and so there was no need to quote his name every time one used them," remarked Jean-Pierre Serre. "His name was rarely mentioned because of that. On the other hand, it was well known that it was due to him. Nobody was saying that it was due to someone else." Serre noted that Grothendieck's complaining about lack of credit is in sharp contrast to his behavior during the 1960s, when he shared his ideas with great generosity and in some cases attached other people's names to ideas he himself had come up with. "It was sad to read *Récoltes et Semailles* because of that," Serre said.

Even granting that there was a shift away from Grothendieck's style of mathematics and that credit was not always specifically accorded to him, it is a long leap from there to the deliberate "burial" that he asserts took place. "In retrospect, very few mathematical ideas have been as widely used as Grothendieck's," said Illusie. "Everybody who is doing algebraic or arithmetic geometry now uses Grothendieck's language, ideas, theorems, and so on. So when you think one second, it is completely ridiculous that he suggested that he could have been buried." There is no question that mathematics suffered a great loss when Grothendieck halted his research career in 1970. But mathematics did not stop; others continued to work, following their own ideas and interests. In February 1986, after receiving a copy of *Récoltes et Semailles*, Serre wrote to Grothendieck: "You are surprised and indignant that your former students did not continue the work that you had undertaken and largely completed. But you do not ask the most obvious question, the one every reader expects you to answer: and you, why did you abandon the work in question?" [Corr].

Contents of *Récoltes et Semailles*

Although the accusations of a "burial" have generated a good deal of notoriety, there is much more to *Récoltes et Semailles*. Those who have read beyond those parts have been deeply touched by the work's beauty and insights. Grothendieck's critique of how the highly competitive atmosphere of the mathematical world stifles creativity and renewal of the field resonated with many. In *Récoltes et Semailles* Grothendieck puts the highest value on the innocent, childlike curiosity that gives birth to the creative impulse, and he mourns the way it is trampled on by competitiveness and the desire for power and prestige.

"I am one of quite probably a minority who think that *Récoltes et Semailles* is a miraculous document," said William Messing. "That is not to say that there are not parts that are excessive and have aspects of what might be referred to as paranoia. But it's very striking that the person who created *EGA* and *SGA* would write in such a style. The systematic and soul-searching aspect is of a piece with his approach to mathematics. Those who have really read it—as opposed to looking at five pages of negative comments—tend to think of it as an extraordinary document."

Lightness Descending

> [A]ujourd'hui je ne suis plus, comme naguère, le prisonnier de tâches

interminables, qui si souvent m'avaient interdit de m'élancer dans l'inconnu, mathématique ou non. Le temps des *tâches* pour moi est révolu. Si l'âge m'a apporté quelque chose, c'est d'être plus léger.

Today I am no longer, as I once was, the prisoner of interminable tasks, which so often prevented me from leaping into the unknown, mathematical or otherwise. The time of *tasks* for me is over. If age has brought me anything, it is lightness.

—*Esquisse d'un Programme*

"[T]he ethics of the scientific profession (especially among mathematicians) have degraded to such a degree that pure and simple theft between colleagues (especially at the expense of those who have no position of power to defend themselves) has almost become the general rule and is in any case tolerated by all, even in the most flagrant and iniquitous cases." So wrote Grothendieck in an April 19, 1988, letter to the Royal Swedish Academy of Sciences in which he declined the 1988 Crafoord Prize. He also sent to the academy the introductory volumes of *Récoltes et Semailles*. The academy had awarded the prize of around US$200,000 to him and Pierre Deligne. Grothendieck's letter became widely known when it was published in *Le Monde* on May 4, 1988 [LeMonde]. To play into the game of accepting prizes and honors, Grothendieck wrote, would be to validate "a spirit and an evolution in the scientific world that I see as profoundly unhealthy, and condemned to disappear soon, so suicidal is it, spiritually as well as intellectually and materially." Evidently these sentiments resonated with many readers of *Le Monde*. One of the newspaper's editors told Jean-Pierre Bourguignon that the paper had received more reactions to Grothendieck's letter than to any other preceding it and that most of the letters registered approval that finally a scientist had recognized how corrupt the scientific milieu had become. News of the letter appeared in other magazines and newspapers, and it was avidly discussed within the mathematical community. An English translation was published in the *Mathematical Intelligencer* [Intell], and a short item appeared in the *Notices* [Notices].

The same year in which he turned down the Crafoord Prize, Grothendieck retired from the Université de Montpellier at the age of sixty. Also that year, six mathematicians decided to assemble a collection of articles as a "Festschrift" on the occasion of Grothendieck's sixtieth birthday [Festschrift] (there was also a special issue of the journal *K-Theory* dedicated to Grothendieck). The Festschrift seems to have been an attempt to make amends with Grothendieck and to show that he had not been "buried", as he asserted in *Récoltes et Semailles*. Some of the people contributing papers were among those he had most heavily criticized. When the Festschrift appeared in 1990, Illusie, who was one of the editors, sent a copy to Grothendieck, whose reaction was extremely bitter. In a letter to Illusie, he objected strongly to the brief foreword of the volume and also to the fact that he had not been told that the volume would appear. He said his work had been used like "confetti," like bright, worthless bits one throws into the air to give the pretense of happiness and celebration while ignoring the malaise underneath. Grothendieck submitted this letter for publication in the *Bulletin de la Société Mathématique de France*. When the SMF told him that the *Bulletin* carries only mathematics articles but that the letter could appear instead in the *SMF Gazette*, Grothendieck refused. The letter was never published.

After he retired, Grothendieck spent little time at the Université de Montpellier, though he continued to live in the area, in a village called Les Aumettes. At this time, Ladegaillerie said, Grothendieck seemed to be going through a deep spiritual crisis and wrote strange letters "that made us fear the worst about his condition." During 1987–88, Grothendieck wrote *La Clef des Songes ou Dialogue avec le Bon Dieu* (*The Key to Dreams or Dialogue with the Good Lord*), which expresses his conviction that God exists and that He speaks to people through their dreams. It also contains a good deal of material about Grothendieck's early life. *La Clef des Songes* runs about three hundred pages and is accompanied by another five hundred pages of notes. According to a lecture given in the summer of 2004 by Winfried Scharlau of the Universität Münster, Grothendieck subsumed *La Clef des Songes* under a collection of works that he called *Méditations* and that included the material making up *Réflexions*, as well as a poetical work called "Eloge de l'Inceste" ("The Eulogy to Incest"). Neither that work nor *La Clef des Songes* was ever widely distributed.

Many of Grothendieck's friends and colleagues became aware of his increasing preoccupation with spiritual matters when they received "La Lettre de la Bonne Nouvelle" ("The Letter of Good News"), which is dated January 26, 1990, and which he sent to about two hundred fifty people. The letter states: "You are part of a group of two to three thousand people, personally known to me, whom God destines for a great mission: That of announcing and preparing the *'New Age'* (or *Age of Liberation...*), which will commence on the *'Day of Truth'*, 14 October 1996." He says that God manifested Himself to him for the first time in 1986 and

communicated to him through dreams. He also describes encounters with a deity named Flora, who imparts revelations but also cruelly tests his faith. Although the content of the letter is baffling, the way it is written is perfectly lucid. Three months later Grothendieck sent a "correction", stating that he was no longer certain of the truth of the revelations described in "La Lettre de la Bonne Nouvelle". He writes: "That I was the victim of a mystification by one of more 'spirits' (among which my limited capacity could not distinguish), invested with prodigious powers over my body and in my psyche, I no longer have the least doubt." Together, the two letters impart an impression of deep disturbance and suffering.

In July 1990 Grothendieck asked Malgoire to take possession of all of his mathematical papers, including books, preprints, correspondence, and manuscripts in various states of preparation. Grothendieck wanted to "lighten" himself of many things, as Malgoire put it. He burned a huge amount of material, most of it nonmathematical, including letters that his parents had exchanged in the 1930s. He showed Malgoire a 200-liter oil drum filled with cinders and estimated he had destroyed a total of 25,000 pages. Grothendieck also left many papers and other items, including his mother's death mask, with a friend named Yolande Levine, to whom he had been very close for the preceding decade. He then disappeared into the Pyrenées to live in complete isolation. A small number of people knew where he was, and he instructed them not to forward any mail that arrived for him at the university. Malgoire said that even today, close to fifteen years after Grothendieck went into seclusion, the university still gets a great deal of correspondence addressed to him. In 1995 Grothendieck formally conferred the legal rights to his mathematical papers to Malgoire.

Grothendieck has had very little contact with mathematicians in the past fifteen years. Among the few who have seen him are Leila Schneps and Pierre Lochak, who met him in the mid-1990s. They told him about the progress made on the program he had outlined in the *Esquisse d'un Programme*, and he was surprised to learn that people were still interested in his work. He had developed a strong interest in physics but expressed frustration with what he felt was a lack of rigor in that field. Lochak and Schneps exchanged some letters with him and also sent him some books on physics that he had asked for. In one letter he asked a disarmingly simple question: What is a meter? His letters began to swing between warm friendliness and cold suspicion, and eventually he severed all contact with them. Although the friendship with Grothendieck could not be sustained, Lochak and Schneps retain a fervent admiration and a deep attachment to the man and his work. Together they painstakingly typed into TEX a large chunk of the handwritten *La Longue Marche à Travers la Théorie de Galois*. They have also started a website, the Grothendieck Circle, which contains a wealth of material about Grothendieck, his life, and his work [Circle].

The Dancing Star

> Ich sage euch: man muß noch Chaos in sich haben, um einen tanzenden Stern gebären zu können. Ich sage euch: ihr habt noch Chaos in euch.
>
> I tell you: one must have chaos inside, to give birth to a dancing star. I tell you: you have yet chaos in you.
>
> —Friedrich Nietzsche, *Also sprach Zarathustra*

The work of Alexandre Grothendieck has had a profound impact on modern mathematics and, more broadly, ranks among the most important advances in human knowledge during the twentieth century. The stature of Grothendieck can be compared to that of, for example, Albert Einstein. Each of them opened revolutionary new perspectives that transformed the terrain of exploration, and each sought fundamental, unifying connections among phenomena. Grothendieck's propensity for investigating how mathematical objects behave relative to one another echoes the relativistic viewpoint proposed by Einstein. Grothendieck's work also has parallels with another great twentieth-century advance, that of quantum mechanics, which turned conventional notions upside down by replacing point particles by "probability clouds". "[T]hese 'probability clouds', replacing the reassuring material particles of before, remind me strangely of the elusive 'open neighborhoods' that populate the toposes, like evanescent phantoms, to surround the imaginary 'points'," he wrote (*R&S*, page P60).

Yet, as extraordinary as Grothendieck's achievements are, he traced his creative capacity to something rather humble: the naive, avid curiosity of a child. "Discovery is the privilege of the child," he wrote in *Récoltes et Semailles* (page 1), "the child who has no fear of being once again wrong, of looking like an idiot, of not being serious, of not doing things like everyone else." For the work of discovery and creation, Grothendieck saw intellectual endowment and technical power as secondary to the child's simple thirst to know and understand. This child is inside each of us, though it may be marginalized, neglected, or drowned out. "Each of us can rediscover what discovery and creation are, and no one can invent them" (*R&S*, page 2).

One aspect of this childlike curiosity is a scrupulous fidelity to truth. Grothendieck taught his students an important discipline when writing about mathematics: never say anything false. Statements that were almost or essentially true were not permitted. It was acceptable to be vague, but when one gives precise details, one must say only things that are true. Indeed, Grothendieck's life has been a constant search for truth. From his mathematical work through *Récoltes et Semailles* and even "La Lettre de la Bonne Nouvelle", Grothendieck wrote with the unblinking honesty of a child. He spoke the truth—*his* truth, as he perceived it. Even when he made factual mistakes or was misled by incorrect assumptions, he presented candidly what was in his mind. He has never tried to hide who he is and what he thinks.

Grothendieck's search for truth took him to the very roots of mathematical ideas and to the far reaches of human psychological perception. He has had a long journey. "In his solitary retirement in the Pyrenées, Alexandre Grothendieck has the right to rest after all he has been through," wrote Yves Ladegaillerie [Ladegaillerie]. "He deserves our admiration and our respect but, above all, in thinking of what we owe him, we must leave him in peace."

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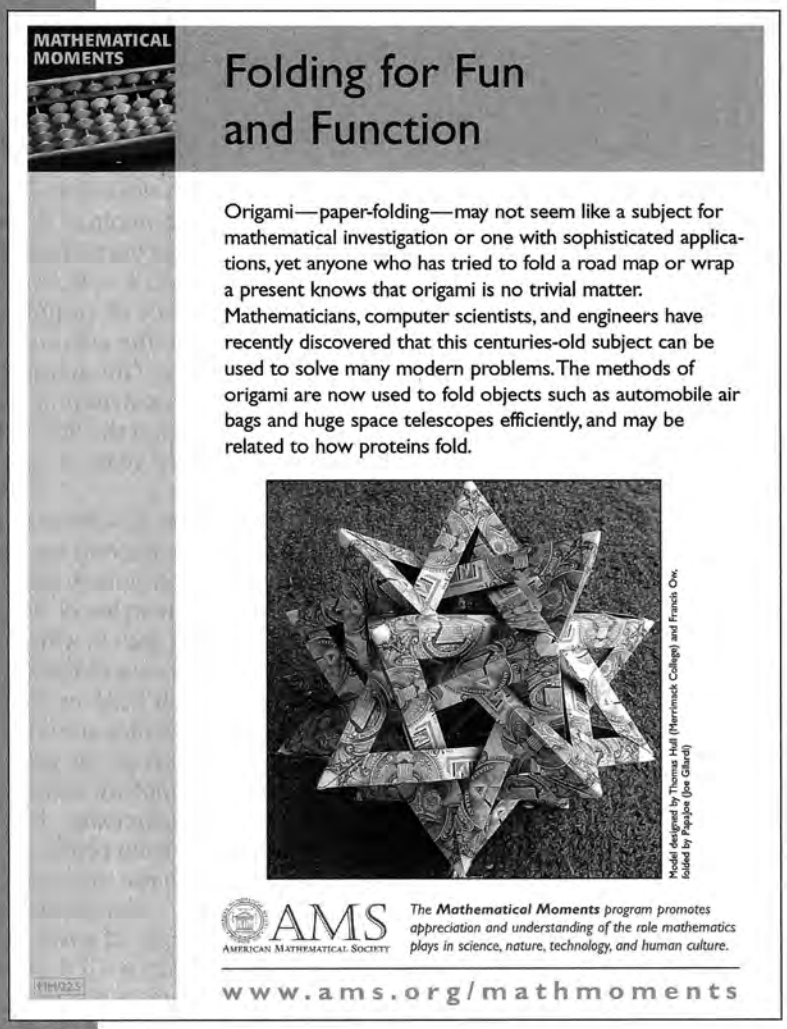

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WHAT IS . . .

a Motive?

Barry Mazur

How much of the algebraic topology of a connected finite simplicial complex X is captured by its one-dimensional cohomology? Specifically, how much do you know about X when you know $H^1(X, \mathbf{Z})$ alone?

For a (nearly tautological) answer, put $GX :=$ the compact, connected abelian Lie group (i.e., product of circles) which is the Pontrjagin dual of the free abelian group $H^1(X, \mathbf{Z})$. Now $H^1(GX, \mathbf{Z})$ is canonically isomorphic to $H^1(X, \mathbf{Z}) = \mathrm{Hom}(GX, \mathbf{R}/\mathbf{Z})$ and there is a canonical homotopy class of mappings

$$X \longrightarrow GX$$

that induces the identity mapping on H^1.

The answer: we know whatever information can be read off from GX and are ignorant of anything that gets lost in the projection $X \to GX$.

The theory of Eilenberg-Mac Lane spaces offers us a somewhat analogous analysis of what we know and don't know about X, when we equip ourselves with n-dimensional cohomology, for any specific n, with specific coefficients.

If we repeat our rhetorical question in the context of algebraic geometry, where the structure is somewhat richer, can we hope for a similar discussion?

In algebraic topology, the standard cohomology functor is uniquely characterized by the basic Eilenberg-Steenrod axioms in terms of a simple normalization (the value of the functor on a single point). In contrast, in algebraic geometry we have a more intricate setup to deal with: for one thing, we don't even have a cohomology theory with coefficients in $\mathbf{Z}$ for varieties over a field k unless we provide a homomorphism $k \to \mathbf{C}$, so that we can form the topological space of complex points on our variety and compute the cohomology groups of that topological space. One perplexity here is that this cohomology construction may (and in general, does!) depend upon the imbedding $k \to \mathbf{C}$. And, of course, there are fields k not admitting embeddings into $\mathbf{C}$.

In compensation, there is a profusion of different cohomology functors beyond the ones coming from classical algebraic topology via imbeddings $k \to \mathbf{C}$. Some of these theories come dependent upon the specific ground field k, with their specific rings of coefficients, and with global requirements on the varieties for which they are defined. Some come with their own particular attendant structure and with their relations to all the other cohomology theories: *Hodge cohomology*, *algebraic de Rham cohomology*, *crystalline cohomology*, the *étale ℓ-adic cohomology theories* for each prime number $\ell, \ldots$

Is there some systematic and natural way of encapsulating all this information about the n-dimensional cohomology of projective smooth varieties V (even just for $n = 1$)? (The tradition has been to simplify things a bit by tensoring the cohomology theories in question with $\mathbf{Q}$ before asking this question.)

If you restrict your attention only to one-dimensional cohomology, things seem promising. For example, recall the construction that associates to any smooth projective curve C over a field k its

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jacobian $J(C)$, which is an abelian variety over k of dimension equal to the genus of C. The group of points of $J(C)$ over an algebraic closure of k consists in the quotient group of divisors of degree zero modulo divisors of zeroes-and-poles of rational functions on C. The classical construction gives us a clean functor, $C \mapsto J(C)$, from the subcategory of such curves to the additive category of abelian varieties over k, preserving all 1-dimensional cohomological information. This is somewhat reminiscent of the passage $X \mapsto GX$ described earlier, except for the fact that the target, $J(C)$, is an abelian variety over k; it has a good deal more structure than the product of circles GX.

Generalizing this, there is a beautiful construction, due essentially to Albanese, that associates to an algebraic variety V of arbitrary dimension an abelian variety $A(V)$ over k. We might hope for something similar for higher dimensional cohomology, seeking some sort of algebraic geometric version of Eilenberg-Mac Lane spaces to replace the abelian varieties (up to isogeny) that do the trick for dimension 1. But it's not that simple.

A strategy to encapsulate all the different cohomology theories in algebraic geometry was formulated initially by Alexandre Grothendieck, who is responsible for setting up much of this marvelous cohomological machinery in the first place. Grothendieck sought a single theory that is *cohomological* in nature that acts as a gateway between algebraic geometry and the assortment of special cohomological theories, such as the ones listed above—that acts as the *motive* behind all this cohomological apparatus. Here is his description:

> Contrary to what occurs in ordinary topology, one finds oneself confronting a disconcerting abundance of different cohomological theories. One has the distinct impression (but in a sense that remains vague) that each of these theories "amount to the same thing", that they "give the same results". In order to express this intuition, of the kinship of these different cohomological theories, I formulated the notion of "motive" associated to an algebraic variety. By this term, I want to suggest that it is the "common motive" (or "common reason") behind this multitude of cohomological invariants attached to an algebraic variety, or indeed, behind all cohomological invariants that are a priori possible. [G]

Grothendieck goes on, in that text, [G], to work out a musical analogy, referring to the *motivic cohomology* he desires to set up as the basic *motif* from which each particular cohomology theory draws its thematic material, playing it in a key, major or minor, and a tempo all its own.

Think of axiomatizing a cohomology theory[1] in algebraic geometry over a field k as a contravariant functor $V \mapsto H(V)$ from the category of smooth projective varieties over k to a graded abelian category $\mathcal{H}$ (where sets of morphisms between objects of $\mathcal{H}$ form $\mathbf{Q}$-vector spaces) with all the properties we expect. For example, we would want any correspondence $V \to W$ (i.e., algebraic cycle in the product $V \times W$ that can be viewed as the "graph" of a multivalued algebraic mapping) to induce, contravariantly, a mapping on cohomology. Moreover, we want our category $\mathcal{H}$ to be an adequate receptacle for our cohomology theory, which should enjoy the standard perquisites of the usual cohomology theories, such as the Künneth formula and Poincaré duality.

Grothendieck's initial attempt to *fashion* a universal cohomology theory is elegant and cleanly straightforward. Start with the category of projective varieties and modify it in a formal, and most economical, manner to produce a category—one hopes that it is abelian—that has all the cohomological properties one wants. There are three steps to this. First, change the morphisms of the category of projective varieties, replacing them by equivalence classes of $\mathbf{Q}$-correspondences, where the equivalence relation is chosen to be the coarsest one which, by the axioms of cohomology theory, can be seen to induce well-defined homomorphisms on cohomology. Second, augment the objects of the category to make it look more like an abelian category (formally deeming, for example, kernels and images of projectors as new objects of the category) and a category in which, for example, the Künneth formula can be formulated. Third, let $\mathcal{H}$ be the *opposite category* of what was constructed in step two. The natural contravariant functor from the category of smooth projective varieties to $\mathcal{H}$ will, by its design, factor through any particular cohomology theory and therefore might be considered to be our "theory of motives".

The first problem with any such construction is its nonexplicit nature. Standing in the way of any explicit understanding of the category of motives is a constellation of conjectures that offer cohomological criteria for existence of correspondences and, more generally, for the existence of algebraic cycles (e.g., versions of *Hodge conjectures* over $\mathbf{C}$ and/or *conjectures of Tate* over finite fields). Any concrete realization of the projected theory of motives—even in some limited context—seems to bear directly upon these standard conjectures, and vice versa.

[1] *Compare the notions of a geometric cohomology theory in [M] and the slightly more restricted version of this, called a Weil cohomology theory, in [K].*

The dream, then, is of getting a fairly usable description of the universal cohomological functor,

$$V \mapsto H(V) \in \mathcal{H},$$

with $\mathcal{H}$ a very concretely described category. At its best, we might hope for a theory that carries forward the successes of the classical theory of 1-dimensional cohomology as embodied in the theory of the jacobian of curves, and as concretized by the theory of abelian varieties, to treat cohomology of all dimensions. Equally important, just as in the theory of group representations where the irreducible representations play a primal role and have their own "logic", we might hope for a similar denouement here and study direct sum decompositions in this category of motives, relating $H(V)$ to irreducible motives, representing cohomological pieces of algebraic varieties, perhaps isolatable by correspondences, each of which might be analyzed separately.

Recently, the work of Vladimir Voevodsky and his collaborators have provided us with a very interesting candidate-category of motives: a category (of sheaves relative to an extraordinarily fine Grothendieck-style topology on the category of schemes) which in some intuitive sense "softens algebraic geometry" so as to allow for a good notion of homotopy in an algebro-geometric setup and is sufficiently directly connected to concrete algebraic geometry to have already yielded some extraordinary applications.

The quest for a full theory of motives is a potent driving force in complex analysis, algebraic geometry, automorphic representation theory, the study of L functions, and arithmetic. It will continue to be so throughout the current century.

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The Elephant in the Internet

Daniel K. Biss

Although we live in a time of endlessly overhyped sociogeopolitical trends (the threat of terrorism, the Asian economic miracle, the genius of Eminem, etc.), the most revolutionary and important change taking place in human society is puzzlingly neglected, perhaps precisely because its earth-shaking status has delayed the development of a vocabulary adequate for the sort of discourse that is called for. I am referring, of course, to the rise of the personal computer and the internet and the resulting reorganization of the relationship between human beings and information.

Perhaps the most crucial aspect of this discussion is the question of how the Internet is to influence the existing global power dynamic. Glimmers of this debate are already slipping into the public eye; the legal battle over downloaded music has been deemed the most newsworthy, but it is merely a single node in a vast web of intellectual property conundra, which itself fits into a yet bigger picture cluttered with concerns about free speech, international trade, tax law, and so forth.

The crux of the issue is simple: like any invention that redefines the way we communicate, the Internet empowers some groups of people and weakens others. Again, the most widely publicized example is the radical shift in the interaction between consumer and producer in the music industry; other prominent instances include political activism, publishing, and, of course, sex and dating. When a sea change like this occurs, those whose dominance is threatened tend to become overwhelmed by paranoia; on the other side of the coin, a delighted alliance forms between those who have been vaulted into power and those who instinctively support any revolution.

Of course, one must be careful to give no quarter to either side; nothing has been gained if the Internet merely serves to replace one unjust or oppressive ruling class by another. Instead, we should strive to use new technologies to right existing wrongs and open closed doors without creating new imbalances or leaving anyone behind; needless to say, this is no easy task. The mathematical community interacts with this headache in a primarily one-dimensional way, namely via the tension between print and electronic media, and particularly between high-priced corporate journals and everybody else. As is perhaps sadly emblematic of a broader pattern, mathematicians seem to be engaging primarily with the least complex issues that arise, namely the (astonishing) cost of privately owned journals and the administrative entity that needs to form in response to the widespread use of electronic archives that lack any kind of peer review.

Apparently I'm missing something, but each of these issues seems fairly straightforward to me. The question of journal pricing strikes me as essentially an economic one, rather than a moral one, notwithstanding the lexicon that is usually brought to the table. Simply put, *The Annals of Mathematics* delivers a product that compares quite favorably to that offered by *Advances in Mathematics* and at a fraction of the price. Thus, if library budgets are at all constrained, then given that mathematicians stay mindful of these disparities, *Advances* will remain able to engage in its aggressive pricing for only so long; if, by contrast, university libraries suddenly magically attain the ability to function like the American military, then the Halliburton-Elsevier axis will prosper for centuries to come.

In a similar vein, it's my belief that the level of concern surrounding the nexus of electronic

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archives and peer review is distinctly exaggerated. Leaving aside the (deeply fundamental) existential questions that arise automatically from the use of words such as *proof* and *correct*, let me just point out that no honest mathematician uses a result simply because it has been published. Rather, we use results that we trust are true; it is incumbent upon each individual to arrive at a considered personal decision about what the defining threshold for this notion is, but surely, for any of us, the answer lies in some complex mélange of what has been published, what has been accepted as true by a larger community, and (most importantly, one hopes) what we believe ourselves to understand. Presumably, even if we are to entirely abandon the stamp of peer review, we can take some comfort in the fact that the audience (of potential debunkers) reached by any given paper is now potentially much wider and more diverse than it ever could have been before.

On the other hand, I do believe that the Internet has the potential to influence the nature of research mathematics in a much subtler and potentially more pernicious manner than those we've addressed so far. To convey this, it's perhaps best to begin with a little discussion about the nature of the mathematical community, with particular attention to the features that make it unique and, in certain respects, uniquely attractive.

There is an oft-repeated analogy that holds that the relationship between mathematics and physics is akin to that between classical and popular music. Though shallow and imperfect, the analogy contains a grain of truth. A piece of classical music, the argument goes, is composed with painstaking attention to detail and subtlety; thus the resulting text is something close to sacred, and consequently, the devotion of countless hours to perfecting a rendering of a brief passage is a noble task. At the same time, one cannot expect such a delicate, carefully balanced creation to speak to us on a primal level (but try telling that to Igor Stravinsky!). By contrast, popular music is supposedly coarse and elemental; it is highly sensitive to cultural change and thus has urgency and currency, but it is disposable and too blunt to be worth burnishing (but try telling that to Thom Yorke!).

You can now surely see where this is going: physics lurches to and fro, replete with fads, false starts, and fanciful leaps of insight, whereas mathematics keeps pushing heroically forward, unencumbered by external concerns. A physics paper, like a newspaper article, is not meant for posterity; dotting of i's and crossing of t's is meant to happen after the fact, and is not in any case the "real" work of a physicist. A mathematics paper, on the other hand, is supposed to be a work of art: perfect, complete, and beautiful. We write in the hope that we will be read centuries from now (and, indeed, we still delight in reading the works of the old masters, for reasons that extend well beyond the historical). Most mathematicians seem to feel that one should never write a paper whose ideas are not fully fleshed out, whose details are not all in place.

It is my belief that these stereotypes are extremely dangerous but not entirely without merit. Because exposing all of their shortcomings would carry us too far afield, let us instead take from all of this one crucial fact, namely that there exists in mathematics a tradition of great expository care and love, that (all evidence aside) mathematicians care deeply about how their papers look and sound and spend endless hours agonizing over wording, phrasing, and structure. It is my (aggressively clung to) belief that this is emphatically good. In fact, pretty much every mathematician has spent hours involved in debates about whether what we do constitutes an art or a science; surely the only meaningful answer is that it is neither, and the attitude we have toward our creations as purely aesthetic entities—which attitude is strongly reinforced by our approach to writing—is one of the crucial differences between our discipline and that of a scientist.

At this point, it's perhaps not clear what any of this has to do with the Internet. The answer lies in the fact that the Internet is a novel medium primarily in the ease with which anyone can make information publicly available. It consists of a vast and largely unfiltered pile that can quite easily bury a potential reader. This presents authors with a new challenge; rather than try to impress an élite group of professionals (publishers, referees, and the like) in order to attain a specific goal whose consequences are known quantities, one must now post writings for all to see and somehow hope to snatch the wandering attentions of a large enough slice of the audience. For readers, this has the effect of creating a vast and bewildering array of options, and our instinctive response is to reach out for whatever strikes us first. This in turn creates a system that rewards large gestures and makes it more difficult to reach any audience at all with subtleties that demand careful attention or even (God forbid) repeated readings.

This effect is easy to see in the arena of fiction. The weblog has given rise to a whole generation of young, trendy writers who have attained prominence on the strength of their popular websites and online journals. Most of these authors have extremely sharp wits and are absolute masters of the brief, comedic, and highly autobiographical essay. However, in spite of my admiration for their writing (and in spite of the extent to which they help ease the pain of my less mathematically productive days), I suspect that we can all agree that literature would suffer if success came to be equated

entirely with this type of cleverness. Indeed, it is still emphatically possible to attain success by sending a manuscript to a few influential agents, editors, or publishers; I have heard no one suggest that it would be likely or desirable for this to change in the foreseeable future.

By contrast, we seem to be reaching a moment during which essentially all mathematical writings are distributed first (if not exclusively) on cluttered archives. To be sure, there are important differences between the enterprises of mathematical (or, more generally speaking, scholarly) publication and broadly marketed fiction. In the first place, it is usually agreed that a mathematical publication is to be judged primarily on the content of its results; so long as the writing is at all competent, any expert should be able to identify these almost instantaneously and evaluate them accordingly. Therefore, preprint archives, at least in principle, allow researchers to quickly peruse the entire literature in a given area and decide which articles to read more carefully; this is almost exactly the orthodox argument in favor of the archives.

What, then, is the influence of the Internet on the nature of mathematical writing itself, as opposed to just its distribution? I have already conceded that it is unclear to what extent the information-glut aspect of the Internet induces us to produce shorter, punchier, flashier documents. However, another, somewhat different, force is in very clear evidence. Namely, the Web allows us to communicate in a less formal environment that is mediated by fewer norms and less historical baggage. Moreover, an electronic Web-based document is never necessarily completed; there is no publication date after which revisions become impossible. These two qualities have the effect of decreasing the author's emotional investment in the finer expository aspects of a mathematics paper. Indeed, the reasoning goes, if I do not intend to see this piece of work promoted to canonic status by virtue of its binding and typesetting, then why should I invest agonized hours in the aesthetic aspects of its writing? Furthermore, even if I do in principle intend to put in the required time, why should that occur now, given that this current version is not expected to be permanent in any case?

The effects of this phenomenon are already being felt: online, one often encounters articles that the authors readily admit to be unsuitable for paper-journal publication. (It is interesting to note that this self-policed dual standard arose organically, in spite of the fact that hardly anyone ever attempts to carefully articulate what sort of writing is "good enough to publish".) The more we feel that there is an acceptable outlet for these unpolished works, the less likely we are to devote the energy needed to bring them to what used to be considered completion. One could, of course, argue that this merely has the effect of creating a second forum for mathematical publication, which has some advantages over paper journals (efficiency, breadth, and cost of distribution) and some disadvantages (lower standards that give rise to a general lapse in quality). However, although this already seems to contradict the vision of most advocates of Web-based publishing, I fear that there is a much more serious problem brewing.

Beautiful mathematical writing is already an unfortunately underemphasized, underpracticed, and underrewarded art; our community desperately clings to the untenable position that someone already recognized as a great mathematician is perhaps entitled to extra admiration by virtue of being an exemplary expositor but that an extraordinary writer who cannot back up this skill with amazing new theorems is of no particular value. Disappointing though this system may be, it at least ascribes some—albeit insufficient—worth to the creation of carefully designed articles, whose merits comprise not just correctness and readability but beauty and innovation in structure, use of language, and so forth. If we now expect to find most papers on the Web, where we demand less of writing and think of any document as an unfinished work, a mere attempt to get the facts out in advance of some subsequent "real" version (which might well never appear), then our interest in, or at least capacity to expect, beautiful writing cannot help but dwindle further yet.

It also surely does not help that the physical manifestation of an online article is either on screen and thus, well, not physical, or else an unbound printout. In addition to simply feeling informal, these formats do not encourage the reader to think of a paper as a single document whose global structure might be of some importance. Rather, we download a paper, print and skim it, and possibly even dispose of all but the most relevant pages: to most of us, these printouts instinctively feel like disorganized notes, so why not treat them that way? For this reason, I, for one, am hesitant to post my papers online; it always feels a little like leaving my infant in a dumpster.

The fact is that our current relationship to the Internet has the undeniable effect of degrading the sacrosanct status of the mathematical text. To me, this is inescapably sad: I became a mathematician because I fell in love many years ago. I fell in love with the writings of Poincaré, of Steenrod, and of Bott; these texts are filled with a divine light and extraordinary beauty and, like any great piece of writing, grant the reader proximity to and sympathy for the author. Without this light, this beauty, this proximity, and this sympathy—in other words, without sacred texts—mathematics can only go in one direction: toward the profane.

Book Review

The Constants of Nature and *Just Six Numbers*

Reviewed by Brian E. Blank

The Constants of Nature
John D. Barrow
Pantheon Books, 2003
368 pages, $26.00
ISBN 0-375-42221-8

Just Six Numbers
Martin Rees
Basic Books, 2001
208 pages, $14.95 (softcover)
ISBN 0-465-03673-2 (softcover)
ISBN 0-465-03672-4 (hardcover)

Consider the two constants G and G. The first G arises frequently when we manipulate special functions. We represent this G by dozens of series and integrals, we study its continued fraction expansion, and we calculate millions of its digits. Any mathematician who sees its definition *knows* that it is an interesting number. This first G, Catalan's constant, is an exemplar of the mathematical constant: we are not surprised to see it appear in disparate problems in combinatorics and analysis, but we do not expect to ever learn that it has anything to do with the price of tea in China. How different it is from the second constant G. This second G is, for now, of little interest to the mathematician. We do not ask whether it is irrational. We do not, in fact, give it a second thought. This G, Newton's gravitational constant, is an exemplar of the constant of nature, and it has everything to do with the price of tea in China.

The contrast between the constants of mathematics and the constants of nature brings to mind "The Road" that physicist Leon Lederman talks about [6]. In Lederman's metaphor, The Road branches off into tempting side streets down which the chemist, the electrical engineer, and other unnamed vagabonds wander. But "Those who stay with The Road find that it is clearly marked all the way with the same sign: 'How does the universe work?'" It is not a sign that mathematicians always heed. We go where we please, gratified nonetheless by the frequency with which our meandering side streets cross The Road. The physicists who have not strayed tell us that the workings of the universe, as they are now understood, involve a small number of matter particles, or fermions; a small number of interactions among the fermions; and a small number of carrier particles, or bosons, that affect the interactions. The particles, as well as the equations that describe their interactions, entail certain constants, quantities that might be called fundamental constants of nature.

One or two at a time, the constants of physics make their appearance in many of the popular books that cram the cosmology shelves. In the last few years two nontechnical works entirely devoted to these constants have been added to the shelves. Each is written by a leading English astrophysicist with a long track record of superb expository writing. In *Just Six Numbers*, Sir Martin Rees discusses how his six titular numbers shape the universe. His theme is that these numbers are *fine-tuned*: if at an early instant of the universe the value of one of these numbers had been changed by more than a bit, then a sterile, lifeless universe would have resulted. John Barrow's *The Constants of Nature* discusses this theme as well, but with very little overlap. Whereas Rees is concerned with hypothetical change, Barrow concentrates on the real thing.

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Just Six Numbers lives up to the brevity of its title. By the end of the third page Rees has described his six numbers and set out his program for the reader. Within another 160 pages he has neatly wrapped it up. There is scarcely an equation in his book, but it turns out that a good deal of physics can be explained by concepts rather than mathematics. Many physicists excel at this type of exposition, but Rees must surely be among the best.

We can get a good idea of Rees's book by restricting the discussion to just one number, the nuclear fusion number $\mathcal{E} \approx 0.007$ that measures the strong nuclear force. It is this number $\mathcal{E}$ that determines the lifetime of a star and the elements of the atomic table. When hydrogen atoms fuse to form helium in a stellar reaction, 0.7% of their mass is converted into energy. This fusion is a multistep process, the second step of which is the formation of deuterium. If the strong nuclear force were weaker so that $\mathcal{E} = 0.006$, then deuterium would be an unstable isotope and the process would not continue to the formation of helium. If the strong nuclear force were stronger so that $\mathcal{E} = 0.008$, then two protons would be able to bind directly, with no need of neutrons to overcome the electrical repulsion. In this scenario, no hydrogen would have survived from the big bang, and without stellar fuel there would be no life.

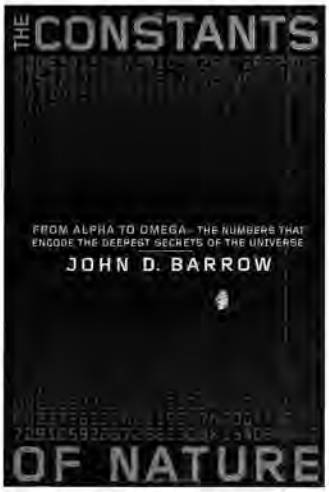
This analysis of $\mathcal{E}$ is typical of the fine-tuning argument. In the case of $\mathcal{E}$, additional requirements may further limit the range in which $\mathcal{E}$ must lie. For example, in order for life to exist, carbon must be synthesized, a process that also goes forward in stages. First, two helium atoms come together to form the isotope beryllium 8. This isotope then captures another helium atom to form a radioactive isotope that decays to stable carbon. The problem is that beryllium 8 is itself unstable and apt to disintegrate before a carbon nucleus has been formed. Without further fine-tuning of $\mathcal{E}$, an essential step in the creation of carbon would be most unlikely and carbon-based life forms would not exist.

One by one, Rees constrains the values of his numbers most persuasively. He is like an expert magician who induces us to keep our eyes on his right hand while his left hand is busy pushing unwanted complications from our view. Few who read Rees's proton-proton fusion discussion will pause to wonder, "Hey, wait a minute! Where does that deuterium neutron come from?" In the end, readers will have to rely on Rees's considerable authority. However, not everything he asserts is without controversy. In an essay titled "A designer universe?" [13, p. 236], Steven Weinberg also considers the implications of carbon synthesis, referring to precisely the same research that Rees cites. But where Rees sees fine-tuning, Weinberg concludes, "Looked at more closely, the fine-tuning of the constants of nature here does not seem so fine."

Rees closes his book with the sort of chapter that has become commonplace in popular cosmology writing: science fiction with academic cachet. As he has done in a few previous cosmology books, Rees advances a conjectural but "compellingly attractive" theory of the multiverse, a theory that allows for multiple big bangs. In the multiverse, "Separate universes may have cooled down differently, ending up governed by different laws and defined by different numbers." At one time a theory postulating multiple universes would have been dismissed as inordinately extravagant. Nowadays, however, the paradigm of simplicity is not an implicit principle of physical law. As Weinberg states the matter [12, p. 224], "The experience of the last three-quarters of a century has taught us to distrust [Ockham's razor]; we generally find that any complication in our theories that is not forbidden by some symmetry or some other fundamental principle actually occurs. Simplicity, like everything else, must be explained."

One basic simplifying assumption, the hypothesis that the constants of nature do not change from place to place in our universe or from epoch to epoch, is currently under intense scrutiny. The possibility that this assumption might be refuted is the basis of Barrow's book on the constants of nature. Although Barrow once took a stab at defining these fundamental numbers [2, p. 358], he shies away from a precise definition in his new monograph. Instead, he relies on imprecise prose. We read that the constants of nature "give the Universe its distinctive character," that they are the "bedrock ingredients of our Universe," that they "lie at the root of sameliness in the Universe," that they "encode the deepest secrets of the Universe," that "they define the fabric of all that is," and that "they are the barcodes of ultimate reality, the pin numbers that will unlock the secrets of the Universe—one day." For those of us not following The Road, these descriptions may elicit a pang of aimlessness, but they do not allow us, for example, to look at the numbers that constitute Rees's list and say, "This one is a constant of nature and this one is not."

In fact, at the time of this writing there is no canonical list of fundamental constants of nature. There is not even agreement on what sorts of constants should go on such a list [4]. To begin with, physics has two kinds of constants. One type of constant consists of what you and I call numbers. Physicists call them *pure numbers* or *dimensionless numbers*. The constant π is an example: we measure the circumference and diameter of a circle using some sort of units, and then when we form the ratio, the units cancel and the dimensionless number π results. In this example, the numerator



and denominator are what the physicists call *dimensionful numbers*. So are the speed c of light in a vacuum and the masses m_p and m_e of, respectively, the proton and electron. Although a dimensionful number is a numerical quantity, the pure number used to describe it depends on the choice of units.

There are three basic physical dimensions that require units: mass M, length L, and time T. These are necessary and sufficient for describing the dimension of any physical quantity. From this point of view, Boltzmann's constant k, though important as a conversion factor between energy and temperature, is not fundamental. In the 1870s the Irish physicist George Johnstone Stoney postulated the basic carrier of electric charge, the electron (as he later named it). Stoney also predicted the charge e of the electron and proposed that G, c, and e be used to create fundamental units of measurement. The dimensions of G, c, and e are $L^3M^{-1}T^{-2}$, LT^{-1}, and $L^{3/2}M^{1/2}T^{-1}$ respectively. Simple algebra shows that powers of G, c, and e cannot combine to produce a dimensionless number, but combine in exactly one way to yield each of the three basic dimensions. Thus it was that Stoney introduced the fundamental units $M_S = e/\sqrt{G}$, $L_S = e\sqrt{G}/c^2$, and $T_S = e\sqrt{G}/c^3$.

Stoney's units were neither adopted nor even much noticed. In 1899 Max Planck rediscovered them in a slightly different guise. Using the quantum of action h instead of e, Planck advocated the natural units $M_P = \sqrt{hc/G}$, $L_P = \sqrt{Gh/c^3}$, and $T_P = \sqrt{Gh/c^5}$. As he argued, "All systems of physical units, including the so-called absolute C.G.S.-system, have appeared up to now due to accidental circumstances...from the needs of our earthly culture." The proposed Planck units "would not depend on the choice of special bodies or substances and would be valid for all epochs and all cultures including extraterrestrial and extrahuman ones and could therefore serve as 'natural units of measurements.'"

If we let $\alpha = 2\pi e^2/(hc) = e^2/(\hbar c)$, then we find $M_S/M_P = L_S/L_P = T_S/T_P = \sqrt{\alpha/(2\pi)}$. The dimensionless constant α that appears in these ratios is the *fine structure constant*, which Arnold Sommerfeld introduced in 1916. One place in which the fine structure constant shows up is quantum electrodynamics (QED), where $\sqrt{\alpha}$ is the amplitude for an electron to emit a photon. In his book *QED* [5, p. 129], Feynman says of $1/\alpha \approx 137.036$, "It has been a mystery ever since it was discovered more than fifty years ago, and all good theoretical physicists put this number up on their wall and worry about it. Immediately you would like to know where this number for a coupling comes from. Nobody knows. It is one of the *greatest* damn mysteries of physics: a *magic number* that comes to us with no understanding by man."

One physicist who dearly wished to understand $1/\alpha$ was Wolfgang Pauli. Abraham Païs relates how Pauli, defeated in his efforts to get to the bottom of $1/\alpha$, took it as a bad omen that he was assigned Room 137 when he entered Zurich's Red Cross Hospital in December 1958. Pauli died ten days later [10].

Whereas Pauli did not understand $1/\alpha$ and knew it, the distinguished astrophysicist Sir Arthur Eddington did not understand $1/\alpha$ but deluded himself into thinking that he did. Eddington came to international prominence in 1919 when he confirmed Einstein's theory of general relativity by measuring the deflection of starlight as it passed through our sun's gravity field. Eddington is also remembered for discovering the role of nuclear fusion in stellar evolution. More than any other physicist of his time, Eddington was obsessed with explaining the constants of nature. To the detriment of his reputation, this pursuit brought out a mystical side of his character. In 1946 Eddington's final thoughts on the constants of nature were published posthumously under the title *Fundamental Theory*. It is a work that Eddington's most respectful critics call "an exceedingly obscure, annoying book." More frequently, the book is dismissed as pseudoscience or numerology or just plain "nuts".

In *Fundamental Theory* Eddington lists seven basic constants of physics, including an 80-digit integer, N_{Edd}, claimed to be the exact number of protons in the universe. After eliminating three of the constants through a choice of units, Eddington settles on m_p/m_e, $1/\alpha$, G, and N_{Edd} as the "constants of nature." He then carries out a program in which "all four constants are obtained by purely theoretical calculation." In particular, Eddington believed he could prove that $1/\alpha$ is exactly 137. At the time, only three significant digits of α were known, permitting Eddington to say, "So far as I can make out, the values of the constants given by this theory are in full agreement with observation." Although the contents of *Fundamental Theory* have received plenty of ridicule, every mathematician can sympathize with Eddington's attempt to bring Newton's constant G into the mathematical fold.

Another list of the constants of nature was compiled by Freeman Dyson in 1972. In addition to the constants m_p, c, e, $\hbar$, and G that we have already encountered, Dyson included Fermi's constant g of weak interactions, Hubble's constant H, and the average mass density ρ of the universe. The eight constants in Dyson's list combine to form five pure

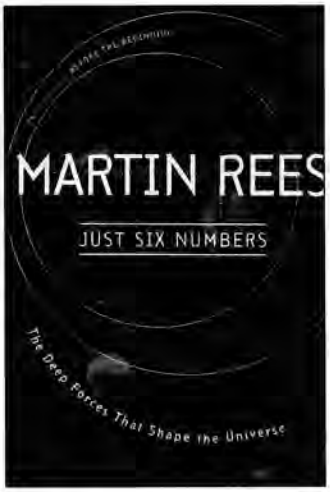
numbers: α, $\beta = \left(gm_p^2 c\right) / \hbar^3$, $\gamma = \left(Gm_p^2\right) / (\hbar c)$, $\delta = (H\hbar) / \left(m_p c^2\right)$, and $\epsilon = G\rho / H^2$. The presence of the cosmological *variables* H and ρ in Dyson's tally points to an unfortunate awkwardness in the terminology of physics: not only does the term *constant* refer to dimensionful numbers that are not impervious to a change of units, the term is also used to describe quantities that vary with time. Until the 1930s nobody seriously questioned whether the quantities m_p, c, e, $\hbar$, and G were truly constant. That changed quickly when the English physicists Edward Arthur Milne and Paul Dirac pointed out that the beliefs that then prevailed amounted to untested hypotheses. In particular, Dirac conjectured that Newton's gravitational constant obeys the proportionality law $G \propto 1/t$.

The inspiration for Dirac's suspicion was a seemingly untenable coincidence among three astoundingly large dimensionless numbers: N_1, the ratio of the radii of the observable universe and the electron; N_2, the electromagnetic-to-gravitational force ratio between the proton and electron; and N_p, the number of protons in the observable universe. Dirac noticed that $N_1 \approx N_2 \approx \sqrt{N_p} \approx 10^{40}$. On the basis of this evidence, Dirac conceived the Large Numbers Hypothesis (LNH), which in 1938 he stated as: "All very large dimensionless numbers which can be constructed from the important natural constants of cosmology and atomic theory are connected by simple mathematical relations involving coefficients of the order of magnitude unity." Given the relationships $N_1 \propto t$ and $N_2 = e^2 / \left(Gm_e m_p\right)$, Dirac's LNH seems to require at least one of the constituent constants of N_2 to be changing. Thus it was that Dirac proposed the proportionality $G \propto 1/t$.

It was not long before Dirac's suggestion was dismissed. Nevertheless, the idea that the fundamental constants can change is still very much with us. It should be noted that physicists do not agree on whether a change in a dimensionful constant such as G can be regarded as anything more than a change in units [4]. Refutations and counterrefutations have been flying [3], [9]; this controversy has even been the subject of a book-length tirade [7]. What is not contentious is that any change in a dimensionless constant such as α must be significant. Think of it this way: If your girth measurement is greater than last year's, then you may attribute it to a contraction in your tape measure. But if your girth-to-height ratio has increased, then you must accept that you have changed.

In 2001 a research team to which Barrow belonged announced statistically significant evidence of a time-variation of α. It was a news item with a headline too good to ignore. Though the idea of a varying fine structure constant is not revolutionary among physicists, news of an inconstant constant is about as close to a "man bites dog" story as the popular press can anticipate from The Road. You may remember newspaper and magazine articles that proclaimed "The Cosmos Becomes More Fickle" or "As Constant as the Stars?" or "Speed of Light May Not Have Been Constant after All" or "Challenge to a 'Constant' Shakes Modern Physics" or "Anything Can Change, It Seems, Even an Immutable Law of Nature". The purpose of Barrow's new book is to explain the physics behind these headlines at greater depth than a newspaper or magazine article can afford.

In Barrow's hands, the constants of nature make for a pretty fair science yarn with a natural beginning, middle, and end. His first six chapters introduce the reader to the most basic of the fundamental constants and develop the contributions of Stoney, Planck, Eddington, and Dirac. These chapters conclude with the final rebuttal of Dirac's LNH by the American physicist Robert Dicke in the late 1950s. To Dicke, the large numbers that intrigued Dirac were exactly what were to be expected *given the presence of sentient life in our universe.* We have seen this line of thought at work in the discussion of the nuclear fusion number $\mathcal{E}$: we cannot explain the value of $\mathcal{E}$ from first principles, but, given that we are here at a time in cosmic history when heavy elements have formed, intelligent life has evolved, and the stars have not all died, we can deduce that $\mathcal{E}$ must lie in a narrow interval. This type of reasoning has given rise to a number of axioms that are now called *anthropic cosmological principles.* Barrow devotes the middle portion of his book to these ideas.



In the final third of *The Constants of Nature*, Barrow describes some of the efforts that have been made to detect any changes that α may have had over time. We learn, for instance, how a natural nuclear reactor at Oklo, Gabon, has allowed physicists to measure the value α had on Earth some two billion years ago. In the recent research that resulted in the announcement of a time-variation in α, Barrow's team used the ancient light of quasars to determine the value that α had 11 billion years ago. If their measurements hold up, they will have accomplished quite a feat!

The Constants of Nature describes striking research on a topic of fundamental importance. It is a first-hand account written by a prominent physicist. Clearly, it is a book that has a lot going for it. Unfortunately, it is also an extremely exasperating book. The first harbinger of systemic trouble is

found on the second page of the preface, where Barrow refers to a line of reasoning that he asserts he set out in 1981 in his "first book, *The Anthropic Cosmological Principle.*" *The Constants of Nature* does not have a bibliography, but twice in the end-of-book notes Barrow gives the correct year, 1986, for *The Anthropic Cosmological Principle.* The discrepancy in the preface cannot be a simple matter of getting one digit in the year wrong: elsewhere Barrow cites *The Left Hand of Creation*, a book with a 1983 copyright, as his first book. These are inconsequential details, noteworthy only for being the first of a relentless series of bewildering errors and inaccuracies.

Let us consider an example that illustrates how much carelessness can be inserted into a very small space. On page 30 Barrow discusses the late nineteenth-century perception of physics as a dead subject. He states, "Caricaturing this hubris, Albert Michelson wrote in 1894 that there was a view abroad that 'The more important fundamental laws and facts of physical science have all been discovered.... Our future discoveries must be looked for in the sixth place of decimals.'" In fact, in the write-up of an address that he gave at a University of Chicago laboratory dedication in 1894, Michelson states, "An eminent physicist has remarked that the future truths of physical science are to be looked for in the sixth place of decimals." Since there is quite a bit of folklore associated with Michelson's attribution to an unnamed eminent physicist [12, p. 13], an attribution that does not appear in Barrow's quotation, I thought it worthwhile to track down Barrow's reference. My trip to the physics library turned out to be a waste of time: Barrow has misquoted his source. Moreover, my waste of time was greater than it should have been: Barrow's citation is itself inaccurate. It would be confusing enough that Barrow ascribes words to Michelson that Michelson himself ascribed to someone else. But Barrow compounds the confusion by prefacing his misquotation with a grammatical lapse that misrepresents the *intent* of Michelson's remarks. Because Barrow's participial phrase "Caricaturing this hubris" modifies Michelson, the conscientious reader can only infer that Michelson meant his remarks to be taken as a caricature. To the contrary, Michelson sincerely believed that the future of physics would lie in better measurement, a position he reiterated several years later, even though Planck's discovery of the quantum nature of energy had occurred in the interim [8, p. 24].

The following sample will suffice to illustrate the numerical and logical errors that abound in *The Constants of Nature.* On page 45 a plot of computer processing speed as a function of time begins with the year 1900. On page 86 the formula for $1/\alpha$ contains two mistakes. On page 206 the sentence "If you walk at random in three (or more) dimensions of space you will never return to your starting point" badly misstates Pólya's Theorem. On page 252 it is asserted that sunlight reaches us in "about 3 seconds." In the very next sentence, Alpha Centauri is said to be 4.1 light years away from us, a figure that is at least one trillion kilometers off the mark. On page 236 we encounter a passage that surely invites a second reading: "When the Earth formed about 4.5 billion years ago...After about 2.5 billion years, when the Earth was 2 billion years old...". Well, these things happen. More seriously, only seven pages later Barrow asserts that the Earth is 4.6 billion years old. This inconsistency mirrors a similar discrepancy with the stated age of the universe: 13 billion years on page 129, "about 14 billion years" on page 243. One billion years here, one trillion kilometers there—when an author is so nonchalant about numerical accuracy, how excited can the reader become about a possible change in a far-flung significant digit of α?

The problems that infest *The Constants of Nature* are not characteristic of Barrow's previous work. Perhaps haste is to blame here. The stuff of headlines come and go; the attention of the public is known to be fickle. Certainly one can understand the desire to publish a book while its subject is still hot. One can even imagine a desire to publish research findings before contradictory results arrive to muddle the story. So far as I have been able to determine, at the time of this writing the existence of a time-variation in α has not been definitively refuted or confirmed. I can point to a paper that raises concerns with the methodology of Barrow's team [1], but browsing the abstracts that are available on the physics preprint server, I find no overwhelming body of opinion that justifies the statement "The consensus is that there are subtle problems with the observations—the fine-structure constant is probably not changing after all" [11, p. 222].

There is surely a great book about the constants of nature yet to be written. In the meantime, Barrow's *The Constants of Nature* may be regarded as an interesting, albeit flawed, progress report. To the reader who desires only a brief, nontechnical look at how the constants of nature are fine-tuned for life in the universe, Rees's *Just Six Numbers* can be confidently recommended. An earlier book written by Rees, *Before the Beginning*, may be suggested to the reader who prefers a less narrowly focused introduction to cosmology that covers similar ground. All of these books prepare their readers for the next front in the science curriculum wars, the theory of "intelligent design". During the past decade, the battle over biological evolution has escalated into a heated debate that encompasses the evolution of our universe. The fine-tuning of the basic physical constants has been cited as evidence that the universe is the result of

intelligent design. As I write this review, several initiatives placed before school boards and state legislatures seek to mandate instruction in the theory of intelligent design. Whether or not we as mathematicians find the constants of nature interesting, we may as citizens wish to learn more about them.

Physicists tell a joke that emphasizes the stubborn mystery of the constants of nature. According to the story, God grants the spirit of Pauli one question. When Pauli asks why α is approximately $1/137$, God fills a blackboard with equations and when done turns to Pauli. The frustrated scientist shrugs off the explanation and exclaims, "Baloney!" That is where we remain. There is still a fleeting hope that a theory of everything will one day explain the constants of nature. However, more and more physicists are coming to believe that the best we can do is use anthropic principles to further refine the bounds that constrain the constants of nature. Could Michelson have had the right thought, wrong century? It might just be that the numbers so fundamental to our universe are mathematical duds.

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Some of What Mathematicians Do

Martin H. Krieger

Whether it be at a party or at a tavern or while being examined by a physician, on announcing that you are a mathematician, you are likely to be greeted with comments about your companion's failure in high school math, or a request for a brief account of the proof of Fermat's Last Theorem, or perhaps an offer of a counterexample to the Four Color Theorem. Your parents, your friends and relatives, airplane seatmates, or your dean or provost are not likely to be mathematicians, and they too would like to know what you do, preferably in bite-sized pieces.

Might we provide an *everyday* description that has sufficient technical detail so that a mathematician would recognize the work as real research mathematics? I suggest that if we think of mathematical work as showing that what might seem arbitrary is actually necessary, as analyzing everyday notions, as calculation, and as analogizing—using rich examples of mathematical work itself, we might be able to say a bit more about *some* of what mathematicians do. None of these descriptions are easy, but I think they connect better with the work of other people, so that they might see our work and their own as having some shared features.

Conventions

Mathematicians make certain notions conventional. What might seem arbitrary is shown to be in effect necessary, at least within a wide enough range of situations. For example, means and variances were once taken merely as ways of "combining observations", to use a term of art of two hundred years ago. There were other ways, including medians and average absolute deviations ($\Sigma|x_i - x|/N$). But through the central limit theorem, for example, the variance became entrenched as a good measure of the width of a distribution for various different kinds of more or less identically distributed independent random variables. Moreover, it was easy to depict such statistics in a Euclidean space of observations, the various formulas being Pythagorean theorems with Euclidean distances. And if one used a large electromechanical calculator, it was not hard to set up the calculation so that one could calculate a sum of the squares of x_i and y_i and a sum of $x_i y_i$. In the law of the iterated logarithm, Khinchin provided an estimate of fluctuations that would not be readily accounted for by gaussian behavior, so even exceptional behavior fit under this regimen.

Variances turned out to be good measures of the kinds of noise and dissipation physicists encountered, and Einstein's work on fluctuations (1905, 1917) entrenched variances as the measure of choice. It also turned out that variances were good measures of the risk involved in financial markets, and the calculus of Lévy and Itô (where, in effect, dx is replaced by $\sqrt{dx}$) became the bread and butter of finance professors.

As for exceptions to means and variances, Lévy showed that the crucial fact was the asymptotic norming constant, the $\sqrt{N}$ that appears in the central limit theorem: that is, $N^{1/\alpha}$, here $\alpha = 2$. For α need not be 2 but could be other numbers for other

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distributions ("distributions without variance", that is, with infinite variance), which still scaled asymptotically, such as the world of fractals. However, if the variance is finite, then the only game in town is the gaussian. The deep idea turns out to be asymptotic approximation and scaling, that $N^{1/\alpha}$. And this is seen in modern results related to random matrices and prime number distributions, where the norming constant can be $N^{1/6}$, for example.

What is made conventional here is the gaussian, characterized by its mean and variance, and its being the asymptotic limit of sums of nice random variables. And that is made clear by the description of its exceptions. Although means and variances might well be arbitrary, they are demonstrably the right statistics ("necessary") for a wide range of cases.

Nowadays, statisticians are realizing that for actual data sets, often infected by wild and outlying data, one needs statistical methods that are "robust" and "resistant", not a strong point of means and variances. For a wide range of new cases, means and variances will no longer be conventions, and presumably new statistics are proven to be "necessary" and become the reigning conventions.

Mathematicians affirm that these conventions are not arbitrary. They are well grounded in mathematical practice and theory.

Analyzing Everyday Notions

Mathematicians formally analyze everyday notions. Topology developed as a way of understanding nearbyness, connectivity, and networks. It turned out that the key idea was continuity of mappings and how that continuity was affected by other transformations. For continuity preserved nearbyness, connectivity, and networks. Of course, this demanded a number of conceptual and mathematical discoveries. One great discovery was the subtleties of continuity, uniform vs. pointwise, for example. A second discovery was the fact that one might represent continuity and neighborhoods in terms of mappings: if the neighborhood of a point was mapped into an open set, that neighborhood itself was open, *if* the mapping was continuous. A third discovery was that networks could be characterized in terms of how they decomposed into simpler networks and that characterization would be preserved under continuous mappings. Moreover, a space might well be approximated by a skeletal framework, and a study of that framework would tell us about the space. A fourth discovery was that that decomposition sequence had a natural algebraic analog in commutative algebra. And a fifth discovery was that the algebraic decomposition had a natural analog with derivatives and second derivatives (Stokes's and Green's theorems and Gibbs's vector calculus), again the world of continuity.

As a consequence of this analysis, it was realized that there are many different kinds of nearbyness and many different topologies for a space, yet they might share important features. Functions came to be understood as mappings, in terms of what they did. And the transcendental realm turned out to be deeply involved with the algebraic realm. That analysis of everyday notions led to powerful technologies for analyzing connectivity and networks, techniques vital to current society. Those technologies are grounded in the formal mathematical analysis.

Calculation

Perhaps "proofs should be driven not by calculation but solely by ideas", as Hilbert averred in what he called Riemann's Principle. But some of the time, if not often, mathematicians have to calculate—doggedly and lengthily—in order to get interesting results. In some future time, knowing the solution, other mathematicians may well be able to provide a one-line proof driven solely by ideas, plus a great deal of mathematical superstructure built up in the intervening period of time. Or, in fact, lengthy proof and calculation are unavoidable, and delicate arguments involving hairy technology are the only way to go. The mathematician's achievement is, first of all, to actually follow through on that long and complex calculation and come to a useful conclusion, and, second, to present that calculation so that it is mildly illuminating. As we shall see, such a presentation involves matters of structure, organizing the whole; strategy, being able to tell a story about how it all holds together; and tactics, being able to do what needs to be done to get on with the next main step of the proof.

The first proof, by Dyson and Lenard (1967–1968), of the stability of matter—that bulk matter, held together by electrical forces of electrons and nuclei, won't collapse (then to explode)—is considered one of these long and elaborate calculations. What one has to prove is that the binding energy of bulk matter per nucleus is *bounded from below* by a negative constant, $-E^*$. The proof begins with an idea: an insight by Onsager (1939) about how to incorporate the screening of positively charged nuclei by negatively charged electrons. But the actual calculation would seem to involve a number of preliminary theorems and a goodly number of lemmas, all of which might seem a bit distant from the main problem. Actually, many of the preliminary theorems motivate the proof and indicate what is needed if a proof is to go through. And the lemmas might be seen as lemmas hanging from a tree of theorems or troops lined up to do particular work. As in many such calculations, the result almost miraculously appears at the end. And in this

case the proportionality constant is about 10^{14} larger in absolute value than it need be.

A few years later, Lieb and Thirring (1975) were able to figure out how to efficiently use the crucial physics of the problem (Onsager's screening, and also that the electrons are fermions and are represented by antisymmetric wave functions). As a consequence, the proof was now about ideas, involved comparatively little calculation, and could be readily seen in outline, and the proportionality constant was about 10 rather than 10^{14}. Their crucial move was to employ the Thomas-Fermi model of an atom: the many electrons in an atom exist in a field due to their own charges (as well as that of the nucleus), and hence one seeks a self-consistent field.

Dyson and Lenard had all these ideas except for Thomas-Fermi. But in their pioneering proof, getting to the endpoint was avowedly more important than efficiency or controlling the size of the proportionality constant, $-E^*$. Theirs was a first proof of a fundamental fact of our world. By the way, in retrospect, the Dyson-Lenard proof is rather less long than it once appeared, its various manipulations along the way rather more rich with meaning.

Over the next decades a variety of rigorous proofs were provided of various fundamental facts about our world, many of which proofs are lengthy and complex and involve much calculation.

(1) *Thermodynamics.* One would like to be able to estimate the binding energy of bulk matter, the energy required to break it up into isolated atoms, as being proportional to the number of atoms. Such an estimate justifies thermodynamics, with its separation of intensive variables (such as temperature) and extensive variables (such as volume or number of particles). In a remarkable and lengthy proof, Lebowitz and Lieb (1972) provided a calculation of the asymptotic form of the binding energy of bulk matter, $E \approx -AN$, where N is the number of atoms—just the required form. Along the way, they employed the Dyson-Lenard result.

In all of these calculations, one technical problem is to figure out how to break up space into balls or boxes, fitting the atoms into those containers ("balls into boxes"). For example, Lebowitz and Lieb develop a Swiss-cheese decomposition: smaller balls fit into the interstices between larger balls.

(2) *A gas of atoms.* One would like to prove that at a suitable temperature and pressure, atoms form, and one has a gas of such atoms. Charles Fefferman (1983–1986) provides the proof with all of its "gruesome details", as he refers to the latter endeavor. First, he employs a technology he developed for solving partial differential equations—what he called "the uncertainty principle", the idea that the phase space of x and d/dx might be divided into suitably shaped boxes on which the differential equation is trivial—and then fill balls of phase space with these boxes, fitting "boxes into balls". Along the way, he redoes the Lieb-Thirring proof.

What is notable is his technical definition of an atom and, later, of a gas of atoms, a mathematically precise way of describing a physical state, one that would allow him to make mathematical progress on the problem. What is remarkable, and this is true for much of Fefferman's work, is his capacity to push through a lengthy calculation.

In order to complete the proof of "the atomic nature of matter" (that a gas of atoms forms), Fefferman then needs an even better estimate for the proportionality constant for the stability of matter than was provided by Lieb and Thirring, and with de la Llave and Trotter he provides a lengthy proof and an exact numerical calculation for E*. (Lieb and his followers have provided another route to such better constants.) So far, it should be noted, the calculated E* is still about two times too big for Fefferman's purposes and given what we expect.

(3) *An isolated atom.* Finally, one would like to estimate the ground state energy of a large *isolated* atom. The hydrogen atom's proverbial 13.6 electron-volts is the only calculation one might make in closed form (one of the first calculations in a quantum mechanics course). For larger atoms one must use approximations in which the errors are not in general rigorously known. In a series of calculations, some rigorous, some merely physical, by Lieb and Simon, Scott, Dirac, and Schwinger, a good idea of the asymptotic formula for the ground state energy in terms of Z, the atomic charge, is given in terms of a series in $Z^{1/3}$: $Z^{7/3}$, $Z^{6/3}$, $Z^{5/3}$. What Fefferman and Seco (1990–1996) provide in something like 800 pages of proof is a rigorous derivation of this formula with a rigorous estimate of its error, $O(Z^{5/3-1/a})$. Whole new technologies for partial differential equations are developed along the way, and even the paper that brings these all together is almost two hundred pages in length. Their achievement is again the ability to divide up the problem into tractable parts, to orchestrate the parts so that they work together, and to be able to tell a story of the proof (in this case, in fourteen pages). There have been subsequent simplifications for parts of the Fefferman-Seco derivation, but much of the calculation remains lengthy and complicated. And Córdoba, Fefferman, and Seco have found the next term in the asymptotic expansion.

Lengthy calculation demands enormous technical skill, courage, and insight and usually demands herculean inventions along the way. But sometimes it is the only way to make progress on a problem. I have chosen examples in which the lengthy calculations also lead to analyses of everyday notions, such as a gas of atoms.

Analogy

Some time ago, Pólya showed that analogy plays a vital role in mathematical work. Sometimes those analogies are provably true, such as the analogy between ideals and varieties: polynomials and their properties, considered as algebraic objects, and the graphs of those polynomials and their properties, considered as geometric objects. At other times, the analogies are not provable but provide for ongoing research programs for hundreds of years. Here I want to describe a syzygy, an analogy of analogies, between mathematical work and work in mathematical physics. What the physicists find, the mathematicians would expect, although the mathematicians could never have predicted such an analogy in the physical realm without the physicists' work.

For the mathematicians, I am thinking of the Riemann-Dedekind/Weber-Weil-Langlands analogy of analysis, algebra, and arithmetic. I will call it the Dedekind-Weil analogy, for short. Dedekind and Weber tried to derive Riemann's results concerning the transcendental realm (that is, referring to the realm of the continuous)—think here of Riemann surfaces and the Riemann-Roch theorem—using rigorous algebraic methods with no intuitions about continuity. Again, could there be a useful analogy between curves or surfaces and algebra? They were guided by what was known algebraically about numbers (number theory); in fact, they were able to translate those concepts and results to the realm of polynomials, and so were able to algebraicize Riemann's transcendental point of view. Subsequently, Hilbert and Weil and others extended the analogy.

André Weil describes the analogy in a particularly poignant way in a long letter he wrote from prison to his sister, Simone, in 1940. It is a remarkable document, combining a rich mixture of mathematics, a notional history of the analogy, reflections on how Weil himself does mathematics, and analogies of the interchange among the moments of the analogy to incest and war. I urge the reader to get hold of it (either in the original French in the first volume of Weil's *Collected Papers*, or in English translation in my *Doing Mathematics*).

Weil refers to three columns, in analogy with the Rosetta Stone's three languages and their arrangement, and the task is to "learn to read Riemannian". Given an ability to read one column, can you find its translation in the other columns? In the first column are Riemann's transcendental results and, more generally, work in analysis and geometry. In the second column is algebra, say polynomials with coefficients in the complex numbers or in a finite field. And in the third column is arithmetic or number theory and combinatorial properties. So, for example: (Column 3) Arithmetically, the zeta function packages the prime numbers. (2) Algebraically, its Mellin transform (a Fourier-like transform) is the theta function, originally found by Fourier in solving the heat equation. Theta has wonderful algebraic properties, such as automorphy (transformations of the function, that is, of its argument, can be expressed in terms of the function itself) and a functional equation that defines it. And (1), analytically, the spectrum of the zeta function (its zeros) is rich with information about the prime numbers. A simple example of the threefold analogy is found in the sine function: its series expansion packages the factorials of the odd numbers; $\sin Mx$ is expressible in terms of the trigonometric functions themselves (say, $\sin x$ and $\cos x$); and the periodicity of the sine function (its spectrum) more or less defines it. Weil points out that the analogy continues to be productive, his later having proved the Riemann hypothesis in the algebraic column being a case in point.

In the twentieth century, mathematicians discovered that attaching group representations (or systems of matrices) to objects would often lead to progress in understanding those objects. Langlands's very great contribution (1960s ff) was to suggest, following Emil Artin, that attaching a group representation to the algebraic or automorphy column would turn out to be very productive for understanding the arithmetic column. The idea is to extend the analogy of theta functions to zeta functions into a much more complicated realm. Moreover, what might be impossibly difficult to prove from the point of view of one column is readily built in in another, much as theta's automorphy and functional equation leads to zeta's functional equation.

While the mathematicians worked at their analogy, physicists were solving a simple classical model of a ferromagnet using statistical mechanics: the Ising model in two dimensions, up-down spins arranged on a, say, rectangular lattice. The spins' interaction is local and simplified. The first exact solution was provided by Onsager in 1944, using a combination of Clifford or quaternion algebra and elliptic functions. Over the subsequent sixty years, physicists have provided many different solutions of the Ising model. (One solution refers to itself as the "399th solution".) Of course, they all get the same result for the partition function (in effect, the zeta function for this problem). When we examine the solutions, we discover that we might group the solutions into those that are arithmetic and combinatorial, those that are algebraic and automorphic, and those that are analytic or transcendental concerned with the zeros of the partition function. Moreover, from the initial solutions of the Ising model by Kramers and Wannier and by Montroll (1941), matrices played a crucial role in many of the solutions. They were in fact group representations, although they were

not taken as such. They were taken to be matrices that conveniently did the combinatorics, and it was the algebraic properties of those matrices that allowed for the Onsager solution. No one worried much about what those matrices were a group representation *of*, although Onsager surely had many insights. The trace of those transfer matrices was the partition function of interest. Moreover, once again, there were functional equations that allowed for the solution for the partition function, and there were the scaling symmetries and automorphies characteristic of theta or elliptic functions. The latter were eventually canonized in the renormalization group techniques of Wilson (1960s, 1970s).

Parenthetically, I should note that Onsager's original paper might well be another candidate for a lengthy calculation. Subsequent calculations of asymptotic properties of the Ising model by Wu and McCoy (1966 ff) and collaborators are impressive for their length and complexity and for the courage needed to carry them through. What is striking is that at the end of one such calculation, the Painlevé transcendents appear, and that appearance has since become significant for much of contemporary mathematics and mathematical physics.

It would seem that there are two analogies here. The Dedekind-Weil analogy has been worked on as an analogy for 150+ years, most recently in its connection with representation theory in the Langlands Program. The physicists have been exactly solving the Ising model in two dimensions for more than sixty years and have produced a wide variety of solutions, employing what are in effect group representations from the beginning. Those various solutions would seem to be naturally described and classified using the categories provided by the mathematicians. The analogy the mathematicians seek to develop generically is developed and proven in its particular realm as a matter of course by the everyday work of the physicists. What the mathematicians seek, the physicists by the way provide an example of. The multiplicity of the physicists' solutions is given meaning and order by the mathematicians' hard-won concepts. I am unsure whether the physicists' analogy is provably the same as the mathematicians'. But surely the Dedekind-Weil analogy provides a way of thinking of diverse phenomena as being naturally connected, rather than their being merely many ways of solving a problem.

These analogies and the analogy between them (the syzygy) organize an enormous amount of information, suggest facts in one realm that might be true in another, and illuminate concepts among the columns and the analogies.

What Do Mathematicians Do?

Words such as convention, analyzing everyday notions, calculation, and analogy might be used to describe activities other than mathematics. And it is just in this sense that we might give outsiders a sense of what mathematicians do. At the same time, those notions have very specific meanings for mathematical work. And it is just in this latter sense that we might describe mathematics to ourselves. The shared set of terms allows us to connect our highly technical and often esoteric work with the work of others. Mathematicians show why some ways of thinking of the world are the right ways, they explore our everyday intuitions and make them rather more precise, they do long and tortuous calculations in order to reveal the consequences of their theories, and they explore analogies of one theory with others in order to find out the truths of the mathematical world.

I would also claim that, in a very specific sense, mathematical work is a form of philosophical analysis. The mathematicians and mathematical physicists find out through their rigorous proofs just which features of the world are necessary if we are to have the kind of world we do have. For example, if there is to be stability of matter, electrons must be fermions. The mathematicians show just what we mean by everyday notions such as an average or nearbyness. And mathematics connects diverse phenomena through encompassing theories and speculative analogies.

So when you are asked, What do mathematicians do?, you can say: I like to think we are just like lawyers or philosophers who explore the meanings of our everyday concepts, we are like inventors who employ analogies to solve problems, and we are like marketers who try to convince others they ought to think "Kodak" when they hear "photography" (or the competition, who try to convince them that they ought to think "Fuji"). Moreover, some of the time, our work is not unlike solving a two-thousand-piece jigsaw puzzle, all in one color. That surely involves lots of scut work, but also ingenuity along the way in dividing up the work, sorting the pieces, and knowing that it often makes sense to build the border first.

Sources

The material in this article is drawn from Martin H. Krieger, *Constitutions of Matter* (Chicago: University of Chicago Press, 1996) and *Doing Mathematics* (Singapore: World Scientific, 2003). See, especially, R.P. Langlands, "Representation theory: Its rise and role in number theory", which originally appeared in *Proceedings of the Gibbs Symposium* (Providence: AMS, 1990), but is also available at `http://www.sunsite.ubc.ca/DigitalMathArchive/Langlands/pdf/gibbs-ps.pdf`.

Société Mathématique de France

Marie-Françoise Roy and Michel Waldschmidt

Mathematics is an international adventure, and mathematicians are accustomed to cooperating with colleagues all around the world. The American Mathematical Society (AMS) and the French Mathematical Society (SMF) have several agreements, particularly reciprocity membership, publication, and distribution agreements. Most French mathematicians know the AMS, but not all members of the AMS know the SMF. The aim of this article is to fill this gap.

The SMF

The Société Mathématique de France was created in 1872 by Michel Chasles, who happened to be the first French member of the London Mathematical Society. He became the first president of the SMF, elected for one year. The SMF statutes, published in the first issue of the *Bulletin de la Société Mathématique de France*, state that the purpose of this learned society is to promote the progress of science and to propagate studies in pure and applied mathematics. This is done through programs of the society and publications by its members.

Our society was created to provide linkages among French mathematicians. At the time the SMF was founded, this was a quite small community, almost of a familial size. Due to the expansion of mathematics, the number of mathematicians working in France today exceeds 5,000, and our society now includes around 2,000 members.

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Michel Waldschmidt is professor of mathematics at the Université Pierre et Marie Curie (Paris VI) and is immediate past president of the SMF. His email address is miw@math.jussieu.fr.

Publications

From the beginning, one important activity of the SMF has been mathematical publication. In 1873, just one year after the SMF was created, the first issue of the *Bulletin de la Société Mathématique de France* appeared. Today, in addition to the paper version, an electronic version of the *Bulletin* is available for subscribers of the printed issues. Our collection of publications has progressively enlarged. Begun in 1964 as a supplement to the *Bulletin*, the *Mémoires* are devoted mainly to monographs. *Astérisque*, created in 1973 on the occasion of the first centenary of the SMF, publishes monographs as well as proceedings of major international conferences and Bourbaki seminars. The *Revue d'Histoire des Mathématiques* was founded in 1995. Other series are Panoramas and Synthèses (survey monographs at a high level), Cours Spécialisés (courses at the graduate level for doctoral students), and Séminaires and Congrès (the electronic version of which is freely accessible on the SMF website). A new series, Documents Mathématiques, was recently started: the first volume, published in 2001, contained correspondence between Alexandre Grothendieck and Jean-Pierre Serre. That volume has been quite successful, and a French-English version has now appeared, published by the AMS. Besides these series, sporadic volumes have been published by the SMF, in particular a reprinting of the Bourbaki Seminars from 1948 to 1968. Our society is now the main publisher in France of

mathematical books and journals at a high level. A large percentage of this material is in French, as the great tradition of publishing mathematics in the French language is still alive: for example, Fields Medalist Laurent Lafforgue wrote all his papers in French. We now have an agreement with the AMS for translations of some SMF monographs that have appeared only in French; these will be published in the series SMF/AMS Texts and Monographs. We also have a distribution agreement with the AMS.

Digitization is a concern of all publishers nowadays. We rely on the NUMDAM program (Numérisation de Documents Mathématiques), which is led by the Cellule MathDoc in Grenoble and participates in the international project of the Digital Mathematical Library.

Meetings

Unlike many mathematical societies, we do not run a big annual conference. Instead, we have a "Journée Annuelle" one Saturday in the middle of June, during which the official yearly General Assembly takes place, followed by scientific activities featuring three or four lectures on a topic of general interest. For instance, on June 15, 2002, the theme was "Mathematical Biology"; on June 14, 2003, it was "Groups and Geometry"; and on June 19, 2004, it was "Operations Research".

Every other year at the "Journée Annuelle" the SMF awards its Prix d'Alembert in recognition of a work that raises public awareness of mathematics. Since 2002 we have also awarded at the same time the Prix Anatole Decerf of the Fondation de France, whose aim is to promote the pedagogy of mathematics. Four years ago we celebrated World Mathematical Year 2000 by awarding four special prizes, Prix d'Alembert des Lycéens, for lectures on mathematics that could be understood by high school students.

Mathematical research is growing at a high speed, and it is of fundamental importance to keep informed of new developments. This is why the SMF organizes on a regular basis the so-called "sessions de la recherche", where specialists in a given subject introduce the state of the art to other mathematicians and to graduate students. In June 2002 the topic was "Random Schrödinger Operators: Methods, Results and Perspectives", and in 2003 it was "Stochastic Aspects of Vision". The next session, for 2004, is on "Dynamics of Conservative Diffeomorphisms of Surfaces: A Topological Point of View". Some of these lectures are published in Panoramas and Synthèses.

We run a number of international conferences with other learned societies; the first one took place in Lyon in July 2001 and was a joint conference with the AMS. The next one took place in Nice (February 2003) with the European Mathematical Society and the Société de Mathématiques Appliquées et Industrielles (SMAI). A third one was held in Toulouse in July 2004 with the SMAI, the Canadian Mathematical Society, the Canadian Statistical Society, and the Société Française de Statistique. Two smaller joint conferences involving the SMF are scheduled for 2005, one with the Scandinavian mathematical societies, the other with the mathematical societies of Bénélux.

CIRM in Luminy

Mathematicians need to work together, either in small groups or by participating in conferences. This is why the SMF created the Centre International de Rencontres Mathématiques (CIRM) in Luminy in 1981. This center is comparable to Oberwolfach in Germany or the Banff International Research Station in Canada. At the CIRM the superb mountain setting of those two institutes is replaced by the proximity of the Mediterranean Sea and the *calanques* (limestone fjords), but the main idea is the same, namely, to offer to mathematicians the best possible conditions for working together. The CIRM mathematical library is the biggest in the south of France (70,000 volumes), and a number of journals are obtained through exchange agreements with the SMF.

As a center for research and training, the CIRM organizes international meetings, bringing together mathematicians and researchers in related fields (like theoretical physics, computing, artificial intelligence, information theory, and mathematical biology) from France and all over the world. Also, the CIRM provides training for young researchers through intensive courses or summer courses. The center's capacity was recently increased, and more than sixty people can now be accommodated. A new program of the "Research in Teams" type was started in 2001 and offers scientific and housing facilities for small research groups. The CIRM is continuing to expand its activities, and a new auditorium is under construction. A subscription to CIRM's recent guests has been opened for helping this construction.

Education

The SMF is active in a variety of matters related to mathematics, and problems in education are one of our main concerns. The SMF contributed to the creation of a think-tank group on the teaching of mathematics, which was later officially launched by the minister of education, who appointed a committee with Jean-Pierre Kahane as president. A report of its work was published in 2002 ["L'Enseignement des Sciences Mathématiques" ("Learning of the Mathematical Sciences"), Éd. Odile Jacob] and is being translated into English. Recently Jean-Christophe Yoccoz was appointed president of this committee.

The program of school teaching deserves the attention of professional mathematicians, but it is also important to introduce mathematics on a lighter basis to high school students. This is the goal of a number of associations created or supported by the SMF, such as Animath and Math en Jeans, where young people enjoy their free time by doing mathematics.

Every year the Committee for Education of the SMF runs a meeting to study matters related to school teaching. In January 2002 a roundtable took place on the theme "Mathématiques et enseignement des sciences" ("Mathematics and Teaching of the Sciences"). The following January we dealt with the forthcoming reform of academic education in Europe: "Les Mathématiques dans les nouveaux cursus universitaires (licence master doctorat)" ("Mathematics and the New University Degree Programs"). This past January we organized a discussion on "Mathématiques dans les années de licence: spécialisation et pluridisciplinarité" ("Mathematics in the University Years: Specialization and Multidisciplinarity").

The SMF maintains contacts with organizations like the Association des Professeurs de Mathématiques de l'Enseignement Public, which is an association of high school mathematics teachers, and the Union des Professeurs de Spéciales. The SMF is also one of fourteen associations and learned societies that are concerned about the lack of interest in science among young people and that are acting together by alerting politicians as well as the general public. The shortage of students in science is an important issue and a subject of a number of debates. There is no unanimity on what the solution might be. A number of individual mathematicians are offering their own proposals for curricular reform, while the SMF tries to propose solutions that are likely to be welcomed by a large majority of scientists.

Activities with Other Learned Societies

We mentioned the SMAI, which was founded in 1983 by a group of French applied mathematicians. Our two societies have close links, and a number of joint activities are taking place. One of them, which is joint with the Société Française de Physique, aims to promote cooperation with developing countries, and our three societies recently created a joint committee, Sciences de Base et Coopération (Basic Sciences and Cooperation), for this purpose. France hosts the Centre International de Mathématiques Pures et Appliquées, which organizes schools in many developing countries, and our societies support this activity. Lack of funding is always the main difficulty, despite the support of UNESCO.

Another joint activity of the SMF and the SMAI is oriented towards young mathematicians. The group Opération Postes aims to distribute widely and in real time information related to open positions (for professors or *maîtres de conférences*). The French bureaucratic system for filling academic positions is somewhat complicated and would take a good deal of space to explain. Indeed, this system is usually modified every few years, so the current one may change in the near future.

Popularizing mathematics is one goal of our society. For many years such activity was not well supported by leading French mathematicians. That situation changed ten years ago, when Jean-Pierre Bourguignon was president of the SMF. World Mathematical Year 2000 had a strong positive effect on such activities. The above-mentioned prizes of the SMF also contribute to this goal. In addition, a booklet called *Explosion des Mathématiques* was released in July 2002, thanks to the joint efforts of the SMF and the SMAI; the purpose is to promote mathematics to a wide audience. The booklet may be downloaded for free on the server of the SMF. With the SMAI, the association Femmes et Mathématiques, and the Société Française de Statistique, we prepare another, similar booklet devoted to careers in mathematics. We also organized with the SMAI, the Institut des Hautes Études Scientifiques, and the magazine *Pour la Science* a one-day conference on "The Hidden Face of Mathematics", held March 18, 2004, at the Pompidou Center (Beaubourg). We anticipate joint activities with the Société Française de Physique for the World Year of Physics in 2005.

Nowadays communication plays an essential role in all that mathematicians do. When it comes to communication within the French mathematical community, the *Officiel des Mathématiques* (which has been freely available on the website of SMF since 1998) provides information on seminars in France, while our *Gazette des Mathématiciens* can be thought of as an analogue of the AMS *Notices*, bringing together information on different topics of interest for our members.

Our website, `http://smf.emath.fr`, provides a wealth of information about our society, including a directory of members; online order forms for books and journals; and information about our publications, conferences, and meetings, as well as various position papers.

As already noted, our two societies, SMF and AMS, have reciprocity agreements. We encourage members of the AMS to join the SMF as reciprocity members.

Further Information: Société Mathématique de France, Institut Henri Poincaré, 11, rue Pierre et Marie Curie, 75231 Paris cedex 05, France; `http://smf.emath.fr`; `smf@dma.ens.fr`.

Mathematics People

SIAM Prizes Awarded

The Society for Industrial and Applied Mathematics (SIAM) awarded several prizes at its annual meeting in Portland, Oregon, in July 2004.

ROLAND GLOWINSKI of the University of Houston was awarded the 2004 Theodore von Kármán Prize for his sustained, outstanding contributions to mechanics and applied and computational mathematics, especially in the area of complex problems in fluid mechanics. The prize carries a cash award of $1,000 and is given for a notable application of mathematics to mechanics and/or the engineering sciences made during the five to ten years preceding the award.

ARTHUR J. KRENER of the University of California, Davis, won the 2004 W. T. and Idalia Reid Prize for fundamental contributions to control and estimation of nonlinear dynamical systems and stochastic processes.

DIEGO DOMINICI of the University of Illinois at Chicago was awarded the 2004 Richard C. DiPrima Prize for his dissertation "Asymptotic Analysis of a Data-Handling System and Its Generalization". The prize carries a cash award of $1,000.

The 2004 George Pólya Prize was awarded jointly to NEIL ROBERTSON of Ohio State University and PAUL SEYMOUR of Princeton University for their proof of the Wagner conjecture in the theory of graph minors. A cash award of $20,000 will be divided between the winners.

ALAN C. NEWELL of the University of Arizona was awarded the John von Neumann Lectureship in recognition of his pioneering research in nonlinear evolution equations modeling physical systems. The prize carries a cash award of $2,500.

RICHARD A. TAPIA of Rice University received the 2004 SIAM Prize for Distinguished Service to the Profession. The prize is awarded to an applied mathematician who has made distinguished contributions to the furtherance of applied mathematics on the national level.

—From a SIAM announcement

MAA Writing Awards Presented

The Mathematical Association of America (MAA) presented several awards for excellence in expository writing at its Summer Mathfest in Providence, Rhode Island, in August 2004.

The Carl B. Allendoerfer Awards are given for articles published in *Mathematics Magazine* and carry a cash award of $500. The 2004 awards were given to CHARLES I. DELMAN and GREGORY GALPERIN of Eastern Illinois University for their joint article "A tale of three circles", *Mathematics Magazine*, February 2003.

The Trevor Evans Award is given to authors of expository articles that are accessible to undergraduates and that were published in *Math Horizons*. This prize carries a cash award of $250. Two awards were presented for 2004. DOUGLAS DUNHAM of the University of Minnesota, Duluth, was selected for his article "A tale both shocking and hyperbolic", *Math Horizons*, April 2003. HUGH MCCAGUE of York University, York, Ontario, was honored for his article "A mathematical look at a medieval cathedral", *Math Horizons*, April 2003.

The Lester R. Ford Award honors articles published in *The American Mathematical Monthly* and carries a cash prize of $500. Four awards were made for 2004. NOAM ELKIES of Harvard University was selected for his article "On the sums $\sum_{k=-\infty}^{\infty}(4k+1)^{-n}$", *The Monthly*, August–September 2003. CHARLES LIVINGSTON of Indiana University was honored for his article "Enhanced linking numbers", *The Monthly*, May 2003. R. MICHAEL RANGE of the State University of New York at Albany was honored for his article "Complex analysis: A brief tour into higher dimensions", *The Monthly*, February 2003. RUEDIGER THIELE of the University of Leipzig was selected for his article "Hilbert's twenty-fourth problem", *The Monthly*, January 2003.

The George Pólya Award is given for articles published in *The College Mathematics Journal* and has a cash prize of $500. GREG N. FREDERICKSON of Purdue University was honored for his article "A new wrinkle on an old folding problem", *College Mathematics Journal*, September 2003.

The Chauvenet Prize for Expository Writing consists of a cash prize of $1,000 and is awarded to the author of an outstanding expository article on a mathematical topic by a member of the MAA. The 2004 awardee is EDWARD B. BURGER of Williams College for his article "Diophantine Olympics and world champions: Polynomials and primes Down Under", *The American Mathematical Monthly*, November 2000.

The Henry L. Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member honors a beginning college or university teacher whose teaching has been extraordinarily successful and whose effectiveness in teaching undergraduate mathematics is shown to have influence beyond his or her own classroom. The two awardees for 2004 are FRANCIS E. SU of Harvey Mudd College and ZVEZDELINA STANKOVA of Mills College. The award carries a cash prize of $1,000.

—From an MAA announcement

B. H. Neumann Awards Given

The B. H. Neumann Awards for 2004 have been presented by the Board of the Australian Mathematics Trust to ANTHONY J. GUTTMANN, University of Melbourne; ANNA NAKOS, Temple Christian College, Adelaide; and JAMIE SIMPSON, Curtin University of Technology, Perth. The awards, named for Bernhard H. Neumann, are presented each year to mathematicians who have made important contributions over many years to the enrichment of mathematics learning in Australia and its region.

—Board of the Australian Mathematics Trust

Vadhan Receives ONR Young Investigator Award

The Office of Naval Research (ONR) has announced the awarding of twenty-six grants in the 2004 ONR Young Investigators Program competition. SALIL P. VADHAN of Harvard University was awarded a grant to study pseudorandomness and applications.

The Young Investigator Program supports basic research by exceptional faculty at U.S. universities who have received Ph.D.'s or equivalent degrees within the preceding five years. Grants to their institutions provide up to $100,000 per year for three years. The funds may be applied to a variety of research costs, including salary, graduate student support, laboratory supplies, and operating costs. Young Investigators are selected on the basis of prior professional achievement, the submission of a meritorious research proposal, and evidence of strong support by their respective universities. The program supports outstanding research in a wide range of science and engineering fields that are critical to the evolution of a first-rate Navy and Marine Corps.

—From an ONR announcement

AMS Menger Awards at the 2004 ISEF

The 2004 Intel-International Science and Engineering Fair (ISEF) was held May 9–15 in Portland, Oregon. This was the fifty-fifth year of the ISEF competition. More than twelve hundred ninth- through twelfth-graders from the United States and abroad competed in the fair. The participants had qualified by winning competitions in local, regional, and state fairs in the United States or national science fairs abroad. The ISEF administers the general awards. In addition more than fifty organizations, including the American Mathematical Society, participated by presenting special awards at the ISEF. The prizes awarded by the AMS included cash prizes, certificates, books, and briefcases.

This was the seventeenth year that the AMS participated in the ISEF, and it marked the fifteenth year of the presentation of the Karl Menger Awards. The members of the 2003-2004 AMS Menger Prize Committee are Elwyn Berlekamp, University of California at Berkeley; Gisèle Goldstein, University of Memphis (chair); and Hugh Montgomery, University of Michigan, Ann Arbor. The Special Awards Panel of Judges for the AMS this year consisted of the members of the AMS Menger Prize Committee and Paul Latiolais, Portland State University. The panel of judges reviewed more than sixty-five individual and team projects in the fields of mathematics, physics, and computer science.

Each entrant under consideration for a Menger Prize was interviewed by a member of our panel, and finalists were interviewed by the entire panel. The AMS gave one first-place award, two second-place awards, four third-place awards, and five honorable mention awards.

Menger Prize winners: Front row (left to right), Gisèle Goldstein (prize committee chair), Brett Harrison, Ilya Gurwich, Brian Rice; middle row, Huan-Chun Yeh, Brianna Satinoff, Ning Zhang, Sam Lewallen; back row, Nimish Ramanlal, Nurlan Bakitzhanov, Ginger Howell, Carlos Arreche-Aguayo, Allison Berke. Tair Assangali is not in the photograph.

The Karl Menger Memorial Prize winners were as follows:

First Place Award: ($1,000): "A Proof of Seymour's Conjecture for All Oriented Graphs", BRETT ALEXANDER HARRISON, Half Hollow Hills High School West, Dix Hills, New York.

Second Place Awards ($500): "Deviations from an Isotropic and Homogeneous Expansion of the Universe", ILYA GURWICH, Amit State Religious/Municipal Comprehensive School, Beer-Sheva, Israel; "On the Properties of Jump Points in the Game of n-times Nim", BRIAN TODD RICE, Marion Senior High School, Marion, Virginia.

Third Place Awards ($250): "A Novel Set of Representations of the Two-Component Link Group and Consequent Link Invariants", SAM JAY LEWALLEN, Stuyvesant High School, New York, New York; "An Investigation of Irreducible Polynomials over Zp Using Abstract Algebra", BRIANNA RACHEL SATINOFF, Palm Harbor University High School, Palm Harbor, Florida; "$m \times n$ Admissible Boards", HUAN-CHUN YEH, Taipei Municipal Junior High School, Taipei, Taiwan; "Research on the Number-Reasoning Problem", NING ZHANG, the High School Affiliated to Fudan University, Shanghai, China.

Honorable Mention Awards: "The Membership Problem for Ideals in the Ring of Polynomials over the Integers $Z[x]$", CARLOS EDUARDO ARRECHE-AGUAYO, University Gardens High School, San Juan, Puerto Rico; "Constructing Boxes with N-tetracubes", TAIR ASSANGALI and NURLAN BAKITZHANOV, Kasakh-Turkish Lycée, Aktobe, Kazakhstan; "The Snake Lemma and Its Applications to Graph Theory", ALLISON PAIGE BERKE, Mira Loma High School, Sacramento, California; "Diophantine Equations: Which Numbers Are Linear Combinations?", GINGER BEARDSLEE HOWELL, Trinity Collegiate School, Darlington, South Carolina; "A Quantum Algorithm for the Simultaneous Evaluation of Functions: A Combinatorics Solution with Fractal Properties", NIMISH P. RAMANLAL, Seminole High School, Sanford, Florida.

The AMS'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 or to make contributions to the fund, contact the AMS Development Office, 201 Charles Street, Providence, RI 02904-2294; send email to `development@ams.org`; or telephone 401-455-4111.

—Gisèle Goldstein, University of Memphis

Editor's Note: The September 2004 issue of the *Notices* carried an incorrect version of the announcement about the 2004 Menger Awards. The correct version appears here.

Mathematics Opportunities

American Mathematical Society Centennial Fellowships

Invitation for Applications for Awards for 2005–2006
Deadline December 1, 2004

The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. The eligibility rules are as follows.

The primary selection criterion for the Centennial Fellowship is the excellence of the candidate's research. Preference will be given to candidates who have not had extensive fellowship support in the past. Recipients may not hold the Centennial Fellowship concurrently with another research fellowship such as a Sloan or National Science Foundation Postdoctoral Fellowship. Under normal circumstances, the fellowship cannot be deferred. A recipient of the fellowship shall have held his or her doctoral degree for at least three years and not more than twelve years at the inception of the award (that is, received between September 1, 1993, and September 1, 2002). Applications will be accepted from those currently holding a tenured, tenure-track, postdoctoral, or comparable (at the discretion of the selection committee) position at an institution in North America.

The stipend for fellowships awarded for 2005–2006 is expected to be approximately $62,000, with an additional expense allowance of about $3,000. Acceptance of the fellowship cannot be postponed.

The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Society supplements contributions as needed. At most, two fellowships will be awarded for the 2005–2006 academic year. A list of previous fellowship winners can be found at `http://www.ams.org/prizes-awards`.

Applications should include a cogent plan indicating how the fellowship will be used. The plan should include travel to at least one other institution and should demonstrate that the fellowship will be used for more than reduction of teaching at the candidate's home institution. The selection committee will consider the plan in addition to the quality of the candidate's research and will try to award the fellowship to those for whom the award would make a real difference in the development of their research careers. Work in all areas of mathematics, including interdisciplinary work, is eligible.

The deadline for receipt of applications is **December 1, 2004**. Awards will be announced in February 2005 or earlier if possible.

Application forms are available via the Internet at `http://www.ams.org/employment/centflyer.html`. For paper copies of the form, write to the Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; or send electronic mail to `prof-serv@ams.org`; or call 401-455-4107.

—AMS announcement

ICM 2006 Travel Grants

The International Mathematical Union (IMU) and the Organizing Committee of ICM 2006 will award a limited number of grants for travel to the International Congress of Mathematicians (ICM 2006) in Madrid, Spain, August 22–30, 2006. The grants will be awarded to active young research mathematicians (less than thirty-five years old at the time of the congress) and to senior mathematicians from developing and economically disadvantaged countries.

The travel grants, provided by the IMU Special Development Fund, will support travel costs and living expenses for the duration of the congress. The Organizing Committee will also provide partial support for a limited number of senior mathematicians from Latin America and from developing Mediterranean countries, as well as for young Spanish mathematicians (less than thirty-two years old at the time of the congress).

Deadline for grant applications is **January 1, 2006**. For more information, see http://www.icm2006.org or email: grants@icm2006.org.

—From an ICM announcement

Research Opportunities for U.S. Graduate Students in Asia

The National Science Foundation (NSF) and the National Institutes of Health (NIH) are cosponsoring a summer research program in Japan, Korea, and Taiwan for U.S. graduate students during the summer of 2005. The East Asia and Pacific Summer Institutes (EAPSI) provide U.S. graduate students in science and engineering firsthand research experience in Australia, China, Japan, Korea, or Taiwan; an introduction to the science and science policy infrastructure of the respective location; and orientation to the culture and language. The primary goals of EAPSI are to introduce students to East Asia and Pacific science and engineering in the context of a research laboratory and to initiate personal relationships that will better enable them to collaborate with foreign counterparts in the future. The institutes last approximately eight weeks, from June to August, and are administered in the United States by the NSF. The NIH cosponsors the summer institute in Japan.

Applicants must be U.S. citizens or permanent residents. They must be enrolled at U.S. institutions in science or engineering Ph.D. programs, in M.D. programs with an interest in biomedical research, or in master's degree programs with at least one full academic year completed by the end of the calendar year of application. They must be pursuing studies in fields of science or engineering that are supported by the NSF or the NIH (for Japan) and that also are represented among the potential host institutions. International travel will be provided, and each awardee will receive an allowance of $3,000.

The deadline for application materials to be postmarked is **December 10, 2004**. Proposers are required to prepare and submit all proposals for this announcement/solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: http://www.nsf.gov/pubs/2003/nsf03608/nsf03608.

—From an NSF announcement

AAUW Educational Foundation Fellowships and Grants

The American Association of University Women (AAUW) awards Selected Professions Fellowships to women who intend to pursue a full-time course of study at accredited institutions during the fellowship year in a designated degree program in which women's participation has traditionally been low. All women who are candidates for the master of science (M.S.) degree in mathematics or statistics are eligible to apply.

Applications are now available for Master's and First Professional Awards, which carry cash awards of between $5,000 and $12,000. The deadline for applications to be postmarked is **January 10, 2005**. The fellowship year runs from July 1, 2005, to June 30, 2006. For more information see the AAUW's website at http://www.aauw.org/fga/fellowships_grants/selected.cfm, or contact the AAUW Educational Foundation, 1111 Sixteenth St., N.W., Washington, DC 20036; telephone 800-326-2289 (AAUW); fax 202-872-1425; email: info@aauw.org.

—From an AAUW announcement

Call for Nominations for Third World Academy of Sciences Prizes

The Third World Academy of Sciences (TWAS) Prizes will be awarded to individual scientists in developing countries in recognition of outstanding contributions to knowledge in eight fields of science.

This new prize was formed by merging the TWAS Awards in Basic Sciences and the Third World Network of Scientific Organizations (TWNSO) Prizes in Applied Science. Eight awards are given each year in the fields of mathematics, basic medical sciences, biology, chemistry, physics, agricultural sciences, earth sciences, and engineering sciences. Each award consists of a prize of US$10,000 and a plaque. Candidates for the awards must be nationals of developing countries and, as a rule, must be living and working in those countries.

Nomination forms should be sent to: Helen Grant, TWAS Prizes, Third World Academy of Sciences (TWAS), c/o The Abdus Salam International Centre for Theoretical Physics (ICTP), 34014 Trieste, Italy; fax: (39) 040-224559. Further information is available on the World Wide Web at http://www.ictp.trieste.it/~twas/twas_prizes.html.

—From a TWAS announcement

Twentieth Reunion of Budapest Semesters Program

The Budapest Semesters in Mathematics (BSM) Program will celebrate its twentieth year with a gala reunion to be held in Budapest, June 15–23, 2005.

Initiated by Paul Erdős, László Lovász, and Vera T. Sós, the Budapest Semesters in Mathematics program draws on Hungary's long tradition of excellence in mathematics education to provide a unique opportunity for North American undergraduates. Through this program, mathematics and computer science majors in their junior/senior years spend one or two semesters in Budapest and study under

the tutelage of eminent Hungarian scholar-teachers. The BSM instructors are members of Eötvös University and the Mathematical Institute of the Hungarian Academy of Sciences, the two institutions known for having educated more than half of Hungary's highly acclaimed mathematicians.

The BSM has had more than 1,300 participants in its twenty years of existence. The reunion will feature keynote addresses by Ronald Graham of the University of California, San Diego, and László Babai of the University of Chicago, as well as distinguished BSM alumni. There will be a gathering of faculty and former students, talks on the history of the program, and a three-day high-level survey-research conference with six plenary speakers. The reunion will also feature excursions and day trips, including a film festival, folk dance lessons, music from the Festival Orchestra and the Liszt Academy, an evening dinner cruise to the Danube Bend, and a picnic on Margaret Island.

For further information on BSM and to register for the reunion, visit the website `http://www.stolaf.edu/depts/math/budapest/`.

—Paul Humke
St. Olaf College, BSM North American Director

NSF International Research Fellow Awards

The International Research Fellow Awards Program of the National Science Foundation (NSF) provides support for postdoctoral and junior investigators to do research in basic science and engineering for three to twenty-four months in any country in the world. The goal of the program is to establish productive long-term relationships between U.S. and foreign science and engineering communities. Applicants must be U.S. citizens or permanent residents who have earned their doctoral degrees within six years before the date of application or who expect to receive their degrees by the date of the award.

The deadline for applying is the second Tuesday in October each year. For further information contact the program officer, Susan Parris, 703-292-7225, email: `sparris@nsf.gov`; or visit the website `http://www.nsf.gov/cgi-bin/getpub?nsf02149`.

—From an NSF announcement

NSA Funding Opportunity in Quantum Computing Algorithms

The National Security Agency (NSA) solicits proposals for one-year research grants in the area of quantum computing algorithms.

Grants are for one year only, but it is quite possible that innovative research will receive additional funding in subsequent years. Proposals of up to $100,000 will be considered. In some cases, exceptional proposals may qualify for more funding. The agency is not interested in funding work such as quantum error correction, but more interested in algorithms related to number theory, algebra, and combinatorics than in topics such as physical modeling and database analysis.

Deadline for proposals is **Monday, December 20, 2004.** Please see the NSA website `www.nsa.gov/msp/msp00002.cfm` for more details on what to include with the proposal. Send six hard copies of proposals to: Mathematical Sciences Program, ATTN: Quantum Computing Algorithm Grants, NSA, Suite 6557, Fort Meade, MD, 20755-6557. In addition, email PDF copy of proposal to: `mdwagn4@nsa.gov`. Direct questions to: Mel Currie, 301-688-0298, `mrcurri@orion.ncsc.mil`.

—From an NSA 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 NSA gives 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. Due to a recent policy change, research in cryptology is no longer being supported. The NSA also accepts proposals for small grants for conferences, workshops, and special academic endeavors. Research grants are designed principally to provide summer salaries for professors and limited support for their graduate students.

The deadline for submission of all grant proposals is **October 15** each year. Grants begin in the fall of the following year. For more information on the application process, see `http://www.nsa.gov/msp/msp00002.cfm`.

The sabbatical opportunities offered by the NSA provide support for academic mathematical scientists to visit the NSA for periods ranging from nine to twenty-four months. The NSA pays half of a sabbatical visitor's salary and benefits during academic months and 100 percent of salary and benefits during any summer months of the sabbatical detail. 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. Because a complete background investigation is required, applications should be submitted well in advance of the requested starting date. To apply, send a cover letter and curriculum vitae with list of publications. The cover letter should contain a description of research interests, how the applicant could contribute to NSA's mission, and how doing a sabbatical at NSA would affect teaching and research upon returning to academia.

For more information see http://www.nsa.gov/msp/msp00003.cfm.

More information on these programs may be obtained from the NSA's website: http://www.nsa.gov/msp. Michelle D. Wagner (mdwagn4@nsa.gov) is the new director, and Rosalie (Jackie) Smith (rjsmit2@nsa.gov) is the program administrator of the Mathematical Sciences Program. The phone number is 301-688-0400, and the fax number is 301-688-0697. Grant and sabbatical applications should be mailed to Dr. Michelle D. Wagner, NSA Mathematical Sciences Program, National Security Agency, ATTN: R1, Suite 6557, Fort Meade, MD 20755-6557.

—From an NSA announcement

MATHEMATICS OPPORTUNITIES

Inside the AMS

Fan and Caldwell Scholarships Awarded

The AMS awarded six scholarships to students attending programs for mathematically talented high school students held in summer 2004. Five Ky and Yu-Fen Fan Scholarships and one Roderick P. C. Caldwell Scholarship were awarded. The scholarships are intended to cover the tuition for the programs.

Information about the five students receiving Fan Scholarships follows.

PETER MCLARNAN, home schooled, from Richmond, Indiana, attended the Ross Mathematics Program at Ohio State University. He is 17 years old and is now entering the twelfth grade. He was an enthusiastic student in 2003 and is currently a junior counselor in the Ross Program. His father, Timothy McLarnan, was himself a student and counselor in the Ross Program during the 1970s.

GEEHOON HONG, Benjamin Cardoza High School, Bayside, New York, attended the CANADA/USA Mathcamp at Colby College in Waterville, Maine. Hong, 19 years old, will enter the twelfth grade in fall 2004. He has attended courses at City College of New York and Columbia University. This year he was the individual high scorer in the New York City Interscholastic Math League.

DONAVION HUSKEY, Tustin High School, Tustin, California, attended the Texas State University Honors Summer Math Camp. He is 16 years old and will enter the twelfth grade in fall 2004. He will serve as his school's Science Olympiad Team captain and secretary of its Math Club. He is also a member of the California Scholarship Federation.

MARIAH KELLAM of Hereford High School, Parkton, Maryland, attended the Hampshire College Summer Studies Program. Also a participant in 2003, Kellam is now 16 years old. She describes herself as arriving at the program not knowing a sigma or a Fermat and valuing mathematics only for its utility; she left with an appreciation for the intrinsic beauty of the subject and a passion to learn more.

ABRAHAM RASHIN, Academy for Advancement of Science and Technology (AAST), Teaneck, New Jersey, attended PROMYS (Program in Mathematics for Young Scientists) at Boston University. He is 15 years old and will enter eleventh grade in fall 2004. He says he came to PROMYS to "exercise and open" his mind and relished the "untimed, thought-provoking, apt mathematical explorations" encouraged at PROMYS.

The student receiving the Roderick P. C. Caldwell Scholarship is AMBREEN RAHMAN, Texas Academy of Mathematics and Science at the University of North Texas in Denton. She attended the Texas State University Honors Summer Math Camp. Born in Karachi, Pakistan, she has been raised in a single-parent home since coming to the United States in 2000. She is 16 years old and will enter the eleventh grade in fall 2004. She started a branch of Amnesty International at her school. After graduation she plans to pursue a major in mathematics, computer science, and engineering.

The Fan Scholarships are supported by the Society's Ky and Yu-Fen Fan Endowment. This endowment was established through a gift by Ky Fan and his wife, Yu-Fen Fan. Income from the endowment supports mathematics in China and mathematically talented high school students in the U.S. The Caldwell Scholarships were endowed by a gift from Winifred A. Caldwell in memory of her husband, Roderick P. C. Caldwell. The scholarships are part of the AMS Epsilon Fund, which supports programs for mathematically talented high school students.

—Allyn Jackson

Reference and Book List

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

Contacting the *Notices*

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

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

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

Upcoming Deadlines

October 12, 2004: Applications for NSF International Research Fellow Awards. See "Mathematics Opportunities" in this issue.

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

October 15, 2004: Applications for support from the Pacific Institute for the Mathematical Sciences (PIMS) for conferences, workshops, seminars and related activities in the mathematical sciences. See http://www.pims.math.ca/opportunities/proposals.html.

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

October 15, 2004: Proposals for NSA Grant and Sabbatical Programs. See the website http://www.nsa.gov/msp/index.cfm or telephone 301-688-0400.

October 15, 2004: Applications for NSF Postdoctoral Research Fellowships. See http://www.nsf.gov/pubs/2001/nsf01126/nsf01126.htm.

October 29, 2004: Entries for AWM essay contest. See http://www.awm-math.org/biographies/contest.html or contact Victoria Howle, the contest organizer, by email at vehowle@sandia.gov or by mail at Sandia National Labs, MS 9159, P.O. Box 969, Livermore, CA 94551.

Where to Find It

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

October 30, 2004: Nominations for Clay Research Fellowships. See the CMI website at http://www.claymath.org/fas/research_fellows/; telephone 617-995-2600; email: nominations@claymath.org.

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

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

December 10, 2004: Applications for East Asia and Pacific Summer Institutes. See "Mathematics Opportunities" in this issue.

December 20, 2004: NSA grants in quantum computing algorithms. See "Mathematics Opportunities" in this issue.

January 1, 2005: Entries for *Cryptologia* undergraduate paper competitions. See http://www.dean.usma.edu/math/pubs/cryptologia/.

January 10, 2005: Applications for AAUW Selected Professions Fellowships. See "Mathematics Opportunities" in this issue.

February 1, 2005: Applications for AWM Travel Grants and AWM Mentoring Travel Grants. See the AWM website http://www.awm-math.org/travelgrants.html, telephone: 301-405-7892, email: awm@math.umd.edu.

May 1, 2005: Applications for AWM Travel Grants. See the AWM website http://www.awm-math.org/travelgrants.html, telephone: 301-405-7892, email: awm@math.umd.edu.

June 30, 2005: Nominations for the 2005 Fermat Prize. See http://www.ups-tlse.fr/ACTUALITES/Sciences/Prix_Fermat_2004/Areglement.html.

January 1, 2006: Applications for ICM 2006 Travel Grants. See "Mathematics Opportunities" in this issue.

Book List

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

* *Just Six Numbers: The Deep Forces That Shape the Universe*, by Martin Rees. Basic Books, May 2001. ISBN 0-465-03673-2. (Reviewed in this issue.)

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

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

Linked: The New Science of Networks, by Albert-László Barabási. Perseus Publishing, May 2002. ISBN 0-738-20667-9. (Reviewed February 2004.)

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

Math through the Ages: A Gentle History for Teachers and Others, by William P. Berlinghoff and Fernando Q. Gouvêa. Oxton House, 2002. ISBN 1-881929-21-3. (Reviewed October 2004.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The Reader of Gentlemen's Mail: Herbert O. Yardley and the Birth of American Codebreaking, by David Kahn. Yale University Press, March 2004. ISBN 0-300-09846-4.

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

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

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

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

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

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

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

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

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

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

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

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

From the AMS Secretary

The AMS has five policy committees, each of which has one face-to-face meeting annually. Two of them meet in the spring, three in the fall. This is a report on the spring 2004 meetings of the Committee on Science Policy (CSP), held in Washington, DC, on 1–3 April 2004, and of the Committee on Meetings and Conferences (CoMC), held in Providence, RI, on 24 April 2004.

Committee on Science Policy

The Committee on Science Policy meeting was expanded this year and organized as a forum to allow for free-flowing discussion on issues of policy and funding for the mathematical sciences, as well as discussion of overall federal funding for science. The forum provided an opportunity for participants to interact with Capitol Hill and federal agency staff. The meeting was held immediately preceding the AMS Council meeting, and Council members were invited to attend the forum. In addition, as in past years, department chairs also were invited to participate. It is hoped that the forum will evolve into a yearly event that provides useful information for department chairs, much like the Department Chairs Colloquium of the Board of Mathematical Sciences and Applications did.

The forum, which had over fifty participants, consisted of a focused open discussion on Thursday evening, followed by presentations from administration and congressional officials and federal agency representatives on Friday, and a wrap-up session Saturday morning.

Prior to the beginning of the meeting, the AMS honored Bernard S. McDonald, the executive officer of the Division of Mathematical Sciences at the National Science Foundation, on the occasion of his imminent retirement. Jane Hawkins, CSP chair, recognized Bernie's work on behalf of the mathematical sciences community. David Eisenbud, president of the AMS, and John Ewing, executive director of the AMS, thanked Bernie on behalf of the AMS. Several of Bernie's colleagues also made brief presentations. John Ewing presented Bernie with a certificate of appreciation from the AMS Committee on Science Policy.

Opening Discussions

The forum kicked off with discussions centered around three questions:

1. Do enough mathematicians receive federal funding? (What percentage of academic mathematicians should be funded?)
2. Has the mathematical community been affected by the current U.S. visa regulations?
3. Do we really need more U.S. students in the mathematics pipeline?

Slides and graphs were presented to provide backup data on funding, enrollments, and other quantitative information useful to the discussions. There was even some disagreement about the accuracy of the data provided, but the discussion soon made its way to the substance of the questions themselves. The size of grants and their success rates were discussed, as well as the fact that other fields have more avenues for research funding than the mathematical sciences. No consensus was reached on grant size, but most agreed that more mathematicians should receive federal funding.

The discussion then turned to visa regulations, particularly the way the law is administered since September 11, 2001. Some anecdotal evidence was given about the current state of the system, and all were encouraged to contact their congressional representatives to bring the difficulties experienced at universities and elsewhere to light.

Highlights from Presentations Given by Administration, Congressional and Federal Agency Officials:

Daniel A. Hitchcock
Ph.D., Senior Technical Advisor, Advanced Scientific Computing Research (ASCR), U.S. Department of Energy
Dr. Hitchcock summarized the work of the ASCR and the strategic issues on which it focuses within the Office of Science, such as providing high-performance computing and network facilities and accelerating the transition from research to application. He then discussed the ASCR budget and gave an overview of ASCR programs.

Hitchcock spoke briefly about SciDAC (Scientific Discovery Through Advanced Computation), a program developed across the Office of Science a few years ago to accelerate the transition of software and mathematical ideas into application codes. He went on to discuss how important mathematics is to DOE and how applied mathematics contributes to ASCR strategic goals through well-posed mathematical models, mathematical analysis of model behavior, efficient algorithms for solving the discretized models, predictability analysis and uncertainty quantification for model reduction and to determine levels of confidence in the results.

He highlighted one of the areas ASCR will focus on next year—the mathematics needed for multi-scale systems. DOE will try to address the significant issues associated with multi-scale systems (such as those in materials, chemistry, biology, climate and ground water) that require new mathematical insight to understand them. A workshop was held in May 2004 to bring mathematicians and applications people together to talk about the challenges and opportunities for the future. A report will be issued on workshop discussions and ideas as to where future investments should be made. This report will be widely distributed.

David Trinkle
Staff Specialist, Office of Management and Budget
David Trinkle began his presentation with an overview of the Office of Management and Budget (OMB) and the federal budget process in general. OMB is the largest White House office in terms of staff and fulfills a number of roles, including helping to prepare the president's budget, overseeing the day-to-day operations of federal agencies, and management and implementation of any long-term management initiatives. Trinkle, an examiner of the National Science Foundation (NSF), looks at broad research issues across the government.

Now that the FY2005 budget request is out, the OMB is focusing on the FY2006 budget. Presently, OMB is developing FY2006 budget guidance for agencies to follow in constructing their budgets. Agencies will present a first draft of their FY2006 budgets to OMB in September. OMB and the agencies will work together through the end of the year finalizing the FY2006 budget.

The president's request for FY2005 was founded on certain priorities, including the war on terrorism, homeland defense, and economic recovery. Growth in discretionary spending is held down in favor of funding for defense-related expenses. When defense and homeland security are taken out of the equation, discretionary spending will grow by only 0.5%. Even with this cap, the NSF will increase by 3.0% for FY2005. Trinkle's expectation is that the FY2006 budget will be similar to FY2005, possibly even be more restrictive given that the presidential election will have happened.

Forum participants posed several questions, including one related to the shift of funds from the Mathematics and Science Partnership (MSP) Program at NSF to the Department of Education. He explained that MSP and DoEd had parallel programs and the desire was to put the program in one agency only. The administration of the program already funded through the MSP at NSF will continue through the NSF (many of those grants are five years in duration). Other questions touched on how funding is prioritized, what impact the president's Mars initiative will have on future budgeting, and what, if anything, can be done to get back on track with doubling NSF's budget in five years as outlined in Public Law 107-338, passed in 2002.

Michael Stephens
Professional Staff, House Appropriations Subcommittee on VA, HUD and Independent Agencies
Michael Stephens spoke about the legislative environment surrounding the appropriations process for the FY2005 budget. He characterized the FY2005 budget as being very bleak in terms of growth. The current federal budget deficit of $521 billion has created a funding environment that is hugely constrained. However, the legislative process is one of individuals making choices among large numbers of priorities both at the macro and micro levels, so the possibility for surprises is significant.

The situation for science funding, particularly for NSF, is that there is enormous support for federal investment in science, and the long-term value of this support is a recognition that a significant amount of high-quality research is being left unfunded to the detriment of the country. In Stephens' estimation, the House did not overtly "buy in" to Public Law 107-338, but rather would like to see significant increases in the NSF budget without prescription for how to get there. Up until last year the NSF had been receiving 7–13% increases. Last year, the NSF received an increase of 3.9%. A similar situation appears likely for the FY2005 budget, with a currently proposed increase of just 3%.

With current federal finances such as they are, it is extremely difficult to see where any additional resources will come from. There may be an ability to move some monies around within the NSF budget, but it is unlikely that the foundation will receive more than a 3% increase overall for FY2005. In addition, the near term does not look optimistic for increases in discretionary spending even as far out as FY2008, even if there is no change in administrations.

Stephens took questions from forum participants that included how the No Child Left Behind (NCLB) initiative impacts the budget process. In his view, NCLB is a large factor both politically and programmatically, because next to veteran's health care, it is the most urgent political challenge for Congress. NCLB has a constraining influence on money being available for other things. Other questions had to do with congressional earmarking, the Mathematics and Science Partnership program being moved to the Department of Education from the NSF, and increasing budget dollars going to community colleges.

Patrick Looney
Assistant Director for Physical Sciences and Engineering, Office of Science and Technology Policy
Patrick Looney began by giving an overview of the Office of Science and Technology Policy (OSTP), an executive

office of the president at the White House. He discussed OSTP's mission in assisting the president to evaluate the federal effort in science and technology. He also presented the factors influencing the direction of research and development, which he broke down into three components: scientific "push", which represents opportunities; societal "pull", representing demands; and the R&D environment, representing capacity and infrastructure.

With the president's priorities for the country in mind, OSTP and OMB are currently defining the areas of emphasis for science and technology for the FY2006 budget and will issue a priorities memo to the agencies as part of the budget process. These areas of emphasis have not changed in the last four years, and they include research and development for: homeland and national security, nanotechnology, networking and information technology, environment and energy, and molecular level of understanding of life processes.

Looney then discussed some ongoing OSTP activities and went over the FY05 R&D budget, both in terms of the basic research budget and in terms of R&D as a share of discretionary spending. He pointed out that although nondefense R&D spending hasn't changed over the last forty years, the distribution of these funds across agencies has changed significantly. The portfolio balance has shifted over time, and most areas of science are flat in constant dollar terms, with the exception of health.

In conclusion, he pointed out that the U.S. will spend $60 billion in nondefense R&D this year and that we spend more today in constant dollars than we ever have. In addition, overall R&D spending has accelerated since 2000.

Deborah Lockhart
Acting Executive Officer, Division of Mathematical Sciences, National Science Foundation

Deborah Lockhart reviewed the structure of the NSF in terms of directorates, divisions, and programs and then discussed new activities and programs in the Division of Mathematical Sciences (DMS). There is a new, broad activity within DMS called "Enhancing the Mathematical Sciences Workforce in the 21st Century". This builds on the existing VIGRE program and has three components: Research Training Groups (RTG), Mentoring through Critical Transition Points in the Mathematical Sciences (MCTP), and Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM).

1. RTG was designed for groups of researchers with related research goals based in mathematical sciences and covers undergraduates, graduates, and postdocs. The award size is up to $500,000 per year and the duration is one to five years. The FY04 awards were announced this summer.

2. MCTP facilitates mentoring devoted to points of transition in a career path in the mathematical sciences. The projects may be comprehensive efforts by many individuals or focused involving a few individuals, and the transition points may range from points in undergraduate studies to early years in a tenure-track position. The award size is up to $500,000 per year and the duration is one to five years. The FY04 awards were announced this summer.

3. UBM was introduced last year and was designed to enhance undergraduate education and training at the intersection of the biological and mathematical sciences. The award size is $250,000 per year and the duration is one to five years. The deadline for this was April 26, 2004.

Lockhart then mentioned the priority areas within the DMS, including fundamental mathematics and statistics, connections with other science disciplines and engineering, and addressing mathematical sciences education through research. She also reviewed the criteria used to judge proposals received, including intellectual merit and the broader impact of the proposed activity. She encouraged participants to visit their website to know what to address in proposals for funding and also to visit `http://www.fastlane.nsf.gov/` to get a list of awards and abstracts of awards.

Catherine Woytowicz
Science and Technology Diplomacy Fellow, Office of Science and Technology Cooperation, U.S. Department of State

Catherine Woytowicz discussed what the Office of Science and Technology Cooperation does. She explained that science and technology agreements in bilateral treaties increase cooperation between the U.S. and foreign science enterprises and show that the U.S. values science as a priority.

Woytowicz discussed the process by which these bilateral agreements are formed, and she talked about the implementation and funding of such agreements. She explained that the hardest part of creating these agreements was finding collaborating partners for whom the science and technology priorities are comparable.

She identified three fellowship programs at the U.S. Department of State: Embassy Science Fellows, American Association for the Advancement of Science Fellows, and the Jefferson Science Fellows. She gave a brief overview of the AAAS and Jefferson Science fellows programs. She then detailed the Embassy Science Fellows program, explaining that it places scientists in overseas posts to serve a specific function and to address a specific problem. She suggested that there may be opportunities for mathematicians in this program, especially if they are already employed by the government. The Department of State hopes to also reach out by bringing in scientists from outside the government to participate in this program, as some positions in the past have gone unfilled due to a lack of available government personnel.

Woytowicz then took questions from participants, which centered on security clearances and visa applications. She explained that visa applications are processed through the U.S. Department of State, but visa policy is set by the U.S. Department of Homeland Security. She acknowledged that the application process is exceedingly slow and has resulted in a significant drop in visa applications. She emphasized that the U.S. Department of State understands that foreign visitors contribute significantly to the development of science and technology in the U.S. and that visa applications should be submitted early so as to accommodate travel effectively.

James Turner
Chief Counsel, Minority House Committee on Science
Jim Turner presented a federal legislative update, focusing on research and development funding. He pointed out that the federal share of R&D as a percentage of GDP is in decline, life science (NIH) R&D has doubled in the last five years, but physical science research has continued its decline and will be down in absolute dollars in 2005. He identified the increasing pressure on the federal budget from deficits and unfunded Social Security and Medicare liability as a cause for the decline.

Turner went through what he deemed the R&D winners and losers in the FY2005 budget: the largest winner is the Department of Homeland Security, whose funding will increase in 2005 by 15%; the biggest loser is the Department of Defense science and technology budget, which will decrease by 15% next year.

He then discussed trends that he has seen on Capitol Hill. Increased congressional earmarking is one of those trends. He has seen a tenfold increase in earmarking in the last three years, due in large part to the pressures placed on members of Congress to deliver to their constituencies. Another trend is the decrease in the length of time that people stay in Congress or on congressional staffs. A reason is that the pension system for Congress and staff changed in 1984, significantly reducing the benefits for those starting after 1984. This causes newer personnel to move on to other jobs more quickly and creates a problem with the most senior, knowledgeable people on Capitol Hill retiring earlier and leaving behind much less experienced congressional staffs.

Turner then stated his feeling that the appropriations process for the FY2005 budget would not produce an overall budget that is larger than the president's proposal. He also discussed how far in the last five to ten years the science community has come on increasing the visibility for science and technology in Congress and how this success is due in large measure to the work of the AMS and other professional societies in their collaborative efforts.

Scott Weidman
Director, Board on Mathematical Sciences and Their Applications
Scott Weidman introduced the Board on Mathematical Sciences and Their Applications (BMSA) to participants, identifying those individuals associated with it. He then discussed the four major themes of BMSA's programs: new directions for the discipline, risk analysis, data overload, and computational modeling. The process of the board's work is to identify major program themes; then the federal agencies decide whether to move forward with a study or a workshop, and if so, a workshop is funded.

Related to the theme of new directions for mathematics, the BMSA has had several studies and workshops in the areas of: computational biology, the interface between mathematical and computer science, the mathematical and statistical challenges in data mining and pattern recognition, and the detection and epidemiology of bioterrorist attacks.

In addition, under the major theme of risk analysis, an enterprise risk management workshop was held in January 2004, and studies on systemic risk in the financial sector and risks in the Army's future combat system are currently being defined.

Weidman went on to discuss a current major BMSA theme, data overload. Several workshops on massive data streams and the mathematical sciences role in homeland security have been held. Another workshop focused on computer models.

CSP Activities at Joint Mathematics Meetings, Atlanta 2005

Historically CSP panels at the Joint Meetings have had poor attendance. This fact initiated discussion on what to do to increase interest in CSP activities. One idea centered around sponsoring a special session at the Atlanta meeting.

Sam Rankin and David Eisenbud have already had some discussions with NIH representatives about areas of opportunity for collaboration between the mathematics and biomedical research communities. Those discussions have produced the idea of the AMS working with the National Institute for General Medical Sciences (NIGMS), one of the NIH institutes, to set up a special session to discuss how the mathematical sciences contribute to biomedical research. The committee decided to move forward with this idea.

Report from the Washington Office

Sam Rankin gave a brief report on the recent work of the Washington office, including preliminary work on the FY2006 federal budget and plans to meet with the new director of the NSF. He reported that the AMS recently joined the "Bridging the Sciences Coalition", an initiative spearheaded by the Biophysical Society to encourage interdisciplinary involvement in biomedical research. Also, the AMS gave joint testimony before the House Appropriations Subcommittee on VA, HUD and Independent Agencies in support of increased funding for NSF. Jane Hawkins, CSP chair, presented the testimony for the AMS.

Rankin spoke in more detail about the federal budget process and current difficulties that will likely prohibit efforts to substantially increase funding levels in FY2006. Even so, he discussed the work being undertaken to try to affect the process, including meetings with congressional offices, working through coalitions, and implementing letter-writing campaigns.

Committee on Meetings and Conferences

Report of the Secretariat

AMS secretary Robert Daverman reported on the Secretariat meeting, held the previous evening.

1. The Secretariat is holding active discussions with the London Mathematical Society for an international meet-

ing in 2007 in Ireland or England and with IMPA to hold an international meeting in 2008 in Brazil.

2. The secretary and the Meetings Department will put together archival minutes of the sectional meetings, per the recommendation of the 2003 CoMC Review subcommittee.

3. CoMC approved the recommendation of the Secretariat to continue with the Special Session on Mathematical Current Events at the JMM meetings in 2005 and 2006.

4. The secretary will continue to send out President David Eisenbud's letter reminding Program Committees of their goal to select speakers who will deliver high-quality talks, with a commitment to gender diversity.

Report on the Subcommittee to Review Special Lectures Series, Special Projects and Short Courses

This subcommittee, composed of Colin Adams (chair), Tepper Gill, and Lesley Sibner, surveyed members from the past few years who attended the Gibbs, the Colloquium, and the Short Course and reviewed the past lectures in the Arnold Ross Lecture Series and the Erdős Lecture Series. It reported:

Gibbs Lecture

Those surveyed felt that the Gibbs Lecture was successful and the most popular lecture at the meeting.

Colloquium Lectures

Those surveyed who had attended the Colloquium Lecture the past few years had mixed reactions to the Colloquium Lectures. The secretary had reported that the Council felt that the third lecture should be kept, but asked CoMC for recommendations on how to approach it. CoMC made several suggestions, including:

- Making the third lecture part of a Special Session
- Putting the third lecture in a smaller room
- Holding a Special Session on the topic after the third lecture in the ballroom

CoMC approved the following:

- The secretary should encourage the Colloquium lecturer to hold a Special Session in conjunction with the third lecture.
- The secretary should send a letter to the lecturer with various ideas and options for the third lecture.

Arnold Ross Lecture

The subcommittee reported on the success of the Arnold Ross Lecture. CoMC members made some suggestions on holding the lectures in high schools and universities. CoMC also suggested looking for AMS members who may have contacts in the local high schools to encourage the local high school students to attend. No formal action was taken.

Short Course

The subcommittee reported on the overall value of the Short Course to the participants and recommended that the Short Course be continued.

CoMC accepted the subcommittee report on the Short Course, noted the financial deficit, and made it known that if management felt that there was a need to lower the number of speakers from six to five, CoMC in general approved this philosophy.

Report on the Phoenix Focus Group

Paul Zorn moderated the January 2004 CoMC Focus Group discussion. The comments and suggestions from the focus group were discussed at the meeting during Zorn's oral report. No formal CoMC action was taken.

Discussion of the Interim Report on Focused Planning on Meetings

The AMS is engaged in a five-year cycle of focused planning analyses of key Societal activities. Meetings are the topic of the 2004 focused planning effort. The CoMC discussion centered on three important questions raised in the interim report on Focused Planning on Meetings.

1. Should there be more sectional meetings?

CoMC supported the concept of having more sectional meetings and supported continuing to discuss the best way to achieve this, including having a fifth associate secretary who would be "at large" without a specific defined geographic area and who could hold sectionals with other societies.

2. In what form should the AMS seek to continue its research conference program?

CoMC approved the following resolution: "CoMC recommends the submission of a renewal proposal to the NSF that makes refinements to the way the SRCs are currently working."

CoMC also supported the continued collaboration with both SIAM and IMS in the conduct of the SRCs. It recommended that the current spirit of flexibility in accommodating various conference forms be maintained in the renewal proposal, including conferences of duration beyond a single week as well as conferences that target "young researchers".

3. What role should the meetings activities play in the overall finances of the Society?

CoMC discussed the role currently played by meetings in the finances of the Society, felt that they were appropriate, and did not raise any additional questions.

CoMC also raised additional questions to review as follow-up to the planning process.

Other Informational Items

CoMC's topic for annual review for 2005 is to be the Review of National Meetings (Scientific program). CoMC will host a focus group at the Atlanta meeting, with Jean Taylor as moderator.

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Reciprocity Agreements

Africa

Egyptian Mathematical Society (ETMS)

Apply to: Dr. Mohamed H. Fahmy, Department of Mathematics, Faculty of Science, Al-Azhar University, Nasr City 11884, Cairo, Egypt.

Dues: U.S. $15, payable to Egyptian Mathematical Society, Al-Azhar Univ., Fac. of Sci., Dept. of Math., Nasr City 11884, Cairo, Egypt.

Privileges: Receive a 60% discount on the prices of ETMS publications, a 50% discount on the publication charge per printed page in *ETMS Journal*, and reduced charge for participating at ETMS conferences.

Officers: A.-S. F. Obada (President), E. H. Doha (Vice-President), F. F. Ghaleb (Treasurer), M. H. Fahmy (Secretary).

Nigerian Mathematical Society*

Apply to: Jerome A. Adepoju (Secretary), Nigerian Mathematical Society, Department of Mathematics, University of Lagos, Akoka-Yaba, Lagos, Nigeria; email: matdeplg@infoweb.abs.net.

Dues: U.S. $16, payable to A. U. Afuwape (Treasurer), Dept. of Maths., Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

Privileges: *Journal of the Nigerian Mathematical Society* at the price normally charged to individual members.

Officers: J. C. Amazigo (Ag. President), G. O. S. Ekhaguere (Vice-President), A. U. Afuwape (Treasurer), J. A. Adepoju (Secretary).

South African Mathematical Society*

Address for mail: Prof. M. S. Maharaj, Mathematics and Applied Mathematics, University of Durban-Westville, Private Bag X54001, Durban 4000, South Africa; email: mmaharaj@pixie.udw.ac.za.

Apply to: Prof. N. T. Bishop, Mathematics, Applied Mathematics and Astronomy, P. O. Box 392, Unisa 0003, South Africa.

Dues: R180.00 (One hundred eighty rands), payable to the South African Mathematical Society (SAMS), c/o Prof. N. T. Bishop (Treasurer) at the above address.

Privileges: The right to present papers at meetings of the Society; the right to receive at no additional cost: the *Notices of the SAMS*; reduced fees at all SAMS meetings.

Officers: E. A. K. Brüning (President), J. Baniasek (Vice-President), N. T. Bishop (Treasurer), M. S. Maharaj (Secretary).

The Americas

Canadian Mathematical Society*

Apply to: Membership and Publications Agent, Canadian Mathematical Society, 577 King Edward Ave., Suite 109, P. O. Box 450, Station A, Ottawa, Ontario, Canada K1N 6N5; email: office@cms.math.ca; http://www.cms.math.ca/.

Dues: 50% off applicable rate, payable in U.S. funds to the Canadian Mathematical Society.

Privileges: *CMS Notes*, access to members section on website; reductions on all CMS periodicals, publications, and meeting registration.

Officers: Christiane Rousseau (President); Eddy H.E.A. Campbell (President Elect); Kathryn Hare, Samuel Shen, Jon H. Thompson, and Steven Boyer (Vice-Presidents); Arthur Sherk (Treasurer); 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 $74 for 2004 and $76 for 2005. 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 November *Notices* went to press.

Sociedad Colombiana de Matemáticas*

Address for mail: Apartado Aereo 2521, Bogotá, Colombia; email: scm@scm.org.co; http://www.scm.org.co.

Apply to: Carlos H. Montenegro E., Apartado Aereo 2521, Bogotá, Colombia.

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

Privileges: Subscription to one of the publications of the Society (*Revista Colombiana de Matemáticas or Lecturas Matematicas*), discounts for participation in Society activities, and e-mail in the scm.org.co domain.

Officers: Carlos H. Montenegro E. (President), Jose Ricardo Arteaga (Vice-President).

Sociedad de Matemática de Chile*

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

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 Rebolledo (President), Victor Cortés (Vice-President), Hernán Burgos (Treasurer), Rodrigo Bamón and Sergio Plaza (Secretaries).

Sociedad Matemática de la República Dominicana*

Apply to: Isidro Rodríguez, Sociedad Matemática de la República Dominicana, Apartado 797-2, Santo Domingo, República Dominicana.

Dues: U.S. $10, payable to Amado Reyes at the above address.

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

Officers: Isidro Rodriguez (President), Mariana Morales (Vice-President), Amado Reyes (Treasurer), Eliseo Cabrera (Secretary).

Sociedad Matemática Mexicana*

Apply to: Olivia Lazcano, Apartado Postal 70-450, México, D.F. 04510, México; email: smm@smm.org.mx/; http://www.smm.org.mx/.

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 *Miscelánea Matemática.*

Officers: Emilio Lluis-Puebla (President), Carlos Signoret (Vice-President), Eugenio Garnica (Treasurer), Pablo Padilla (General Secretary), Isidro Romero (Secretary), Lino Reséndiz and Silvia Morelos (Vocal).

Sociedad Uruguaya de Matemática y Estadística (SUME)*

Address for mail: J. Herrera y Reissig 565, CC 30, CP 11300, Fac. de Ingeniería, IMERL, Montevideo, Uruguay; email: jlvb@fing.edu.uy.

Apply to: José L. Vieitez (Presidente de SUME), at the above address.

Dues: U.S. $100, payable to Jorge Blanco at the above address.

Privileges: Receive PMU series and Predat series free.

Officers: José L. Vieitez (President), Jorge Blanco (Vice-President), Gonzalo Perera (Treasurer), F. Pelaez (Secretary).

Sociedade Brasileira de Matemática*

Apply to: Fernanda Job, Diretoria da SBM, Estrada Dona Castorina–110, Jardim Botânico, Rio de Janeiro, RJ, Brasil, 22460-320; email: sbm@sbm.org.br.

Dues: U.S. $10, payable to Sociedade Brasileira de Matemática (contact: Telma Teixeira) at above address.

Privileges: *Revista Matématica Universitária* (RMU) (two issues per year); other publications can be purchased at a 25% discount.

Officers: Suely Druck (President), César Camacho (Vice-President), Carlos Frederico B. Palmeira (Treasurer), Elon Lages Lima (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 Cipolati (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), *Monografias da Sociedade Paranaense de Matemática.*

Officers: C. Pereira da Silva (President), R. J. B. De Sampaio (Vice-President), E. Andretta (Treasurer), A. Moser (Secretary).

Unión Matemática Argentina*

Apply to: Alejandro Neme, IMASL, Ave. Ejercito de los Andes 950, 5700 San Luis, Argentina; email: uma@unsl.edu.ar; 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).

Asia

Allahabad Mathematical Society

Apply to: Secretary, Allahabad Mathematical Society, 10 C. S. P. Singh Marg, Allahabad-211001, India; email: pramila8@sancharnet.in; http://www.amsallahabad.org.

Dues: U.S. $30 for annual members, U.S. $250 for life members, payable to Allahabad Mathematical Society at the above address.

Privileges: All members receive a copy of the *Bulletin of the Allahabad Mathematical Society* (free of cost). In addition, members can purchase other publications of the Society at a discount of 50% for their personal use. Members of the American Mathematical Society receive a 50% discount on the annual membership fee.

Officers: Pramila Srivastava (President), M. S. Rangachari and S. L. Singh (Vice-Presidents), Shalini Srivastava (Treasurer), Mona Khare (Secretary).

Calcutta Mathematical Society

Apply to: M. R. Adhikari, Secretary, Calcutta Mathematical Society, AE-374, Sector-1, Salt Lake City, Calcutta 700 064, India; telephone: 2337-8882; telex: 021-5380 BID IN; Fax: (0091) 33-23376290; email: cms@cal2.vsnl.net.in.

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

Privileges: *Bulletin of the Calcutta Mathematical Society*; *News Bulletin of the Calcutta Mathematical Society*; *Review Bulletin of the Calcutta Mathematical Society*; library, seminars/symposia, summer school, winter school, conferences, etc.

Officers: S. N. Ghosh (President), A. P. Baisnab, A. Chakrabarty, S. Kumaresan, P. Muldowney, and H. M. Srivastava (Vice-Presidents), U. C. De (Treasurer), M. R. Adhikari (Secretary), H. P. Mazumdar (Editorial Secretary).

Indian Mathematical Society*

Apply to: S. P. Arya, Treasurer, Maitreyi College, Bapu Dham Complex, Chanakyapuri, New Delhi 110021, India; email: drsparya@vsnl.net.

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

Officers: M. A. Pathan (President), S. P. Arya (Treasurer), M. K. Singal (Administrative Secretary), N. K. Thakare (Academic Secretary), R. P. Agarwal (General Secretary).

Indonesian Mathematical Society (IndoMS)

Apply to: Indonesian Mathematical Society, c/o Dr. Edy Tri Baskoro (Vice President), Department of Mathematics, Institut Teknologi Bandung (ITB), Jalan Ganesa 10 Bandung, Indonesia; email: ebaskoro@dns.math.itb.ac.id; http://www.indoms.org.

Dues: $10, payable to Dr. Lina Aryati (Treasurer), Department of Mathematics, University of Gadjah Mada (UGM), Sekip Utara, Yogyakarta 55281 Indonesia.

Privileges: The right to present papers at meetings of the Society; the right to receive complementary issues of the *Newsletter of The IndoMS* (3 per year); reduced price for any publications; reduced registration at conferences sponsored by The IndoMS.

Officers: Sri Wahyuni (President), Abdur Rahman As'ari, M.Pd, M.A., Edy Tri Baskoro (Vice-Presidents), Lina Aryati (Treasurer), Ch. Rini Indrati (Secretary).

Korean Mathematical Society

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

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

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

Officers: Yong Seung Cho (President), Kyung Chan Min and In Su Kim (Vice-Presidents), Jongsu Kim (Treasurer), Byung Hak Kim (Secretary).

Mathematical Society of Japan

Apply to: Liang Zhang, Secretary, Mathematical Society of Japan, 34-8, Taito 1 chome, Taito-ku, Tokyo 110-0016, Japan.

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

Privileges: Category I: *Journal of the Mathematical Society of Japan, Sugaku-Tsusin* (2 issues); Category II: *Journal of the Mathematical Society of Japan, Sugaku* (in Japanese), *Sugaku-Tsushin* (4 issues).

Officers: Yasuo Morita (President), Liang Zhang (Treasurer), Hirotaka Izumi (Secretary).

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

Dues: U.S. $5, payable to Mathematical Society of the Philippines.

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

Officers: Jose Marasigan (President), Rene P. Felix (Vice-President), Aurora Trance (Treasurer), Rolando Ramos (Secretary).

Mathematical Society of the Republic of China

Apply to: Hung Chen, c/o Department of Mathematics, National Taiwan University, #1, Roosevelt Road Section 4, Taipei 106, Taiwan; email: tms@math.ntu.edu.tw; http://tms.math.ntu.edu.tw.

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

Privileges: One-year free subscription to the *Taiwanese Journal of Mathematics.*

Officers: Kuo-Shung Cheng (President), Pjek-Hwee Lee (Vice-President), Jyh-Hao Lee (Treasurer), Hung Chen (Secretary).

Mongolian Mathematical Society

Address for mail: A. Galtbayar, Mongolian Mathematical Society, P. O. Box 46A/187, Ulaanbaatar, Mongolia; email: galtbayar@yahoo.com.

Apply to: A. Galtbayar, D. Purevsuren and B. Battsengel at the above address.

Dues: U.S. $20, payable to A. Galtbayar at the above address.

Privileges: Right to receive the *Journal of MMS* for free and to publish in the *Journal of MMS*.

Officers: A. Mekei (President), B. Battsengel (Vice-President), A. Galtbayar and D. Purevsuren (Secretaries).

Nepal Mathematical Society

Apply to: Y. P. Koirala, Secretary, Nepal Mathematical Society, Department of Mathematics, Tribhuvan University, Kirtipur, Kathmandu, Nepal; email: cdmath@wlink.com.np.

Dues: U.S. $20, payable to B. L. Vaidya (Treasurer), Central Department of Mathematics, Tribhuvan University.

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

Officers: S. R. Pant (President), D. D. Regmi (Vice-President), B. L. Vaidya (Treasurer), Y. P. Koirala (Secretary).

Persatuan Sains Matematik Malaysia

Address for mail: Pusat Pengajian Sains Matematik, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia; email: maslina@pkrisc.cc.ukm.my; http://www.tmsk.uitm.edu.my/~persama.

Apply to: Dr. Maslina at the above address.

Dues: U.S. $7.50, payable to Bendahari, PERSAMA, at 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: Mohd Salmi Md Noorani (President), Husna Hassan and Arsmah Ibrahim (Vice-Presidents), Wan Rosmanira Ismail (Treasurer), Maslina Darus (Secretary).

Punjab Mathematical Society*

Address for mail: Department of Mathematics, University of the Punjab, Quaid-i-Azam Campus, Lahore, Pakistan; email: 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.

Officers: G. Mustafa Habibullah (President), Zia Ullah Randhawa and Munir Ahmad Ch. (Vice-Presidents), Umar Farooq Qureshi (Treasurer), Nawazish Ali Shah (Secretary).

Ramanujan Mathematical Society*

Apply to: Professor V. Thangaraj, Secretary, Ramanujan Institute for Advanced Study in Mathematics, University of Madras, Chennai-600005, India; email: riasm@md3.vsnl.net.in; http://rms.enmail.com/.

Dues: U.S. $20 (annual), U.S. $200 (life), payable to Professor V. Thangaraj at the above address.

Privileges: Complimentary copy of the *Journal of the Ramanujan Mathematical Society.*

Officers: Phoolan Prasad (President), S. Sri Bala (Vice-President), P. Paulraja (Treasurer), V. Thangaraj (Secretary).

Singapore Mathematical Society

Address for mail: Secretary, Singapore Mathematical Society, c/o Department of Mathematics, National University of Singapore, 2 Science Drive 2, Singapore 117543, Singapore; email: smsuser@math.nus.edu.sg; http://sms.math.nus.edu.sg.

Apply to: Chan Lai Chee at the above address.

Dues: 10 Singapore dollars, payable to Singapore Mathematical Society at the above address.

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

Officers: Tan Eng Chye (President), Ling San (Vice-President), Zhang De-Qi (Treasurer), Tang Wee Kee (Secretary).

Southeast Asian Mathematical Society

Address for mail: Secretary, Southeast Asian Mathematical Society, c/o Department of Mathematics, National University of Singapore, 2 Science Drive 2, Singapore 117543, Singapore; email: matzuows@nus.edu.sg; http://seams.math.nus.edu.sg.

Apply to: Zuowei Shen at the above address.

Dues: U.S. $10, payable to Southeast Asian Mathematical Society at the above address.

Privileges: *SEAMS Newsletter.*

Officers: Eng Chye Tan (President), Ali Rosihan (Vice-President), Zuowei Shen (Treasurer), San Ling (Secretary).

Vijnana Parishad of India

Apply to: R. C. Singh Chandel, Secretary, Vijnana Parishad of India, D. V. Postgraduate College, Orai-285001, U.P., India; email: rc_chandel@yahoo.com.

Dues: U.S. $10, payable to Vijnana Parishad of India, D. V. Postgraduate College, Orai-285001, U.P., India.

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

Officers: V. P. Saxena (President), S. L. Singh, G. C. Sharma, and N. D. Samadhia (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.

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

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, University Politechnica of Bucharest, Splaiul Independentei 313, Bucharest 77206, Romania; fax: (401) 411.53.65; email: udriste@mathem.pub.ro.

Dues: U.S. $30 (except persons of countries with financial difficulties, U.S. $10), payable to the Balkan Society of Geometers.

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

Officers: Grigorios Tsagas (President), Constantin Udriste and Mihai Anastasiei (Vice-Presidents), Constantin Udriste (Treasurer), Vasile Iftode (Secretary).

Belgian Mathematical Society*

Apply to: Jan van Casteren, Secretary, Campus Plaine, C.P. 218/01, Bld. du Triomphe, B-1050 Brussels, Belgium; email: bms@ulb.ac.be; http://www.ulb.ac.be/assoc/bms/.

Dues: 15 euros, payable to Belgian Mathematical Society, at the above address.

Privileges: A free subscription to: *Bulletin of the Belgian Mathematical Society—Simon Stevin* (four issues per year); newsletter.

Officers: Adhemar Bultheel (President), Catherine Finet (Vice-President), Stefaan Caenepeel (Treasurer), Jan van Casteren (Secretary).

Berliner Mathematische Gesellschaft*

Apply to: Prof. Dr. Michael Pohst, Inst. Mathematik MA 8-1, TU Berlin, Strasse des 17, Juni 136, 10623 Berlin, Germany; email: pohst@math.tu-berlin.de.

Dues: DM 12, payable to Prof. Dr. Günter Ziegler at Inst. Math. MA 6-2, TU Berlin, Strasse des 17, Juni 136, 10623 Berlin, Germany.

Privileges: One free copy of *Sitzungsberichte der BMG.*

Officers: Jürg Kramer (President), Ralf Kornhuber (Vice-President), Günter Ziegler (Treasurer), Michael Pohst (Secretary).

Croatian Mathematical Society

Apply to: Dr. Renata Svedrec, Secretary, HMD, Department of Mathematics, Bijenička 30, 10000 Zagreb, Croatia; email: hmd@cromath.math.hr; http://www.math.hr.

Dues: U.S. $10, payable to HMD, Zagrebačka banka d.d. Zagreb, Swift ZABA HR 2X, 2500-03688780.

Privileges: *Vjesnik HMD* (in Croatian) plus one of four journals edited by CMS free of charge. All publications of the CMS and all fees reduced by at least 25%.

Officers: Darko Veljan (President), Miljenko Marušić (Vice-President), Ivica Gusić (Treasurer), Renata Svedrec (Secretary).

Cyprus Mathematical Society*

Apply to: Gregory Makrides, 36 Stasinou Street, Suite 102, Strovolos 2003, Nicosia, Cyprus; email: cms@cms.org.cy.

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 and the Annual Summer Math School organized in Cyprus at the end of June.

Officers: Gregory Makrides (President), Athanasios Gagatsis (Vice-President), Antreas Philippou (Treasurer), Savvas Antoniou (Secretary).

Dansk Matematisk Forening (Danish Mathematical Society)*

Address for mail: Department of Mathematical Sciences, University of Aarhus, Ny Munkegade, Building 530, DK-8000 Aarhus, Denmark; email: dmf@mathematics.dk/; http://www.dmf.mathematics.dk/.

Apply to: Please use the electronic form on the home page at http://www.dmf.mathematics.dk/.

Dues: DKr. 150, payable to Viggo Andreasen, Treasurer, Dept. of Mathematics, Roskilde University, DK-4000 Roskilde, Denmark.

Privileges: *Mathematica Scandinavica* (DKr. 290 per volume), *Nord. Mat. Tidss.* (*Normat*) (NKr. 260 per volume). (Members of the American Mathematical Society do not have to join Dansk Matematisk Forening 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*, Matematisk Institut, Aarhus Universitet, 8000 Aarhus C, Denmark.) Members of the American Mathematical Society who join the Danish Mathematical Society as reciprocity members will receive the newsletter *Matilde*.

Officers: Johan P. Hansen (President), Jan Philip Solovej (Vice-President), Viggo Andreasen (Treasurer), Jan Philip Solovej (Secretary).

Deutsche Mathematiker-Vereinigung (DMV)

Apply to: Mrs. Bertholdt, DMV, c/o WIAS, Mohrenstr. 39, D 10117 Berlin, Germany; email: dmv@wias-berlin.de; http://www.mathematik.uni-bielefeld.de/DMV/.

Dues: 23 euros, payable to Volksbank Freiburg 6855002 (BLZ 680 900 00).

Privileges: *Mitteilungen der Deutschen Mathematiker-Vereinigung* and one of two publications: *Jahresbericht der Deutschen Mathematiker-Vereinigung*, EUR 21; *Math. Semesterberichte*, EUR 20.

Officers: G. Wildenhain (President), V. Nollau (Vice-President), J. Kramev (Treasurer), E. Behrends (Secretary).

Edinburgh Mathematical Society

Apply to: Dr. A. D. Gilbert, Honorary Secretary, Edinburgh Mathematical Society, James Clerk Maxwell Building, King's Buildings, Mayfield Road, Edinburgh EH9 3JZ, Scotland; email: edmathsoc@maths.ed.ac.uk; http://www.maths.ed.ac.uk/~ems/.

Dues: U.S. $14 (£7 sterling) without Society's proceedings, U.S. $38 (£19 sterling) with Society's proceedings, payable to the Honorary Secretary, as above.

Privileges: The Society's proceedings are available at a concessionary rate; see above.

Officers: P. Rowlinson (President), T. A. Gillespie (Vice-President), N. K. Dickson (Treasurer), A. D. Gilbert and T. H. Lenagan (Secretaries).

European Mathematical Society

Apply to: Tuulikki Makelainen, Department of Mathematics and Statistics, P.O. Box 68, F1-00014 University of Helsinki, Finland.

Dues: 40 euros payable to the European Mathematical Society at the above address.

Privileges: All privileges of a normal individual EMS member.

Officers: John Kingman (President), Luc Lemaire and Bodil Branner (Vice-Presidents), Olli Martio (Treasurer), Helge Holden (Secretary).

Gesellschaft für Angewandte Mathematik und Mechanik e.V. (GAMM)

Address for mail: V. Ulbricht, Institut für Festkörpermechanik, Technische Universität Dresden, 01062 Dresden, Germany; email: Gamm@mailbox.tu-dresden.de; http://www.gamm-eV.de.

Apply to: R. Kienzler, Universität Bremen, Fachbereich Produktionstechnik, Postfach 330440, 28334 Bremen, Germany.

Dues: 51 euros, payable to A. Frommer, Bergische Universität Wuppertal, Fachbereich C–Mathematik, 42097 Wuppertal, Germany.

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

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Glasgow Mathematical Association*

Apply to: Frances Goldman, Treasurer, Glasgow Mathematical Association, Department of Mathematics, University of Glasgow, 15 University Gardens, Glasgow G12 8QW, Scotland; email: fhg@maths.gla.ac.uk.

Dues: £7, payable to Glasgow Mathematical Association, at the above address.

Privileges: *Glasgow Mathematical Journal* at reduced rate (£45).

Officers: A. Craw (President), F. Goldman (Treasurer), P. Moon (Secretary).

Hellenic (Greek) Mathematical Society*

Apply to: Hellenic Mathematical Society, 34, Panepistimiou Street, 106 79 Athens, Greece; email: info@hms.gr; http://www.hms.gr/.

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

Privileges: The *Bulletin of HMS*, News-Bulletin (Enimerosi), discounts that are available to all members.

Officers: Nikolaos Alexandris (President), George Dimakos and Dionysios Anapolitanos (Vice-Presidents), Evaggelos Eustathiou (Treasurer), Ioannis Tyrlis (Secretary).

Icelandic Mathematical Society

Address for mail: Icelandic Mathematical Society, Raunvisindastofnun Haskolans, Dunhaga 3, IS-107 Reykjavik, Iceland; email: kristjanj@simnet.is; http://www.vedur.is/is/.

Apply to: Dr. Kristjän Jonasson at the above address.

Dues: U.S. $12, payable to Dr. Hersir Sigurgeirsson at the above address.

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

Officers: Kristjän Jonasson (President), Hersir Sigurgeirsson (Treasurer), Fjola Run Björnsdóttir (Secretary).

Irish Mathematical Society

Apply to: David Wraith, Treasurer, Irish Mathematical Society, National University of Ireland, Maynooth, Co. Kildare, Ireland; email: David.Wraith@may.ie; http://www.maths.tcd.ie.pub/ims/.

Dues: U.S. $10, payable to David Wraith 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: G. Lessells (President), M. O'Reilly (Vice-President), David Wraith (Treasurer); Ann O'Shea (Secretary).

János Bolyai Mathematical Society

Apply to: Cecilia Kulcsár, Executive Director, János Bolyai Mathematical Society, Fő utca 68, H-1027 Budapest, Hungary; email: bjmt@renyi.hu.

Dues: Are voluntary but should minimally cover duplication and mailing costs; for reciprocity members (residing outside Hungary) suggested fee is 1/8 of 1 percent of the member's net income, payable to Kereskedelmi ES Hitelbank P.T., Account Number 10200830-32310243. Sponsoring members pay at least U.S. $180 or equivalent per year.

Privileges: Upon request, *Matematikai Lapok* (twice a year), *Középiskolai 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.

Officers: Imre Csiszár (President), Cecilia Kulcsár (Executive Director), György Lippner (Treasurer), István Juhász (Secretary General), Antal Balog (Vice Secretary General).

Jednota českých matematiků a fyziků (Union of Czech Mathematicians and Physicists)*

Apply to: Jan Kratochvil, Union of Czech Mathematicians and Physicists, Žitná 25, 117 10 Praha 1, Czech Republic; email: jcmf@math.cas.cz; http://www.jcmf.cz.

Dues: U.S. $20, payable to Jan Obdržálek.

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

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

Address for mail: Secretary of JSMF, FMFI UK Pavilon F1, Mlynská dolina, 842 48 Bratislava, Slovak Republic; email: JSMF@CENTER.FMPH.UNIBA.SK; http://www.uniba.sk/~jsmf.

Apply to: Hilda Draškovičová, FMFI UK, KATC, Mlynská dolina, 842 48 Bratislava, Slovak Republic.

Dues: U.S. $20, payable to Slovenská sporitel'ňa, Záhradnicka 93, 8000 Bratislava, Slovak Republic; č.u.: 101848-019/0900 IČO: 178705.

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

Officers: Victor Bezak (President), Hilda Draškovičová (Vice-President), Edmund Dobročka (Treasurer), Imrich Morva (Secretary).

London Mathematical Society

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

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

Dues: £15 (U.S. $30) payable to London Mathematical Society at the above address.

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: F. C. Kirwan (President), A. G. Chetwynd and A. J. Scholl (Vice-Presidents), N. M. J. Woodhouse (Treasurer), P. R. Cooper (Executive Secretary).

Mathematical Society of Serbia*

Apply to: Mathematical Society of Serbia, Knez Mihailova 35/IV, p.p. 791, 11000 Belgrade, Yugoslavia.

Dues: U.S. $12, payable to Beobanka A. D. (Swift Code: BEOBYUBG) Acct. No. 733782, Mathematical Society of Serbia (Druśtvo Matematičara Srbije) Acct. No. 718000-840-0708491900.

Privileges: *Matematički Vesnik, Teaching Mathematics.*

Officers: Rade Doroslovački (President), Pavle Mladenovič (Vice-President), Milica Babić (Treasurer), Mirjana Djorić (Secretary).

Norsk Matematisk Forening (Norwegian Mathematical Society)

Apply to: Øyvind Solberg, Norsk Matematisk Forening, Department of Mathematical Sciences, NTNU, No-7491, Trondhi, Norway; email: nmf@math.ntnu.no; http://www.matematikkforeningen.no.

Dues: NOK 100, payable to Øyvind Solberg at the above address.

Privileges: All regular membership privileges, including the monthly newsletter *Infomat.*

Officers: Kristian Seip (President), Audun Holme (Vice-President), Øyvind Solberg (Treasurer and Secretary).

Österreichische Mathematische Gesellschaft (OMG)

Apply to: Heinz W. Engl, Institut Für Industrie Mathematik, Universität Linz, Altenbergerstrasse 69, A-4040 Linz, Austria; email: oemg@oemg.ac.at; http://www.oemg.ac.at/.

Dues: 18 euros, payable to ÖMG, Wiedner Hauptstr. 8, A-1040 Wien, Bank Austria-Creditanstalt Kto: 22910389200, IBAN:AT 83 12000229 103892a, BIC: BKAUATWW.

Privileges: *Internationale Nachrichten* (*IMN*), reduction of fees at our congresses and meetings.

Officers: Heinz W. Engl (President), Robert F. Tichy (Vice-President), Walter Schachermayer (Treasurer), Michael Oberguggenberger (Secretary).

Polskie Towarzystwo Matematyczne*

Apply to: President of Polish Mathematical Society, ul. Śniadeckich 8, 00-950 Warszawa, Poland; email: zgptm@impan.gov.pl.

Dues: U.S. $40, payable to Polskie Towarzystwo Matematyczne, Zarząd Główny, ul. Śniadeckich 8, 00-950 Warszawa, Poland.

Privileges: Participation in scientific conferences organized by the Polish Mathematical Society and in its scientific sessions; in addition, members receive one of the following four series of the publication *Annales Societatis Mathematicae Polonae*: *Commentationes Mathematicae* in congress languages, *Wiadomości Matematyczne* (*Mathematical News*) in Polish, *Matematyka Stosowana. Matematyka dla Społevzenstwa* (*Applied Mathematics*) in Polish and congress languages, *Dydaktyka Matematyki* (*Didactics of Mathematics*) in Polish.

Officers: Bolesława Szafirski (President), Andrzej Cegielski and Łukasz Stettner (Vice-Presidents), Adam Obtułowicz (Treasurer), Ryszarda Rempała (Secretary), Janusz Kowalski (Vice-Secretary).

Real Sociedad Matemática Española

Apply to: Secretaria de la RSME, Facultad de Matemáticas, Despacho 525, Universidad Complutense de Madrid, 28040 Madrid, Spain; email: secretaria@rsme.es; http://www.rsme.es.

Dues: 22 euros, payable to Real Sociedad Matemática Española at the above address.

Privileges: *La Gaceta de la Real Sociedad Matemática Española.*

Officers: Carlos Andradas (President), Manuel de León, Olga Gil (Vice-Presidents), Alberto Elduque (Treasurer), Patricio Cifuentes (Secretary).

SEMA, Sociedad Española de Matemática Aplicada

Apply to: Luis Alberto Fernandez, Despacho 520, Facultad de Matematicas, Universidad Complutense, 28.040 Madrid; email: sema@uca.es; http://www.uca.es/sema/ .

Dues: 15 euros, payable to SEMA at the above address.

Privileges: Information concerning applied mathematics in Spain through *Boletín de la SEMA*, reduced inscription fee for activities sponsored by SEMA.

Officers: Eduardo Casas (President), Mikel Lezaun (Vice-President), Luis Alberto Fernandez (Treasurer), Rosa Pardo (Secretary).

Sociedade Portuguesa de Matemática

Address for mail: Sociedade Portuguesa de Matemática, Av. da República 37/4, 1050-187 Lisboa, Portugal; email: spm@mail.telepac.pt; http://www.spm.pt/~spm/.

Apply to: Pedro Freitas at the above address.

Dues: Payable to Antonieta Horta at the above address. The current fee is 30.00 euros, and reciprocity members are asked to pay half of this amount. This is revised before the end of each year.

Privileges: Each member receives the following publication of our Society free of charge: *Boletim da Sociedade Portuguesa de Matemática* (2 issues per year). Additionally, members may subscribe to the following publications at reduced rates: *Portugaliae Mathematica*

(4 issues, 55.50 euros) and *Gazeta de Matemática* (2 issues, 6.50 euros).

Officers: Ana Bela Cruzeiro (President), Pedro Freitas (Vice-President), Maria Carvalho (Treasurer), Nuno Crato and Adérito Araújo (Secretaries).

Societat Catalana de Matemàtiques

Address for mail: C/ Carme 47, 08001, Barcelona, Spain; email: scm@iecat.net; http://www.iecat.net/scm.

Apply to: Secretary, Catalan Mathematical Society, at the address above.

Dues: 15 euros, payable to the Societat Catalana de Matemàtiques.

Privileges: *Butlletí de la Societat Catalana de Matemàtiques* (two times per year) plus *SCM/Notices* (two times per year).

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Societatea Matematicienilor din Romania*

Apply to: Horia I. Ene, Calea Grivitei 21, P. O. Box 1-764, 70700 Bucharest, Romania.

Dues: U.S. $10, payable to Societatea Matematicienilor din Romania at the address above.

Privileges: Reduced rates for participation in scientific conferences organized by SMR, *Bulletin Mathématiques* (four times per year) free.

Officers: Horia I. Ene (President), Nicolae Popa (Vice-President), Serban Barcanescu (Treasurer), Radu Purice (Secretary).

Societatea de Ştiinţe Matematice din România

Apply to: Mircea Trifu, Secretary-General, Str. Academiei, NR. 14, Sector 1, 010014, Bucureşti, Rômania.

Dues: U.S. $15, payable to Societatea de Ştiinţe Matematice din România, Account 2511.1-489.5/USD, at Banca Comercială România, Filiala Sector 5, Bucureşti, România.

Privileges: A free subscription to one of the Society's journals. Exempt from taxes for participation in the annual meetings of the Society.

Officers: Dorin Popescu (President), Mircea Becheanu (Vice-President), Cristina Luţu (Treasurer), Mircea Trifu (Secretary-General).

Société Mathématique de France

Apply to: Société Mathématique de France, Attn. Claire Ropartz, Institut Henri Poincaré, 11 Rue Pierre et Marie Curie, 75231 Paris cedex 05, France; email: smf@dma.ens.fr; http://smf.emath.fr/.

Dues: U.S. $46, payable to the American Mathematical Society or SMF.

Privileges: *Officiel des Mathématiques*, U.S. $37; *Bulletin*, U.S. $154; *Memoires*, U.S. $123; *Bulletin* and *Mémoires*, U.S. $277; *Astérisque*, U.S. $469; *Histoire des Mathématiques*, U.S. $73; *Panoramas et Synthèses*, U.S. $62.

Officers: M. Waldschmidt (President); J. Wolfmann, C. Sabbah, G. Godefroy (Vice-Presidents); A. Jacquemard (Treasurer); M. Chardin (Secretary).

Société Mathématique du Luxembourg

Apply to: Carine Molitor-Braun, Société Mathématique du Luxembourg, Université du Luxembourg, Campus Limpertsberg, 162A, Avenue de la Faïencerie, L-1511 Luxembourg, Luxembourg; email: carine.molitor@uni.lu.

Dues: 20 euros, payable to Société Mathématique du Luxembourg at the above address.

Privileges: Discount on membership dues (same percent as for AMS); information concerning activities of the SML.

Officers: Carine Molitor-Braun (President), Norbert Poncin (Vice-President), Jean Schiltz (Treasurer), Guy Kass (Secretary).

Société Mathématique Suisse

Apply to: Swiss Mathematical Society, Department of Mathematics, University of Fribourg, 1700 Fribourg, Switzerland; email: norbert.hungerbuehler@unifr.ch; http://www.math.ch.

Dues: 50 CHF or 34 EUR if residing in Switzerland, 25 CHF or 17 EUR if residing outside Switzerland, payable by check to SMS, Louise Wolf, Department of Mathematics, University of Fribourg, Perolles, Chemin du Musee 23, CH-1700 Fribourg, Switzerland or by bank transfer to "Credit Suisse (Switzerland) SPH 30.265'892/0".

Privileges: *Commentarii Mathematici Helvetici* (reduced price), information concerning activities of SMS.

Officers: Peter Buser (President), Norbert Hungerbuehler (Vice-President), Viktor Schroeder (Secretary-Treasurer).

Société de Mathématiques Appliquées et Industrielles (SMAI)*

Apply to: Société de Mathématiques Appliquées et Industrielles (SMAI), Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France; email: smai@ihp.jussieu.fr; http://smai.emath.fr/.

Dues: 34 euros, payable to Société de Mathématiques Appliquées et Industrielles at the above address.

Privileges: Free subscription to the Society's bulletin, *Matapli* (three issues per year).

Officers: M. Théra (President), G. Pages, C. Le Bris, H. Le Dret, and B. Lucquin (Vice-Presidents), C. Picard (Treasurer), C. Graffigne (Secretary).

Society of Associations of Mathematicians and Computer Scientists of Macedonia*

Apply to: Boro Piperevski, President SAMCSM, Pirinska B.B., 91000 Skopje, Macedonia.

Dues: $5, payable to SDMI na MAKEDONIA, acct. 40120-678-10217, Pirinska B.B., 91000 Skopje, Macedonia.

Privileges: Receiving the *Bulletin of SAMCSM* and taking part in SAMCSM activities.

Officers: Boro Piperevski (President), Borko Ilievski (Vice-President), Kosta Miševski (Treasurer), Vasile Marčevski (Secretary).

Society of Mathematicians, Physicists, and Astronomers of Slovenia

Address for mail: DMFA, P.P. 2964, 1001 Ljubljana, Slovenia; email: peter.legisa@fmf.uni-lj.si; http://www.dmfa.si/.

Apply to: Peter Legiša, FMF, P.P. 2964, 1001 Ljubljana, Slovenia.

Dues: U.S. $30, payable to SKB banka, Ajdovscina 4, 1000 Ljubljana, Slovenia; SKBASI2X, No. 042961.

Privileges: Subscription to *Obzornik za matematiko in fiziko* (surface mail).

Officers: Peter Petek (President), Nada Razpet (Vice-President), Andreja Jaklič (Treasurer), Janez Krušič (Secretary).

Suomen matemaattinen yhdistys (Finnish Mathematical Society)

Address for mail: Department of Mathematics, P. O. Box 68 (Gustaf Hällströmin katu 2b), FIN-00014 University of Helsinki, Finland; email: pekka.pankka@helsinki.fi; http://www.math.helsinki.fi/~smy/.

Apply to: Pekka Pankka, Secretary, at the above address.

Dues: 15 euros, payable to Jari Taskinen, Treasurer, at the above address.

Privileges: *Arkhimedes* (six issues per year) and *Eukleides* (newsletter), *Mathematica Scandinavica* at reduced price.

Officers: Kari Astala (President), Marjatta Näätänen (Vice-President), Jari Taskinen (Treasurer), Pekka Pankka (Secretary).

Svenska Matematikersamfundet

Address for mail: Sten Kaijser, Department of Mathematics, P.O. Box 480, SE-751 06 Uppsala, Sweden; email: sms@math.uu.se; http://www.matematikersamfundet.org.se/.

Apply to: Milagros Izquierdo, Department of Mathematics, Linköping University, SE-581 83 Linköping, Sweden.

Dues: 100 Swedish crowns, payable to Milagros Izquierdo at above address.

Privileges: *Mathematica Scandinavia* and *Nordisk Matematisk Tidskrift* at reduced rate. Newsletter about the activities and meetings of the Society.

Officers: Sten Kaijser (President), Ölle Häggström (Vice-President), Milagros Izquierdo (Treasurer), Ming Fan (Secretary), Anette Jahnke (Fifth Member).

Ukrainian Mathematical Society

Apply to: A. S. Serdyuk, Institute of Mathematics, National Academy of Sciences, Ukraine, Tereschenkivskaja str., 3, 01601 Kyiv-4, Ukraine; email: sam@imath.kiev.ua.

Dues: U.S. $30, payable to N. A. Nazarenko at the above address.

Privileges: All privileges of a normal individual UMS member.

Officers: A. M. Samoilenko (President), M. L. Gorbachuk (Vice-President), N. A. Nazarenko (Treasurer), A. S. Serdyuk (Secretary).

Union of Bulgarian Mathematicians*

Apply to: Sava Ivanov Grozdev, Secretary, Union of Bulgarian Mathematicians, Acad. G. Bonchev Str., Block 8, BG-1113 Sofia, Bulgaria.

Dues: 20 USD, payable to Union of Bulgarian Mathematicians, Account #1100366612, BULBANK AD Central office, code 62196214.

Privileges: The right to attend all events organized by the UBM at reduced rate and to present papers at them, the right to attend other events in Bulgaria at a reduced rate, and the right to purchase all UMB editions at a reduced rate.

Officers: St. Dodunekov (President), I. Tonov, O. Mushkarov R. Nikolaev (Vice Presidents).

Unione Matematica Italiana*

Apply to: Giuseppe Anichini, Segreteria dell'Unione Matematica Italiana, Dipartimento di Matematica, Piazza Porta S. Donato, 5, 40126 Bologna, Italy; email: umi@dm.unibo.it; http://www.dm.unibo.it~umi/.

Dues: 45 euros, payable to Unione Matematica Italiana.

Privileges: Free *Notiziario dell'UMI* (monthly), *Bollettino dell'UMI, Ser. A* (three issues a year), and membership list. 20 euros only for subscriptions to *Bollettino dell'UMI, Ser. B* (three issues per year).

Officers: Carlo Sbordone (President), Salvatore Coen (Vice-President), Barbara Lazzari (Treasurer), Giuseppe Anichini (Secretary).

Wiskundig Genootschap

Apply to: Herman te Riele, CWI, P. O. Box 94079, 1090 GB Amsterdam, The Netherlands; email: Herman.te.Riele@cwi.nl; http://www.wiskgenoot.nl.

Dues: 50 euros.

Privileges: Free periodical *Nieuw Archief voor Wiskunde.*

Officers: J. van Mill (President), H. W. Broer (Vice-President), S. A. J. Dekkers (Treasurer), H. J. J. te Riele (Secretary).

Middle East

Iranian Mathematical Society

Apply to: M. Shookuhi, Iranian Mathematical Society, P.O. Box 13145-418, Tehran, Iran; email: iranmath@ims.ir; http://www.ims.ir.

Dues: Students: U.S. $15; Others: U.S. $30, payable to Iranian Mathematical Society at the above address.

Privileges: *Bulletin of the Iranian Mathematical Society* (two issues per year in English), *Farhang va Andisheh Riazi* (two issues per year in Persian), *Khabarnameh* and *Gozaresh* (8 issues per year in Persian), and reduced rate for participation in the conferences and seminars organized by IMS.

Officers: Ebadollah S. Mahmoodian (President), A. Iranmanesh (Treasurer).

Israel Mathematical Union (IMU)

Address for mail: Israel Mathematical Union, Department of Mathematics, Technion, 32000 Haifa, Israel; email: imu@imu.org.il; http://www.imu.org.il

Apply to: Eli Aljadeff, Secretary, at the above address.

Dues: U.S. $15, payable to Uri Elias, at the above address.

Privileges: Participation in meetings and all other privileges enjoyed by an ordinary member.

Officers: Allan Pinkus (President), Uri Elias (Treasurer), Eli Aljadeff (Secretary).

Palestinian Society for Mathematical Sciences*

Address for mail: Mathematics Department, Birzeit University, P. O. Box 14, West Bank, Palestine.

Apply to: Fawzi Yagoub, Department of Mathematics and Computer Science, SUNY College at Fredonia, Fredonia, NY 14063.

Dues: U.S. $30, payable to Fawzi Yagoub; see address above.

Privileges: Free issues of the *PSMS Newsletter*, 50% reduction on all PSMS conference fees, 50% reduction on all PSMS publications.

Officers: Mohammad Al-Amleh (President); Mohammad Saleh, Tahseen Mughrabi (Vice-Presidents); Raghib Abu Saris, Nur edden Rabei, Mohammad El-Atrash, Taha Abu Kaf, Saber Elaydi (Members).

Saudi Association for Mathematical Sciences*

Apply to: M. A. Alabdullatif, President, King Saud University, College of Science, P. O. Box 2455, Riyadh 11451, Saudi Arabia.

Dues: U.S. $30, payable to Saudi Association for Mathematical Sciences at the above address.

Privileges: Reduction in membership fee from U.S. $40 to U.S. $30; proceedings of conferences, symposia, and seminars arranged by the Association.

Officers: M. A. Alabdullatif (President), A. Alshihah (Vice-President), M. A. Aseerj (Treasurer), M. S. Qutaifan (Secretary).

South Pacific

Australian Mathematical Society Inc.

Address for mail: Department of Mathematics, University of Queensland, Brisbane, Queensland 4072, Australia; email: Secretary@austms.org.au; http://www.austms.org.au/.

Apply to: The Business Manager, Australian Mathematical Society, Department of Mathematics, Australian National University, Canberra ACT 0200, Australia.

Dues: $AUD 45 (in 2004), payable to the Australian Mathematical Society, c/o The Business Manager, at the above address.

Privileges: Complimentary issues of *The Gazette* (five issues in 2004), *Journal AustMS–Pure Mathematics and Statistics* ($AUD 54), *ANZIAM Journal* ($AUD 48), *Bulletin of AustMS* ($AUD 51). Reduced price for volumes in Lecture Series and reduced registration at conferences sponsored by AustMS.

Officers: M. G. Cowling (President); J. M. Hill (Vice-President); A. J. Guttmann (Immediate Past President); A. Howe (Treasurer); E. J. Billington (Secretary).

New Zealand Mathematical Society

Apply to: NZ Mathematical Society, c/o Dr. Shaun Hendy (NZMS Secretary), Industrial Research Ltd., P. O. Box 31 310, Lower Hutt, New Zealand; email: S.hendy@irl.cri.nz; http://www.math.waikato.ac.nz/NZMS/NZMS.html.

Dues: Payable to Dr. John Shanks, Department of Mathematics and Statistics, University of Otago, P.O. Box 56, Dunedin, NZ.

Privileges: *Newsletter of the NZMS* (three per year).

Officers: Mick Roberts (President), Tammy Smith (Treasurer), Shaun Hendy (Secretary).

Mathematics Calendar

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

November 2004

*14-19 **LISA '04 - 18th Large Installation System Administration Conference**, Atlanta, Georgia.
Information: The annual LISA conference is the meeting place of choice for system and network administrators. System administrators of all specialties and levels of expertise meet at LISA to exchange ideas, sharpen old skills, learn new techniques, debate current issues, and meet colleagues and friends.
Organizer: Alex Walker, alex@usenix.org.

*16-19 **International Conference "Partial Differential Equations and Related Problems of Analysis and Informatics"**, Institute of Mathematics of Uzbek Academy of Sciences, Tashkent, Uzbekistan.
Organizers: Academy of Sciences of Uzbekistan, National University of Uzbekistan named after M. Ulugbek, Institute of Mathematics named after V. I. Romanovskiy, Samarkand State University, Fergana State University, Urgench State University, Karshi State University, Bukhara State University.
Main Topics: Equations of mathematical physics; Partial differential equations of mixed, composite, and mixed-composite types; Equations of degenerate type; Equations with multiple characteristics; Free boundary problems; Spectral theory for differential operators; Inverse and improperly posed problems; Control theory; Mathematical modeling of nonlinear processes; Theory of real operator algebras and Leibniz algebras; Multidimensional potential theory and other questions of complex analysis.
Deadlines: Deadline for registration is May 1, 2004. Deadline for submission of papers is July 1, 2004.
Contact: A. Khashimov, Institute of Mathematics, F. Khodjaev str. 29, 700125, Tashkent, Uzbekistan; phone (998-71)162-9531, (998-71)162-7544; email: mathinst@uzsci.net, m.aripov@nuuz.uzsci.net.
Information: To participate in the conference it is necessary to fill out the registration form and send it to the Local Organizing Committee. Conference materials will be published by the beginning of the conference. Additional information is available at http://www.deit.tkt.uz.

*22-26 **Workshop on Variance Estimation in Stereology**, Aarhus, Denmark.
Information: http://www.imf.au.dk/conferences/VSE2004/.

December 2004

*14-16 **Sixth IMA International Conference on Mathematics in Signal Processing**, The Royal Agricultural College, Cirencester, UK.
Information: Up-to-date information about the conference programme, accommodations and travel to Cirencester can be found on our website: http://www.ima.org.uk/mathematics/conferences.htm.
Keynote Speaker: Louis Scharf, Colorado State University.
Members of the Organizing Committee: J. G. McWhirter (Conference Chairman) (QinetiQ, Malvern), I. K. Proudler (Technical Programme Chairman) (QinetiQ, Malvern), S. D. Hayward (QinetiQ, Malvern), O. R. Hinton (University of Newcastle) S. McLaughlin (University of Edinburgh), E. Stansfield (Thales), P. White (ISVR, University of Southampton).

January 2005

*6-9 **24th Nordic and 1st Franco-Nordic Congress of Mathematicians**, University of Iceland, Reykjavik, Iceland.

This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found on the last page of each issue.
An announcement will be published in the *Notices* if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in every third issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.
In general, announcements of meetings and conferences held in North America carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the *Notices* in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.
In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence **eight months** prior to the scheduled date of the meeting.
The complete listing of the Mathematics Calendar will be published only in the September issue of the *Notices*. The March, June/July, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.
The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through the AMS website on the World Wide Web. To access the AMS website, use the URL: http://www.ams.org/.

Aim: The main goal of the congress is to bring together mathematicians to present recent results in several important areas of research in the Nordic countries and France. Around half the programme will be devoted to 3 main themes: Algebraic Geometry, Geometric Analysis, and Probability. Satellite meetings will be organized the days before the congress.
Scientific Committee: Hermann Thorisson (chair) (Iceland), Jon Kr. Arason (Iceland), Gerd Grubb (Denmark), Christer Kiselman (Sweden), Jean-Francois Le Gall (France), Pekka Koskela (Finland), Mireille Martin-Deschamps (France), Ragni Piene (Norway), and Michel Waldschmidt (France).
Plenary Speakers: Sigurdur Helgason (Iceland/USA), Marc Yor (France), Michele Audin (France), Sergey Neshveyev (Norway), Henrik Schlichtkrull (Denmark), Cedric Villani (France), Francois Loeser (France), Anders Buch (Denmark), Mikael Passare (Sweden), Xiao Zhong (Finland), Olav Kallenberg (Sweden/USA).
Information: email: FrancoNordicCongress@raunvis.hi.is, website: http://www.raunvis.hi.is/1FrancoNordicCongress/.

*10-14 **International Symposium on "Variational Methods and Nonlinear Differential Equations on the Occasion of the 60th Birthday of Antonio Ambrosetti"**, University of Rome 3, Rome, Italy.
Plenary Speakers: H. Amann (Zurich), D. Arcoya (Granada), A. Bahri (Rutgers), H. Berestycki (EHESS, Paris), H. Brezis (Paris VI), D. G. de Figueiredo (Campinas), I. Ekeland (British Columbia), M. J. Esteban (Paris IX), J. L. Gamez (Granada), J. Garcìa Azorero (UAM, Madrid), Y. Y. Li (Rutgers), Y. Long (Nankai), J. Mawhin (Louvain), W.-M. Ni (Minnesota), L. Nirenberg (Courant Inst., NYU), I. A. Peral (UAM, Madrid), P. H. Rabinowitz (Wisconsin), E. Sèrè (Paris IX), J. Serrin (Minnesota), S. Spagnolo (Pisa), M. Struwe (ETH, Zurich), C.A. Stuart (EPF, Lausanne), K. Tanaka (Waseda, Tokyo), R.E. Turner (Wisconsin), Z.-Q. Wang (Utah).
Information: http://www.mat.uniroma3.it/AnalisiNonLineare/roma05.html.

March 2005

*6-12 **International Conference on Algebras, in Memory of Kostia Beidar**, National Cheng Kung University, Tainan, Taiwan.
Aims: The conference is dedicated to the memory of Professor Kostia Beidar, one of the founders of the Taiwan ring-theoretic center. The aim of the conference is to highlight the recent developments in theory of rings and modules and linear algebra.
Organizers: M. Chebotar (Tula University, Tula, Russia), Y. Fong (National Cheng Kung University, Tainan, Taiwan), W.-F. Ke (National Cheng Kung University, Tainan, Taiwan), P.-H. Lee (National Taiwan University, Taipei, Taiwan).
Invited Speakers: Matej Bresar (Slovenia), Surender Jain (USA), Tsit-Yuen Lam (USA), Lenny Makar-Limanov (USA), Wallace Martindale (USA), Gueter Pilz (Austria), Edmund Puczylowski (Poland), Robert Raphael (Canada), Peter Semrl (Slovenia), Blas Torrecillas (Spain), Richard Wiegandt (Hungary), Robert Wisbauer (Germany).
Deadlines: Those who are interested in taking part please send an email to Wen-Fong Ke (wfke@mail.ncku.edu.tw) or fill out the registration form on the webpage. You will then receive a second announcement containing accommodation and travel information sometime in October 2004. The deadline for sending in titles and abstracts is January 15, 2005.
Information: http://moonstone.math.ncku.edu.tw/AlgebraConference/;email: wfke@mail.ncku.edu.tw.

*27-31 **The 3rd International Conference on Sciences of Electronic, Technologies of Information and Telecommunications (SETIT 2005)**, Susa, Tunisia.
Submissions: The paper submission can be done online at http://www.conference-papers.org/. Accepted papers will be published in the conference proceedings with the ISBN: 973-51-546-3.
Solicitations: Papers are solicited in the following areas: Information Processing, Signal Processing, Image and Video, Multimedia, Telecommunications & Networks, Electronic, Applications.
Important Dates: September 30, 2004, for submission of articles and tutorials; December 31, 2004, for notification of acceptance; January 15, 2005, for submission of final versions.
Information: http://www.universites.tn/setit.

*29-April 1 **14th International Workshop on Matrices and Statistics**, Massey University, Albany Campus, Auckland, New Zealand.
Description: The purpose of the workshop is to stimulate research and, in an informal setting, to foster the interaction of researchers at the interface between statistics and matrix theory. The workshop will provide a forum through which statisticians may be better informed of the latest developments and newest techniques in linear algebra and matrix theory and may exchange ideas with researchers from a wide variety of countries. The workshop will include invited and contributed talks. It is intended that refereed conference proceedings will be published.
Organizers: The local Organizing Committee is chaired by Jeff Hunter; email: j.hunter@massey.ac.nz. The International Organizing Committee consists of George Styan (Chair), email: styan@math.mcgill.ca; Hans Joachim Werner (Vice-Chair), email: werner@united.econ.uni-bonn.de; and Simo Puntanen,
Information: Further details will become available on the conference website, http://iwms2005.massey.ac.nz/. The website will be updated on a regular basis.

April 2005

*4-8 **Stiff Sources and Numerical Methods for Conservation Laws**, AIM Research Conference Center, Palo Alto, California.
Organizers: Doron Levy and Benoit Perthame.
Workshop Topics: This workshop, sponsored by AIM and the NSF, will focus on unifying techniques that were developed in different application areas and on exploring new application areas where existing techniques have not yet been applied.
Deadline: January 15, 2005.
Information: http://aimath.org/ARCC/workshops/balancelaws.html.

May 2005

*15-18 **HPCS 2005: The New HPC Culture in Canada, The 19th Annual Symposium on High Performance Computing Systems & Applications**, University of Guelph, Guelph, Ontario, Canada.
Host:] SHARCNET. The Shared Hierarchical Academic Research Computing Network http://www.sharcnet.ca/events/hpcs2005/, submit papers via email: hpcs2005@sharcnet.ca.
Call for Papers: HPCS is a multi-disciplinary meeting to discuss new and exciting scientific and technical work involving High Performance Computing. Researchers from all disciplines in the sciences,engineering, mathematics and applied human sciences are invited to participate. Students are particularly encouraged to submit papers. There will be multiple parallel paper sessions as well as poster presentations, industrial events and discussion forums. HPCS 2005 has designated eight themes but all relevant HPC and HPC-related research will be considered.
Deadline: December 15, 2004.

*15-18 **OSCAR'05: The 3rd Annual Symposium on Open Source Cluster Application Resources (OSCAR)**, University of Guelph, Guelph, Ontario, Canada.
Topics of Interest: Authors are encouraged to submit papers related to OSCAR software stack, including but not limited to the following: experiences using the OSCAR environment, packages to consider adding to the OSCAR software stack, clustering Frameworks, cluster and Grid as it relates to OSCAR, experiences creating OSCAR packages, proposals for new OSCAR projects or distributions, experiences creating new OSCAR distributions, cluster tools, design proposals, experiences in cluster and grid computing.

Submission Guidelines: All accepted papers will appear in the proceedings to be published by the IEEE. Formatting information will be available on the conference website. Papers will be limited to 7 pages.
Submission Deadline: December 15, 2004.
Call for Papers: With over 130,000 downloads since its first public release in April 2001, OSCAR's popularity speaks to its effectiveness in providing cluster installation, management, and computing software stack. OSCAR is a snapshot of best-known methods for building, programming and using clusters. OSCAR started as a traditional Beowulf software stack; has expanded in recent years to embrace numerous cluster computing styles, including diskless, high-availability, scalable systems, and single system image. The project is an open effort among industry, academic and research groups to help simplify the setup and management of computing clusters.
Information: http://www.csm.ornl.gov/oscar05. Submit papers via email: oscar05@mailhub.ornl.gov. Further information is available at the OSCAR website: http://oscar.openclustergroup.org/.

*15-21 **43rd International Symposium on Functional Equations**, Batz-sur Mer, France.
Topics: Functional equations and inequalities, mean values, functional equations on algebraic structures, Hyers-Ulam stability, regularity properties of solutions, conditional functional equations, iteration theory, functional-differential equations; applications of the above, in particular to the natural, social, and behavioral sciences.
Organizer: Nicole Brillouët-Belluot, Ecole Centrale de Nantes, Département d'Informatique et des Mathématiques, 1 rue de la Noë, BP 92101, F-44321 Nantes Cedex 3, France (Nicole.Belluot@ec-nantes.fr).
Scientific Committee: J. Aczél (Honorary Chair; Waterloo, ON, Canada), Z. Daróczy (Debrecen, Hungary), R. Ger (Chair; Katowice, Poland), J. Rätz (Bern, Switzerland), L. Reich (Graz, Austria), and A. Sklar (Chicago, IL, U.S.A.).
Information: Participation at these annual symposia is by invitation only. Those wishing to be invited should send details of their interest and, preferably, publications (paper copies) and/or manuscripts, with their postal and email addresses, to R. Ger, Institute of Mathematics, Silesian University, Bankowa 14, PL-40-007 Katowice, Poland (romanger@us.edu.pl), before March 1, 2005.

*16-20 **Stability Criteria for Multi-dimensional Waves and Patterns**, AIM Research Conference Center, Palo Alto, California.
Organizers: Christopher K. R.T. Jones, Yuri Latushkin, Robert Pego, Arnd Scheel, and Bjorn Sandstede.
Deadline: February 5, 2005.
Information: http://aimath.org/ARCC/workshops/multidimwaves.html.

June 2005

*7-10 **SIAM Conference on Mathematical and Computational Issues in the Geosciences**, Palais des Papes, The International Conference Center, Avignon, France.
Description: From points of view ranging from science to public policy, there is burgeoning interest in modeling of geoscientific problems. Some examples include petroleum exploration and recovery, underground waste disposal and cleanup of hazardous waste, earthquake prediction, weather prediction, and global climate change. Such modeling is fundamentally interdisciplinary; physical and mathematical modeling at appropriate scales, physical experiments, mathematical theory, probability and statistics, numerical approximations, and large-scale computational algorithms all have important roles to play.
Purpose: This conference facilitates communication between scientists of varying backgrounds and work environments facing similar issues in different fields and provides a forum in which advances in parts of the larger modeling picture can become known to those working in other parts. These kinds of interactions are needed for meaningful progress in understanding and predicting complex physical phenomena in the geosciences.
Information: http://www.siam.org/meetings/gs05/index.htm.

*7-17 **Fields Institute Summer School on Operator Algebras**, University of Ottawa, Ottawa, Ontario, Canada.
Program: A two weeks' summer school will consist of short introductory courses in various areas of operator algebra theory of major current interest.
List of Courses: 1) Ian Putnam: C*-algebras and dynamical systems; 2) Michael Rordam: Amenable C*-algebras and their classification; 3) Nigel Higson: An introduction to noncommutative geometry; 4) Roland Speicher: Free probability theory; 5) Marius Junge: An introduction to the theory of operator spaces.
Funding Support: Funding support for graduate students and postdoctoral fellows to cover travel and local expenses will be available through Fields Institute.
Information: http://www.fields.utoronto.ca/programs/scientific/04-05/opalg_school/.

*19-24 **33rd Canadian Operator Symposium (COSy), dedicated to George Elliott's 60th birthday**, University of Ottawa, Ottawa, Ontario, Canada.
General information: The meeting, sponsored by the Fields Institute, immediately follows the Summer School on Operator Algebras (June 7-17, 2005).
Funding Support: Funding Support for graduate students and postdoctoral fellows to cover travel and local expenses will be available through the Fields Institute.
Registration: To be informed of when registration opens please contact email: gensci@fields.utoronto.ca.
Information: http://www.fields.utoronto.ca/programs/scientific/04-05/COSy/.

*19-24 **First Announcement: Conference on Applied Mathematics and Scientific Computing 4: On the occasion of Professor Aganovic's 70th birthday**, Brijuni, Croatia.
Topics: Mathematical methods in fluid mechanics (main topic)-Splines and wavelets with applications to CAGD, CAD/CAM, computer graphics and differential equations-Ordinary and partial differential equations, integral equations, singular perturbation problems-Mathematics of Finance-Numerical Mathematics in general-Optimization-Scientific Computing-Engineering.
List of Invited speakers (temporary): Maria Rosaria Padula, Univ. of Ferara, Italy; Sunèica Èaniæ, Univ. of Houston, USA; Alain Bourgeat, Univ. Lyon 1, France; Andro Mikeliæ, Univ. Lyon 1, France; Kreúimir Veseliæ, Fernuniversitat, Hagen, Germany; Brahim Amaziane, Univ. of Pau, France.
Organizer: Department of Mathematics, Univ. of Zagreb; Phone: 385-1-4605745; fax: 385-1-4680335; email: ApplMath03@math.hr.
Further Information: http://ApplMath05.math.hr.

*19-July 8 **Random processes, random matrices and integrable systems (C.R.M. Short Program)**, Centre de recherches mathématiques, Université de Montréal.
Organizers: John Harnad (CRM, Concordia); Jacques Hurtubise (CRM, McGill).
Speakers: M. Adler, P. Bleher, A. Its, C. Tracy, P. Van Moerbeke, H. Widom, K. McLaughlin, M. Bertola, B. Eynard, P. Wiegmann, and others Topics: Spectral theory of random matrices, Determinantal ensembles; Dyson processes; Airy, Bessel, sine and Laguerre processes, Matrix Riemann Hilbert methods, applications to large N asymptotics, Differential equations for gap distributions and transition probabilities, Applications to random tilings, random graphs, random partitions, Relations to integrable systems and isomonodromic deformations.
Deadlines: Application for participation: May 1, 2005. Application for financial support: March 1, 2005.

Information: http://omega.crm.umontreal.ca/~physmath/home.dir/RANDOM.dir/random-workshop.html.

July 2005

*2-9 **Mile High Conference on Quasigroups, Loops and Nonassociative Systems**, University of Denver, Denver, Colorado.
Topics: nonassociative algebra, quasigroups, loops.
Information: http://www.math.du.edu/milehigh; email: milehigh@nsm.du.edu.

*10-15 **SampTA05 (Sampling Theory and applications)**, Ondokuz Mayýs University Samsun, Turkey.
Objective: The objective of SampTA05 International Conference is to bring together mathematicians, engineers and applied scientists interested in sampling theory and its applications to exchange results in the following areas: Topics include, but not limited to 1.Nonuniform sampling, 2.Numerical methods and fast numerical algorithms, 3.Sampling and interpolation in spline-type spaces, 4.Effective bandwidth and noise reduction, 5.Frames,non-orthogonal expansions and applications, 6.Greedy algorithms and thresholding methods, 7.Radial basis functions, 8.Wavelet and Gabor methods in sampling theory, 9.Sampling topics related to wavelet and Gabor theory.
Information: http://sampta05.omu.edu.tr.

*10-16 **Stochastic Modelling of Complex Systems (SMOCS-05)**, Daydream Island resort (Whitsundays, Queensland, Australia).
Information: http://www.conferences.unimelb.edu.au/smocs05/index.html.

*11-15 **Gravitational Lensing in the Kerr Spacetime Geometry**, AIM Research Conference Center, Palo Alto, California.
Workshop topics: This workshop, sponsored by AIM and the NSF, will be devoted to advancing the understanding of gravitational lensing by spinning lenses in both the weak and strong field regimes. The main purpose of the workshop is to promote research into this relatively unexplored problem by surveying, discussing and transmitting the current status of spinning lenses to a diverse group of participants, including graduate students, post-doctoral fellows, and faculty. A specific goal of the workshop is to characterize the signatures of spinning lenses in a unified and systematic way that will be useful to researchers new to the field.
Application deadline: March 18, 2005.
Information: http://aimath.org/ARCC/workshops/lensing.html.

*11-16 **Strings 2005, Toronto**, University of Toronto, Toronto, Ontario, Canada.
Information: email: abrand@fields.utoronto.ca.

*18-23 **Algorithms for Approximation V**, University College, Chester, UK.
Description: The Roman City of Chester, UK, will host the fifth International Algorithms for Approximation Conference. This conference brings together approximation theorists and practical users of approximation theory, both from academia and industry, for a sharing of ideas and practices. The previous conferences in this series have been very successful, the last having over 100 delegates, and the speakers, as in previous years, are world leaders in their fields.
Speakers: R. Beatson, Christchurch, NZ; C. Burges, Microsoft (US)' N. Dyn, Tel Aviv, Israel; C. Farmer, Schlumberger and Oxford, UK; A. Forbes, NPL, UK; A. Iske, Leicester, UK; A. Kunoth, Bonn, Germany; C. Manni, Rome, Italy; M. Neamtu, Vanderbilt (US); E. Quak, SINTEF, Norway; M. Unser, Lausanne, Switzerland; E. Weniger, Regensburg, Germany.
Special sessions: On RBFs, data mining, machine learning, spectral methods, metrology, wavelets, fast evaluation, and imaging.
Information: http://scom.hud.ac.uk/scomjkb/a4a5.
Organizers: Jeremy Levesley (Leicester, UK), John Mason (Huddersfield, UK), Andrew Crampton (Huddersfield, UK), Neville Ford (Chester, UK).

*20-27 **The 5th International Algebraic Conference in Ukraine**, Odessa I. I. Mechnikov National University, Odessa, Ukraine.
Topical Sections: (1) Rings and Modules; (2) Theory of Groups; (3) Groups and Algebraic Dynamics; (4) Algebraic Geometry, Theory of Representations and Linear algebra; (5) The Analytical and Algebraic Theory of Numbers; (6) Computer Algebra and Discrete Mathematics; (7) Topological Methods in Algebra; (8) Semigroups and Algebraic Systems.
Information: Prof. Dr. P.D. Varbanets, Department of Mathematics, Economics and Mechanics, Odessa I.I. Mechnikov National University, 2 Dvoryanskaya str., 65026 Odessa, Ukraine; fax: +38 (0482) 23-82-00; tel: +38 (0482) 68-83-29; email: algconf@imem.odessa.ua; email: varb@te.net.ua.
Information and registration: http://www.imem.odessa.ua/algconf.
Deadline: April 15, 2005.

August 2005

*8-13 **XX Nevanlinna Colloquium**, ETH Lausanne, Lausanne, Switzerland.
Topics: Geometric invariants of Riemannian surfaces and hyperbolic manifolds.Kleinian groups, arithmetic groups, discrete subgroups of Lie groups. Numerical methods in conformal geometry. Quasiregular maps. Geometric analysis.
Information: http://www.math.ch/Conferences/Conferences.html#temps.

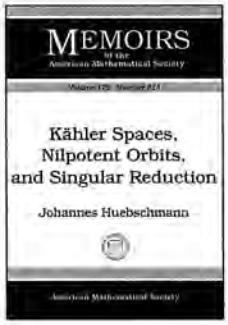
The following new announcements will not be repeated until the criteria in the next to the last paragraph at the bottom of the first page of this section are met.

August 2006

*22-30 **International Congress of Mathematicians**, Madrid, Spain.
Information: http://www.icm2006.org.

New Publications Offered by the AMS

Algebra and Algebraic Geometry



Kähler Spaces, Nilpotent Orbits, and Singular Reduction

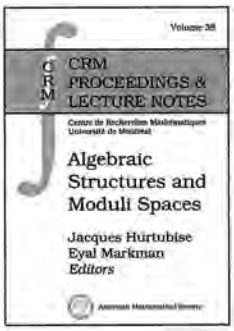
Johannes Huebschmann, *Université des Sciences et Technologies de Lille, Villeneuve, France*

This item will also be of interest to those working in geometry and topology.

Contents: Introduction; Poisson algebras and Lie-Rinehart algebras; Stratified polarized spaces; The closure of a holomorphic nilpotent orbit; Reduction and stratified Kähler spaces; Associated representations and singular reduction; Associated representations for the remaining classical case; Hermitian Jordan triple systems and pre-homogeneous spaces; The exceptional cases; Contraction of semisimple holomorphic orbits; Projectivization and exotic projective varieties; Comparison with other notions of Kähler space with singularities; References.

Memoirs of the American Mathematical Society, Volume 172, Number 814

October 2004, 96 pages, Softcover, ISBN 0-8218-3572-6, LC 2004054529, 2000 *Mathematics Subject Classification*: 53D20; 14L24, 14L30, 17B63, 17B65, 17B66, 17B81, 17C36, 17C37, 17C40, 17C70, 17C90, 32C20, 32M15, 32Q15, 32S05, 32S60, 53C30, 53D17, 53D30, 53D50, 81S10, **Individual member $32**, List $54, Institutional member $43, Order code MEMO/172/814N



Algebraic Structures and Moduli Spaces

CRM Workshop, July 14–20, 2003, Montréal, Canada

Jacques Hurtubise, *McGill University, Montréal, QC, Canada, and Centre de Recherches Mathématiques, Montréal, QC, Canada*, and **Eyal Markman**, *University of Massachusetts, Amherst*, Editors

This book contains recent and exciting developments on the structure of moduli spaces, with an emphasis on the algebraic structures that underlie this structure. Topics covered include Hilbert schemes of points, moduli of instantons, coherent sheaves and their derived categories, moduli of flat connections, Hodge structures, and the topology of affine varieties.

Two beautiful series of lectures are a particularly fine feature of the book. One is an introductory series by Manfred Lehn on the topology and geometry of Hilbert schemes of points on surfaces, and the other, by Hiraku Nakajima and Kōta Yoshioka, explains their recent work on the moduli space of instantons over $\mathbb{R}^4$.

The material is suitable for graduate students and researchers interested in moduli spaces in algebraic geometry, topology, and mathematical physics.

This item will also be of interest to those working in geometry and topology and mathematical physics.

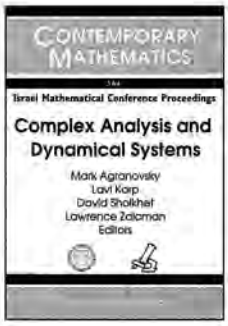
Contents: M. Lehn, Lectures on Hilbert schemes; **H. Nakajima** and **K. Yoshioka**, Lectures on instanton counting; **C. Bartocci** and **M. Jardim**, Hyper-Kähler Nahm transforms; **A. Braverman**, Instanton counting via affine Lie algebras. I. Equivariant J-functions of (affine) flag manifolds and Whittaker vectors; **M. A. A. de Cataldo** and **L. Migliorini**, The Gysin map is compatible with mixed Hodge structures; **N.-K. Ho** and **L. C. Jeffrey**, Representations of fundamental groups of nonorientable 2-manifolds; **Y. Namikawa**, Mukai flops and derived categories. II; **S. Hosono**, **B. H. Lian**, **K. Oguiso**, and **S.-T. Yau**, Fourier-Mukai number of a K3 surface; **J. Sawon**, Derived equivalence of holomorphic symplectic manifolds; **M. Roth** and **R. Vakil**, The affine stratification number and the

moduli space of curves; **M. Verbitsky**, Coherent sheaves on generic compact tori; **W.-P. Li**, **Z. Qin**, and **W. Wang**, The cohomology rings of Hilbert schemes via Jack polynomials.

CRM Proceedings & Lecture Notes, Volume 38

October 2004, 258 pages, Softcover, ISBN 0-8218-3568-8, LC 2004057088, 2000 *Mathematics Subject Classification*: 14Dxx, 14Cxx, **All AMS members $63**, List $79, Order code CRMP/38N

Analysis



Complex Analysis and Dynamical Systems

Mark Agranovsky, *Bar-Ilan University, Ramat-Gan, Israel*, **Lavi Karp** and **David Shoikhet**, *ORT Braude College, Karmiel, Israel*, and **Lawrence Zalcman**, *Bar-Ilan University, Ramat-Gan, Israel*, Editors

This book contains contributions from the participants of an International Conference on Complex Analysis and Dynamical Systems.

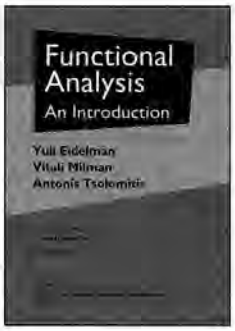
The papers collected here are devoted to various topics in complex analysis and dynamical systems, ranging from properties of holomorphic mappings to attractors in hyperbolic spaces. Overall, these selections provide an overview of activity in analysis at the outset of the twenty-first century. The book is suitable for graduate students and researchers in complex analysis and related problems of dynamics.

With this volume, the Israel Mathematical Conference Proceedings are now published as a subseries of the AMS Contemporary Mathematics series.

Contents: L. Aizenberg, Remarks on the "asymptotic maximum principle"; **C. Beneteau** and **B. Korenblum**, Some coefficient estimates for H^p functions; **R. Brooks**, A statistical model of Riemann surfaces; **M. Budzyńska**, Holomorphic retracts in domains with the locally uniformly linearly convex Kobayashi distance; **M. Budzyńska** and **T. Kuczumow**, Common fixed points of holomorphic mappings and retracts of B_H^∞; **M. Elin**, **A. Goldvard**, **S. Reich**, and **D. Shoikhet**, Dynamics of spirallike functions; **L. A. Harris**, Invertibility preserving linear maps of Banach algebras; **J. Hilgert** and **D. Mayer**, The dynamical zeta function and transfer operators for the Kac-Baker model; **V. A. Khatskevich**, **V. A. Senderov**, and **V. S. Shulman**, On operator matrices generating linear fractional maps of operator balls; **T. Krainer** and **B.-W. Schulze**, Long-time asymptotics with geometric singularities in the spatial variables; **S. L. Krushkal**, Grunsky inequalities of higher rank with applications to complex geometry and function theory; **M. Lanza de Cristoforis**, Asymptotic behaviour of the conformal representation of a Jordan domain with a small hole, and relative capacity; **D. Lenz**, Singular continuous spectrum for certain quasicrystal Schrödinger operators; **E. Malinnikova**, Measures orthogonal to the gradients of harmonic functions; **O. Martio**, **V. Ryazanov**, **U. Srebro**, and **E. Yakubov**, Q-homeomorphisms; **B. Paneah**, Dynamic methods in the general theory of Cauchy type functional equations; **V. S. Rabinovich**, Exponential estimates for eigenfunctions of Schrödinger operators with rapidly increasing and discontinuous potentials; **S. Reich** and **A. J. Zaslavski**, A porosity result for attracting mappings in hyperbolic spaces; **B. Schneider** and **M. Shapiro**, Some properties of the quaternionic Cauchy-type integral for a piece-wise Liapunov surface of integration.

Contemporary Mathematics, Volume 364

December 2004, 260 pages, Softcover, ISBN 0-8218-3686-2, LC 2004052777, 2000 *Mathematics Subject Classification*: 30-XX, 32-XX, 35-XX, 46-XX, 47-XX, **All AMS members $63**, List $79, Order code CONM/364N



Functional Analysis

For Classroom Use

An Introduction

Yuli Eidelman and **Vitali Milman**, *Tel Aviv University, Israel*, and **Antonis Tsolomitis**, *University of the Aegean, Samos, Greece*

This textbook provides an introduction to the methods and language of functional analysis, including Hilbert spaces, Fredholm theory for compact operators, and spectral theory of self-adjoint operators. It also presents the basic theorems and methods of abstract functional analysis and a few applications of these methods to Banach algebras and the theory of unbounded self-adjoint operators.

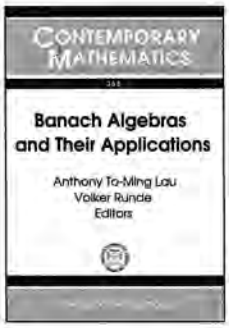
The text corresponds to material for two semester courses (Part I and Part II, respectively) and is essentially self-contained. Prerequisites for the first part are minimal amounts of linear algebra and calculus. For the second part, some knowledge of topology and measure theory is recommended. Each of the 11 chapters is followed by numerous exercises, with solutions given at the end of the book.

The amount of mathematics presented in the book can well be absorbed in a year's study and will provide a sound basis for future reading. It is suitable for graduate students and researchers interested in operator theory and functional analysis.

Contents: *Hilbert spaces and basic operator theory:* Linear spaces; normed spaces; first examples; Hilbert spaces; The dual space; Bounded linear operators; Spectrum. Fredholm theory of compact operators; Self-adjoint operators; Functions of operators; spectral decomposition; *Basics of functional analysis:* Spectral theory of unitary operators; The fundamental theorems and the basic methods; Banach algebras; Unbounded self-adjoint and symmetric operators in H; Solutions to exercises; Bibliography; Symbols index; Subject index.

Graduate Studies in Mathematics, Volume 66

December 2004, approximately 344 pages, Hardcover, ISBN 0-8218-3646-3, LC 2004057393, 2000 *Mathematics Subject Classification*: 46-01, 47-01; 46Axx, 46Bxx, 46Cxx, 46Hxx, 47Axx, 47Bxx, **All AMS members $44**, List $55, Order code GSM/66N



Banach Algebras and Their Applications

Anthony To-Ming Lau and **Volker Runde**, *University of Alberta, Edmonton, AB, Canada*, Editors

This proceedings volume is from the international conference on Banach Algebras and Their Applications held at the University of Alberta (Edmonton). It contains a collection of refereed research papers and high-level expository articles that offer a panorama of Banach algebra theory and its manifold applications.

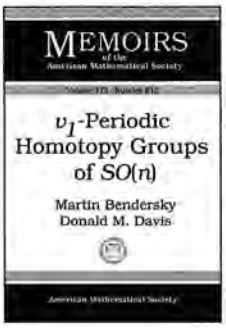
Topics in the book range from K-theory to abstract harmonic analysis to operator theory. It is suitable for graduate students and researchers interested in Banach algebras.

Contents: **M. Amini** and **A. Medghalchi**, Fourier algebras on tensor hypergroups; **O. Yu. Aristov**, Amenability and compact type for Hopf-von Neumann algebras from the homological point of view; **A. Baklouti, N. B. Salah,** and **K. Smaoui**, Some uncertainty principles on nilpotent Lie groups; **D. P. Blecher**, Are operator algebras Banach algebras?; **C.-H. Chu**, Jordan Banach algebras in harmonic analysis; **J. Esterle**, Zero-one and zero-two laws for the behavior of semigroups near the origin; **J. F. Feinstein** and **H. Kamowitz**, Compact homomorphisms between Dales-Davie algebras; **B. Forrest**, Completely bounded multipliers and ideals in $A(G)$ vanishing on closed subgroups; **F. Gourdeau, Z. A. Lykova,** and **M. C. White**, The simplicial cohomology of $L^1(\mathbf{R}_+^k)$; **S. A. Grigoryan** and **T. V. Tonev**, Shift-invariant algebras on groups; **N. Grønbæk**, Self-induced Banach algebras; **A. Ya. Helemskii**, Some aspects of topological homology since 1995: a survey; **E. Kaniuth** and **A. T.-M. Lau**, Fourier algebras and amenability; **W. C. Lang**, Refinement equations and generalized multiresolution analyses for hypergroups; **R. Lasser**, Almost periodic sequences with respect to orthogonal polynomials; **N. J. Laustsen**, K-theory for Banach *-algebras; **V. Losert**, Separation property, Mautner phenomenon, and neutral subgroups; **J. Mashreghi** and **T. Ransford**, Using entire functions to analyse power growth; **M. Mathieu**, Another automatic boundedness technique; **R. Meyer**, Bornological versus topological analysis in metrizable spaces; **T. L. Miller, V. G. Miller,** and **M. M. Neumann**, Banach algebras, local spectral theory, and extensions of operators; **W. J. Ricker**, Banach algebras of p-multiplier operators for the circle group; **E. R. Schulz** and **K. F. Taylor**, Projections in L^1-algebras and tight frames; **Yu. V. Selivanov**, Classes of Banach algebras of global dimension infinity; **N. Spronk**, Representations of multiplier algebras in spaces of completely bounded maps.

Contemporary Mathematics, Volume 363

December 2004, 343 pages, Softcover, ISBN 0-8218-3471-1, LC 2004052924, 2000 *Mathematics Subject Classification*: 46-06; 22Exx, 30Dxx, 43-XX, 43A62, 46Hxx, 46Jxx, 46J10, 46L51, 46L80, 46Mxx, 47A11, 47Dxx, 47L25, 47L50, **All AMS members $71**, List $89, Order code CONM/363N

Geometry and Topology



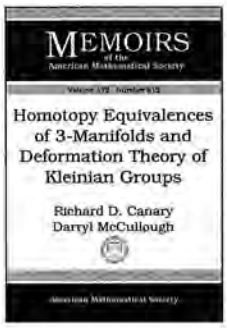
ν_1-Periodic Homotopy Groups of $SO(n)$

Martin Bendersky, *Hunter College, City University of New York,* and **Donald M. Davis**, *Lehigh University*

Contents: Introduction; The BTSS of $\mathrm{BSpin}(n)$ and the CTP; Listing of results; The 1-line of $\mathrm{Spin}(2n)$; Eta towers; d_3 on eta towers; Fine tuning; Combinatorics; Comparison with J-homology approach; Proof of fibration theorem; A small resolution for computing $\mathrm{ext}_{\mathcal{A}}$; Bibliography.

Memoirs of the American Mathematical Society, Volume 172, Number 815

October 2004, 90 pages, Softcover, ISBN 0-8218-3589-0, LC 2004054530, 2000 *Mathematics Subject Classification*: 55Q52, 55T15, 57T20, **Individual member $32**, List $54, Institutional member $43, Order code MEMO/172/815N



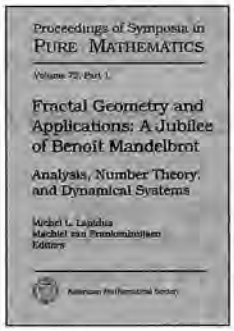
Homotopy Equivalences of 3-Manifolds and Deformation Theory of Kleinian Groups

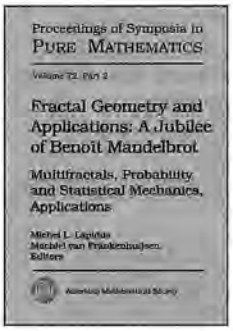
Richard D. Canary, *University of Michigan, Ann Arbor,* and **Darryl McCullough**, *University of Oklahoma, Norman*

Contents: Introduction; Johannson's characteristic submanifold theory; Relative compression bodies and cores; Homotopy types; Pared 3-manifolds; Small 3-manifolds; Geometrically finite hyperbolic 3-manifolds; Statements of main theorems; The case when there is a compressible free side; The case when the boundary pattern is useful; Dehn flips; Finite index realization for reducible 3-manifolds; Epilogue; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 172, Number 812

October 2004, 218 pages, Softcover, ISBN 0-8218-3549-1, LC 2004054528, 2000 *Mathematics Subject Classification*: 57M99; 20F34, 30F40, 57M50, **Individual member $41**, List $68, Institutional member $54, Order code MEMO/172/812N





Fractal Geometry and Applications: A Jubilee of Benoît Mandelbrot

Michel L. Lapidus, *University of California, Riverside*, and **Machiel van Frankenhuijsen**, *Utah Valley State College, Orem*, Editors

This volume offers an excellent selection of cutting-edge articles about fractal geometry, covering the great breadth of mathematics and related areas touched by this subject. Included are rich survey articles and fine expository papers. The high-quality contributions to the volume by well-known researchers—including two articles by Mandelbrot—provide a solid cross-section of recent research representing the richness and variety of contemporary advances in and around fractal geometry.

In demonstrating the vitality and diversity of the field, this book will motivate further investigation into the many open problems and inspire future research directions. It is suitable for graduate students and researchers interested in fractal geometry and its applications.

This is a two-part volume. *Part 1* covers analysis, number theory, and dynamical systems; *Part 2*, multifractals, probability and statistical mechanics, and applications.

This item will also be of interest to those working in analysis.

Contents: *Part 1:* **M. L. Lapidus**, Fractal geometry and applications–An introduction to this volume; **J. Barral** and **S. Jaffard**, Cherche Livre... et plus si affinité/Looking for a book...and more, if affinity; **M. Berry**, Benefiting from fractals; **M.-O. Coppens**, Benoit Mandelbrot, wizard of science; **R. L. Devaney**, Mandelbrot's vision for mathematics; **M. M. Dodson**, Benoit Mandelbrot and York; **B. Duplantier**, Nul n'entre ici s'il n'est géomètre/Let no one ignorant of geometry enter here; **M. L. Frame**, A decade of working with a maverick; **M. Frantz**, Breakfast with Mandelbrot; **J.-P. Kahane**, Old memories; **D. B. Mumford**, My encounters with Benoit Mandelbrot; **L. Nottale**, Fractal geometry and the foundations of physics; **B. Sapoval**, Is randomness partially tamed by fractals?; **J. E. Taylor**, On knowing Benoit Mandelbrot; *Analysis:* **M. M. France**, Reflections, ripples and fractals; **M. Frantz**, Lacunarity, Minkowski content, and self-similar sets in $\mathbb{R}$; **F. Morgan**, Fractals and geometric measure theory: Friends and foes; **H. Furstenberg** and **Y. Katznelson**, Eigenmeasures, equidistribution, and the multiplicity of β-expansions; **A. Kameyama**, Distances on topological self-similar sets; **A. Teplyaev**, Energy and laplacian on the Sierpiński gasket; **C. Sabot**, Electrical networks, symplectic reductions, and application to the renormalization map of self-similar lattices; **B. Solomyak**, Notes on Bernoulli convolutions; *Number theory:* **T. Hilberdink**, Some connections between Bernoulli convolutions and analytic number theory; **S. Jaffard**, On Davenport expansions; **M. M. Dodson** and **S. Kristensen**, Hausdorff dimension and diophantine approximation; **M. L. Lapidus** and **M. van Frankenhuijsen**, Fractality, self-similarity and complex dimensions; *Dynamical systems:* **B. Kahng**, The invariant fractals of symplectic piecewise affine elliptic dynamics; **S. Crovisier**, Almost sure rotation number of circle endomorphisms; **V. Baladi**, Kneading determinants and transfer operators in higher dimensions; **V. Afraimovich**, **L. Ramírez**, and **E. Ugalde**, The spectrum of dimensions for Poincaré recurrences for nonuniformly hyperbolic geometric constructions; **M. Comerford**, A survey of results in random iteration; **D. Schleicher**, On fibers and local connectivity of Mandelbrot and multibrot sets; *Part 2. Multifractals:* **J. Barral** and **B. B. Mandelbrot**, Introduction to infinite products of independent random functions (Random multiplicative multifractal measures, part I); **J. Barral** and **B. B. Mandelbrot**, Non-degeneracy, moments, dimension, and multifractal analysis for random multiplicative measures (Random multiplicative multifractal measures, part II); **J. Barral**, Techniques for the study of infinite products of independent random functions (Random multiplicative multifractal measures, part III); **S. P. Jaffard**, Wavelet techniques in multifractal analysis; **J. L. Véhel** and **S. Seuret**, The 2-microlocal formalism; **J. Peyrière**, A vectorial multifractal formalism; *Probability and statistical mechanics:* **B. M. Hambly** and **T. Kumagai**, Heat kernel estimates for symmetric random walks on a class of fractal graphs and stability under rough isometries; **Y. Xiao**, Random fractals and Markov processes; **G. F. Lawler**, **O. Schramm**, and **W. Werner**, On the scaling limit of planar self-avoiding walk; **B. Duplantier**, Conformal fractal geometry & boundary quantum gravity; *Applications:* **A. Desolneux**, **B. Sapoval**, and **A. Baldassarri**, Self-organized percolation power laws with and without fractal geometry in the etching of random solids; **M.-O. Coppens**, Nature inspired chemical engineering–Learning from the fractal geometry of nature in sustainable chemical engineering; **F. K. Musgrave**, Fractal forgeries of nature.

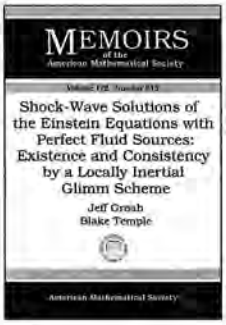
Proceedings of Symposia in Pure Mathematics, Volume 72

Part 1: December 2004, approximately 524 pages, Hardcover, ISBN 0-8218-3637-4, LC 2004057084, 2000 *Mathematics Subject Classification*: 28A12, 28A80, 11K60, 11M41, 37A45, 37F45, 60G57, 60J45, 68U05, 82C41, **All AMS members $87**, List $109, Order code PSPUM/72.1N

Part 2: December 2004, approximately 586 pages, Hardcover, ISBN 0-8218-3638-2, LC 2004057084, 2000 *Mathematics Subject Classification*: 28A12, 28A80, 11K60, 11M41, 37A45, 37F45, 60G57, 60J45, 68U05, 82C41, **All AMS members $87**, List $109, Order code PSPUM/72.2N

Set: December 2004, approximately 1110 pages, Hardcover, ISBN 0-8218-3292-1, LC 2004057084, 2000 *Mathematics Subject Classification*: 28A12, 28A80, 11K60, 11M41, 37A45, 37F45, 60G57, 60J45, 68U05, 82C41, **All AMS members $135**, List $169, Order code PSPUM/72N

Mathematical Physics



Shock-Wave Solutions of the Einstein Equations with Perfect Fluid Sources: Existence and Consistency by a Locally Inertial Glimm Scheme

Jeff Groah, *California State University at Monterey Bay, Seaside,* and **Blake Temple**, *University of California, Davis*

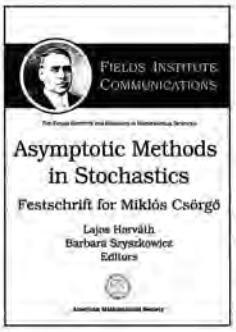
This item will also be of interest to those working in differential equations.

Contents: Introduction; Preliminaries; The fractional step scheme; The Riemann problem step; The ODE step; Estimates for the ODE step; Analysis of the approximate solutions; The elimination of assumptions; Convergence.

Memoirs of the American Mathematical Society, Volume 172, Number 813

October 2004, 84 pages, Softcover, ISBN 0-8218-3553-X, LC 2004054527, 2000 *Mathematics Subject Classification*: 35L65, 35L67, 83C05, **Individual member $31**, List $51, Institutional member $41, Order code MEMO/172/813N

Probability



Asymptotic Methods in Stochastics

Festschrift for Miklós Csörgő

Lajos Horváth, *University of Utah, Salt Lake City,* and **Barbara Szyszkowicz**, *Carleton University, Ottawa, ON, Canada,* Editors

This volume, honoring over forty years of Miklós Csörgő's work in probability and statistics, reflects the state of current research. It offers a comprehensive collection of surveys introducing new results with complete proofs and expository papers giving an historic overview.

Contributions were made by an international cast of experts. The book covers the following topics: path properties of stochastic processes, probability theory with applications, complete convergence of renewal counting processes and bootstrap means, weak convergence of random size sums, almost sure stability of weighted maxima, procedures for detecting changes in statistical models, statistical inference via conditional quantiles, cumulative sums, multinomial samples, empirical processes, applications to economics, and self-normalized partial sums processes. The section, "Applications to Economics", deals primarily with applications of stochastics to financial time series models.

The book is suitable for graduate students and researchers interested in probability theory, stochastic processes, mathematical statistics, and applications of these mathematical/statistical sciences.

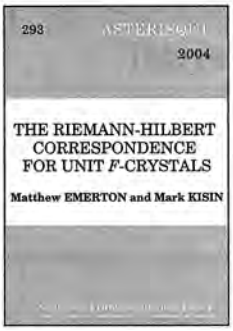
Contents: *Path properties of stochastic processes:* **E. Csáki, A. Földes,** and **Z. Shi,** Our joint work with Miklós Csörgő; **D. Khoshnevisan,** Brownian sheet and quasi-sure analysis; **G. Peccati** and **M. Yor,** Hardy's inequality in $L^2([0,1])$ and principal values of Brownian local times; **G. Peccati** and **M. Yor,** Four limit theorems for quadratic functionals of Brownian motion and Brownian bridge; **P. Révész,** Tell me the values of a Wiener at integers, I tell you its local time; *Probability theory with applications:* **R. J. Bhansali, M. P. Holland,** and **P. S. Kokoszka,** Chaotic maps with slowly decaying correlations and intermittency; **Y. Davydov** and **V. Paulauskas,** Recent results on p-stable convex compact sets with applications; **Y. Davydov** and **R. Zitikis,** Convex rearrangements of random elements; **D. A. Dawson, L. G. Gorostiza,** and **A. Wakolbinger,** Hierarchical random walks; **K. A. Ross** and **Q.-M. Shao,** On Helgason's number and Khintchine's inequality; *Complete convergence of renewal counting processes and bootstrap means:* **A. Gut** and **J. Steinebach,** Convergence rates and precise asymptotics for renewal counting processes and some first passage times; **S. Csörgő,** On the complete convergence of bootstrap means; *Weak convergence of random size sums, almost sure stability of weighted maxima:* **I. Ćwiklińska** and **Z. Rychlik,** Weak convergence of random sums and maximum random sums under nonrandom norming; **R. J. Tomkins,** Criteria for the almost sure stability of weighted maxima of bounded i.i.d. random variables; *Procedures for detecting changes in statistical models:* **M. Hušková,** Permutation principle and bootstrap in change point analysis; **E.-E. A. A. Aly,** Change point detection based on L-statistics; **E. Atenafu** and **E. Gombay,** Sequential tests for change in the parameters of nested random effects model; **M. Orasch,** Using U-statistics based processes to detect multiple change-points; *Statistical inference via conditional quantiles, cumulative sums, multinomial samples, and empirical processes:* **E. Parzen,** Statistical methods learning and conditional quantiles; **M. D. Burke,** Testing regression models: A strong martingale approach; **A. R. Dabrowski** and **H. Dehling,** Conditional distribution of the H-coefficient in nonparametric unfolding models; **K. Ghoudi** and **B. Rémillard,** Empirical processes based on pseudo-observations II: The multivariate case; *Applications to economics:* **I. Berkes, L. Horváth,** and **P. Kokoszka,** Probabilistic and statistical properties of GARCH processes; **R. Kulperger,** Stochastic finance: Discrete time processes and risk neutral pricing; **D. L. McLeish,** Estimating the correlation of processes using extreme values; **H. Yu,** Analyzing residual processes of (G)ARCH time series models; *Self-normalized partial sums processes:* **M. Csörgő, B. Szyszkowicz,** and **Q. Wang,** On weighted approximations and strong limit theorems for self-normalized partial sums processes; **Q. Wang,** On Darling-Erdős type theorems for self-normalized sums.

Fields Institute Communications, Volume 44

December 2004, 530 pages, Hardcover, ISBN 0-8218-3561-0, LC 2004046445, 2000 *Mathematics Subject Classification*: 60-02, 62-02, 60F15, 60F17, 60G15, 60G17, 60G50, 60J55, 60J65, 60K37, 62G30, 62M10, **All AMS members $103**, List $129, Order code FIC/44N

New AMS-Distributed Publications

Algebra and Algebraic Geometry



The Riemann-Hilbert Correspondence for Unit F-crystals

Matthew Emerton and **Mark Kisin**, *Northwestern University, Evanston, IL*

Let $\mathbb{F}_q$ denote the finite field of order q (a power of a prime p), let X be a smooth scheme over a field k containing $\mathbb{F}_q$, and let Λ be a finite $\mathbb{F}_q$-algebra. We study the relationship between constructible Λ-sheaves on the étale site of X, and a certain class of quasi-coherent $\mathcal{O}_X \otimes_{\mathbb{F}_q} \Lambda$-modules equipped with a "unit" Frobenius structure. The authors show that the two corresponding derived categories are anti-equivalent as triangulated categories, and that this anti-equivalence is compatible with direct and inverse images, tensor products, and certain other operations.

They also obtain analogous results relating complexes of constructible $\mathbb{Z}/p^n\mathbb{Z}$-sheaves on smooth $W_n(k)$-schemes, and complexes of Berthelot's arithmetic $\mathcal{D}$-modules, equipped with a unit Frobenius.

The volume is suitable for graduate students and researchers interested in algebra and algebraic geometry.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: General introduction; Introduction to §§1–12: $\mathcal{O}_{F,X}$-modules; Notation and conventions; $\mathcal{O}_{Fr}^{\Lambda}$-modules; Pull-backs of $\mathcal{O}_{Fr}^{\Lambda}$-modules; Push-forwards of $\mathcal{O}_{Fr}^{\Lambda}$-modules; Relations between f_+ and $f^!$; Unit $\mathcal{O}_{Fr}^{\Lambda}$-modules; Locally finitely generated unit $\mathcal{O}_{Fr}^{\Lambda}$-modules; $\mathcal{O}_{Fr}^{\Lambda}$-modules on the étale site; Λ-sheaves on the étale site; The functor $\mathrm{Sol}_{\acute{e}t}$; The functor $\mathrm{M}_{\acute{e}t}$; The Riemann-Hilbert correspondence for unit $\mathcal{O}_{F,X}$-modules; L-Functions for unit F^r-modules; Introduction to §§13–17: $\mathcal{D}_{F,X}$-modules; $\mathcal{D}_{F,X}^{(u)}$-modules; Direct and inverse images for $\mathcal{D}_{F,X}^{(u)}$-modules; Unit $\mathcal{D}_{F,X}$-modules; The Riemann-Hilbert correspondence for unit $\mathcal{D}_{F,X}$-modules; An equivalence of derived categories; Appendix A: Duality and the Cartier operator; Appendix B: Homological algebra; Bibliography.

Astérisque, Number 293

July 2004, 257 pages, Softcover, ISBN 2-85629-154-6, 2000 *Mathematics Subject Classification*: 14F30; 14F10, 14F20, 13N10, **Individual member $74**, List $82, Order code AST/293N

International Journal of Mathematics and Mathematical Sciences

Website: http://ijmms.hindawi.com

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CALIFORNIA

HARVEY MUDD COLLEGE
Department of Mathematics

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

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

Claremont is situated approximately 35 miles east of downtown Los Angeles, at the foot of the San Gabriel Mountains. The community is known for its tree-lined streets and village charm. It is an easy drive from Claremont to the cultural attractions of the greater Los Angeles area, as well as the ocean, mountains, and deserts of Southern California.

Applicants should send a curriculum vitae, a description of their teaching philosophy and experience, a description of their current research program, undergraduate and graduate transcripts, and arrange to have three letters of recommendation sent to the address that appears below. Further information about the college and department may be found at `http://www.math.hmc.edu/`. Preference will be given to applications completed by December 17, 2004.

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

Address for applications:
Professor Francis E. Su
Chair, Search Committee
Department of Mathematics
Harvey Mudd College
Claremont, CA 91711-5990

000055

SCRIPPS COLLEGE
Claremont, CA 91711
Assistant Professor in Mathematics
Tenure-Track Position
Beginning Fall 2005

Scripps College, a women's liberal arts college with a strong interdisciplinary tradition, invites applications for a tenure-track Assistant Professor position in Mathematics to begin in fall 2005. Ph.D. in mathematics and evidence of excellence in teaching required. We are looking for an individual with a strong commitment to undergraduate liberal arts education. Successful teaching experience and evidence of a productive research program are essential. Participation in the interdisciplinary programs of the College is desirable. Applicants should send a curriculum vitae and a statement of teaching interests and philosophy to Chair, Mathematics Search Committee, Scripps College, 1030 Columbia Avenue, Claremont, CA 91711. In addition, applicants should arrange three letters of recommendations to be sent, at least one of which addresses the appli-

Suggested uses for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

The 2004 rate is $100 per inch or fraction thereof on a single column (one-inch minimum), calculated from top of headline. Any fractional text of 1/2 inch or more will be charged at the next inch rate. No discounts for multiple ads or the same ad in consecutive issues. For an additional $10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Headlines will be centered in boldface at no extra charge. Ads will appear in the language in which they are submitted.

There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: December 2004 issue–September 28, 2004; January 2005 issue–October 28, 2004; February 2005 issue–November 22, 2004; March 2005 issue–December 29, 2004; April 2005 issue—January 28, 2005; May 2005 issue—February 25, 2005.

U.S. laws prohibit discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the U.S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U.S. laws. Details and specific wording may be found on page 1373 (vol. 44).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940; or via fax: 401-331-3842; or send email to classads@ams.org . AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 20904. Advertisers will be billed upon publication.

cant's teaching ability. Applications will be reviewed beginning December 15, 2004, and will continue until the position is filled.

Scripps College is one of seven members of The Claremont Colleges cluster located 35 miles east of Los Angeles. In a continuing effort to enrich its academic environment and provide equal educational and employment opportunities, Scripps College actively encourages applications from women and members of historically underrepresented groups.

000114

UNIVERSITY OF CALIFORNIA, BERKELEY
EMSW21 Postdoctoral Positions

We invite applications for two special (non-tenure-track) positions, effective July 1, 2005. Applicants should have a recent Ph.D., or the equivalent, in pure or applied mathematics. Preference will be given to applicants in the areas of representation theory, geometry and combinatorics. These positions are supported in part by the NSF through its EMSW21 Research Training Group program. NSF requires that applicants be citizens, nationals or permanent residents of the United States, its territories and possessions. The term of these appointments is three years, with a reduced teaching load of one course per semester. These appointments carry an additional stipend of $10,000 in each of the first two years for summer research, and up to $2,500 per year for travel and other research-related expenses.

Applicants should send a résumé, reprints, preprints and/or dissertation abstract, and ask three people to send letters of evaluation to The Vice Chair for Faculty Affairs at the above address. All letters of evaluation are subject to Berkeley campus policies on confidentiality of letters of evaluation, a summary of which can be found at: http://apo.chance.berkeley.edu/evalltr.html. We request that applicants use the AMS standardized application form and indicate their subject area using the AMS subject classification numbers. The form is the Academic Employment in Mathematics, Application Cover Sheet, available from the American Mathematical Society.

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

000078

UNIVERSITY OF CALIFORNIA, BERKELEY
Tenure-Track Position

Pending budget approval, we invite applications for one or more positions effective July 1, 2005, at the tenure-track (Assistant Professor) level in the general areas of pure or applied mathematics.

Tenure-track applicants are expected to have demonstrated outstanding research potential, normally including major contributions beyond the doctoral dissertation. Such applicants must send a résumé, reprint or preprints, and/or dissertation abstract, and ask three people to send letters of evaluation to The Vice Chair for Faculty Affairs at the above address. It is the responsibility of the tenure-track applicants to make sure that letters of evaluation are sent. All letters of evaluation are subject to Berkeley campus policies on confidentiality of letters of evaluation, a summary of which can be found on our home page http://math.berkeley.edu/overview_employment_academic.html.

All applicants are required to use the AMS standardized application form and to indicate their subject area using the AMS subject classification numbers. The form is the Academic Employment in Mathematics, Application Cover Sheet. It is available courtesy of the American Mathematical Society.

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

000079

UNIVERSITY OF CALIFORNIA, LOS ANGELES
Department of Mathematics

The following positions are available for the 2005–06 academic year, subject to availability of resources and administrative approval.

(1) Tenure-track/Tenured faculty positions.

(2) E.R. Hedrick Assistant Professorships. Salary is $53,200, and appointments are for three years. The teaching load is four quarter courses per year, which may include one advanced course in a successful candidate's field.

(3) Research Assistant Professorships in Computational and Applied Mathematics (CAM). The salary is $53,200, and appointments are for three years. The teaching load is normally reduced to two or three quarter courses per year by research funding as available and can include one advanced course in a successful candidate's field.

(4) Assistant Adjunct Professorships in the Program in Computing (PIC). Applicants for these positions must show very strong promise in teaching and research in an area related to computing. The teaching load is four one-quarter programming courses each year and one seminar every two years. Initial appointments are for one year and possibly longer, up to a maximum service of four years.The salary is $56,800.

(5) Assistant Adjunct Professorships and Research Postdocs. Normally appointments are for one year, with the possibility of renewal. Strong research and teaching background required. The salary range is $48,900–$53,200. Teaching load for Adjuncts is six quarter courses per year.

(6) Visiting Instructorships.

Applicants should complete the application located on the website at http://www.math.ucla.edu/~search/.

Preference will be given to applicants whose applications are completed by January 10, 2005.

UCLA is an Equal Opportunity/Affirmative Action Employer. Under federal law, the University of California may employ only individuals who are legally authorized to work in the United States as established by providing documents specified in the Immigration Reform and Control Act of 1986.

000106

UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Statistics and Applied Probability and Department of Mathematics

The Department of Statistics and Applied Probability and the Department of Mathematics invite applications for an open-level position, joint between the two departments. Starting date is July 1, 2005. The position is in a general area of Stochastic Analysis. Candidates with interest in Mathematical Finance are strongly encouraged to apply. Qualifications: research and teaching excellence and Ph.D. in Statistics, Mathematics, or relevant field. To apply submit résumé, statement of research and teaching objectives, the AMS Cover Sheet (available online at http://www.ams.org), and have four letters of reference sent (at least one of which is directed towards teaching). Materials should either be submitted electronically via http://www.mathjobs.org or sent to: Search Committee, Department of Statistics and Applied Probability, University of California, Santa Barbara, CA 93106-3110, USA. Selection process begins November 20, 2004, and continues until the position is filled. Candidates who can contribute to the diversity and excellence of the academic community through research, teaching and service are particularly encouraged to apply. An EE/AO Employer. Additional information at http://www.pstat.ucsb.edu or http://www.math.ucsb.edu.

000122

CONNECTICUT

YALE UNIVERSITY
Josiah Willard Gibbs Instructorships/Assistant Professorships

Description: Offered to men and women with the doctorate who show definite promise in research in pure mathematics. Applications from women and members of minority groups are welcome. Appointments are for two/three years. The

teaching load is kept light to allow ample time for research. This will consist of 3 one-semester courses. Part of the teaching duties over the term of the appointment may consist of a one-semester course at the graduate level in the general area of the instructor's research. Grant Amount: The 2005–2006 salary will be at least $53,800. Deadline: January 1, 2005. Application information: Inquiries and applications can be obtained at the following website: http://www.math.yale.edu. Inquiries and application-supporting documents should be sent to the Gibbs Committee, Department of Mathematics, Yale University, via email: gibbs.committee@math.yale.edu. Yale University is an Affirmative Action/Equal Opportunity Employer.

000065

GEORGIA

GEORGIA INSTITUTE OF TECHNOLOGY

Beginning with the 2004/05 academic year, the School of Mathematics at Georgia Tech will embark on an ambitious faculty recruitment program, one which will be sustained over the next five years. Building on past successes, this recruiting effort is intended to make rapid advances in the scope and quality of our research and graduate education programs. Candidates will be considered at all ranks, with priority given to those candidates who (1) bring exceptional quality research credentials to Georgia Tech; (2) complement existing strengths in the School of Mathematics; (3) reinforce bridges to programs in engineering and the physical, computing and life sciences; (4) have strong potential for external funding; and (5) have a demonstrated commitment to high quality teaching at both the undergraduate and graduate levels. Consistent with these priorities, candidates will be considered in all areas of Pure and Applied Mathematics and Statistics. Candidates for positions at the Assistant and Associate Professor levels should arrange for a résumé, at least three letters of reference, and a summary of future research plans to be sent to the Hiring Committee, School of Mathematics, Georgia Institute of Technology, Atlanta, GA 30332-0160, USA. Candidates for Full Professor positions should submit a résumé and a letter outlining their vision for service as a senior faculty member at Georgia Tech. Review of applications will begin in September 2004, and the roster of candidates being considered will be updated on a monthly basis. Georgia Tech, an institution of the University System of Georgia, is an Equal Opportunity/Affirmative Action Employer.

000101

ILLINOIS

NORTHWESTERN UNIVERSITY
Department of Mathematics
2033 Sheridan Road
Evanston, IL 60208-2730

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

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

Applications are welcome at any time, but the review process starts in October 2004.

Northwestern University is an Affirmative Action, Equal Opportunity Employer committed to fostering a diverse faculty; women and minority candidates are especially encouraged to apply.

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NORTHWESTERN UNIVERSITY
Department of Mathematics
2033 Sheridan Road
Evanston, IL 60208-2730
Boas Assistant Professor

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

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

Applications are welcomed at any time, but the review process starts December 1, 2004. Northwestern University is an Affirmative Action, Equal Opportunity Employer committed to fostering a diverse faculty; women and minority candidates are especially encouraged to apply.

000091

UNIVERSITY OF CHICAGO
Department of Mathematics

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

1. L. E. Dickson Instructor: This is open to mathematicians who have recently completed or will soon complete a doctorate in mathematics or a closely related field and whose work shows remarkable promise in mathematical research and teaching. The appointment typically is for two years, with the possibility of renewal for a third year. The teaching obligation is up to four one-quarter courses per year. For applicants who are U.S. citizens or permanent residents, there is the possibility of additional resources for summer support and travel from the department's VIGRE grant.

2. Assistant Professor: This is open to mathematicians who are further along in their careers, typically two or three years past the doctorate. These positions are intended for mathematicians whose work has been of outstandingly high caliber. Appointees are expected to have the potential to become leading figures in their fields. The appointment is generally for three years, with a teaching obligation of three one-quarter courses per year.

Applicants will be considered for any of the positions above which seem appropriate. Complete applications consist of (a) a cover letter, (b) a curriculum vitae, (c) three or more letters of reference, one of which addresses teaching ability, and (d) a description of previous research and plans for future mathematical research, including a brief (200 words or less) summary of your research interests. Applicants are strongly encouraged to include a statement describing their teaching experience and philosophy and an AMS cover sheet. If you have applied for an NSF Mathematical Sciences Postdoctoral Fellowship, please include that information in your application, and let us know how you plan to use it if awarded. Applications should be sent to:

Appointments Secretary
Department of Mathematics
University of Chicago
5734 S. University Avenue
Chicago, IL 60637

Applications may also be submitted online through http://www.mathjobs.org. We will begin screening applications on November 29, 2004. Screening will continue until all available positions are filled. The University of Chicago is an Equal Opportunity/Affirmative Action Employer.

000048

INDIANA

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

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

000067

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

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

000068

UNIVERSITY OF NOTRE DAME
Department of Mathematics
Notre Dame, IN 46556
Regular Position in Numerical Analysis

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

000069

KANSAS

KANSAS STATE UNIVERSITY
Department of Mathematics

Subject to budgetary approval, applications are invited for tenure-track and visiting positions commencing August 14, 2005; rank and salary commensurate with qualifications. The department seeks candidates whose research interests mesh well with current faculty. The department has research groups in the areas of analysis, algebra, geometry/topology, and differential equations. Applicants must have strong research credentials as well as strong accomplishment or promise in teaching. Letter of application, current vita, description of research, and at least three letters of reference evaluating research should be sent to:

Louis Pigno
Department of Mathematics
Cardwell Hall 138
Kansas State University
Manhattan, KS 66506

The department also requires that the candidate arrange for letters to be submitted evaluating teaching accomplishments and potential. Offers may begin by December 1, 2004, but applications for positions will be reviewed until February 1, 2005, or until positions are closed. AA/EOE.

000047

MARYLAND

JOHNS HOPKINS UNIVERSITY
Department of Mathematics

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

1. One tenure-track or tenured positions in all areas of pure mathematics.

2. One non-tenure-track J. J. Sylvester Assistant Professor.

3. One FRG postdoc position: This is open to mathematicians who have recently completed or will soon complete a doctorate in mathematics and whose research interests concern Eigenfunctions of the Laplacian.

For questions, send an email to math@math.jhu.edu. Applications should be sent to: Appointments Committee, Department of Mathematics, Johns Hopkins University, 404 Krieger Hall, Baltimore, MD 21218-2689, and should include a complete curriculum vitae, at least four letters of recommendation (including a letter concerning teaching), and a description of current and planned research. Applications received by November 1, 2004, will be given priority. Johns Hopkins University is an Affirmative Action/Equal Opportunity Employer. Minorities and women candidates are encouraged to apply. See our ad online at http://www.mathematics.jhu.edu/mathnew/jobs.html.

000058

UNITED STATES NAVAL ACADEMY
Department of Mathematics
Annapolis, MD 21146

The USNA Mathematics Department anticipates at least one tenure-track position (subject to approval and funding) at the Assistant Professor level to start in August 2005. See website http://www.usna.edu/MathDept/website/Hire.htm for full information. Tel: 410-293-6701; Fax: 410-293-4883; email: amg@usna.edu. The United States Naval Academy is an Affirmative Action/Equal Employment Opportunity Employer and provides reasonable accommodations to applicants with disabilities.

000125

MASSACHUSETTS

AMHERST COLLEGE
Department of Mathematics

Statisticians are invited to apply for a tenure-track position in the Department of Mathematics and Computer Science, at the

Assistant Professor level, beginning in fall 2005. Ph.D. in statistics, biostatistics, or closely related field required. The department seeks candidates with broad intellectual interests and a strong commitment to excellence in research and undergraduate teaching. Departmental responsibilities include teaching courses in statistics and mathematics and supervising undergraduate honors projects. There are thirteen weeks of classes in the fall, fourteen in the spring, and faculty members teach two courses each semester.

Candidates should submit a cover letter, curriculum vitae, graduate transcript, research description, teaching statement, and three letters of recommendation. At least one letter should primarily address the candidate's teaching. All applications received by December 15, 2004, are assured of consideration. Send applications to Professor John E. Rager, Chair, Department of Mathematics and Computer Science, Amherst College, Amherst, MA 01002.

Amherst College is a private undergraduate liberal arts college for men and women, with 1,600 students and 165 faculty members. Located in the Connecticut River Valley of western Massachusetts, Amherst participates with Hampshire, Mount Holyoke, and Smith Colleges and the University of Massachusetts in the Five College Consortium. Candidates should have a strong commitment to undergraduate teaching in a liberal arts context and a well-articulated plan for sustained research. Additional information on faculty openings at the College can be found at http://www.amherst.edu/~deanfac/facultypositions.

Amherst College is an Equal Opportunity/Affirmative Action Employer and encourages women, persons of color, and persons with disabilities to apply. The administration, faculty, and student body are committed to attracting qualified candidates from groups currently underrepresented on campus.

000112

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mathematics
Applied Mathematics

The applied mathematics group at MIT is seeking to fill possible positions at the level of Instructor, Assistant Professor, or higher, beginning September 2005. Appointments will be made based on demonstrated outstanding research qualifications. Candidates in all areas of applied mathematics, including physical applied mathematics, computational molecular biology, numerical analysis and scientific computation, will be considered. Current activities of the group include: combinatorics, operations research, theory of algorithms, numerical analysis, astrophysics, condensed matter physics, computational physics, fluid dynamics, geophysics, nonlinear waves, theoretical and computational molecular biology, quantum computing, quantum field theory and material science, but new hiring may involve other areas. Please send curriculum vitae, research description, along with three letters of recommendation by January 10, 2005, to: Committee on Applied Mathematics, Room 2-345, Department of Mathematics, M.I.T., 77 Massachusetts Ave., Cambridge, MA 02139-4307. M.I.T. is an Equal Opportunity/Affirmative Action Employer. (For more information about the position and institution: http://www-math.mit.edu.)

000126

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mathematics

The Department of Mathematics may make appointments, at the level of lecturer and assistant professor or higher, in pure mathematics for the year 2005–2006. The teaching load will be nine hours for the academic year (eight hours for assistant professor appointments). These positions are open to mathematicians with doctorates who show definite promise in research. Applications should be complete by January 10, 2005. Applicants should arrange to have sent (a) vita, (b) three letters of reference, (c) a description of their most recent research, and (d) a research plan for the immediate future to: Pure Mathematics Committee, Massachusetts Institute of Technology, Room 2-263, 77 Massachusetts Ave., Cambridge, MA 02139-4307. M.I.T. is an Equal Opportunity Affirmative Action Employer. (For more information about the position or institution: http://www-math.mit.edu.)

000127

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mathematics C.L.E. Moore Instructorships in Mathematics

These positions are open to mathematicians with doctorates who show definite promise in research. The teaching load will be nine hours for the academic year. Applications should be complete by January 10, 2005. Applicants should arrange to have sent (a) a vita, (b) three letters of reference, (c) a description of the research in their thesis, and (d) a research plan for the next year to: Pure Mathematics Committee, Massachusetts Institute of Technology, Room 2-263, Cambridge, MA 02139-4307. M.I.T. is an Equal Opportunity/Affirmative Action Employer. (For more information about the position or institution: http://www-math.mit.edu.)

000128

MICHIGAN

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

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

000001

MICHIGAN STATE UNIVERSITY
Department of Mathematics
East Lansing, MI 48824-1027
RTG Postdoctoral Instructorships in Geometry/Topology

Description: Two three-year positions will be available beginning Fall 2005 for new or recent Ph.D.'s who specialize in geometry or topology and who show strong promise in research and teaching. These positions are supported by a Research Training Group (RTG) grant from the National Science Foundation. The teaching load is 1-1. These positions also include support for two summers plus funds for travel and supplies.

Eligibility: Applicants must be U.S. citizens or permanent residents.

Salary: $45,000 per year plus $10,000 summer support.

Application Information: Applicants should send a vita and a statement of research interests, and should arrange for at least four letters of recommendation to be sent, one of which must specifically address the applicant's ability to teach. Please apply by visiting http://www.mth.msu.edu/Hiring. Further information about Geometry/Topology at Michigan State and about the RTG Program can be found at http://www.math.msu.edu/gt. Completed applications (including letters of recommendation) received by December 30, 2004, are assured of consideration. Women and minorities are strongly encouraged to apply. MSU is an Affirmative Action/Equal Opportunity Institution. Handicappers have the right to request and receive reasonable accommodation.

000123

MICHIGAN STATE UNIVERSITY
Department of Mathematics
East Lansing, MI 48824-1027
Postdoctoral Instructorship in Geometry/Topology

Description: A two-year position will be available beginning Fall 2005 for new or recent Ph.D.'s who specialize in geometry or topology and who show strong promise in research and teaching. The teaching load for this position is 2-2.

Eligibility: There are no citizenship restrictions for this position.

Salary: $45,000 per year. Additional income for summer teaching is usually available, if desired.

Application Information: Applicants should send a vita and a statement of research interests, and should arrange for at least four letters of recommendation to be sent, one of which must specifically address the applicant's ability to teach. Please apply by visiting http://www.mth.msu.edu/Hiring. Further information about Geometry/Topology at Michigan State can be found at http://www.math.msu.edu/gt. Completed applications (including letters of recommendation) received by December 30, 2004, are assured of consideration. Women and minorities are strongly encouraged to apply. MSU is an Affirmative Action/Equal Opportunity Institution. Handicappers have the right to request and receive reasonable accommodation.

000124

UNIVERSITY OF MICHIGAN
Department of Mathematics

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

000074

MONTANA

MONTANA STATE UNIVERSITY
Department of Mathematical Sciences

The Department of Mathematical Sciences at Montana State University invites applications for a tenure-track position in Mathematics at the Assistant Professor level to begin in August 2005. Exceptional candidates may be considered for an appointment at the Associate Professor level. Preference will be given to a candidate in the area of theoretical dynamical systems, broadly understood. For more information visit http://www.math.montana.edu/~stanley/TTPosition/index.html.

Montana State University is an ADA/AA/EO/Veteran Preference Employer.

000109

NEBRASKA

UNIVERSITY OF NEBRASKA-LINCOLN
Department of Mathematics

Applications are invited for one tenure-track position and one postdoctoral position in mathematics, starting in August 2005, as follows:

1. One tenure-track assistant professor position in partial differential equations or in any closely related field, including the numerical analysis of PDE's. Applicants must have a strong background in analysis.

2. One three-year (non-tenure-track) Edith T. Hitz Research Assistant Professor position in mathematics. Preference will be given to applicants within three years of having received the Ph.D. who show strong research promise in one of the areas in which UNL's mathematics faculty is currently active.

For both positions, use of the AMS application cover sheet is encouraged. First review of all applications will begin on December 6, 2004, and will continue until suitable candidates are found. Successful candidates for each position should have a Ph.D. in mathematics and outstanding potential for research and teaching in mathematics. Applicants should send a letter of application, a CV, statements addressing their research and teaching, and three or four letters of reference, at least one of which should address teaching, to:

Search Committee
Department of Mathematics
University of Nebraska-Lincoln
Lincoln, NE 68588-0130

Applicants should state clearly in their cover letter which position(s) they are seeking. For more information see the department's website: http://www.math.unl.edu.

The University of Nebraska is committed to a pluralistic campus community through affirmative action and equal opportunity and is responsive to the needs of dual-career couples. We assure reasonable accommodation under the Americans with Disabilities Act; contact Marilyn Johnson at (402) 472-8822 for assistance.

000098

NEW HAMPSHIRE

DARTMOUTH COLLEGE
John Wesley Young Research Instructorship

The John Wesley Young Instructorship is a postdoctoral two-year appointment intended for promising Ph.D. graduates with strong interests in both research and teaching and whose research interests overlap a department member's. Current research areas include applied mathematics, combinatorics, geometry, logic, noncommutative geometry, number theory, operator algebras, probability, set theory and topology. Instructors teach four 10-week courses distributed over three terms, though one of these terms in residence may be free of teaching. The assignments normally include introductory, advanced undergraduate, and graduate courses. Instructors usually teach at least one course in their own specialty. This appointment is for 26 months with a monthly salary of $4,350.00 and is not renewable. Salary includes 2-month research stipend for Instructors in residence during two of the three summer months in 2006 and 2007. To be eligible for a 2005–2007 Instructorship, candidate must be able to complete all requirements for the Ph.D. degree before September 2005.

Applications may be obtained at http://www.math.dartmouth.edu/recruiting/. Or submit a letter of application, curriculum vitae, graduate school transcript, thesis abstract, statement of research plans and interests, and at least three, preferably four, letters of recommendation to Donna Black, Department of Mathematics, Dartmouth College, 6188 Bradley Hall, Hanover, NH 03755-3551. At least one referee should comment on applicant's teaching ability; at least two referees should write about applicant's research ability. Applications received by January 5, 2005, receive first consideration; applications will be accepted until position is filled. Dartmouth College is committed to diversity and strongly encourages applications from women and minorities.

000103

DARTMOUTH COLLEGE
Department of Mathematics

The Department of Mathematics anticipates a tenure-track opening with initial appointment in the 2005–2006 academic year. The position is for an applied mathematician at the rank of Assistant Professor. In extraordinary cases, an appointment at a higher rank is possible. Successful candidate should have demonstrated ability to work across disciplines; particularly, it is expected that he or she seek out and strike up collaborations across campus with departments such as biology, physics, computer science; he/she should also aggressively seek funding in his/her area of research. Current applied

interests include (but are not limited to) imaging, signal processing, computational number theory, statistical physics, stochastic processes, quantum computing, and computational biology and are receiving funding from various sources including NSF and NIH. Candidates for the position must be committed to outstanding teaching and interaction with students at all levels of undergraduate and graduate study.

To create an atmosphere supportive of research, Dartmouth offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence, and flexible scheduling of teaching responsibilities. The teaching responsibility in mathematics is three courses spread over three of four 10-week terms. To apply for the position, applications may be obtained at http://www.math.dartmouth.edu/recruiting/. Or send a letter of application, curriculum vitae, and a brief statement of research results and interests, and arrange for four letters of reference, at least one of which specifically addresses teaching, to be sent to Donna Black, Recruiting Secretary, Department of Mathematics, Dartmouth College, 6188 Bradley Hall, Hanover, NH 03755-3551. Applications received by December 15, 2004, will receive first consideration. Dartmouth College is committed to diversity and strongly encourages applications from women and minorities. Inquiries about the progress of the selection process may be directed to Dan Rockmore, Recruiting Chair.

000104

DARTMOUTH COLLEGE
Department of Mathematics

The Department of Mathematics anticipates a tenure-track opening with initial appointment in the 2005–2006 academic year. In extraordinary cases, an appointment at a higher rank is possible. Preference given to candidates working in either set theory/logic or areas of algebra with connections to existing research interests in the department, including computational algebra, algebraic and arithmetic geometry, representation theory, coding theory and algebraic combinatorics. Candidates for the position must also be committed to outstanding teaching and interaction with students at all levels of undergraduate and graduate study.

To create an atmosphere supportive of research, Dartmouth offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence, and flexible scheduling of teaching responsibilities. The teaching responsibility in mathematics is three courses spread over three of four 10-week terms. To apply for the position, applications may be obtained at http://www.math.dartmouth.edu/recruiting/. Or send a letter of application, curriculum vitae, and a brief statement of research results and interests, and arrange for four letters of reference, at least one of which specifically addresses teaching, to be sent to Donna Black, Recruiting Secretary, Department of Mathematics, Dartmouth College, 6188 Bradley Hall, Hanover, NH 03755-3551. Applications received by December 15, 2004, will receive first consideration. Dartmouth College is committed to diversity and strongly encourages applications from women and minorities. Inquiries about the progress of the selection process may be directed to Dan Rockmore, Recruiting Chair.

000105

NEW JERSEY

THE INSTITUTE FOR ADVANCED STUDY
School of Mathematics

The Institute for Advanced Study, School of Mathematics, has a limited number of memberships, some with financial support for research in mathematics and computer science at the Institute during the 2005–06 academic year. Candidates must have given evidence of ability in research comparable at least with that expected for the Ph.D. degree. During the academic year 2005–06 the school will host a program on Lie groups, representations and discrete mathematics. The program will be led by Alexander Lubotzky of The Hebrew University of Jerusalem. The goal of the program is to bring together mathematicians from several areas in order to strengthen the ties between the fields and generate further collaborations. For additional information on the program, see http://www.math.ias.edu/liegroups.html.

The School of Mathematics and the Department of Mathematics at Princeton University have established the Veblen Research Instructorship, and three-year instructorships will be offered each year to candidates who have received their Ph.D. within the last 3 years. The first and third year of the instructorship will be spent at Princeton University and will carry regular teaching responsibilities. The second year will be spent at the Institute and be dedicated to independent research of the instructor's choice.

Application materials for both the IAS MEMBERSHIPS and the VEBLEN RESEARCH INSTRUCTORSHIP positions may be requested from Applications, School of Mathematics, Institute for Advanced Study, Einstein Drive, Princeton, NJ 08540; email: applications@math.ias.edu. Application forms may be downloaded via a Web connection to http://www.math.ias.edu. Both deadlines are December 1.

000070

RUTGERS UNIVERSITY
Mathematics Department

The Rutgers University Mathematics Department invites applications for the following positions which may be available September 2005.

TENURE-TRACK OR TENURED POSITION: The Department anticipates at least two appointments at the level of Assistant Professor or above. Candidates with interests in mathematical biology, numerical analysis/scientific computation, the mathematics of materials science, algebra/algebraic geometry, and differential geometry are especially encouraged to apply, although strong candidates in all fields will be considered. Applicants must have the Ph.D., outstanding research accomplishments in pure or applied mathematics, and concern for teaching.

HILL ASSISTANT PROFESSORSHIPS (nontenure track): These three-year nonrenewable positions include reduced teaching load for research. Candidates should have received the Ph.D., show outstanding promise of research ability in pure or applied mathematics, and have concern for teaching.

NON-TENURE-TRACK ASSISTANT PROFESSORSHIPS: These are three-year non-renewable positions. Candidates should have a Ph.D., show evidence of superior teaching accomplishments, and show promise of research ability.

Applicants should send a printed résumé, with the AMS Application Cover Sheet attached, and have four letters of recommendation (one of which evaluates teaching) sent to: Search Committee, Dept. of Math-Hill Center, Rutgers University, 110 Frelinghuysen Road, Piscataway, NJ 08854-8019. In addition, an electronic version of the AMS Application Cover Sheet should also be submitted at the website http:///www.mathjobs.org/jobs. It is essential you fill out this cover sheet completely, including specific position(s) applied for and the AMS Subject Classification number of your area(s) of specialization. Rutgers is an Affirmative Action/Equal Opportunity Employer and encourages applications from women and minority-group members.

The department will begin reviewing applications December 1, 2004, and will continue its review until the positions are filled. Updated details of these positions will appear on the Rutgers Mathematics Department webpage at http://www.math.rutgers.edu.

000102

NEW YORK

CLARKSON UNIVERSITY
Mathematics and Computer Science

The Division of Mathematics and Computer Science (http://www.clarkson.edu/mcs invites applications for a tenure-track position in applied mathematics starting in August 2005. We are especially interested in candidates with expertise in computational dynamical systems, but all areas of applied mathematics will be con-

sidered. Responsibilities will include teaching undergraduate and graduate-level mathematics courses, and directing graduate students. Minimum requirements for the assistant professor level are a Ph.D. in mathematics by the date of appointment, demonstrated excellence in both research potential and teaching ability, and fluency in English. In addition, the candidate should be able to interact with other faculty in the department and the university. We expect to fill this position at the assistant professor level, but an appointment at a senior level may be considered for an exceptional candidate.

Applications including vita and three reference letters should be submitted to Prof. P. A. Turner, Department of Mathematics and Computer Science, Clarkson University, Potsdam, NY 13699-5815. Completed applications will be reviewed starting immediately. Women and minorities are urged to apply. Clarkson University is an AA/EOE Employer. (Pos. # 01-04)

000120

NEW YORK UNIVERSITY
The Courant Institute of Mathematical Sciences

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

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

The deadline for applications is December 15, 2004.

000053

NEW YORK UNIVERSITY
The Courant Institute of Mathematical Sciences

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

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

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

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

The deadline for applications is December 15, 2004.

000054

NORTH CAROLINA

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

Applications are invited for a tenure-track position at the assistant professor level beginning Fall 2005. Applicants in all areas of pure and applied mathematics of interest to members of the department will be considered. Applicants should have a doctorate in mathematics, successful postdoctoral experience, an outstanding research program, and a commitment to effective teaching at the undergraduate and graduate levels. The department has strong research programs in both pure and applied mathematics and significant collaborations with other departments, institutions, and industry. Information about the department may be found at `http://www.math.ncsu.edu`.

Applicants should send a vita, research plan and three letters of recommendation to Mathematics Search Committee, Department of Mathematics, NC State University, Box 8205, Raleigh, NC 27695-8205. NC State University is an Equal Opportunity and Affirmative Action Employer. ADA Accommodations: Dr. Jean-Pierre Fouque, email: `fouque@math.ncsu.edu`, (919) 515-2382. Complete applications received before December 31, 2004, will receive full consideration.

000117

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

We invite applications for an anticipated tenure track position at the assistant professor level in Numerical Analysis beginning Fall 2005. Applicants must have a doctorate in mathematics or a closely related area, a strong ongoing research program, and a commitment to effective teaching at the undergraduate and graduate levels. Candidates in all areas of numerical analysis who have had at least one year of postdoctoral experience will be considered. Those in numerical optimization are particularly invited to apply. The numerical analysis group at NC State University is large, active, and deeply involved in interdisciplinary research. Our group has expertise in optimization, nonlinear equations, linear algebra, ordinary and partial differential equations, and control theory. The successful candidate will have the opportunity to participate in the programs of the Statistical and Applied Mathematical Sciences Institute (SAMSI), the Center for Research in Scientific Computation, the Industrial Applied Mathematics Program, and the Operations Research Program. Information about the department may be found at `http://www.math.ncsu.edu`.

Applicants should send a vita, research plan, and three letters of recommendation to Numerical Analysis Search Committee, Department of Mathematics, NC State University, Box 8205, Raleigh, NC 27695-8205. NC State University is an Equal Opportunity and Affirmative Action Employer. ADA Accommodations: Dr. Jean-Pierre Fouque, email: `fouque@math.ncsu.edu`, (919) 515-2382. Complete applications received before December 31, 2004, will receive full consideration.

000118

OHIO

THE OHIO STATE UNIVERSITY
College of Mathematical and Physical Sciences
Department of Mathematics

The Department of Mathematics in the College of Mathematical and Physical Sciences at The Ohio State University expects to have tenure-track/tenured positions and several visiting positions available, effective Autumn Quarter 2005. Candidates in all areas of pure and applied mathematics are invited to apply. A Ph.D. in mathematics, significant mathematical research accomplishment, and evidence of excellent teaching ability are required.

The department will also have several Hans J. Zassenhaus Assistant Professorships and VIGRE Arnold Ross Assistant Professorships available. These term positions are renewable annually for up to a total of three years. Candidates are expected to have a Ph.D. in mathematics and to present evidence of excellence in research and teaching. Further information on the department can be found at `http://www.math.ohio-state.edu` and `http://mbi.osu.edu`.

All candidates should apply online at `http://www.math.ohio-state.edu/`

applications/ and have at least three letters of recommendation sent to:

Advisory Committee
Department of Mathematics
The Ohio State University
231 W. 18th Avenue
Columbus, OH 43210

If you cannot apply online, please send vita, research statement, and teaching statement to the above address.

Applications are considered on a continuing basis, but the annual review process begins November 15, 2004. Please direct inquiries to: email: faculty-search@math.ohio-state.edu.

To build a diverse work force Ohio State encourages applications from individuals with disabilities, minorities, veterans, and women. EEO/AA Employer.

000107

THE OHIO STATE UNIVERSITY
College of Mathematical and Physical Sciences
Department of Mathematics

The Department of Mathematics in the College of Mathematical and Physical Sciences at The Ohio State University expects to have openings at both the junior and senior level in the area of mathematical and computational biology, effective Autumn Quarter 2005.

Applicants should have a Ph.D. in mathematics or a related area, such as mathematical sciences, biomathematics, biology, chemistry, computer science, physics, and engineering, and show outstanding promise and/or accomplishments in both research and teaching. The successful candidate will be expected to teach courses in the Department of Mathematics and actively participate in the newly formed Mathematical Biosciences Institute (MBI). Further information on the department and the MBI can be found at http://www.math.ohio-state.edu and http://mbi.osu.edu.

All candidates should apply online at http://www.math.ohio-state.edu/applications/ and have at least three letters of recommendation sent to:

Mathematical Biosciences Search
Department of Mathematics
The Ohio State University
231 W. 18th Avenue
Columbus, OH 43210

If you cannot apply online, please send vita, research statement, and teaching statement to the above address.

Applications are considered on a continuing basis, but the annual review process begins November 15, 2004. Please direct inquiries to email: faculty-search@math.ohio-state.edu.

To build a diverse work force Ohio State encourages applications from individuals with disabilities, minorities, veterans, and women. EEO/AA Employer.

000108

PENNSYLVANIA

DREXEL UNIVERSITY
Department of Mathematics
Tenure-Track/Tenured Positions

The Department of Mathematics at Drexel University invites applications for at least two tenure-track/tenured positions, effective September 2005. The university is committed to strong growth in the Mathematics Department following the recent hire of a new department head. We are especially interested in candidates in (i) Applied Matrix and Operator Theory, (ii) Biomathematics, (iii) Financial and Actuarial Mathematics, (iv) Statistics, (v) Mathematics Education, though exceptional candidates in other areas will be considered as well. Our hiring strategy allows for the possibility of making multiple hires in the same area in the case of a cohesive group of researchers.

Applicants must possess a doctoral degree in mathematics, statistics, or equivalent and show a strong record and commitment to teaching and research. Applicants for senior positions should demonstrate an outstanding record of achievement commensurate with the level of appointment, including a track record of external support and research group leadership.

Drexel University is a private, urban university with over 10,000 full-time undergraduates and is well-known for its cooperative education program. The Mathematics Department offers undergraduate, master's and Ph.D. degrees.

Send letter of application, vita, statement of research program and evidence of teaching effectiveness, and arrange to have at least three letters of reference sent to Math Search Committee, Department of Mathematics, Drexel University, Philadelphia, PA 19104; phone: 215-895-2668; fax: 215-895-1582; email: mathsearch@drexel.edu; http://www.math.drexel.edu.

Review of applications will begin December 15, 2004, and will continue until the positions are filled. Drexel University is an Equal Opportunity/Affirmative Action Employer.

000119

RHODE ISLAND

BROWN UNIVERSITY
J. D. Tamarkin Assistant Professorship

One three-year nontenured nonrenewable appointment, beginning July 1, 2005. The teaching load is one course one semester and two courses the other semester, and consists of courses of more than routine interest. Candidates are required to have received a Ph.D. degree or equivalent by the start of this appointment, and they may have up to three years of prior academic and/or postdoctoral research experience.

Applicants should have strong research potential and a commitment to teaching. Field of research should be consonant with the current research interests of the department. For full consideration, a curriculum vita, an AMS Standard Cover Sheet, and three letters of recommendation must be received by December 1, 2004. All inquiries and materials should be addressed to: Junior Search Committee, Department of Mathematics, Brown University, Providence, RI 02912. To access the AMS Standard Cover Sheet, visit our website: http://www.math.brown.edu/juniorsearch.shtml. Email inquiries should be addressed to juniorsearch@math.brown.edu. Brown University is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

000080

BROWN UNIVERSITY
Associate Professor

One professorship at the Associate Professor level with tenure, the appointment to begin July 1, 2005. (Exceptionally qualified candidates may be considered for appointment at the level of Professor.) This position is targeted in the area of analysis, broadly construed. Candidates should have a distinguished research record and a strong commitment to excellence in undergraduate and graduate teaching. Preference will be given to applicants with research interests consonant with those of the present members of the department (for a list of faculty members and their fields, see http://www.math.brown.edu/faculty/faculty.html).

Applicants who wish to be considered for this position should send a letter of application together with a curriculum vitae and arrange to have at least five letters of recommendation sent to: Senior Search Committee, Department of Mathematics, Box 1917, Brown University, Providence, RI 02912. Applications must be postmarked by December 13, 2004, in order to receive full consideration. Later applications will be accepted and considered to the extent feasible. Email inquiries can be addressed to srsearch@math.brown.edu. This position is pending approval. Brown University is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

000081

SOUTH CAROLINA

UNIVERSITY OF SOUTH CAROLINA
Department of Mathematics
Palmetto Assistant Professor

Applications are invited for the Palmetto Assistant Professorship in Mathematics. This

is a tenure-track position at the assistant professor rank open to mathematicians who have completed a doctorate in mathematics within the past two to four years and whose work shows remarkable promise in mathematical research and teaching. The Palmetto Assistant Professor will be hired at a competitive base salary, and during the initial three year appointment will be given a one-course per-semester teaching load and provided with a $10,000 annual supplement, half of which will be used as a salary supplement to the base salary. The department seeks outstanding individuals in any field of pure or applied mathematics.

Visiting Appointments: Applications are invited for one or more anticipated visiting positions, primarily at the postdoctoral or assistant professor rank. Applicants must have the Ph.D. in mathematics or related area, outstanding research credentials, and demonstrated excellence in teaching. The department seeks accomplished individuals in any field of pure or applied mathematics.

The beginning date for all positions is August 16, 2005. A complete application should include a detailed vita with a summary of research accomplishments and goals, a completed AMS Standard Cover Sheet, and four letters of recommendation. One letter should appraise the applicant's teaching abilities. Applications may be sent either in hard copy or by e-mail in the form of .pdf or .ps files to: Hiring Committee, Department of Mathematics, University of South Carolina, Columbia, SC 29208; email: hiring@math.sc.edu. Full consideration will be given to applications received by December 3, 2004.

Further information about our department can be obtained on our website http://www.math.sc.edu. The University of South Carolina is an EOE/AA Employer, and the department encourages applications from women and minorities.

000099

UNIVERSITY OF SOUTH CAROLINA
Department of Mathematics
The Wyman L. Williams and Ernest A. and Marguerite Zeigel Hedberg Chair of Mathematics

The Department of Mathematics at the University of South Carolina continues to invite applications or nominations for the Wyman L. Williams and Ernest Albert and Marguerite Zeigel Hedberg Chair in Mathematics. Candidates are expected to have demonstrated excellence in both teaching and research and have a substantial record of external funding. Candidates in all areas of mathematics or applied mathematics are encouraged to apply. The Williams-Hedberg-Hedberg Professor will have a permanent position as a tenured full professor in the mathematics department at a competitive salary. The appointment to chair is an open-ended appointment; however, the chair holder is subject to review every five years in accordance with university procedures.

Nominations or letters of application (with a curriculum vita) should be sent to: Hiring Committee, Department of Mathematics, University of South Carolina, Columbia, SC 29208. Electronic submissions in the form of .pdf or .ps files are welcome and should be sent to: hedberg@math.sc.edu. Full consideration will be given to all applications received by December 3, 2004. However, applications and nominations will continue to be accepted until the position is filled.

Professor of Mathematics and Director of the Industrial Mathematics Institute

The Department of Mathematics at the University of South Carolina continues to invite applications or nominations for the position of director of the Industrial Mathematics Institute (IMI) within the Department of Mathematics of the University of South Carolina. The appointee will possess a distinguished record of scholarship in the mathematical sciences, a strong record of external grant funding, and superior management skills. The successful candidate will hold the rank of full professor with tenure within the Department of Mathematics and, in addition, will assume the directorship of the Industrial Mathematical Institute for an initial three-year term.

Applicants should send a curriculum vitae with a cover letter and arrange to have at least four letters of recommendation sent to: IMI Search Committee, Department of Mathematics, University of South Carolina, Columbia, South Carolina 29208. Electronic submissions in the form of .pdf or .ps files are welcome and should be sent to: imidir@math.sc.edu. Applications will be screened beginning December 3, 2004. However, applications and nominations will continue to be accepted until the position is filled.

Further information about our department and the IMI can be obtained on our website http://www.math.sc.edu. The University of South Carolina is an EOE/AA Employer, and the department encourages applications from women and minorities.

000100

TENNESSEE

VANDERBILT UNIVERSITY
Department of Mathematics
1326 Stevenson Center
Nashville, TN 37240

We invite applications for two non-tenure-track assistant professor positions in the areas of noncommutative geometry/topology and operator algebras beginning Fall 2005. These are three-year appointments at the non-tenure-track assistant professor level with a 1-1 teaching load, a summer stipend, and an award for research related-travel. The positions are supported by a Research Training Group (RTG) grant from the National Science Foundation. They are intended for recent Ph.D.'s who are U.S. citizens or residents with demonstrated research potential and a strong commitment to excellence in teaching.

Submit your application and supporting materials to the attention of the "Noncommutative Geometry Hiring Committee". These materials should include a vita, a publication list, a research summary and the American Mathematical Society Cover Sheet. Please include an email address and fax number if available. Applicants should also arrange to have four letters of recommendation sent to the hiring committee, including one that discusses the candidate's teaching qualifications. Evaluation of the applications will commence on November 1, 2004, and will continue until the position is filled. For information about the research group in noncommutative geometry and operator algebras at Vanderbilt University, please consult the Web at http://www.math.vanderbilt.edu/~ncgoa/. Vanderbilt University is an Affirmative Action/Equal Opportunity Employer.

000049

VANDERBILT UNIVERSITY
Positions Available in Biomathematics

Please visit: http://www.math.vanderbilt.edu/~biomath.

000121

TEXAS

RICE UNIVERSITY
Department of Mathematics
Postdoctorate

Griffith Conrad Evans Instructorships Postdoctoral appointments for two to three years for promising research mathematicians with research interests in common with the active research areas at Rice, particularly geometric topology, geometric analysis, differential geometry, combinatorics, analysis, algebraic geometry, and ergodic theory. Duties will include research and classroom teaching. Applications received by December 15, 2004, will receive full consideration. Rice University is an Equal Opportunity Affirmative Action Employer and strongly encourages applications from women and minority group members. Inquiries and applications should be addressed to Chair, Evans Committee, Department of Mathematics, Rice University, P.O. Box 1892, Houston, TX 77251-1892. Submitting the AMS Application Cover Sheet (available in *Notices*, EIMS, or on the AMS website) would be greatly appreciated.

000111

RICE UNIVERSITY
Mathematics Department

Applications are invited for a tenure-track position in the Department of Mathematics at the rank of Assistant Professor. Candidates should have extremely strong research potential and very good teaching skills. Send a curriculum vitae to: Appointments Committee, Department of Mathematics, Rice University, P.O. Box 1892, Houston, TX 77251-1892. In addition, please solicit at least 3 letters of reference and ask that they be sent directly to the address above. Submission of the AMS Application Cover Sheet would be greatly appreciated. Applications which are complete by December 1, 2004, will be assured full consideration. Rice University is an Equal Opportunity/Affirmative Action Employer and strongly encourages applications from women and members of underrepresented minority groups.

Deadline for Applications: December 1, 2004.

000129

TEXAS A&M UNIVERSITY
Department of Mathematics

The Department of Mathematics is in the second year of an aggressive hiring plan to increase its tenure and tenure-track faculty by 25% over the next several years. As part of this effort, we anticipate several openings for tenured, tenure-eligible, and visiting faculty positions beginning fall 2005. The field is open, but we particularly seek applications from individuals whose mathematical interests would augment and build upon existing strengths both within the Mathematics Department as well as other departments in the university. Salary, teaching loads and start-up funds are competitive.

For a tenured position the applicant should have an outstanding research reputation and would be expected to fill a leadership role in the department. An established research program, including success in attracting external funding and supervision of graduate students, and a demonstrated ability and interest in teaching are required. Informal inquiries are welcome.

For an Assistant Professorship, we seek strong research potential and evidence of excellence in teaching. Research productivity beyond the doctoral dissertation will normally be expected.

We also have several visiting positions available. Our Visiting Assistant Professor positions are for a three-year period and carry a three-course-per-year teaching load. They are intended for those who have recently received their Ph.D., and preference will be given to mathematicians whose research interests are close to those of our regular faculty members. Senior Visiting Positions may be for a semester or one-year period.

For full consideration, the complete dossier should be received by December 15, 2004. Applicants should send the completed "AMS Application Cover Sheet", a vita, and letters of recommendation to: Faculty Hiring, Department of Mathematics, Texas A&M University, College Station, TX 77843-3368. Further information can be obtained from: `http://www.math.tamu.edu/hiring`.

Texas A&M University is an Equal Opportunity Employer. The university is dedicated to the goal of building a culturally diverse and pluralistic faculty and staff committed to teaching and working in a multicultural environment and strongly encourages applications from women, minorities, individuals with disabilities, and veterans. The university is responsive to the needs of dual-career couples.

000082

UNIVERSITY OF TEXAS-ARLINGTON
Department Chair Position

The Mathematics Department at the University of Texas-Arlington invites applications for the position of department chairman, a tenured full professor position. The appointment begins September 1, 2005, and is subject to the availability of funding.

Applicants should have an outstanding record of research and external funding, commensurate with appointment at the level of full professor. Special consideration will be given to candidates with a major research initiative compatible with the research interests of the faculty and with administrative experience. The successful applicant will be committed to both graduate and undergraduate education and will be an effective communicator with faculty, students and upper administration.

The University of Texas-Arlington, located in the Dallas/Fort Worth metroplex, is the second largest campus in the UT system and has 25,000 students. It has strong research programs in engineering and science. The Mathematics Department houses 23 tenured and tenure-track faculty and has research strengths in both pure and applied fields. The department offers undergraduate, master's and doctoral degrees. As part of the university's College of Science, the department actively participates in interdisciplinary research efforts at the interface between mathematics/statistics, science, engineering and local industries.

Applications will be reviewed immediately upon receipt. The search will remain open until the position is filled. Applications should include a letter of interest, a current vita and the names of at least three references. Electronic applications are encouraged and may be submitted to email: `mathsearch@uta.edu`. Hard-copy application materials should be sent to: Chairman, Math Chair Search Committee, Department of Mathematics, University of Texas at Arlington, Box 19408, Arlington, TX 76019-0408.

More information may be obtained from the department's webpage at `http://www.uta.edu/math`.

The University of Texas-Arlington is an Equal Opportunity and Affirmative Action Employer.

000052

THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Mathematics
Austin, TX 78712

Expected openings for Fall 2005 include: (a) Instructorships, some that have R.H. Bing Faculty Fellowships attached to them and others that are VIGRE Instructorships; and (b) three positions at the tenure-track/tenured level.

(a) Instructorships at the University of Texas at Austin are postdoctoral appointments, renewable for two additional years. It is assumed that applicants for Instructorships will have completed all Ph.D. requirements by August 31, 2005. Other factors being equal, preference will be given to those whose doctorates were conferred in 2004 or 2005. Candidates should show superior research ability and have a strong commitment to teaching. Consideration will be given only to persons whose research interests have some overlap with those of the permanent faculty. Duties consist of teaching undergraduate or graduate courses and conducting independent research. The projected salary is $40,000 for the nine-month academic year.

Each R. H. Bing Fellow holds an Instructorship in the Mathematics Department, with a teaching load of two courses in one semester and one course in the other. The combined Instructorship-Fellowship stipend for nine months is $47,000, which is supplemented by a travel allowance of $1,000. Pending satisfactory performance of teaching duties, the Fellowship can be renewed for two additional years. Applicants must show outstanding promise in research. Bing Fellowship applicants will automatically be considered for other departmental openings at the postdoctoral level, so a separate application for such a position is unnecessary.

VIGRE Instructorships are partially funded by an NSF VIGRE Grant awarded to the department (in partnership with the Texas Institute for Computational and Applied Mathematics). The combined Instructorship-VIGRE Postdoctoral Fellowship carries a nine-month stipend of $45,000, with an annual allocation of $2,500 to cover equipment, supplies, and travel. The position also includes summer support in the amount of $6,500 for the first two summers of the appointment. VIGRE appointments are contingent upon continued funding. The teaching load for VIGRE Instructors is one course per se-

mester. Only citizens, nationals and permanent residents of the U.S. are eligible for VIGRE Instructor appointments. Furthermore, a VIGRE Instructor must have received the Ph.D. within eighteen months of the date the appointment becomes effective. All eligible applicants for postdoctoral positions in either the Mathematics Department or TICAM will automatically be considered for a VIGRE Instructorship.

Those wishing to apply for Instructor positions are asked to send a vita and a brief research summary to the above address c/o Instructor Committee. Transmission of the preceding items via email (address: instructor@math.utexas.edu) is encouraged.

(b) An applicant for a tenure-track or tenured position must present a record of exceptional achievement in her or his research area and must demonstrate a proficiency at teaching. In addition to the duties indicated above for Instructors, such an appointment will typically entail the supervision of M.A or Ph.D. students. The salary will be commensurate with the level at which the position is filled and the qualifications of the person who fills it.

Those wishing to apply for tenure-track/tenured positions are asked to send a vita and a brief research summary to the above address, c/o Recruiting Committee. Transmission of the preceding items via email (address: recruit@math.utexas.edu) is encouraged.

All applications must be supported by three or more letters of recommendation, at least one of which speaks to the applicant's teaching credentials. The screening of applications will begin on December 1, 2004. The University of Texas at Austin is an Equal Opportunity Employer.

000096

UTAH

UNIVERSITY OF UTAH
Department of Mathematics

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

Full-time tenure-track or tenured appointments at the level of assistant, associate professor or full professor. Applicants should have received their Ph.D. degrees in 2003 or earlier.

Visiting faculty positions of one year or less, in any of the professional ranks, depending upon availability of funding.

Mathematical Biology postdoctoral positions with Research Training Group.

Please see our website at http://www.math.utah.edu/positions for information regarding available positions, application requirements and deadlines. Applications must be completed through the website http://mathjobs.org.

The University of Utah is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities, and provides reasonable accommodation to the known disabilities of applicants and employees.

000060

WEST VIRGINIA

WEST VIRGINIA UNIVERSITY
Eberly College of Arts and Sciences
Position in Applied Mathematics

An anticipated tenure-track **Assistant Professorship** is announced in the area of applied mathematics, with an expected starting date of August 16, 2005. The successful applicant should have demonstrated outstanding research potential, excellent communication and classroom skills, and a commitment to undergraduate education, graduate supervision, and establishing a thriving funded research program. The appointee should add expertise and research strength to one of our program initiatives, such as the joint undergraduate program in Industrial Mathematics and Statistics, a cooperative Ph.D. program in Computational Computing and Discrete Mathematics, or university-wide initiatives in biometrics or nano-technology. An interest in interdisciplinary research connections and/or collaboration with industry and government research lab/agencies will be an advantage. The federal research presence in the area includes the National Energy Technology Laboratory, a NASA Software Independent Validation and Verification Facility, an FBI Identification Facility in Clarksburg, and a NIOSH facility.

Applicants should provide a letter of application, a vita with statements commenting on their research program and teaching philosophy, and names and contact information for references. Applications, nominations, inquiries and at least three letters of reference should be sent to:

Chair, Department of Mathematics
320 Armstrong Hall
West Virginia University
P.O. Box 6310
Morgantown, WV 26506-6310
email: jobs@math.wvu.edu

Priority will be given to applications received by January 15, 2005.

West Virginia University is an Equal Opportunity/Affirmative Action Employer. Minority, disabled, and women candidates are urged to apply.

000073

WISCONSIN

UNIVERSITY OF WISCONSIN-MADISON
Department of Mathematics

The Department of Mathematics invites applications for possible Van Vleck Visiting Assistant Professorships to begin August 22, 2005. Appointments are for a fixed term of two or three years. The usual teaching load is two courses per semester. Ordinarily only those applicants who have received their doctorate since 2002 will be considered. Promise of excellence in research and teaching is important. Preference will be given to candidates who are likely to interact well with other members of the department. The department also will have available one or more VIGRE Van Vleck Assistant Professorships, partially funded by an NSF VIGRE grant, with a reduced teaching load. VIGRE awards are restricted to U.S. citizens and permanent residents who have received the Ph.D. within 18 months of the start of the award.

Applicants should send a completed AMS Standard Cover Sheet, a curriculum vitae which includes a publication list, and a brief statement of research plans to:

Hiring Committee
Dept. of Mathematics, Van Vleck Hall
University of Wisconsin-Madison
480 Lincoln Drive
Madison, WI 53706-1388

Applicants should also arrange to have sent to the above address three to four letters of recommendation, at least one of which must discuss the applicant's teaching experiences and capabilities. Other evidence of good teaching will be helpful.

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.

For more information about the position please consult http://www.math.wisc.edu.

Deadline for Applications: December 15, 2004, although applications will continue to be considered until all available positions are filled.

000110

WYOMING

UNIVERSITY OF WYOMING
Department of Mathematics
Tenure-Track Position in Nonlinear Partial Differential Equations and Free Boundary Problems

Applications are invited for an assistant professor tenure-track position starting August 2005. A higher rank is possible for persons with outstanding research qualifications. The minimum qualifications are an earned Ph.D., significant record of accomplishments in research, evidence of a strong commitment to teaching, and appropriate level of communication skills. Candidates with research emphasis in Nonlinear and Stochastic PDE, and Free Boundary Problems with applications in Fluid Mechanics and Geosciences are preferred. The position requires the ability and interest to advise undergraduates and supervise master's and doctoral students; to teach a variety of undergraduate, graduate and outreach courses; to collaborate with colleagues in the math department and faculty in related disciplines; and to develop a competitive, externally funded research program. Review of completed applications will begin December 15, 2004. A complete application will consist of a letter of application, a complete CV, a statement of research interests and accomplishments, and a statement of teaching philosophy. Please forward applications to: Analysis Search Committee, Department of Mathematics, University of Wyoming, Laramie, WY 82071-3036. Please have at least three letters of recommendation, one of which should address the candidate's teaching, sent directly to the search committee. For further information please refer to: http://math.uwyo.edu. UW is an EO/AA Employer.

000061

UNIVERSITY OF WYOMING
Department of Mathematics
Tenure-Track Position in Information Theory

Applications are invited for an assistant professor tenure-track position starting August 2005. A higher rank is possible for persons with outstanding research qualifications. The minimum qualifications are an earned Ph.D., significant record of accomplishments in research, including computational aspects, and evidence of a strong commitment to teaching, with demonstrated strength in communication skills. Candidates with research emphasis in Computational Combinatorics, Computational Geometry/Algebraic Geometry, or Computational Number Theory with expertise in Information Theoretic applications including Coding Theory and/or Cryptology are preferred. The position requires the ability and interest to supervise master's and doctoral students, to advise undergraduate students, to teach a variety of our graduate and undergraduate and outreach courses, to collaborate with colleagues in the math department and faculty in related disciplines, and to develop a competitive, externally funded research program. Review of complete applications will begin December 15, 2004.

A complete application will consist of a letter of application, complete CV, statement of research interests and accomplishments, and statement of teaching philosophy. Please forward applications to: The Information Theory Search Committee, Department of Mathematics, University of Wyoming, Laramie, WY 82071-3036. Please have at least three letters of recommendation, one of which should address the candidate's teaching, sent directly to the search committee. For further information please refer to: http://math.uwyo.edu. UW is an EO/AA Employer.

000062

UNIVERSITY OF WYOMING
Department of Mathematics
Tenure-Track Position in Computational Fluid Dynamics

Applications are invited for an assistant professor tenure-track position starting August 2005. A higher rank is possible for persons with outstanding research qualifications. The minimum qualifications are an earned Ph.D., significant record of accomplishments in research, evidence of a strong commitment to teaching, and appropriate level of communication skills. Candidates with research emphasis in areas such as computational multiphase flow (modeling, simulation, parameter estimation, optimization and control) as well as computational methods for free boundaries and fluid discontinuities (e.g., fluid interfaces, shock waves, etc.) will be preferred. The position requires the ability and interest to advise undergraduates and supervise master's and doctoral students; to teach a variety of undergraduate, graduate and outreach courses; to collaborate with colleagues in the math department and faculty in related disciplines; and to develop a competitive, externally funded research program. Review of completed applications will begin December 15, 2004.

A complete application will consist of a letter of application, a complete CV, a statement of research interests and accomplishments, and a statement of teaching philosophy. Please forward applications to: Search Committee on Computational Multiphase Flow, Department of Mathematics, University of Wyoming, Laramie, WY 82071-3036. Please have at least three letters of recommendation, one of which should address the candidate's teaching, sent directly to the search committee. For further information please refer to: http://math.uwyo.edu. UW is an EO/AA Employer.

000097

CANADA

THE UNIVERSITY OF TORONTO
Department of Mathematics

The department anticipates having a number of open positions over the next several years, subject to budgetary approval.

- Full professorships (tenured). Successful candidates will be nominated for a Canada Research Chair. Applicants must be outstanding mathematicians who are leaders in their field (Code: CRC).

- Assistant Professorships (tenure-stream). Applicants must demonstrate excellent accomplishments and outstanding promise in research and strong commitment to graduate and undergraduate teaching. Preference will be given to researchers in areas of Analysis (Code: ANA), Algebra (Code: ALG), and Geometric Analysis (Code: GAN). However, exceptional candidates in all fields of pure or applied mathematics are encouraged to apply (Code: OTHER).

- Limited-Term Assistant Professorships, for a period of one to three years. Applicants must demonstrate strength in teaching and significant research promise (Code: CLTA).

- Postdoctoral positions, for a period of one to two years. Applicants must demonstrate strength in teaching and research. Applicants must directly contact faculty members who may support them from their grants. For a list of faculty members and their research interests, see http://www.math.toronto.edu/dept/dirfac.htm l (Code: PDF).

Applicants are asked to specify the code of the most relevant positions and to include the standard AMS Cover Sheet. Applicant material must include the candidate's curriculum vitae, list of publications, and four letters of recommendation, of which at least one letter primarily addresses the candidate's teaching. All application material should be sent to the Search Committee by email (text, Postscript, or PDF only) to email: mathjobs@math.utoronto.ca, or by fax to 416-978-4107, or by post to the Department of Mathematics, University of Toronto, 100 St. George Street, Room 4072, Toronto, Ontario, Canada M5S 3G3. Preference will be given to applications received by December 1, 2004.

The University of Toronto offers the opportunity to teach, conduct research, and live in one of the most diverse cities in the world. See http://www.toronto.ca and http://www.toronto.com.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applicants from visible minority group members,

women, aboriginal persons, persons with disabilities, members of sexual minority groups, and others who may contribute to the further diversification of ideas.

All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority.

000094

EGYPT

THE AMERICAN UNIVERSITY IN CAIRO
Department of Mathematics

The Department of Mathematics anticipates one vacancy. Successful candidates will teach all levels of undergraduate mathematics and statistics courses, as well as participate in research. Founded in 1919, AUC's campus is located in Cairo, Egypt, and its degree programs are accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools. For more information see our website at http://www.aucegypt.edu. The Ph.D. is required. University teaching experience is preferred. One-, two-, or three-year appointments subject to mutual agreement will begin September 2005. Renewal of an appointment depends upon institutional needs and/or the appointee's performance. The normal teaching load is three courses per semester and English is the language of instruction. Salary and rank are according to scale based on qualifications and professional experience. For expatriates, benefits include housing, annual round-trip air travel for appointee and qualifying dependents, plus schooling for the equivalent of up to two children at Cairo American College. In view of AUC's protocol agreement with the Egyptian government, which requires specific proportions of Egyptian, U.S., and third-country citizen faculty, at this time preference will be given to qualified applicants who are U.S. citizens. APPLICATION INSTRUCTIONS: Email a letter of application specifying Position # MATH-1 with C.V. and names and addresses of three references to email: facultyaffairs@aucnyo.edu or mail to: Dr. Earl (Tim) Sullivan, Provost, The American University in Cairo, 420 Fifth Avenue, Fl. 3, New York, NY 10018-2729, and complete the Personnel Information Form provided at http://forms.aucegypt.edu/provost/pif3.html. Applications accepted until position is filled. Formal review of candidates begins November 1, 2004. The American University in Cairo is an Equal Opportunity Employer.

000095

SINGAPORE

NATIONAL UNIVERSITY OF SINGAPORE
Department of Mathematics
2 Science Drive 2
Singapore 117543

The Department of Mathematics at the National University of Singapore (NUS) invites applications for tenure-track and visiting positions beginning July 2005.

NUS is a research-intensive university that provides quality undergraduate and graduate education. The Department of Mathematics, which is one of the largest in the university, will continue to build upon its strength in pure and applied mathematics and to develop mathematical expertise in emerging areas of applications. We seek promising young scholars or candidates with outstanding track records in any field of pure and applied mathematics. The Department offers competitive salaries with start-up grants for research, attractive teaching load for young scholars, a conducive research environment and opportunities for development.

Application materials should be sent to:

Search Committee
Department of Mathematics
National University of Singapore
2 Science Drive 2, Singapore 117543
Republic of Singapore
Fax: +65 6779 5452

and should include: (1) an American Mathematical Society Standard Cover Sheet, (2) a detailed CV including publications list, (3) a statement of research accomplishments and plan, (4) at least three letters of recommendation, including one which indicates the candidate's effectiveness and commitment to teaching. Inquiries may be sent via email to search@math.nus.edu.sg. Review of applications will begin December 15 and will continue until positions are filled. For further information about the department, please see http://www.math.nus.edu.sg.

000113

TAIWAN

NATIONAL CHIAO TUNG UNIVERSITY
Department of Applied Mathematics

Applications invited for regular or visiting positions at all levels (assistant professors and above) beginning August 2005. All areas of pure and applied mathematics considered. Applicant should hold Ph.D. (by August 2005) in mathematics or related field, with strong research potential. Usual language of instruction is Mandarin.

Send letter of application, curriculum vitae, research plans, three recommendation letters, transcripts of graduate works (for recent graduates) to:

Hiring Committee
Department of Applied Mathematics
National Chiao Tung University
Hsinchu 300, Taiwan

Full consideration to applications received by February 20, 2005.

The department is one of the leading research centers in Taiwan, with 24 faculty members in combinatorics, differential equations, differential geometry, dynamical systems, financial mathematics, functional analysis, Lie theory, mathematical physics, number theory, operator theory, probability theory, and scientific computation. Visit website http://www.math.nctu.edu/tw/ for details.

000115

NATIONAL CHUNG CHENG UNIVERSITY
Department of Mathematics

The Department of Mathematics invites applications for regular and visiting positions at either the level of assistant professor or above effect August 1, 2005. Applications are invited in all areas of mathematics. **Partial Differential Equations, Algebra, Global Analysis and Statistics** are among the priorities. A degree of Ph.D. is required. Applicants should send a complete curriculum vitae, three letters of reference, transcripts (if necessary), and a professional statement describing their philosophy about both teaching and research. Applications received by January 31, 2005, will be given full consideration. Send all materials to Dr. Chung-Siung Kao, Chairman, Department of Mathematics, National Chung Cheng University, Ming-Hsiung, Chia-Yi, Taiwan, R.O.C. 62117.

Additional departmental information is available on our website, http://www.math.ccu.edu.tw; fax: 886-5-272-0497; email: director@math.ccu.edu.tw.

000116

Add this Cover Sheet to all of your Academic Job Applications

How to use this form

1. Using the facing page or a photocopy, (or visit the AMS web site for a choice of electronic versions at www.ams.org/coversheet/), fill in the answers which apply to *all* of your academic applications. Make photocopies.

2. As you mail each application, fill in the remaining questions neatly on one cover sheet and include it *on top of* your application materials.

The purpose of the cover form is to aid department staff in tracking and responding to each application for employment. Mathematics departments in Bachelor's-, Master's-, and Doctorate-granting institutions are expecting to receive the form from each applicant, along with the other application materials they require.

The AMS suggests that applicants and employers visit the Job Application Database for Mathematicians (www.mathjobs.org), a new electronic resource being offered by the AMS (in partnership with Duke University) for the second year in 2002-03. The system provides a way for applicants to produce printed coversheet forms, apply for jobs, or publicize themselves in the "Job Wanted" list. Employers can post a job listing, and once applications are made, search and sort among their applicants. Note-taking, rating, e-mail, data downloading and customizable EOE functions are available to employers. Also, reference writers can submit their letters online. A paperless application process is possible with this system, however; employers can choose to use any portion of the service. There will be annual employer fees beginning this year. This system was developed at the Duke University Department of Mathematics.

Please direct all questions and comments to: emp-info@ams.org.

Academic Employment in Mathematics

AMS Standard Cover Sheet

Last Name _____

First Name _____

Middle Names _____

Address *through next June* _____ **Home Phone**

_____ _____

_____ **e-mail Address**

_____ _____

Current Institutional Affiliation **Work Phone**

_____ _____

Highest Degree Held or Expected _____

Granting Institution _____ **Date (optional)** _____

Ph.D. Advisor _____

Ph.D. Thesis Title (optional) _____

Indicate *the mathematical subject area(s) in which you have done research using the Mathematics Subject Classification printed on the back of this form or on the AMS website. Use the two-digit classification which best fits your interests in the Primary Interest line and additional two-digit numbers in the Secondary Interest line.*

Primary Interest ☐ _____

Secondary Interests *optional* ☐ ☐ _____

Give a brief synopsis *of your current research interests (e.g. finite group actions on four-manifolds). Avoid special mathematical symbols and please do not write outside of the boxed area.*

_____

_____

Most recent, if any, position held *post Ph.D.*

University or Company _____

Position Title _____

Indicate the position for which you are applying and position posting code, if applicable

_____

If applying for a position which requires U.S. citizenship or U.S. permanent residency, indicate your eligibility ☐ Yes ☐ No

If unsuccessful for this position, would you like to be considered for a temporary position?

☐ Yes ☐ No If yes, please check the appropriate boxes.

☐ Postdoctoral Position ☐ 2+ Year Position ☐ 1 Year Position

List the names, affiliations, and e-mail addresses *of up to four individuals who will provide letters of recommendation if asked. Mark the box provided for each individual whom you have already asked to send a letter.*

☐ _____

☐ _____

☐ _____

☐ _____

This form is provided courtesy of the American Mathematical Society.

This cover sheet is provided as an aid to departments in processing job applications. It should be included with your application material.

Please print or type. Do not send this form to the AMS.

2000 Mathematics Subject Classification

00 General
01 History and biography
03 Mathematical logic and foundations
05 Combinatorics
06 Order, lattices, ordered algebraic structures
08 General algebraic systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra, matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory, homological algebra
19 *K*-theory
20 Group theory and generalizations
22 Topological groups, Lie groups
26 Real functions
28 Measure and integration
30 Functions of a complex variable
31 Potential theory
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
37 Dynamical systems and ergodic theory
39 Difference and functional equations
40 Sequences, series, summability
41 Approximations and expansions
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations
46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control, optimization
51 Geometry
52 Convex and discrete geometry
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Global analysis, analysis on manifolds
60 Probability theory and stochastic processes
62 Statistics
65 Numerical analysis
68 Computer science
70 Mechanics of particles and systems
74 Mechanics of deformable solids
76 Fluid mechanics
78 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum theory
82 Statistical mechanics, structure of matter
83 Relativity and gravitational theory
85 Astronomy and astrophysics
86 Geophysics
90 Operations research, mathematical programming
91 Game theory, economics, social and behavioral sciences
92 Biology and other natural sciences
93 Systems theory, control
94 Information and communication, circuits
97 Mathematics education

2005 Summer Research Institute—Algebraic Geometry

University of Washington
Seattle, Washington
July 25–August 12, 2005

The forty-fourth Summer Research Institute sponsored by the American Mathematical Society will be devoted to algebraic geometry and will be held at the University of Washington, Seattle, Washington, July 25–August 12, 2005. The members of the Organizing Committee are Aaron Bertram, University of Utah; Dan Abramovich, Brown University; Ludmil Katzarkov, University of California Irvine; and Rahul Pandharipande, Princeton University.

It is anticipated that the institute will be partially funded by a grant from the National Science Foundation and perhaps others. Support will primarily be given for travel and subsistence to young researchers, women, minorities, and other underrepresented groups. Other participants who wish to apply for support funds should so indicate; however, available funds are limited, and individuals who can obtain support from other sources are encouraged to do so. Funding is contingent upon a grant from the National Science Foundation.

The goal of the three-week institute is to review major achievements in and around algebraic geometry in the past decade and bring the attendants to the forefront of the relevant subjects. The three weeks will be roughly focused respectively on

- interactions with physics (M-theory, Gromov-Witten theory...)
- classical geometry (birational geometry, Hodge theory...)
- arithmetic geometry and related topics (geometric Langlands, Motivic integration...).

The institute will be generally modeled on the 1995 Summer Research Institute held at the University of California Santa Cruz, with plenary lecture series in the mornings and seminar series in the afternoons. A new feature will include special lectures sponsored by the Clay Institute.

All persons who are interested in participating in the institute should request an invitation by sending the following information to Summer Institute Coordinator, AMS, P.O. Box 6887, Providence, RI 02940, or by email to `rha@ams.org` no later than **March 4, 2005**. Please type or print the following:

1. Title and dates of conference.
2. Full name.
3. Mailing address.
4. Phone numbers (including area code) for office, home, and fax.
5. Email address.
6. Your anticipated arrival/departure dates.
7. Scientific background relevant to the institute topic; please indicate if you are a student or if you received your Ph.D. on or after 7/1/98.
8. The amount of financial assistance requested (or indicate if no support is required).

Please note that all potential participants, whether or not requesting support, should solicit an invitation from the AMS by the indicated deadline. All requests will be forwarded to the organizing committee for consideration. In late April applicants selected by the organizing committee will receive formal invitations (including specific offers of support if applicable), a brochure of conference information, program information known to date, along with information on travel and local housing. Participants will be required to pay a small conference fee.

Questions concerning the scientific program should be addressed to the organizers. Questions of a nonscientific nature should be directed to the Summer Research Institute coordinator at the address provided above. Please watch `http://www.ams.org/meetings/` for future developments about this institute.

Conferences

Joint Summer Research Conferences in the Mathematical Sciences

Snowbird Resort
Snowbird, Utah
June 5–July 21, 2005

The 2005 Joint Summer Research Conferences will be held at the Snowbird Resort (`http://summer.snowbird.com/pages/home/default.php`) June 5–July 21, 2005. The topics and organizers for the conferences were selected by a committee representing the AMS, the Institute of Mathematical Sciences (IMS), and the Society for Industrial and Applied Mathematics (SIAM). Committee members at the time were Bjorn Birnir, Michael Fried, William Mark Goldman, Ilse Ipsen, Tasso Kaper, Ludmil Katzarkov, Steven Lalley, Hema Srinivasan, Toby Stafford, and Kenneth Stephenson.

It is anticipated that the conferences will be partially funded by a grant from the National Science Foundation and perhaps others. Special encouragement is extended to junior scientists to apply. A special pool of funds expected from grant agencies has been earmarked for this group. Other participants who wish to apply for support funds should so indicate; however, available funds are limited, and individuals who can obtain support from other sources are encouraged to do so.

All persons who are interested in participating in one of the conferences should request an invitation by sending the following information to Summer Research Conferences Coordinator, AMS, P.O. Box 6887, Providence, RI 02940, or by email to `wsd@ams.org` no later than March 3, 2005.

Please type or print the following:

1. Title and dates of conference.
2. Full name.
3. Mailing address.
4. Phone numbers (including area code) for office, home, and fax.
5. Email address.
6. Your anticipated arrival/departure dates.
7. Scientific background relevant to the conference topics; please indicate if you are a student or if you received your Ph.D. on or after 7/1/98.
8. The amount of financial assistance requested (or indicate if no support is required).

All requests will be forwarded to the appropriate organizing committee for consideration. In late April applicants selected by the organizers for each conference will receive formal invitations (including specific offers of support if applicable), a brochure of conference information, program information known to date, along with information on travel and local housing.

Questions concerning the scientific program should be addressed to the organizers. Questions of a nonscientific nature should be directed to the Summer Research Conferences coordinator at the address provided above. Please watch `http://www.ams.org/meetings/` for future developments about these conferences.

***Lectures begin on Sunday morning and run through Thursday. Check-in for housing begins on Saturday. No lectures are held on Saturday. See below for separate dates for the Summer School in Commutative Algebra.**

Quantum Topology—Contemporary Issues and Perspectives

Sunday, June 5–Thursday, June 9

Organizing Committee
Louis H. Kauffman (co-chair), University of Illinois at Chicago
Jozef H. Przytycki (co-chair), George Washington University
Fernando J. O. Souza (co-chair), University of Iowa

Quantum topology is the interdisciplinary study of a number of new invariants of manifolds, links, and related objects, as well as some possible frameworks for them. It has established many unexpected, exciting relations between low-dimensional topology and various areas of mathematics and theoretical physics. It was born through a few independent contributions in the early 1980s and quickly ramified into a wide variety of techniques at several levels of abstraction and generality. Quantum topology comprises algebraic, analytical, categorical, combinatorial, geometrical, and mathematical-physical approaches. Presently, a lot is yet to be learned on the topological interpretation of those new invariants.

This conference aims to: Create a forum that will be a bridge between the several trends in quantum topology, bringing together leading experts in a majority of its topics; examining the surprising recent developments in the area, including cutting-edge contributions by junior researchers; and provoking the participants to make an overall assessment of contemporary quantum topology with a bird's-eye view of the perspectives for the subject, fostering further developments and directions. In addition, this conference will ultimately promote awareness of state-of-the-art quantum topology through its proceedings, which shall contain expositions targeted at a wide audience.

This conference will cover quantum topology in the large sense regarding approach and topic. Its scope will

span invariants of links and related objects, 3-manifolds, and 4-manifolds that are construed via: categorification (Khovanov homology included), state models and state summations, functional integration, skein modules, topological modular functors and topological quantum field theories, as well as generalizations of those methods. Of equal interest are link polynomials and Vassiliev/finite-type invariants and how they fit into the spirit of quantum topology. The algebraic topology of the above invariants is a particularly important aspect to be explored.

A website for this conference will be developed at: `http://www.math.uiowa.edu/~fsouza/Snowbird2005/`.

Mathematical Modeling of Novel Optical Materials and Devices

Sunday, June 12 –Thursday, June 16

Organizing Committee
David Dobson (chair), University of Utah
Peter Kuchment, Texas A&M University
Leonid Kunyansky, University of Arizona
Shari Moskow, University of Florida
Fadil Santosa, University of Minnesota

In recent years, one has seen an avalanche of discoveries and inventions in optical technology. There is a large mathematical component in most of the research leading to these discoveries. Physicists and engineers have been involved in intensive research into this area for many years, while the growing need for mathematical advances in this area is just starting to be met and begs for active participation of mathematicians.

The goal of this conference is to bring together researchers with common interests from mathematics, physics, and engineering to facilitate further progress in this inherently multidisciplinary field.

Among the main themes of this conference are: spectral analysis of pure and doped photonic band gap (PBG) materials, and design of such materials; modeling and analysis of optical waveguides; spectral analysis of microstructured optical fibers; nonlinear optical media (in particular, analysis of nonlinear PBG materials and gap solitons); understanding loss mechanisms in PBG structures; optimal design of photonic structures; numerical analysis and simulation of photonic structures. These themes encompass a wide range of mathematical ideas from spectral theory, linear and nonlinear partial differential equations, optimization theory, numerical analysis, and many other areas.

Invited speakers who have tentatively confirmed:

D. Allan (Physics, Corning), H. Ammari (Math, École Polytechnique), A. Babin (Math, UC Irvine), G. Bao (Math, Michigan State Univ.), S. Blair (Engineering, Utah), J. Dowling (Physics, Jet Propulsion Lab), A. Figotin (Math, UC Irvine), S. Johnson (Physics, MIT), P. Kuchment (Math, Texas A&M), L. Kunyansky (Math, Minnesota), S. Molchanov (Math, Univ. of North Carolina, Charlotte), P. Monk (Math, Delaware), S. Moskow (Math, Florida), J.-C. Nedlec (Math, École Polytechnique), A. Pankov (Math, College of William and Mary), F. Santosa (Math, Arizona), V. Shalaev (Engineering, Purdue University), M. Sigalas (Engineering, Agilent), J. Sipe (Physics, Univ. of Toronto), S. Venakides (Math, Duke University), M. Weinstein (Applied Math, Columbia University), and A. Yariv (Physics, Engineering, Caltech).

Further information about the conference is available at `http://www.math.utah.edu/~dobson/src05/`.

Quantum Graphs and Their Applications

Sunday, June 19–Thursday, June 23

Organizing Committee
Gregory Berkolaiko, Texas A&M University
Robert Carlson, University of Colorado, Colorado Springs
Stephen Fulling, Texas A&M University
Peter Kuchment (chair), Texas A&M University

The conference will bring together a group of mathematicians and physicists to discuss problems of the newly solidifying quantum graph theory and its applications. A graph considered as a (singular) one-dimensional variety and equipped with a differential (in some cases pseudo-differential) "Hamiltonian" is said to be a quantum graph. Such objects have been arising lately in a variety of areas of mathematics, physics, and chemistry. Spectral theory of quantum graphs is also related to the older and more developed spectral theory of combinatorial graphs. One can get an idea of current developments in this field from the articles and references therein in the recent special issue of the journal *Waves in Random Media* (v. 14, no. 1, 2004). It is planned that the conference will address the following related topics: Spectral theory of quantum and combinatorial graphs; Analysis on fractals; Applications of quantum graphs to nanotechnology, optics, quantum chaos, and other areas.

Among the confirmed invited speakers are:

Michael Aizenman, Princeton Univ.; Gregory Berkolaiko, Texas A&M; Robert Carlson, U. Colorado, Colorado Springs; Fan Chung Graham, UC San Diego; Yves Colin De Verdiere, Fourier Institute; Pavel Exner, Nuclear Physics Inst. and Doppler Inst., Acad. Sci.; Mark Freidlin, U. Maryland; Lenny Friedlander, University of Arizona; Stephen Fulling, Texas A&M; Rostislav Grigorchuk, Texas A&M; Jonathan Keating, U. Bristol; Jun Kigami, Kyoto University; Vadim Kostrykin, Fraunhofer Inst.; Peter Kuchment, Texas A&M; Stanislav Molchanov, Univ. of N. Carolina, Charlotte; Petri Ola, Nevanlinna Institute; Lassi Paivarinta, Nevanlinna Institute; Boris Pavlov, Univ. of Auckland; Koby Rubinstein, Indiana Univ.; Peter Sarnak, Princeton Univ.; Holger Schanz, Max-Planck-Institute; Robert Schrader, Freie Univ.; Uzy Smilansky, Weizmann Inst.; Alexander Sobolev, U. Sussex; Michail Solomyak, Weizmann Inst.; Harold M. Stark, UC San Diego; Alexander Teplyaev, U. Connecticut; Audrey A. Terras, UC San Diego.

One can find further information about the conference at http://www.math.tamu.edu/~kuchment/src05_graphs.htm.

In order to ensure sufficient time for informal discussions and interaction, there will be no contributed talks; however, contributed poster sessions are planned.

Summer School in Commutative Algebra: Local Cohomology and Its Applications

Monday, June 20 – Thursday, June 30 (No talks Saturday, June 25)

Organizing Committee
Anurag K. Singh, Georgia Institute of Technology
Uli Walther, Purdue University

The primary goal of the summer school is to familiarize graduate students with techniques and applications of commutative algebra to other parts of mathematics. A main theme will be local cohomology theory and its interactions with algebra, geometry and analysis.

The first part of the summer school features introductory lectures by junior researchers in the field, including the organizers. These lectures will be aimed at graduate students in their early years with basic knowledge and interest in commutative algebra and algebraic geometry. We will also have discussion sessions and computer algebra tutorials in this first part.

The last part of the summer school will be a conference with talks by mathematicians working in commutative algebra and adjacent areas. The lecturers for this last part of the summer school include Markus Brodmann, Universität Zürich; Ragnar-Olaf Buchweitz, University of Toronto; Marc Chardin*, CNRS and Université Paris VI; David Eisenbud, MSRI; Phillippe Gimenez, Universidad de Valladolid; John Greenlees*, University of Sheffield; Melvin Hochster*, University of Michigan; Joe Lipman*, Purdue University; Gennady Lyubeznik, University of Minnesota; Paul Roberts, University of Utah; Rodney Sharp, University of Sheffield; Karen Smith*, University of Michigan; Ngo Viet Trung, Institute of Mathematics, Hanoi; Keiichi Watanabe*, Nihon University; Santiago Zarzuela, Universitat de Barcelona.

The introductory lectures will be delivered by Srikanth Iyengar, University of Nebraska; Graham Leuschke, Syracuse University; Anton Leykin, UIC; Claudia Miller, Syracuse University; Ezra Miller*, University of Minnesota; and the organizers.

(* = participation expected)

Graduate student participants will be reimbursed expenses for a shared double room as well as boarding, and we hope to cover a portion of the transportation costs. Support for the conference comes primarily from NSF funding for the AMS-IMS-SIAM Summer Research Conferences, with supplementary funding provided through Mathematical Sciences Research Institute (MSRI). Applicants from departments that are academic sponsors of MSRI are encouraged to mention this in their application.

For more information consult the conference webpage http://www.math.purdue.edu/~walther/snowbird.html.

Control Methods in PDE-Dynamical Systems

Sunday, July 3–Thursday, July 7

Organizing Committee
Fabio Ancona, University of Bologna
Irena Lasiecka, University of Virginia
Walter Littman, University of Minnesota
Roberto Triggiani, University of Virginia

This conference is intended for two distinct research communities in partial differential equations (PDE): (1) the PDE-control community, which is focused on the study of control-theoretic properties of PDEs (e.g., well-posedness, interior and boundary regularity, controllability, stabilization, and optimization); and (2) the PDE-dynamical systems community, which is focused on the long-time behavior of solutions (e.g., global attractors and their geometric, topological, and structural properties).

These communities, while pursuing different interests and using different methodologies, share a substantial body of common knowledge and background on evolutionary equations. The time is ripe and the momentum is propitious to bring them together at a joint conference. The main goal of this conference is to develop mutual stimulation and joint interactions, thereby leading to a marked advancement of the broader area of research.

For example, recent research developments in these two communities suggest that this goal will be met, for the benefit of all. As an illustration, one may cite one of the goals of PDE-control research in this area: to force otherwise unstable dynamics to acquire good stability properties locally or, when possible, globally, by the insertion of a suitable feedback dissipative controller, possibly on the boundary. Thus the exchange of information and experience between these two mathematical groups is uniquely well-suited at this stage to produce significant advances on a broad spectrum of problems of control-theoretic and long-time behavior relevance.

Dynamics to be considered encompass the following systems: (i) parabolic equations including equations of fluid dynamics with turbulent flows (such as Navier-Stokes equations); (ii) hyperbolic or Petrowski-like equations, including hyperbolic conservations laws and systems of nonlinear elasticity; (iii) systems of strongly coupled PDEs, whether they display a hyperbolic/hyperbolic coupling (such as in shell theory) or else a hyperbolic/parabolic coupling (such as in thermoelasticity and in structural acoustic chamber models).

The timeliness of the conference is reinforced by the very recent breakthrough on the well-posedness theory of conservation laws, which opens the door to the treatment of related control problems.

The organizers have secured a preliminary list of top specialists in both controlled PDE-systems and PDE- based dynamical systems.

Competitive Mathematical Models of Disease Dynamics: Emerging Paradigms and Challenges

Sunday, July 17–Thursday, July 21

Organizing Committee:
Carlos Castillo-Chavez, Arizona State University
Dominic P. Clemence (co-chair), North Carolina A&T State University
Abba B. Gumel (co-chair), University of Manitoba
Trachette Jackson (co-chair), University of Michigan
Ronald E. Mickens, Clark-Atlanta University

The study of disease dynamics raises numerous mathematical challenges, ranging from broad theoretical issues to specific practical ones relating to the design and implementation of therapeutic and public health control strategies. The proposed conference will address modeling, analytical, and computational aspects relevant to today's public health concerns. It is in particular expected to highlight some of the mathematical challenges emerging from consideration of biological, social, and medical issues. The presentations, emphasizing the connection between theory and applications, will include diseases of current public interest such as AIDS/HIV, tuberculosis, influenza, SARS, and cancer.

The goals of the conference are to provide a forum for researchers in various specialties to debate the merits of many modeling approaches and exploit insights from other areas to stimulate new ideas for addressing pressing issues, and to encourage new researchers into the field. Participants will include mathematicians; researchers in the social, biomedical, or health sciences; as well as others interested in the interface of mathematics and health issues. The proposed conference will immediately follow the IAS Park City Summer School on Mathematical Biology (organized by Mark Lewis, Jim Keener, and Mark Chaplain).

A preliminary list of confirmed participants includes the following established and young investigators: Mingxiang Chen, North Carolina A&T State University; Mohd L. Garba (MD), UNC–Chapel Hill, and Moses Cone Hospitals; Wenzhang Huang, University of Alabama–Huntsville; Monica C. Jackson, Emory University; Denise Kirschner, University of Michigan; Ramesh Krishnraj (MD), Guilford County Health Department; Suzanne Lenhart, University of Tennessee–Knoxville; Simon Levin, Princeton University; Jean M.-S. Lubuma, University of Pretoria (SA); Edward M. Lungu, University of Botswana; Patrick Nelson, University of Michigan; Gaston N'guerekata, Morgan State University; Asamoah Nkwata, Morgan State University; and Abdulaziz Yakubu, Howard University.

Further information is available from Dominic P. Clemence at `clemence@ncat.edu`.

Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices*. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See `http://www.ams.org/meetings/`. Programs and abstracts will continue to be displayed on the AMS website in the Meetings and Conferences section until about three weeks after the meeting is over. Final programs for Sectional Meetings will be archived on the AMS website in an electronic issue of the *Notices* as noted below for each meeting.

Evanston, Illinois

Northwestern University

October 23–24, 2004

Saturday–Sunday

Meeting #1001

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: August 2004
Program first available on AMS website: September 9, 2004
Program issue of electronic *Notices*: October 2004
Issue of *Abstracts*: Volume 25, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Ian Agol, University of Illinois at Chicago, *Two generator Kleinian groups.*

Robert W. Ghrist, University of Illinois, Urbana-Champaign, *The geometry and topology of reconfiguration.*

Yuri Manin, Northwestern University, *Fractional dimensions in geometry and algebra.*

Paul Seidel, Imperial College-London and University of Chicago, *Title to be announced.*

Special Sessions

Algebraic Representations and Deformations, **Stephen R. Doty** and **Anthony Giaquinto**, Loyola University of Chicago.

Algebraic Topology: Interactions with Representation Theory and Algebraic Geometry, **Paul G. Goerss**, Northwestern University, **Jesper Kragh Grodal**, University of Chicago, and **Brooke E. Shipley**, University of Illinois at Chicago.

Applications of Motives, **Eric M. Friedlander**, Northwestern University, **Alexander Goncharov**, Brown University, **Mikhail Kapranov**, Yale University, and **Yuri Manin**, Max Planck Institute for Mathematics.

Codes and Applications, **William C. Huffman**, Loyola University of Chicago, and **Vera S. Pless**, University of Illinois at Chicago.

Computability Theory and Applications, **Robert I. Soare** and **Denis R. Hirschfeldt**, University of Chicago.

Differential Geometry, **Anders Ingemar Linner** and **Hongyou Wu**, Northern Illinois University.

Extremal Combinatorics, **Dhruv Mubayi** and **Yi Zhao**, University of Illinois at Chicago.

Fluid Dynamics, Diffusion and Reaction, **Peter S. Constantin** and **Leonid V. Ryzhik**, University of Chicago.

Geometric Aspects of the Langlands Program, **Edward Frenkel**, University of California Berkeley, **Dennis Gaitsgory**, University of Chicago, **Mark Goresky**, Institute for Advanced Study, and **Kari Vilonen**, Northwestern University.

Geometric Partial Differential Equations, **Gui-Qiang Chen** and **Jared Wunsch**, Northwestern University.

Hopf Algebras at the Crossroads of Algebra, Category Theory, and Topology, **Louis H. Kauffman** and **David E. Radford**, University of Illinois at Chicago, and **Fernando J. O. Souza**, University of Iowa.

Index Theory, Morse Theory, and the Witten Deformation Method, **Igor Prokhorenkov** and **Ken Richardson**, Texas Christian University.

Iterated Function Systems and Analysis on Fractals, **Ka-Sing Lau**, Chinese University of Hong Kong, and **Stephen S.-T. Yau**, University of Illinois at Chicago.

Low-Dimensional Topology and Kleinian Groups, **Ian Agol**, **John Holt**, and **Saul Schleimer**, University of Illinois at Chicago.

Mathematical Problems in Robotics, **Robert W. Ghrist**, University of Illinois at Urbana-Champaign.

Mathematical Techniques in Musical Analysis, **Judith Baxter**, University of Illinois at Chicago, **Richard Cohn**, University of Chicago, and **Robert Peck**, Louisiana State University.

Modern Schubert Calculus, **Ezra Miller**, University of Minnesota, and **Frank Sottile**, University of Massachusetts.

Nonlinear Partial Differential Equations and Applications, **Gui-Qiang Chen**, Northwestern University, and **Mikhail Feldman**, University of Wisconsin at Madison.

Nonlinear Waves, **Jerry L. Bona**, University of Illinois at Chicago, **Shuming Sun**, Virginia Polytechnic Institute and State University, and **Bingyu Zhang**, University of Cincinnati.

Representation Theory of Reductive Groups, **Jeffrey D. Adler**, University of Akron, and **Ju-Lee Kim**, University of Illinois at Chicago.

Solving Polynomial Systems, **Anton Leykin** and **Jan Verschelde**, University of Illinois at Chicago.

Special Functions, Orthogonal Polynomials, and Their Applications, **George Gasper**, Northwestern University, and **Ahmed I. Zayed**, DePaul University.

Spectral Problems of Differential Operators, **Qingkai Kong**, **Hongyou Wu**, and **Anton Zettl**, Northern Illinois University.

Stability Issues in Fluid Dynamics, **Susan J. Friedlander** and **Roman Shvydkoy**, University of Illinois at Chicago.

Pittsburgh, Pennsylvania

University of Pittsburgh

November 6–7, 2004

Saturday–Sunday

Meeting #1002

Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: September 2004
Program first available on AMS website: September 23, 2004
Program issue of electronic *Notices*: November 2004
Issue of *Abstracts*: Volume 25, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Jeffrey F. Brock, Brown University, *Ending laminations, tame ends, and the classification of hyperbolic 3-manifolds*

Der-Chen Chang, Georgetown University, *Geometric analysis on a class of degenerate elliptic operators.*

Robert Schapire, Princeton University, *The boosting approach to machine learning.*

Ofer Zeitouni, University of Minnesota, Minneapolis, *Homogenization in asymmetrical random media: Recent results and challenges.*

Special Sessions

Convexity and Combinatorics, **James F. Lawrence** and **Valeriu Soltan**, George Mason University.

Geometric Analysis and Partial Differential Equations in Subelliptic Structures, **Cristian E. Gutiérrez**, Temple University, **Guozhen Lu**, Wayne State University, and **Juan J. Manfredi**, University of Pittsburgh.

Graph Polynomials, **E. Glen Whitehead Jr.**, University of Pittsburgh.

The History of Mathematics, **Robert E. Bradley**, Adelphi University, and **Lawrence A. D'Antonio**, Ramapo College of New Jersey.

Invariants of Knots and 3-Manifolds, **Marta M. Asaeda**, University of Maryland, **Jozef H. Przytycki**, George Washington University, and **Adam S. Sikora**, SUNY at Buffalo.

Knots and Macromolecules, **Kenneth C. Millett**, University of California Santa Barbara, and **Eric J. Rawdon**, Duquesne University.

Mathematical Biology, **Jonathan E. Rubin** and **Bard Ermentrout**, University of Pittsburgh.

Mathematical Finance, **David Saunders** and **John Chadam**, University of Pittsburgh.

Mathematical Modeling of Nonlinear Phenomena in Biology and Mechanics, **Anna Vainchtein** and **William C. Troy**, University of Pittsburgh.

Modularity of Galois Representations and Serre's Conjecture, **Mark E. T. Dickinson**, University of Pittsburgh.

Multiscale Algorithms in Computational Fluid Dynamics, **William J. Layton**, University of Pittsburgh, and **Anastasios Liakos**, U.S. Naval Academy.

Multivariate Hypergeometric Functions: Combinatorial and Algebro-Geometric Aspects, **Eduardo Cattani**, University of Massachusetts, Amherst, **Alicia M. Dickenstein**, Universidad de Buenos Aires, and **Laura Felicia Matusevich**, Harvard University.

Partial Differential Equations and Applications, **Xinfu Chen** and **Dehua Wang**, University of Pittsburgh.

PDE-Based Methods in Imaging and Vision, **Stacey E. Levine**, Duquesne University, and **Yunmei Chen**, University of Florida.

Trends in Operator Theory and Banach Spaces, **Christopher J. Lennard** and **Thomas A. Metzger**, University of Pittsburgh.

Atlanta, Georgia

Atlanta Marriott Marquis and Hyatt Regency Atlanta

January 5–8, 2005
Wednesday–Saturday

Joint Mathematics Meetings
ATLANTA, GEORGIA
January 5–8, 2005

Meeting #1003

Joint Mathematics Meetings, including the 111th Annual Meeting of the AMS, 88th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association of Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: October 2004
Program first available on AMS website: November 1, 2004
Program issue of electronic *Notices*: January 2005
Issue of *Abstracts*: Volume 26, Issue 1

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired
For summaries of papers to MAA organizers: Expired

For the latest information on this meeting, see `www.ams.org/amsmtgs/2091_intro.html`.

Atlanta Program Updates

Who Wants to be a Mathematician, Thursday, 10:00 a.m.–11:00 a.m., organized by **Michael A. Breen** and **Annette W. Emerson**, AMS; and **William T. Butterworth**, Barat College of DePaul University. This is a new version of the popular game. This year, eight high school students from Atlanta and the surrounding region will have a chance to win up to $4,000 by answering questions about mathematics. Contestants can ask for help from anyone in the audience, so the more people in the audience who know mathematics, the better it is for the contestants. You are invited to come and take part in this educational and fun presentation.

MAA Program Updates

Special Programs and Strategies to Reach Underrepresented Populations, Friday, 9:00 a.m.–11:00 a.m., organized by **Elizabeth (Betsy) Yanik**, Emporia State University; **Jennifer Hontz**, Meredith College; and **Kathleen Sullivan**, Seattle University. This poster session is designed to publicize successful activities which have been used to attract and encourage underrepresented populations in mathematics. It is expected that posters representing a wide range of programming would be appropriate for this session. Efforts such as after-school clubs, special conferences, mentoring programs, and summer camps are just a few of the possible formats that might be highlighted. Recipients of grants from the Tensor Foundation or the NSF programs in Gender Diversity in STEM Education or Informal Science might be particularly interested in sending in a poster proposal. Those who are conducting pilot projects or beginning projects are also welcome to submit a poster proposal to present in this session.

Send title and abstract by email to `yanikeli@emporia.edu` or by regular mail to Betsy Yanik, Department of Mathematics and Computer Science, Emporia State University, Emporia, KS 66801, by December 7, 2004. Include author's name, address, phone number, email, and affiliation. Trifold, self-standing 48-by-36-inch tabletop posters will be provided. Additional material or equipment is the responsibility of the presenters. The session is sponsored by the Committee on the Participation of Women and the Women and Mathematics Network.

Social Events

University of Wisconsin-Madison Reunion Reception, Friday, 5:30 p.m. to 7:00 p.m.

Pomona College Reception, Thursday, 6:30 p.m. to 8:30 p.m. All alumni and friends of the Claremont Colleges are invited.

Travel Information

Many travel regulations regarding visas and passports have changed. Our international participants should see important information at `http://www7.nationalacademies.org/visas/`.

Other Events of Interest

Mathematical Art Exhibit, organized by **Robert Fathauer**, Tesselations Company; **Nat Friedman**, ISAMA and University at Albany; and **Reza Sarhangi**, Bridges Conference, Towson University. A popular feature at the last Joint Mathematics Meetings in Phoenix, this exhibit provides a break in your day. On display are paintings, prints, and sculpture by artists whose work is inspired by mathematics and by mathematicians who use visual art to express their findings. Fractals, symmetry and tiling, topology, polyhedra, optical illusions and unusual perspective systems are some

of the ideas at play here. Don't miss this unique opportunity to see a different side of mathematics! The exhibit will be located in the exhibit area; the hours are Wednesday, 12:15 p.m. to 5:30 p.m.; Thursday, 10:00 a.m. to 6:00 p.m.; Friday, 9:30 a.m. to 5:30 p.m.; and Saturday, 9:00 a.m. to noon.

Bowling Green, Kentucky

Western Kentucky University

March 18–19, 2005
Friday–Saturday

Meeting #1004
Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: January 2005
Program first available on AMS website: February 3, 2005
Program issue of electronic *Notices*: March 2005
Issue of *Abstracts*: Volume 26, Issue 2

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: November 30, 2004
For abstracts: January 25, 2005

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Bennett Chow, University of California, San Diego, *Title to be announced.*

Robert McCann, University of Toronto, *Title to be announced.*

M. Susan Montgomery, University of Southern California, *Title to be announced.*

Special Sessions

Advances in the Study of Wavelets and Multiwavelets (Code: SS 5A), **Douglas P. Hardin**, Vanderbilt University, and **Bruce Kessler**, Western Kentucky University.

Commutative Ring Theory (Code: SS 11A), **Michael C. Axtell**, Wabash College, and **Joe Alyn Stickles Jr.**, University of Evansville.

Dynamic Equations on Time Scales and Applications (Code: SS 3A), **Ferhan M. Atici** and **Daniel C. Biles**, Western Kentucky University, and **Billur Kaymakcalan**, Georgia Southern University.

Graph Theory (Code: SS 2A), **Mustafa Atici**, Western Kentucky University.

Hopf Algebras and Related Topics (Code: SS 10A), **David E. Radford**, University of Illinois at Chicago, and **Bettina Richmond**, Western Kentucky University.

Knot Theory and Its Applications (Code: SS 4A), **Yuanan Diao**, University of North Carolina, Charlotte, and **Claus Ernst**, Western Kentucky University.

L-Functions (Code: SS 9A), **Heather Russell**, **Nilabh Sanat**, and **Dominic Lanphier**, Western Kentucky University.

Numerical Analysis, Approximation, and Computational Complexity: Interdisciplinary Aspects (Code: SS 1A), **David Benko**, Western Kentucky University, and **Steven B. Damelin**, Georgia Southern University.

Representation Theory (Code: SS 6A), **Markus Hunziker**, University of Georgia.

Semigroups of Operators and Applications (Code: SS 7A), **Khristo Boyadzhiev**, Ohio Northern University, **Lan Nguyen**, Western Kentucky University, and **Quoc-Phong Vu**, Ohio University.

Topology, Convergence, and Order, in Honor of Darrell Kent (Code: SS 8A), **Gary Richardson**, University of Central Florida, and **Thomas A. Richmond**, Western Kentucky University.

Newark, Delaware

University of Delaware

April 2–3, 2005
Saturday–Sunday

Meeting #1005
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: February 2005
Program first available on AMS website: February 17, 2005
Program issue of electronic *Notices*: April 2005
Issue of *Abstracts*: Volume 26, Issue 2

Deadlines
For organizers: Expired
For consideration of contributed papers in Special Sessions: December 14, 2004
For abstracts: February 8, 2005

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Xiu Xiong Chen, University of Wisconsin, *Title to be announced.*

Anna Gilbert, AT&T Labs-Research, *Title to be announced.*

Alex Lubotzky, Hebrew University of Jerusalem, *Title to be announced.*

Lorenz Schwachhoefer, University of Dortmund, *Title to be announced.*

Special Sessions

Arithmetic Groups and Related Topics (Code: SS 9A), **Alex Lubotzky**, Hebrew University of Jerusalem, and **Andrei Rapinchuk**, University of Virginia.

Asymptotic Behavior of Evolution Equations (Code: SS 4A), **Gaston M. N'Guerekata**, Morgan State University, and **Nguyen Van Minh**, James Madison University.

Designs, Codes, and Geometries (Code: SS 5A), **James A. Davis**, University of Richmond, **Keith E. Mellinger**, University of Mary Washington, and **Qing Xiang**, University of Delaware.

Frontiers on Complex Fluid Flows: Analytic and Computational Methods (Code: SS 7A), **L. Pamela Cook** and **Louis F. Rossi**, University of Delaware.

Geometric Analysis (Code: SS 12A), **Xiuxiong Chen**, University of Wisconsin, Madison, **Pengfei Guan**, McMaster University, **Zhiqin Lu**, University of California Irvine, and **Jeff A. Viaclovsky**, Massachusetts Institute of Technology.

High Dimensional Probability (Code: SS 6A), **Wenbo Li**, University of Delaware, and **Joel Zinn**, Texas A&M University.

Homotopy Theory (in Honor of Donald M. Davis's and Martin Bendersky's 60th Birthdays) (Code: SS 1A), **Kenneth G. Monks**, University of Scranton, and **W. Stephen Wilson**, Johns Hopkins University.

Integral and Operator Equations (Code: SS 13A), **Charles W. Groetsch**, University of Cincinnati, and **M. Zuhair Nashed**, University of Central Florida.

Mathematical Biology (Code: SS 8A), **David A. Edwards**, University of Delaware.

Mathematical Methods for Efficient Simulation of Stochastic Nonlinear Optical Systems (Code: SS 15A), **Richard O. Moore**, New Jersey Institute of Technology, and **Tobin A. Driscoll**, University of Delaware.

Mathematical Methods in Electromagnetic Wave Propagation (Code: SS 3A), **Fioralba Cakoni** and **Peter B. Monk**, University of Delaware.

Recent Progress in Thin Fluid Flows (Code: SS 11A), **Richard J. Braun**, University of Delaware.

Singular Analysis and Spectral Theory of Partial Differential Equations (Code: SS 2A), **Juan B. Gil**, Pennsylvania State University, Altoona, and **Gerardo A. Mendoza**, Temple University.

Spectral and High-Order Discretization Methods for Partial Differential Equations (Code: SS 14A), **Tobin A. Driscoll**, University of Delaware.

Symmetry Methods for Partial Differential Equations (Code: SS 10A), **Philip Broadbridge**, University of Delaware, and **Danny Arrigo**, University of Central Arkansas.

Lubbock, Texas

Texas Tech University

April 8–10, 2005

Friday–Sunday

Meeting #1006

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: February 2005
Program first available on AMS website: February 24, 2005
Program issue of electronic *Notices*: April 2005
Issue of *Abstracts*: Volume 26, Issue 3

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: December 21, 2004
For abstracts: February 15, 2005

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Nikolai Ivanov, Michigan State University, *Title to be announced.*

Mattias Jonsson, University of Michigan, *Title to be announced.*

Nicolas Monod, University of Chicago, *Title to be announced.*

Hee Oh, California Institute of Technology, *Title to be announced.*

Special Sessions

Classical and Differential Galois Theory (Code: SS 3A), **Lourdes Juan** and **Arne Ledet**, Texas Tech University, and **Andy R. Magid**, University of Oklahoma.

Differential Geometry and Its Applications (Code: SS 2A), **Josef F. Dorfmeister**, Munich University of Technology, **Magdalena D. Toda**, Texas Tech University, and **Hongyou Wu**, Northern Illinois University.

Extinction, Periodicity, and Chaos in Population and Epidemic Models (Code: SS 10A), **Linda J. S. Allen**, Texas Tech University, **Sophia Ruey-Jen Jang**, University of Louisiana at Lafayette, and **Lih-Ing W. Roeger**, Texas Tech University.

Future Directions in Mathematical Systems and Control Theory (Code: SS 11A), **David Gilliam** and **W. P. Dayawansa**, Texas Tech University.

Homological Algebra and Its Applications (Code: SS 4A), **Alex Martsinkovsky**, Northeastern University, and **Mara D. Neusel**, Texas Tech University.

Invariants of Links and 3-Manifolds (Code: SS 8A), **Mieczyslaw Krzysztof Dabkowski**, University of Texas at Dallas,

Razvan Gelca, Texas Tech University, and **Jozef Henryk Przytycki**, George Washington University.

Real Algebraic Geometry (Code: SS 6A), **Anatoly Korchagin** and **David Weinberg**, Texas Tech University.

Recent Advances in Complex Function Theory (Code: SS 5A), **Brock Williams, Roger W. Barnard**, and **Kent Pearce**, Texas Tech University.

Theory and Application of Stochastic Differential Equations (Code: SS 9A), **Edward J. Allen**, Texas Tech University, and **Armando Arciniega**, University of Texas at San Antonio.

Topology of Continua (Code: SS 1A), **Wayne Lewis**, Texas Tech University.

Topology of Dynamical Systems (Code: SS 7A), **Brian Raines**, Baylor University.

Santa Barbara, California

University of California Santa Barbara

April 16–17, 2005

Saturday–Sunday

Meeting #1007

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: February 2005
Program first available on AMS website: March 3, 2005
Program issue of electronic *Notices*: April 2005
Issue of *Abstracts*: Volume 26, Issue 3

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: December 28, 2004
For abstracts: February 22, 2005

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Mei-Chu Chang, University of California Riverside, *Title to be announced.*

Mischa Kapovich, University of California Davis, *Title to be announced.*

Mihai Putinar, University of California Santa Barbara, *Title to be announced.*

James Sethian, University of California Berkeley, *Title to be announced.*

Special Sessions

Automorphisms of Surfaces (Code: SS 4A), **Anthony Weaver**, Bronx Community College of the City University of New York.

Complexity of Computation and Algorithms (Code: SS 10A), **Mark Burgin**, University of California Los Angeles.

Dynamical Systems in Neuroscience (Code: SS 1A), **Eugene M. Izhikevich**, The Neurosciences Institute.

Geometric Methods in Three Dimensions (Code: SS 6A), **Daryl Cooper, David Darren Long**, and **Martin G. Scharlemann**, University of California Santa Barbara.

Geometry and Physics (Code: SS 8A), **Xianzhe Dai**, University of California Santa Barbara, and **Zhiqin Lu**, University of California Irvine.

History of Mathematics (Code: SS 2A), **Shawnee L. McMurran**, California State University San Bernardino, and **James J. Tattersall**, Providence College.

Noncommutative Geometry and Algebra (Code: SS 5A), **Kenneth R. Goodearl**, University of California Santa Barbara, **J. T. Stafford**, University of Michigan, and **J. J. Zhang**, University of Washington.

Recent Advances in Combinatorial Number Theory (Code: SS 3A), **Mei-Chu Chang**, University of California Riverside, and **Van Ha Vu**, University of California San Diego.

Representation Theory of Algebras (Code: SS 7A), **Alex Martsinkovsky**, Northeastern University, **Dan Zacharia**, Syracuse University, and **Birge K. Huisgen-Zimmermann**, University of California Santa Barbara.

Ricci Flow/Riemannian Geometry (Code: SS 9A), **Guofang Wei** and **Rugang Ye**, University of California Santa Barbara.

Mainz, Germany

June 16–19, 2005

Thursday–Sunday

Meeting #1008

Joint International Meeting with the Deutsche Mathematiker-Vereinigung (DMV) and the Oesterreichische Mathematische Gesellschaft (OMG)
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: February 2005
Program first available on AMS website: N/A
Program issue of electronic *Notices*: N/A
Issue of *Abstracts*: N/A

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/internmtgs.html`.

Invited Addresses

Helene Esnault, University of Essen, *Title to be announced.*

Richard Hamilton, Columbia University, *Title to be announced.*

Michael J. Hopkins, Massachusetts Institute of Technology, *Title to be announced.*

Christian Krattenthaler, University of Lyon-I, *Title to be announced.*

Frank Natterer, University of Muenster, *Title to be announced.*

Horng-Tzer Yau, New York University and Stanford University, *Title to be announced.*

Special Sessions

Affine Algebraic Geometry, **Shreeram Abhyankar**, Purdue University, **Hubert Flenner**, Fakultät für Mathematik, and **Makar Limanov**, Wayne State University.

Algebraic Combinatorics, **Patricia Hersh**, University of Michigan, **Christian Krattenthaler**, University of Lyon-I, and **Volkmar Welker**, Philipps University Marburg.

Algebraic Cryptography, **Dorian Goldfeld**, Columbia University, **Martin Kreuzer** and **Gerhard Rosenberger**, Universität Dortmund, and **Vladimir Shpilrain**, City College of New York.

Algebraic Cycles, **Eric Friedlander** and **Marc Levine**, Northwestern University, and **Fabien Morel**, Université Paris.

Algebraic Geometry, **Yuri Tschinkel**, Georg-August-Universität Göttingen, and **Brendan E. Hassett**, Rice University.

Dirac Operators, Clifford Analysis and Applications, **Klaus Gürlebeck**, University of Weimar, **Mircea Martin**, Baker University, **John Ryan**, University of Arkansas, and **Michael Shapiro**, IPN Mexico.

Discrete Geometry, **Jacob Eli Goodman**, The City College of New York (CUNY), **Emo Welzl**, Eidgen Technische Hochschule, and **Gunter M. Ziegler**, Technical University of Berlin.

Function Spaces and Their Operators, **Ernst Albrecht**, Universität des Saarlandes, **Raymond Mortini**, Université de Metz, and **William Ross**, University of Richmond.

Functional Analytic and Complex Analytic Methods in Linear Partial Differential Equations, **R. Meise**, University of Dusseldorf, **B. A. Taylor**, University of Michigan, and **Dietmar Vogt**, University of Wuppertal.

Geometric Analysis, **Victor Nistor**, Pennsylvania State University, and **Elamr Schrohe**, Universität Hannover.

Geometric Topology and Group Theory, **Cameron McA. Gordon**, The University of Texas at Austin, **Cynthia Hog-Angeloni**, Johann Wolfgang Goethe-Universität, and **Wolfgang Metzler**, University of Frankfurt.

Group Theory, **Luise-Charlotte Kappe**, Universitat Freiburg, **Robert Fitzgerald Morse**, University of Evansville, and **Gerhard Rosenberger**, University of Dortmund.

Hilbert Functions and Syzygies, **Uwe Nagel**, University of Kentucky, **Irena Peeva**, Cornell University, and **Tim Römer**, Universität Osnabrück.

History of Mathematics: Mathematics and War, **Thomas W. Archibald**, Acadia University, **John H. McCleary**, Vassar College, **Moritz Epple**, University of Stuttgart, and **Norbert Schappacher**, Technische Universität Darmstadt.

Homotopy Theory, **Paul G. Goerss**, Northwestern University, **Hans-Werner Henn**, Institut de Recherche Mathématique Avancée, Strasbourg, and **Stefan Schwede**, Universität Bonn.

Hopf Algebras and Quantum Groups, **Susan Montgomery**, University of Southern California, and **Hans-Jurgen Schneider**, University of Munich.

Mathematics Education, **Gunter Torner**, Universität Duisburg-Essen, and **Alan Schoenfeld**, School of Education, Berkeley.

Modules and Comodules, **Sergio López-Permouth**, Ohio University, and **Robert Wisbauer**, University of Düsseldorf.

Multiplicative Arithmetic of Integral Domains and Monoids, **Scott Chapman**, Trinity University, San Antonio, **Franz Halter-Koch**, University of Graz, and **Ulrich Krause**, Universität Bremen.

Nonlinear Elliptic Boundary Value Problems, **Thomas Bartsch**, Universitaet Giessen, and **Zhi-Qiang Wang**, Utah State University.

Nonlinear Waves, **Herbert Koch**, University of Dortmund, and **Daniel I. Tataru**, University of California Berkeley.

Ordinary Differential, Difference, and Dynamic Equations, **Werner Balser**, Universität Ulm, **Martin Bohner**, University of Missouri-Rolla, and **Donald Lutz**, San Diego State University.

Quantum Knot Invariants, **Anna Beliakova**, Universität Zürich, and **Uwe Kaiser**, Boise State University.

Representations and Cohomology of Groups and Algebras, **Dave Benson**, University of Georgia, and **Henning Krause**, Universität Paderborn.

Set Theory, **Joel Hamkins**, City University New York, **Peter Koepke**, Universität Bonn, and **Benedikt Löwe**, Universiteit van Amsterdam.

Spectral Analysis of Differential and Difference Operators, **Evgeni Korotyaev**, Humboldt-University Berlin, **Boris Mityagin**, The Ohio State University, and **Gerald Teschl**, University of Vienna.

Stochastic Analysis on Metric Spaces, **Laurent Saloff-Coste**, Cornell University, **Karl-Theodor Sturm**, University of Bonn, and **Wolfgang Woess**, Graz Technical University.

Topics in Applied Mathematics and Mechanics: Mathematical Control Theory and Numerical Methods, **Peter Benner**, Fakultat fur Mathematik.

Topics in Applied Mathematics and Mechanics: Mechanics, **Friedrich Pfeiffer**, Technical University of Munich.

Topics in Applied Mathematics and Mechanics: Multiscale Problems, Oscillations in PDEs, and Homogenization, **Alexander Mielke**, University of Hannover.

Topics in Applied Mathematics and Mechanics: Numerical PDEs, Equations with Inherent Conditions, **Rolf Jeltsch**, Eidgen Technische Hochschule, **Maria Lukacova**, Technical

University of Brno, and **Mac Hyman**, Los Alamos National Laboratory.

Topics in Applied Mechanics: Algebraic Approaches to Preconditioning, **Heike Fassbender**, Technical University of Braunschweig, and **Andreas Frommer**, University of Wuppertal.

Topology of Manifolds, **Matthias Kreck**, University of Heidelberg, and **Andrew Ranicki**, University of Edinburgh.

Annandale-on-Hudson, New York

Bard College

October 8–9, 2005

Saturday–Sunday

Meeting #1009

Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: August 2005
Program first available on AMS website: August 25, 2005
Program issue of electronic *Notices*: October 2005
Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: March 8, 2005
For consideration of contributed papers in Special Sessions: June 21, 2005
For abstracts: August 16, 2005

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Persi Diaconis, Stanford University, *Title to be announced* (Erdős Memorial Lecture).

Johnson City, Tennessee

East Tennessee State University

October 15–16, 2005

Saturday–Sunday

Meeting #1010

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: August 2005
Program first available on AMS website: September 1, 2005
Program issue of electronic *Notices*: October 2005
Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: March 15, 2005
For consideration of contributed papers in Special Sessions: June 28, 2005
For abstracts: August 23, 2005

Lincoln, Nebraska

University of Nebraska in Lincoln

October 21–23, 2005

Friday–Sunday

Meeting #1011

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: August 2005
Program first available on AMS website: September 8, 2005
Program issue of electronic *Notices*: October 2005
Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: March 22, 2005
For consideration of contributed papers in Special Sessions: July 5, 2005
For abstracts: August 30, 2005

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Howard Masur, University of Illinois at Chicago, *Title to be announced.*

Alejandro Uribe, University of Michigan, *Title to be announced.*

Judy Walker, University of Nebraska, *Title to be announced.*

Jack Xin, University of Texas, *Title to be announced.*

Special Sessions

Algebraic Geometry (Code: SS 1A), **Brian Harbourne**, University of Nebraska-Lincoln, and **Bangere P. Purnaprajna**, University of Kansas.

Eugene, Oregon

University of Oregon

November 12–13, 2005

Saturday–Sunday

Meeting #1012

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: September 2005

Program first available on AMS website: September 29, 2005
Program issue of electronic *Notices*: November 2005
Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: April 12, 2005
For consideration of contributed papers in Special Sessions: July 26, 2005
For abstracts: September 20, 2005

Taiwan

December 14–18, 2005

Wednesday–Sunday

Meeting #1013

First Joint International Meeting between the AMS and the Taiwanese Mathematical Society.
Associate secretary: John L. Bryant
Announcement issue of *Notices*: May 2005
Program first available on AMS website: N/A
Program issue of electronic *Notices*: N/A
Issue of *Abstracts*: N/A

Deadlines

For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

San Antonio, Texas

Henry B. Gonzalez Convention Center

January 12–15, 2006

Thursday–Sunday
Joint Mathematics Meetings, including the 112th Annual Meeting of the AMS, 89th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: John L. Bryant
Announcement issue of *Notices*: October 2005
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2006
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 12, 2005
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Durham, New Hampshire

University of New Hampshire

April 22–23, 2006

Saturday–Sunday
Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 22, 2005
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

San Francisco, California

San Francisco State University

April 29–30, 2006

Saturday–Sunday
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Fayetteville, Arkansas

University of Arkansas

November 3–4, 2006

Friday–Saturday
Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 3, 2006
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 4–7, 2007

Thursday–Sunday
Joint Mathematics Meetings, including the 113th Annual Meeting of the AMS, 90th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: October 2006
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2007
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 4, 2006
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

San Diego, California

San Diego Convention Center

January 6–9, 2008

Sunday–Wednesday
Joint Mathematics Meetings, including the 114th Annual Meeting of the AMS, 91st Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2007
Program first available on AMS website: November 1, 2007
Program issue of electronic *Notices*: January 2008
Issue of *Abstracts*: Volume 29, Issue 1

Deadlines

For organizers: April 6, 2007
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Washington, District of Columbia

Marriott Wardman Park Hotel and Omni Shoreham Hotel

January 7–10, 2009

Wednesday–Saturday
Joint Mathematics Meetings, including the 115th Annual Meeting of the AMS, 92nd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: October 2008
Program first available on AMS website: November 1, 2008
Program issue of electronic *Notices*: January 2009
Issue of *Abstracts*: Volume 30, Issue 1

Deadlines

For organizers: April 7, 2008
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

San Francisco, California

Moscone Center West and the San Francisco Marriott

January 6–9, 2010

Wednesday–Saturday
Joint Mathematics Meetings, including the 116th Annual Meeting of the AMS, 93rd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: John L. Bryant
Announcement issue of *Notices*: October 2009

MEETINGS AND CONFERENCES

Program first available on AMS website: November 1, 2009
Program issue of electronic *Notices*: January 2010
Issue of *Abstracts*: Volume 31, Issue 1

Deadlines

For organizers: April 5, 2009
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 3–8, 2011

Monday–Saturday
Joint Mathematics Meetings, including the 117th Annual Meeting of the AMS, 94th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: October 2010
Program first available on AMS website: November 1, 2010
Program issue of electronic *Notices*: January 2011
Issue of *Abstracts*: Volume 32, Issue 1

Deadlines

For organizers: April 2, 2010
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Joint Mathematics Meetings

ATLANTA, GEORGIA
January 5–8, 2005

Joint Meetings Advance Registration/Housing Form

Name _____
(please write name as you would like it to appear on your badge)

Mailing Address _____

_____

Telephone _____ Fax: _____

In case of emergency at the meeting, call: Daytime #_____ Evening #: _____

Email Address _____
(Acknowledgment of this registration will be sent to the email address given here, unless you check this box: *Send by U.S. Mail* ☐)

Badge Information: Affiliation for badge _____

Nonmathematician guest badge name _____
(please note charge below)

Membership
✓ all that apply. First column is eligible for member registration fee

AMS	☐	ASA	☐
MAA	☐	AWM	☐
ASL	☐	NAM	☐
CMS	☐	YMN	☐
SIAM	☐		

☐ **I DO NOT want my program and badge to be mailed to me on 12/10/04.**

Registration Fees

Joint Meetings	**by Dec 10**	**at mtg**	**Subtotal**
☐ Member AMS, ASL, CMS, MAA, SIAM	$199	$259	
☐ Nonmember	$308	$401	
☐ Graduate Student	$ 39	$ 49	
☐ Undergraduate Student	$ 21	$ 27	
☐ High School Student	$ 2	$ 5	
☐ Unemployed	$ 39	$ 49	
☐ Temporarily Employed	$158	$181	
☐ Developing Countries Special Rate	$ 39	$ 49	
☐ Emeritus Member of AMS or MAA	$ 39	$ 49	
☐ High School Teacher	$ 39	$ 49	
☐ Librarian	$ 39	$ 49	
☐ Nonmathematician Guest	$ 10	$ 10	
			$ _____

AMS Short Course: *The Radon Transform and Applications to Inverse Problems (1/3–1/4)*

☐ Member of AMS or MAA	$ 85	$115	
☐ Nonmember	$108	$140	
☐ Student, Unemployed, Emeritus	$ 37	$ 55	
			$ _____

MAA Short Course: *Seven Lectures on Random Graphs (1/3–1/4)*

☐ Member of MAA or AMS	$125	$140	
☐ Nonmember	$175	$190	
☐ Student, Unemployed, Emeritus	$ 50	$ 60	
			$ _____

MAA Minicourses (see listing in text)
I would like to attend: ☐ One Minicourse ☐ Two Minicourses
Please enroll me in MAA Minicourse(s) #_____ and/or #_____
In order of preference, my alternatives are: #_____ and/or #_____
Prices: $95 for Minicourses #1–6; $60 for #7–12, #14-16; $70 for #13
$ _____

Employment Center
Applicant résumé forms and employer job listing forms will be on the AMS website and in *Notices* in September and October.

Employer—First Table ☐ Regular ☐ Self-scheduled	$225	$305
Employer— Each Additional Table ☐ Regular ☐ Self-scheduled	$ 75	$105
☐ Employer—Posting Only	$ 50	N/A
☐ Applicant (all services)	$ 42	$ 80
☐ Applicant (Winter List & Message Ctr only)	$ 21	$ 21

$ _____

Events with Tickets
MER Banquet (1/6) $45 #____Regular #____Veg #____Kosher
NAM Banquet (1/7) $48 #____Regular #____Veg #____Kosher
AMS Banquet (1/8) $44 #____Regular #____Veg #____Kosher
$ _____

Other Events
☐ Graduate Student Reception (1/5) (no charge)
☐ AMS Workshop *TA Development Using Case Studies* $ 20 $ _____

Total for Registrations and Events $ _____

Registration for the Joint Meetings is not required for the Short Courses, but it is required for the Minicourses and the Employment Center

Payment

Registration & Event Total (total from column on left) $ _____

Hotel Deposit (only if paying by check) $ _____

Total Amount To Be Paid **$** _____

(Note: A $5 processing fee will be charged for each returned check or invalid credit card. Debit cards are not accepted.)

Method of Payment
☐ Check. Make checks payable to the AMS. Checks drawn on foreign banks must be in equivalent foreign currency at current exchange rates.
☐ Credit Card. VISA, MasterCard, AMEX, Discover (no others accepted)

Card number: _____

Exp. date: _____ Zipcode of credit card billing address: _____

Signature: _____

Name on card: _____

☐ Purchase order #_____ (please enclose copy)

Other Information

Mathematical Reviews field of interest # _____

How did you hear about this meeting? Check one: ☐ Colleague(s) ☐ *Notices* ☐ *Focus* ☐ Internet

☐ This is my first Joint Mathematics Meeting.
☐ I am a mathematics department chair.
☐ For planning purposes for the MAA Two-year College Reception, please check if you are a faculty member at a two-year college.
☐ **Please do not include my name on any promotional mailing list.**
☐ Please ✓ this box if you have a disability requiring special services.

Mail to:

Mathematics Meetings Service Bureau (MMSB)
P. O. Box 6887
Providence, RI 02940-6887 Fax: 401-455-4004
Questions/changes call: 401-455-4143 or 1-800-321-4267 x4143; mmsb@ams.org

Deadlines *Please register by the following dates for:*

Résumés/job descriptions printed in the *Winter Lists*	**Oct. 25, 2004**
To be eligible for the room lottery:	**Oct. 29, 2004**
For housing reservations, badges/programs mailed:	**Nov. 5, 2004**
For housing changes/cancellations through MMSB:	**Dec. 3, 2004**
For advance registration for the Joint Meetings, Employment Center, Short Courses, MAA Minicourses, & Tickets:	**Dec. 10, 2004**
For 50% refund on banquets, cancel by:	**Dec. 27, 2004***
For 50% refund on advance registration, Minicourses & Short Courses, cancel by:	**Dec. 31, 2004***

***no refunds after this date**

Atlanta Joint Meetings Hotel Reservations

To ensure accurate assignments, please rank hotels in order of preference by writing 1, 2, 3, etc., in the column on the left and by circling the requested room type and rate. If the rate or the hotel requested is no longer available, you will be assigned a room at a ranked or unranked hotel at a comparable rate. Participants are urged to call the hotels directly for details on suite configurations, sizes, and availability; however, suite reservations can be made only through the MMSB to receive the convention rates listed. Reservations at the following hotels must be made through the MMSB to receive the convention rates listed. Reservations made directly with the hotels may be changed to a higher rate. All rates are subject to a 14% sales tax.

Guarantee requirements: First night deposit by check (add to payment on reverse of form) or a credit card guarantee.

☐ Deposit enclosed (see front of form) ☐ Hold with my credit card Card Number _____ Exp. Date _____

Signature _____

Date and Time of Arrival _____ **Date and Time of Departure** _____

Name of Other Room Occupant _____ **Arrival Date** _____ **Departure Date** _____ **Child (give age(s)** _____

Name of Other Room Occupant _____ **Arrival Date** _____ **Departure Date** _____ **Child (give age(s)** _____

Order of choice	Hotel	Single	Double 1 bed	Double 2 beds	Triple 2 beds	Triple 2 beds w/cot	Triple King w/cot	Quad 2 beds	Quad 2 beds w/cot	Suites Starting rates
	Hyatt Regency Atlanta (co-hqtrs) - Regular Rooms	$144	$144	$144	$164	N/A	$164	$174	N/A	$550
	Club Level	$179	$179	$179	$199	N/A	$199	N/A	N/A	N/A
	Student	$116	$116	$116	$126	N/A	$126	$136	N/A	N/A
	Atlanta Marriott Marquis (co-hqtrs) - Regular Rooms	$144	$144	$144	$164	N/A	$164	$184	N/A	$255
	Concierge Level	$184	$184	$184	$204	N/A	$204	N/A	N/A	N/A
	Student	$116	$116	$116	$136	N/A	$136	$156	N/A	N/A
	AmeriSuites	$99	$99	$99	$109 (Double/double or King with sleeper)	N/A	N/A	$119	N/A	(all suites)
	Holiday Inn Atlanta Downtown	$99	$99	$99	$99	N/A	$109 (queen w/cot)	$99	N/A	N/A
	Days Inn Atlanta Downtown	$99	$99	$99	$109	$119	$119	$119	$129	N/A
	Best Western Inn at the Peachtree	$89	$89	$89	$99	$109	$109	$109	$119	N/A

Special Housing Requests:.

☐ I have disabilities as defined by the ADA that require a sleeping room that is accessible to the physically challenged. My needs are: _____

☐ Other requests: _____

☐ I am a member of a hotel frequent-travel club and would like to receive appropriate credit. The hotel chain and card number are: _____

If you are not making a reservation, please check off one of the following:

☐ I plan to make a reservation at a later date.

☐ I will be making my own reservations at a hotel not listed. Name of hotel: _____

☐ I live in the area or will be staying privately with family or friends.

☐ I plan to share a room with _____, who is making the reservations.

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Sproul Hall, Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 909-787-3113.

Central Section: Susan J. Friedlander, Department of Mathematics, University of Illinois at Chicago, 851 S. Morgan (M/C 249), Chicago, IL 60607-7045; e-mail: susan@math.nwu.edu; telephone: 312-996-3041.

Eastern Section: Lesley M. Sibner, Department of Mathematics, Polytechnic University, Brooklyn, NY 11201-2990; e-mail: lsibner@duke.poly.edu; telephone: 718-260-3505.

Southeastern Section: John L. Bryant, Department of Mathematics, Florida State University, Tallahassee, FL 32306-4510; e-mail: bryant@math.fsu.edu; telephone: 850-644-5805.

The Meetings and Conferences section of the *Notices* gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. **Information in this issue may be dated. Up-to-date meeting and conference information can be found at** www.ams.org/meetings/.

Meetings:

Important Information regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 84 in the January 2004 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts

Several options are available for speakers submitting abstracts, including an easy-to-use interactive Web form. No knowledge of LaTeX is necessary to submit an electronic form, although those who use LaTeX may submit abstracts with such coding, and all math displays and similarily coded material (such as accent marks in text) must be typeset in LaTeX. To see descriptions of the forms available, visit http://www.ams.org/abstracts/instructions.html, or send mail to abs-submit@ams.org, typing help as the subject line; descriptions and instructions on how to get the template of your choice will be e-mailed to you.

Completed email abstracts should be sent to abs-submit@ams.org, typing submission as the subject line. Questions about abstracts may be sent to abs-info@ams.org.

Paper abstract forms may be sent to Meetings & Conferences Department, AMS, P.O. Box 6887, Providence, RI 02940. There is a $20 processing fee for each paper abstract. There is no charge for electronic abstracts. Note that all abstract deadlines are strictly enforced.

Conferences: (see http://www.ams.org/meetings/ for the most up-to-date information on these conferences.)

June 5–July 21, 2005: Joint Summer Research Conferences in the Mathematical Sciences, Snowbird, Utah (see November 2004 Notices, page 1294)

Co-sponsored conference: June 2006: Fifth Conference on Poisson Geometry, Tokyo, Japan (watch http://tmugs.math.metro-u.ac.jp/general.html for future information).

IMA INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

Membership opportunities

in connection with the 2005-2006 thematic program on

IMAGING

IMA POSTDOCTORAL FELLOWSHIPS provide an excellent opportunity for mathematical scientists near the beginning of their career who have a background or an interest in imaging science and its mathematical underpinnings. IMA postdoctoral fellowships run one to two years, at the option of the holder, starting September 1, 2005.

IMA INDUSTRIAL POSTDOCTORAL FELLOWSHIPS are designed to prepare mathematicians for research careers in industry or involving industrial interaction. IMA industrial postdoctoral fellowships run two years starting September 1, 2005. Postdocs devote 50% effort to their own research and the IMA program and 50% effort working with industrial scientists.

IMA GENERAL MEMBERSHIPS provide an opportunity for mathematicians and scientists employed elsewhere to spend one month to one year in residence at the IMA, to participate in the 2005-2006 thematic program. Residency should fall in the period June 2005 through August 2006. Logistic support such as office space, computer facilities, and secretarial support will be provided, and local expenses may be provided.

IMA NEW DIRECTIONS VISITING PROFESSORSHIPS provide an extraordinary opportunity for established mathematicians to branch into new directions and increase the impact of their research by spending a year immersed in the 2005-2006 thematic program at the IMA. Visiting Professors will enjoy an excellent research environment and stimulating scientific program with broad mathematical connections including harmonic analysis, partial differential equations, and integral geometry, calculus of variations, probability theory, statistics, and learning theory. New Directions Visiting Professors are expected to be resident and active participants in the program but are not assigned formal duties.

For more information and application materials see
www.ima.umn.edu/docs/membership.html or phone 612-624-6066.

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www.ima.umn.edu

UNIVERSITY OF MINNESOTA

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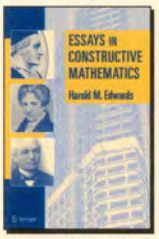
Index of Advertisers

NEW AND NOTEWORTHY

ESSAYS IN CONSTRUCTIVE MATHEMATICS

HAROLD M. EDWARDS, New York University, New York, NY



"The exposition is not only clear, it is friendly, philosophical, and considerate even to the most naive or inexperienced reader. And it proves that the philosophical orientation of an author really can make a big difference. The mathematical content is intensely classical....Edwards makes it warmly accessible to any interested reader. And he is breaking fresh ground, in his rigorously constructive or constructivist presentation. So the book will interest anyone trying to learn these major, central topics in classical algebra and algebraic number theory. Also, anyone interested in constructivism, for or against. And even anyone who can be intrigued and drawn in by a masterly exposition of beautiful mathematics."

—REUBEN HERSH

2005/APPROX. 180 PP./HARDCOVER/$69.95
ISBN 0-387-21978-1

ELEMENTS OF APPLIED BIFURCATION THEORY

THIRD EDITION

YURI A. KUZNETSOV, Rijskuniversiteit Utrecht, The Netherlands

From a review of the first edition:

"I know of no other book that so clearly explains the basic phenomena of bifurcation theory." —MATHEMATICAL REVIEWS

This book provides a student or researcher with a solid basis in nonlinear dynamical systems and their bifurcations, giving them the necessary understanding of the approaches, methods, results and terminology used in the modern applied mathematics literature. It covers the basic topics of the bifurcation theory and can help in composing a course on nonlinear dynamical systems or system theory. This new edition preserves the structure of the previous edition, while updating the context to incorporate recent theoretical and software developments, in particular new and improved numerical methods for bifurcation analysis.

2004/631 PP., 251 ILLUS./HARDCOVER/$89.95
ISBN 0-387-21906-4
APPLIED MATHEMATICAL SCIENCES, VOL. 112

SPACES OF HOLOMORPHIC FUNCTIONS IN THE UNIT BALL

KEHE ZHU, State University of New York at Albany, NY

The book presents a modern theory of holomorphic function spaces in the open unit ball. Spaces discussed include the Bergman spaces, the Hardy spaces, the Bloch space, BMOA, the Dirichlet space, the Besov spaces, and the Lipschitz spaces. Most proofs in the book are new and simpler than the existing proofs in the literature. The central idea in almost all these proofs is based on integral representations of holomorphic functions and elementary properties of the Bergman kernel, the Bergman metric, and the automorphism group.

2004/APPROX. 268 PP./HARDCOVER/$69.95
ISBN 0-387-22036-4
GRADUATE TEXTS IN MATHEMATICS, VOL. 226

TAUBERIAN THEORY

A Century of Developments

JACOB KOREVAAR, University of Amsterdam, The Netherlands

Tauberian theory compares summability methods for series and integrals, helps to decide when there is convergence, and provides asymptotic and remainder estimates. The author shows the development of the theory from the beginning and his expert commentary evokes the excitement surrounding the early results. He shows the fascination of the difficult Hardy-Littlewood theorems and of an unexpected simple proof, and extolls Wiener's breakthrough based on Fourier theory. There are the spectacular "high-indices" theorems and Karamata's "regular variation," which permeates probability theory. The author presents Gelfand's elegant algebraic treatment of Wiener theory and his own distributional approach. There is also a new unified theory for Borel and "circle" methods. The text describes many Tauberian ways to the prime number theorem. A large bibliography and a substantial index round out the book.

2004/483 PP./HARDCOVER/$109.00
ISBN 3-540-21058-X
GRUNDLEHREN DER MATHEMATISCHEN WISSENSCHAFTEN, VOL. 329

UNDERGRADUATE ALGEBRA

THIRD EDITION

SERGE LANG, Yale University, New Haven, CT

From a review of the first edition:

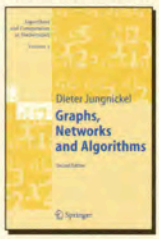
"The exposition is down-to-earth and at the same time very smooth. The book can be covered easily in a one-year course and can be also used in a one-term course...the flavor of modern mathematics is sprinkled here and there." —ZENTRALBLATT

2004/APPROX. 408 PP./HARDCOVER/$69.95
ISBN 0-387-22025-9
UNDERGRADUATE TEXTS IN MATHEMATICS

GRAPHS, NETWORKS AND ALGORITHMS

SECOND EDITION

DIETER JUNGNICKEL, University of Augsburg, Germany



From a review of the first edition:

"The book is a first class textbook and seems to be indispensable for everybody who has to teach combinatorial optimization. It is very helpful for students, teachers, and researchers in this area. The author finds a striking synthesis of nice and interesting mathematical results and practical applications."

—MATHEMATICAL REVIEWS

2004/APPROX. 611 PP., 200 ILLUS./HARDCOVER/$79.95
ISBN 3-540-21905-6
ALGORITHMS AND COMPUTATION IN MATHEMATICS, VOL. 5

DISCRETE-TIME MARKOV CHAINS

Two-time-scale Methods and Applications

GEORGE YIN, Wayne State University, Detroit, MI; and **QING ZHANG,** University of Georgia, Athens, GA

Focusing on discrete-time-scale Markov chains, the contents of this book are an outgrowth of some of the authors' recent research. The motivation stems from existing and emerging applications in optimization and control of complex hybrid Markovian systems in manufacturing, wireless communication, and financial engineering. Much effort in this book is devoted to designing system models arising from these applications, analyzing them via analytic and probabilistic techniques, and developing feasible computational algorithms so as to reduce the inherent complexity.

2005/APPROX. 348 PP./HARDCOVER/$79.95
ISBN 0-387-21948-X
APPLICATIONS OF MATHEMATICS, VOL. 55

A FIELD GUIDE TO ALGEBRA

ANTOINE CHAMBERT-LOIR, Ecole Polytechnique, Palaiseau, France

This unique text focuses on the structure of fields and is intended for a second course in abstract algebra. Besides providing proofs of the transcendance of pi and e, the book includes material on differential Galois groups and a proof of Hilbert's irreducibility theorem. In explaining these concepts, the author also provides comments on their historical development and leads the reader along many interesting paths.

2004/APPROX. 200 PP., 13 ILLUS./HARDCOVER/$49.95
ISBN 0-387-21428-3
UNDERGRADUATE TEXTS IN MATHEMATICS