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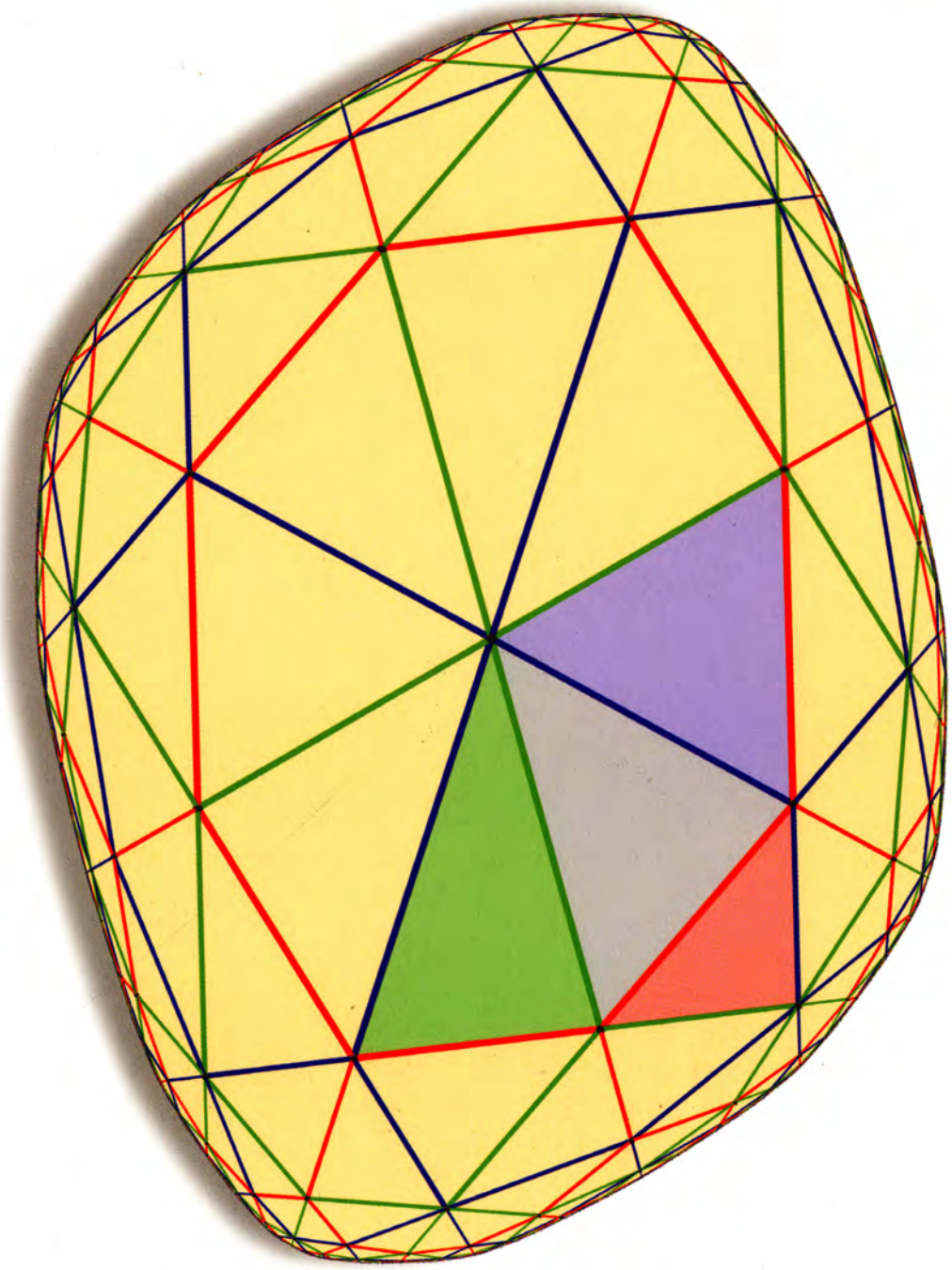

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- A Ring Version of Mazur's Conjecture on Topology of Rational Points, *A. Shlapentokh*
- Approximation and Convergence of Formal CR-Mappings, *F. Meylan, N. Mir, and D. Zaitsev*
- Asymptotic Analysis of (Partially) Orthogonal Polynomials Associated with Root Systems, *J. F. van Diejen*
- Birational Unboundedness of $\mathbb{Q}$-Fano Threefolds, *J. Lin*
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of the American Mathematical Society
November 2002

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Commentary

Notices

of the American Mathematical Society

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Departments

From the AMS Secretary

Whither VIGRE?

The article "VIGRE turns three" in this issue of the *Notices* raises two important questions on which I would like to comment.

1. Should program officers at the National Science Foundation (NSF) seek to influence how mathematics departments train their graduate students and mentor their postdocs? My answer to this question is "Yes, please do." In the Cornell mathematics department many issues are settled by a curious variant of mathematical induction: "We've done things (e.g., graduate education) like this for thirty years, so why change?" The mandatory curriculum review associated with our VIGRE grant brought about a thorough restructuring of course offerings in the general area of analysis, where for decades new courses had been added and old ones atrophied without any attention to the overall structure.

Two other positive influences of the VIGRE program that are well documented in the accompanying article are the broadening of mathematics education at all levels and the requirement of mentoring of postdocs. A fourth mandate of the VIGRE program that has created a considerable amount of unhappiness is its insistence that all recipients of funds must be U.S. citizens, nationals, or permanent residents. At the graduate level this means that fellowship offers are made to domestic students who rank well below some foreign students who only get offers of teaching assistantships. At the postdoc level, after one subtracts about thirty NSF postdoc recipients from the domestic applicant pool, the discrepancy in the quality of applicants is even more pronounced.

An old cartoon says: "Gravity: It's not only the law, but it's also a good idea." I think that the same quote applies to the NSF policy. As several committee reports have concluded, the United States must cultivate its own mathematical talent to retain its leading stature in mathematical research. An important first step in repairing the pipeline is a good job market for mathematics Ph.D.'s, which in turn will encourage more students to go to graduate school.

2. Is it a failure of the VIGRE program that some of the most prestigious mathematics departments do not have grants? Benedict Gross's remarks at the recent VIGRE meeting made it clear his answer was "Yes." Using a fishing metaphor that I cannot remember exactly, he said in effect that the VIGRE program should invest its money where the best students are. Another vote for "Yes" comes from Calvin Moore, who in the full-length version of his report (excerpts of which appear in the accompanying article) says, "Mathematics departments in institutions such as UC Berkeley, MIT, and Stanford will continue to flourish with or without VIGRE grants, but it is evident that NSF through its decisions on VIGRE grants will end up picking and choosing winners from among departments that are less well-established and without access to other resources."

In support of "No" one can argue that (i) there will be a greater effect on the pipeline by awarding VIGRE grants to departments that have seen their graduate programs and research support reduced in the last ten to twenty years as a result of increasing competition for a dwindling supply of students and federal funds, and (ii) distinguished departments that have strong support from alumni and other private sources may have chosen to free themselves from NSF interference by opting out of the VIGRE program.

My recommendations. I agree with Calvin Moore when he says, "One immediate step that should be taken by NSF is to conduct a thorough review of the VIGRE program. This review should engage the mathematical sciences community, should address questions about the proper role of NSF, issues of flexibility within general program goals, the balance of support for graduate students and postdoctoral fellows between VIGRE and other programs, and, most important, should address the mechanisms and process for review and evaluation of VIGRE projects."

The first meeting of VIGRE directors that I attended at NSF in the fall of 2000 was useful because we were able not only to hear about what had been successful in other programs, but also to discuss issues and concerns with NSF program officers. The last two VIGRE meetings held in the spring of 2001 and 2002 have been gatherings with 100-plus participants and a one-way flow of information, primarily aimed at educating potential recipients of VIGRE grants about what makes for a successful proposal.

Given the current situation, in which many VIGRE grant holders are anxiously trying to guess the future evolution of the program and many in academia are unhappy about the decisions and policies of the VIGRE program, there is a pressing need for a much smaller meeting with a two-way exchange of information. Participants should include representatives from schools that have VIGRE grants, as well as from schools that have lost their grants or have never received one. However, the meeting should be kept small enough to allow for discussion in small groups.

The VIGRE program is an important part of the portfolio of the Division of Mathematical Sciences. If it fails, then the consequences for the funding of mathematics will be drastic. However, in order for the VIGRE program to succeed, there must be a dialogue between the NSF program officers and those of us in the trenches, who must implement the overall ideas of the program in ways that are appropriate for our own departments.

—Rick Durrett
Cornell University
Associate Editor, the Notices

Letters to the Editor

A Boycott by Passport

A number of our colleagues are participating in demands organized by groups of European scholars who, in light of the Middle East conflict, would bar all Israeli nationals from academic conferences, publication in scholarly journals, and participation on editorial boards. One boycott effort gathering signatures on the Web asks readers to sign on to the following statement that will hurt mostly our junior colleagues: "I will attend no scientific conferences in Israel, and I will not participate as referee in hiring or promotion decisions by Israeli universities, or in the decisions of Israeli funding agencies. I will continue to collaborate with, and host, Israeli scientific colleagues on an individual basis."

Although this appears to be directed against institutions, in practice (as illustrated below) it is an attack on individual scholars and their academic freedom. Some who at first agreed to participate in this boycott have since asked to have their names removed from the petition. However, this takes place after the damage has been done. The "unsigning" always is less newsworthy than the "signing".

As mathematicians devoted to the advancement of knowledge, we condemn all actions that deny academic freedom to individuals solely on the basis of their nationality. So far, we have not seen any actions taken against mathematicians as a result of the above call. However there have been incidents in other fields.

On June 18, 2002, the *Chronicle of Higher Education* reported that two distinguished Israeli scholars have been dismissed from the boards of two academic journals published in Great Britain. A senior lecturer in translation studies at Bar-Ilan University was dismissed from the editorial board of *The Translator*, and a professor at Tel Aviv University's School of Cultural Studies was dismissed from the international advisory board of *Translation Studies Abstracts*. These actions are reported to have been taken in response to demands of some European scholars who would essentially bar all serious contact with Israeli nationals. No suggestion was made in either case that the dismissed board member had written, said, or done anything that this group deemed improper or that indeed was even relevant to the political issue involved. Had such a suggestion been made, our concern would be not less but different. At issue would be the bounds of civil discourse, the right to express opinions, and the place of politics in academic life—difficult issues all. But what was done in the present instance is far simpler: Two individuals were dismissed for no other reason than their nationality or citizenship. We find it particularly ironic that two journals dedicated to translation should have compromised the very openness that facilitates the building of bridges, carrying understanding from one side of a divide to the other.

Such a boycott by passport is deplorable and against the spirit of free academic inquiry and scholarship.

We applaud the editors of the *Journal of the American Psychoanalytic Association* who have protested this boycott and their colleagues at other journals in that field who will publish editorials against it. We also salute others in the academic world who have raised their voices against this attack on the very nature of the free marketplace of ideas.

We request that the *Notices of the American Mathematical Society* publish this letter and that the Council of the American Mathematical Society pass a resolution opposing nationality based boycotts.

—Irwin Kra
SUNY at Stony Brook

(Received July 11, 2002)

Editor's Note: The above letter has been endorsed by dozens of mathematicians, whose names are listed on the Web at `http://www.math.sunysb.edu/~irwin/boycott.pdf`, and the plural pronouns in the letter reflect this fact. Consideration of the issue is on the agenda for the January 2003 meeting of the Council.

—Harold P. Boas

Responses to Kra

I join the signatories of Irwin Kra's letter, "A Boycott by Passport," in condemning academic boycotts. However, the letter does not go far enough. Kra points out that the two Israeli scholars who were dismissed from the editorial board of British journals in translation studies were singled out purely on the basis of their nationality and leaves open the question of what action might have been acceptable if "either...dismissed board member had written, said, or done anything that [the supporters of the boycott] deemed improper or that...was...relevant to the political issue involved."

An academic boycott based on political views would be every bit as objectionable as one based on nationality. Both violate the principle of the universality of science, embodied in the statutes of the International Council for Science (ICSU), which are adhered to by the AMS as a member of the International Mathematical Union. This principle, as enunciated in ICSU's Statement on Freedom in the Conduct of Science, "affirms the right and freedom of scientists to associate in international scientific activity without regard to such factors as citizenship, religion, creed, political stance, ethnic origin, race, colour, language, age or sex," rights which "are embodied in a variety of articles in the International Bill of Human Rights...."

The issue is not merely theoretical. According to the Ha'aretz daily, although the president of the European Society for Translation Studies, Yves Gambier, condemned the dismissal of the two Israeli editors, his objections to their dismissal were based entirely on his approval of their left-wing political affiliations. It is as if he were proposing a political litmus test for inclusion of Israelis in academic life. Given the current climate in Europe, there is a real danger that this kind of academic McCarthyism could take root.

If science and scholarship normally flourish unimpeded by the great differences in political views among researchers and scholars, it is precisely because people keep their political views separate from their professional judgments.

—Peter B. Shalen
University of Illinois at Chicago

(Received July 30, 2002)

The recent intensification of the conflict in the Mideast has led to a wide range of responses, from many different political perspectives and from all over the world. This is a flashpoint not only in global and American politics, but also in the coffee rooms of American academia. In this situation it is wise for each of us to respect the political judgment of others, and not to lump together widely varying groups whose positions are opposed to our own.

The letter from Irwin Kra falls into this error.

The letter begins with an assertion that unnamed individuals are organizing boycotts which "would bar all Israeli nationals from academic conferences, publication in scholarly journals, and participation on editorial boards." I don't know of any such boycott calls. The only petition identifiably discussed by Kra can be found at `http://www.pjpo.org/`. This commitment has been signed by a large number of academics, including many distinguished mathematicians, mainly in France and Britain. Its principal clauses are quoted in Kra's letter, and have very little to do with the measures described in the opening.

Rather than address the actual terms of this petition, Kra goes on to describe the case of a British professor of translation who dropped two Israelis from the editorial boards of two journals she heads. This action in fact appears to violate the letter and the spirit of the PJPO petition. Citizenship certainly has nothing to do with the the PJPO undertakings.

Tarring all signers with this brush seems unfair, and "A boycott by passport" inaccurate and needlessly provocative. Broadsides open us to the very charges of attacks on freedom that Kra levels at the PJPO petition. Let's avoid them.

Haynes Miller
Massachusetts Institute of Technology
(Received August 11, 2002)

Unemployed Mathematicians

I found the 2001 Annual Survey in the August 2002 issue very interesting and quite disturbing. As pointed out, yes—the results are skewed...if anything the unemployment rate is much higher than what is depicted in the article. For new mathematicians looking for work, the AMS picture is too optimistic and the field is losing a number of very talented individuals. Yes, there are a number of individuals who did not respond to the survey—because you do not even know we exist and we are all unemployed.

Case in point—I received my Ph.D. from a very distinguished university in England in applied mathematics. I have very impressive academic credentials and a few years of international industrial experience as a PM and academic. Not only am I a Fulbright Scholar, but I have also worked for the U.S. Congress, EU Government, and universities throughout Europe.

In returning to the U.S., I have sent out over 1,000 CV's to academic and industrial organizations and to date I have received only five positive responses. The reason the five institutions were interested in me—they thought my Ph.D. was in economics and that I was a banker. The overwhelming majority of responses have not given me a chance because of my Ph.D.—I am either too overqualified or too experienced! I am not alone on this issue, nor am I an outlier...trust me.

What I find most interesting is that if there are 150-300 applicants for every position advertised—then how can the unemployment rate be only 3.7 percent? Maybe the survey is primarily contacting people who are being employed and have not already fallen out of the mathematical framework.

So to make a long story short, having a Ph.D. in mathematics has only hurt my career and my professional prospects. Currently I am serving wine for a living with no benefits and no health insurance. Due to my education in mathematics, I cannot even get a job at a bank being a teller or bag groceries for forty hours per week because HR managers feel that I am overqualified.

So maybe I should return to school and study something useful that will help me get a job. Oh, did I mention that is impossible? The lending institutions tell me I already have a Ph.D., so they will not help me fund another one. To add insult to injury, academic departments refuse to accept people who already have their Ph.D.'s into new programs. Why don't I just do a postdoc since that is what comes next? Well, it appears that the departments are taking care of their own and hiring their people—if I am wrong, then please tell me why 350 applications have been returned with "Thanks but no thanks; we have found an internal person to fill the position."

If one more person tells me how lucky I am to have such an impressive record and amazing academic history...I am going to scream. I would love to stay in this field, but how can I and continue to eat? I had to move in with my grandmother...my extraordinary mathematical skills and computer programming ability can't even help me pay the rent.

Interesting article; shame it is so off the mark and out of touch with reality.

—R. Pefferly Ph.D.
(Pummelled + Humiliated + Depressed)

(Received July 19, 2002)

It's As Easy As *abc*

Andrew Granville and Thomas J. Tucker

Fermat's Last Theorem

In this age in which mathematicians are supposed to bring their research into the classroom, even at the most elementary level, it is rare that we can turn the tables and use our elementary teaching to help in our research. However, in giving a proof of Fermat's Last Theorem, it turns out that we can use tools from calculus and linear algebra only. This may strike some readers as unlikely, but bear with us for a few moments as we give our proof.

Fermat claimed that there are no solutions to

$$x^p + y^p = z^p \tag{1}$$

for $p \geq 3$, with x, y, and z all nonzero. If we assume that there are solutions to (1), then we can assume that x, y, and z have no common factor, else we can divide out by that factor. Our first step will be to differentiate (1) to get

$$px^{p-1}x' + py^{p-1}y' = pz^{p-1}z',$$

and after dividing out the common factor p, this leaves us with

$$x^{p-1}x' + y^{p-1}y' = z^{p-1}z'. \tag{2}$$

We now have two linear equations (1) and (2) (thinking of x^{p-1}, y^{p-1}, and z^{p-1} as our variables), which suggests using linear algebra to eliminate a variable: Multiply (1) by y' and (2) by y, and subtract to get

$$x^{p-1}(xy' - yx') = z^{p-1}(zy' - yz').$$

Therefore x^{p-1} divides $z^{p-1}(zy' - yz')$, but since x and z have no common factors, this implies that

$$x^{p-1} \text{ divides } zy' - yz'. \tag{3}$$

This is a little surprising, for if $zy' - yz'$ is nonzero, then a high power of x divides $zy' - yz'$, something that does not seem consistent with (1).

We want to be a little more precise. Since we differentiated, we evidently never were working with integers x, y, z, but rather with polynomials. Thus if $zy' - yz' = 0$, then $(y/z)' = 0$, and so y is a constant multiple of z, contradicting our statement that y and z have no common factor. Therefore (3) implies that

$$\begin{aligned}(p-1)\ \text{degree}(x) &\leq \text{degree}(zy' - yz') \\ &\leq \text{degree}(y) + \text{degree}(z) - 1,\end{aligned}$$

since $\text{degree}(y') = \text{degree}(y) - 1$ and $\text{degree}(z') = \text{degree}(z) - 1$. Adding $\text{degree}(x)$ to both sides gives

$$p\ \text{degree}(x) < \text{degree}(x) + \text{degree}(y) + \text{degree}(z). \tag{4}$$

The right side of (4) is symmetric in x, y, and z. The left side is a function of x simply because of the order in which we chose to do things above. We could just as easily have derived the same

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This article is based on the first named author's AMS-MAA invited lecture at the Orlando annual meeting in January 1996. It was prepared when both authors worked at the University of Georgia. The work of both authors is supported by the NSF.

statement with y or z in place of x on the left side of (4), so that

$$p \text{ degree}(y) < \text{ degree}(x) + \text{ degree}(y) + \text{ degree}(z)$$

and

$$p \text{ degree}(z) < \text{ degree}(x) + \text{ degree}(y) + \text{ degree}(z).$$

Adding these last three equations together and then dividing out by degree(x) + degree(y) + degree(z) implies

$$p < 3,$$

and so Fermat's Last Theorem is proved!

Well, not quite, but what we have proved (and so simply) is still of great interest:

Proposition 1. There are no genuine polynomial solutions $x(t), y(t), z(t) \in \mathbb{C}[t]$ to $x(t)^p + y(t)^p = z(t)^p$ with $p \geq 3$. By "genuine" we mean that the triple $(x(t), y(t), z(t))$ is not a polynomial multiple of a solution of (1) in $\mathbb{C}$.

That Fermat's Last Theorem is easy to prove for polynomials is an old result, going back certainly as far as Liouville (1851), although his proof, which goes through integration, is much more involved than that given here. The proof we have presented above is certainly some years old; for instance, a variant can be found in standard textbooks of fifty years ago. After reading through it, one sees that this argument is easily generalizable to other Diophantine problems, though it is not obvious what would be the ultimate generalization.

Mason's Generalization

It takes a certain genius to generalize to something far simpler than the original. But what could possibly be more simply stated, yet more general, than Fermat's Last Theorem? It was Richard C. Mason (1983) who gave us that insight:

Look for solutions to

$$a + b = c. \tag{5}$$

We will just follow through the proof above and see where it leads: Start by assuming, with no loss of generality, that a, b, and c are all nonzero polynomials without common factors (else all three share the common factor and we can divide it out). Then we differentiate to get

$$a' + b' = c'.$$

Next we need to do linear algebra. It is not quite so obvious how to proceed analogously, but what we do learn in a linear algebra course is to put our coefficients in a matrix, and solutions follow if the determinant is nonzero. This suggests defining

$$\Delta(t) := \begin{vmatrix} a(t) & b(t) \\ a'(t) & b'(t) \end{vmatrix},$$

Then if we add the first column to the second, we get

$$\Delta(t) = \begin{vmatrix} a(t) & c(t) \\ a'(t) & c'(t) \end{vmatrix},$$

and similarly

$$\Delta(t) = \begin{vmatrix} c(t) & b(t) \\ c'(t) & b'(t) \end{vmatrix}$$

by adding the second column to the first, a beautiful symmetry.

We note that $\Delta(t) \neq 0$, else $ab' - a'b = 0$, so b is a scalar multiple of a (with the same argument as above), contradicting the hypothesis.

To find the appropriate analogy to (3), we interpret that as stating that the factors of x (as well as of y and z) divide our determinant to a high power. So now suppose that α is a root of $a(t)$ and that $(t - \alpha)^e$ is the highest power of $(t - \alpha)$ which divides $a(t)$. Evidently $(t - \alpha)^{e-1}$ is the highest power of $(t - \alpha)$ which divides $a'(t)$, and thus it is the highest power of $(t - \alpha)$ which divides $\Delta(t) = a(t)b'(t) - a'(t)b(t)$ (since α is not a root of $b(t)$). Therefore $(t - \alpha)^e$ divides $\Delta(t)(t - \alpha)$. Multiplying all such $(t - \alpha)^e$ together, we obtain

$$a(t) \text{ divides } \Delta(t) \prod_{a(\alpha)=0} (t - \alpha).$$

In fact, $a(t)$ appears on the left side of this equation only because we studied the linear factors of a; analogous statements for $b(t)$ and $c(t)$ are also true, and since $a(t), b(t), c(t)$ have no common roots, we can combine those statements to read

$$a(t)b(t)c(t) \text{ divides } \Delta(t) \prod_{(abc)(\alpha)=0} (t - \alpha). \tag{6}$$

The next step is to take the degrees of both sides and see what that gives. Using the three different representations of Δ above, we have

$$\text{degree}(\Delta) \leq \begin{cases} \text{degree}(a) + \text{ degree}(b) - 1, \\ \text{degree}(a) + \text{ degree}(c) - 1, \\ \text{degree}(c) + \text{ degree}(b) - 1. \end{cases}$$

The degree of $\prod_{(abc)(\alpha)=0}(t - \alpha)$ is precisely the total number of distinct roots of $a(t)b(t)c(t)$. Inserting all this into (6) we find that

$$\max\{\text{degree}(a), \text{ degree}(b), \text{ degree}(c)\} < \#\{\alpha \in \mathbb{C} : (abc)(\alpha) = 0\}.$$

Put another way, this result can be read as:

Proposition 2. If $a(t), b(t), c(t) \in \mathbb{C}[t]$ do not have any common roots and provide a genuine polynomial solution to $a(t) + b(t) = c(t)$, then the maximum

of the degrees of $a(t), b(t), c(t)$ is less than the number of distinct roots of $a(t)b(t)c(t) = 0$.

This is a "best possible" result in the sense that we can find infinitely many examples where there is exactly one more zero of $a(t)b(t)c(t) = 0$ than the largest of the degrees: for example, the familiar identity

$$(2t)^2 + (t^2 - 1)^2 = (t^2 + 1)^2$$

or the rather less interesting

$$t^n + 1 = (t^n + 1).$$

Classifying such polynomial identities leads us naturally to the study of a special class of rational functions, as we shall see next.

Silverman's Proof

Silverman provided a more sophisticated route to Proposition 2, via the theory of covering maps, an approach that will turn out to be very useful. Consider rational functions

$$\pi : \mathbb{C} \cup \{\infty\} \to \mathbb{C} \cup \{\infty\};$$

that is, $\pi(t) = f(t)/g(t)$ for some polynomials f and g. The Riemann-Hurwitz formula is a key result about rational maps; in this case it tells us that

$$2\ \text{degree}(\pi) = 2 + \sum_{z \in \mathbb{C} \cup \{\infty\}} \left\{ \text{degree}(\pi) - \#\pi^{-1}(z) \right\}. \tag{7}$$

Here $\text{degree}(\pi) = \max\{\text{degree}(f), \text{degree}(g)\}$, and $\pi^{-1}(z)$ is the set of $x \in \mathbb{C} \cup \{\infty\}$ for which $\pi(x) = z$. This is the set of roots of $f(x) - zg(x) = 0$, and so there are at most $\text{degree}(\pi)$ elements of $\pi^{-1}(z)$, and usually exactly that number. If not, then $f(x) - zg(x) = 0$ must have a double root, so that $f'(x) - zg'(x) = 0$.

From a solution to (5) we set $\pi(t) := a(t)/c(t)$. Since every term on the right side of (7) is nonnegative, we get a lower bound if we consider just the sum over a subset of $\mathbb{C} \cup \{\infty\}$. We select our subset to be $\{0, 1, \infty\}$. Note that if $\pi(\infty) \neq 0$, then $\pi(t) = 0$ if and only if $a(t) = 0$, so $\pi^{-1}(0)$ is the set of distinct roots of a. Similarly, if $\pi(\infty) \neq 1$, then $\pi^{-1}(1)$ is the set of distinct roots of b; and if $\pi(\infty) \neq \infty$, then $\pi^{-1}(\infty)$ is the set of distinct roots of c. Since ∞ can belong to at most one of the sets $\pi^{-1}(0), \pi^{-1}(1), \pi^{-1}(\infty)$, we deduce, by putting all this information into (7), that

$$\text{degree}(\pi) \leq \#\{\text{distinct roots of } abc\} - 1, \tag{8}$$

which is equivalent to Proposition 2.

We get equality in (8) if and only if the subsum we considered in (7) actually includes all of the nonzero terms; that is, $\pi^{-1}(z) = \text{degree}(\pi)$ for every $z \notin \{0, 1, \infty\}$. Maps with this property are called *Belyĭ maps* after G. V. Belyĭ, who first identified their central importance. He showed, amongst other things, that for any finite subset S of $\overline{\mathbb{Q}}$ there is a map $\pi : \mathbb{C} \cup \{\infty\} \to \mathbb{C} \cup \{\infty\}$ for which $\pi(S) \subseteq \{0, 1, \infty\}$, and $\pi^{-1}(z) = \text{degree}(\pi)$ for every $z \notin \{0, 1, \infty\}$. We can reinterpret this in terms of polynomials as follows.

Proposition 3. For any $f(t) \in \mathbb{Z}[t]$ there exist $a(t), b(t), c(t) \in \mathbb{Z}[t]$ which do not have any common roots and provide a genuine polynomial solution to $a(t) + b(t) = c(t)$ for which $f(t)$ divides $a(t)b(t)c(t)$, and such that the maximum of the degrees of $a(t), b(t), c(t)$ is exactly one less than the number of distinct roots of $a(t)b(t)c(t) = 0$.

Thus we can use Belyĭ maps to construct many "best possible examples" in Proposition 2. As we shall see later, this elegant construction is central to several important results.

An Analogy for Integers?

Many results for Diophantine equations in integers are analogous to results for Diophantine equations in polynomials. Given Mason's wonderfully simple inequality for polynomial solutions to $a + b = c$ (namely Proposition 2), one cannot help but wonder whether there is a similar result for integers (and evidently, if there is, it should imply a direct proof of Fermat's Last Theorem!).

Usually primes are considered to be the appropriate analogy to irreducible factors of polynomials, so one might guess that the analogy to Proposition 1 would be something like:

If $a + b = c$ in coprime integers a, b, c, then the total number of prime factors of a (or b or c) counting multiplicities is less than the total number of distinct prime factors of abc.

When one checks out this conjecture, one quickly finds counterexamples, like $1 + 1 = 2$ or $1 + 3 = 4$ or $1 + 7 = 8$; and the more one looks, the worse the counterexamples get.[1]

That was too easy! Maybe if we modify the conjecture a bit, it will stand up to testing better. It has long been established in analytic number theory that primes, when counted, are best counted with the weight $\log p$ attached. Thus perhaps the appropriate measure for an integer $a = \prod_p p^{e_p}$, analogous to the degree of the polynomial $a(t)$, is not $\sum_p e_p$, but rather $\sum_p e_p \log p$, which equals $\log a$. Then we replace the total number of distinct factors of $a(t)b(t)c(t)$ by $\sum_{p|abc} \log p$, where the sum is over the distinct prime factors p of abc. Taking exponentials of both sides, we get the aesthetically pleasing conjecture:

If $a + b = c$ in coprime integers a, b, c, then

$$\max\{a, b, c\} \leq \prod_{\substack{p \text{ prime} \\ p|abc}} p. \tag{9}$$

[1] *In fact, if $2^n - 1$ is prime, the above statement implies $n < 1 + 1$!*

Unfortunately, one quickly finds counterexamples: $1+8=9$, then $5+27=32$, $1+48=49$, $1+63=64$, $1+80=81$, $32+49=81\ldots$, though in all of these examples the ratio of the two sides never gets too large. Indeed, when $1 \le a,b,c \le 1000$, the largest ratio we encounter is $9/2$, in the example $1+2^9=3^3\times 19$. This suggests that maybe if we multiply the right side of (9) by a suitably large constant (perhaps 5), we could have a valid inequality. Unfortunately, even this is false, for if $a=1$ and $c=2^{p(p-1)}$ for some large prime p, then $b=2^{p(p-1)}-1$ is divisible by p^2, so that the right side of (9) is $\le 2b/p$, which means that inequality (9) cannot hold with only very minor modifications.

It has become frustrating trying to make a precise conjecture, even though numerical investigation does indicate that we are getting closer to something that is valid. At this point we resort to the mathematician's trick (to be used only when one knows one is close but is unable to formulate things precisely): Fudge things a little by throwing in an ε.

Oesterlé and Masser's abc-conjecture. For any given $\varepsilon > 0$ there exists a constant κ_ε such that if a, b, and c are coprime positive integers for which

$$a+b=c,$$

then

$$c \le \kappa_\varepsilon \left(\prod_{\substack{p \text{ prime} \\ p \mid abc}} p \right)^{1+\varepsilon}.$$

Is This Good for Anything?

One of our goals in formulating this analogy to Mason's Theorem was that we should be able to deduce Fermat's Last Theorem over the integers. We should check that this is the case. If

$$x^n + y^n = z^n$$

in coprime positive integers x, y, z, then take

$$a = x^n,\ b = y^n,\ \text{and } c = z^n$$

in the *abc*-conjecture. We have no way of determining the product of the primes dividing $x^n y^n z^n$ precisely, but we do know that these are exactly the primes dividing xyz, and so their product must be $\le xyz$. Moreover, since x and y are positive, they are both less than z, so $xyz < z^3$. The *abc*-conjecture therefore gives

$$z^n \le \kappa_\varepsilon \left(z^3\right)^{1+\varepsilon},$$

for any given $\varepsilon > 0$. Taking $\varepsilon = 1/6$ and $n \ge 4$, so that $n - 3(1+\varepsilon) \ge n/8$, we deduce from the *abc*-conjecture that

$$z^n \le \kappa_{1/6}^8.$$

We have thus proved that in any solution of (1) with $n \ge 4$, the numbers x^n, y^n, and z^n are all less than some absolute bound, and so there are no more than finitely many such solutions (and Euler had shown that there are no solutions to (1) with $n=3$).

If we had an explicit version of the *abc*-conjecture (that is, with the values of κ_ε given), then we could give an explicit bound on all solutions to the Fermat equation and compute up to that bound to finally determine whether there are any solutions. It would not be the most elegant proof of Fermat's Last Theorem imaginable, but it would achieve our goal.

It has been suggested that the *abc*-conjecture might be valid with $\varepsilon = \kappa_\varepsilon = 1$, so that

$$c \le \left(\prod_{\substack{p \text{ prime} \\ p \mid abc}} p \right)^2.$$

If so, then Fermat's Last Theorem for $n \ge 6$ follows immediately, and the cases $n = 3, 4, 5$ have been known for almost two hundred years (see [Ri]).

It is appealing to look for other Diophantine questions to which we can directly apply the *abc*-conjecture. Obviously it is directly applicable to the Fermat equation with arbitrary coefficients,

$$Ax^n + By^n = Cz^n$$

for fixed integers A, B, C, as well as to the Catalan equation

$$x^p - y^q = 1 \quad \text{with } p, q \ge 2.$$

We leave it as an exercise for the reader to apply the *abc*-conjecture to the more general trinomial equation

$$Ax^p + By^q = Cz^r. \tag{10}$$

We really would like to generalize the Fermat equation not only to other trinomial equations but in fact to equations with arbitrarily many terms. Equations in one variable are not of much Diophantine interest, but the rational solutions to equations in two variables,[2] that is, rational points on curves, have been very much in the center of number theory research.

In 1930 Mordell [Mo] wrote one of the greatest papers in the history of mathematics, a paper which we shall be discussing for two reasons.[3] At the

[2] *The novice might note that rational solutions to equations in two variables are equivalent to integer solutions to equations in three variables where every monomial has the same total degree, as may be seen by multiplying through by denominators.*

[3] *Mordell notes in his "Reminiscences of an octogenarian" that this paper was rejected as uninteresting by the first journal it was submitted to!*

very end of the paper, Mordell asked five questions which were instrumental in motivating much of the important research in Diophantine arithmetic in the twentieth century. The most important and difficult of these questions was answered by Faltings in 1983 by inventing some of the deepest and most powerful ideas in the history of mathematics. In the next section we will try to give some idea of what Faltings' Theorem is about.

The *abc*-conjecture and the *Number Theory "Hall of Fame"*

Faltings' Theorem née Mordell's Conjecture (Fields Medal 1986)

Gerd Faltings

Let $f(x, y) \in \mathbb{Z}[x, y]$ be a polynomial in two variables with integer coefficients. We are interested in finding rational numbers u and v for which $f(u, v) = 0$. Sometimes it is very easy to do so: for example, if $f(x, y) = x + y - 1$, then we can take $u = 1/2 + t$ and $v = 1/2 - t$ for any rational number t, and all rational solutions are of this form. Another example, not so easy but very well known, is $f(x, y) = x^2 + y^2 - 1$, which has solutions $u = 2t/(1 + t^2)$ and $v = (1 - t^2)/(1 + t^2)$ for every rational t. These are both examples of equations in which infinitely many rational solutions may be obtained in a parametrized form (that is, as a rational function of the variable t).

A second class of examples in which we can have infinitely many rational solutions is given by "cubic curves". As an example consider the taxicab curve,[4]

$$x^3 + y^3 = 1729.$$

Ramanujan's two solutions are $12^3 + 1^3 = 10^3 + 9^3 = 1729$; one can easily check that these are the only solutions in integers. However, it is not hard to find infinitely many solutions in rationals. In fact, given any solution (u, v), one can find another simply by taking

$$U = u(u^3 - 3458)/(1729 - 2u^3)$$

and

$$V = v(u^3 + 1729)/(1729 - 2u^3).$$

Starting with $(12, 1)$ we then get further solutions

$$(20760/1727, -3457/1727),$$

$$(184026330892850640/15522982448334911,$$
$$61717391872243199/15522982448334911),$$

and the next solution is pointless to write down, since each ordinate has seventy digits! Our main concern is that we have observed, for a certain class of curves, that one can obtain further solutions as a function of previous solutions and thus get infinitely many solutions (and, since the ordinates grow so fast, one can prove that they could not possibly come from a parametrized form).

Thus we know of two ways that an equation $f(x, y) = 0$ can have infinitely many rational solutions. In fact, Faltings' Theorem tells us that these are the only two ways that an equation like this can have infinitely many rational solutions; in other words, there are only finitely many "sporadic" solutions. Indeed, if we put to one side all solutions of $f(x, y) = 0$ that come from the two methods above, we are left with finitely many solutions. It is even conceivable that the number of rational points left over is bounded by a function of the degree of f. This extraordinary theorem has many wonderful consequences. For example, for any given $p \geq 4$ there are only finitely many positive coprime integer solutions to (1). Similarly, there are only finitely many positive coprime integer solutions to (10) when that is predicted by the *abc*-conjecture. So, for instance,

$$(11) \qquad x^4 + y^4 = 17z^4 \quad \text{and} \quad x^2 + y^3 = z^7$$

each have only finitely many coprime integer solutions.

One important failing of Faltings' Theorem is that it gives no upper bound on the size of the solutions and thus no "algorithm" for finding them all, even though we know there are only finitely many (it took new methods to prove that we know all solutions to the two equations in (11)).

In 1991 Elkies showed that using an explicit version of the *abc*-conjecture (that is, with a value assigned to κ_ϵ for each ϵ), one can deduce an explicit version of Faltings' Theorem. The proof revolves around a careful study of Belyĭ maps (in particular the ideas involved in Proposition 3).

Moret-Bailly, building on ideas of Szpiro, went a step further. He showed that if one could get *good* upper bounds for the size of the coordinates of the rational points on[5] $y^2 = x^5 - x$ in any number field,[6] then the *abc*-conjecture follows. ("Good" bounds in this case are bounds that depend

[4] *When Ramanujan lay ill from pneumonia in an English hospital, he was visited by G. H. Hardy, his friend and coauthor. Struggling for conversation, Hardy remarked that the number 1729 on the taxicab in which he had ridden from the train station to the hospital was extremely dull. Ramanujan contradicted him, noting that it is the smallest number which is the sum of two cubes in two different ways. However, Ramanujan did miss the other notable fact that it is the third smallest Carmichael number!*

[5] *Or, for the initiated, on any other algebraic curve of genus* > 1.

[6] *That is, a finite field extension of* $\mathbb{Q}$.

explicitly on the discriminant of the number field over which the points are rational.) Therefore, in a certain sense, this problem and the *abc*-conjecture are equivalent.

Roth's Theorem (Fields Medal 1958)

Klaus Roth

Let α be a real algebraic irrational number of degree d. A simple pigeonhole principle argument gives infinitely many rational numbers m/n for which $|\alpha - m/n| < 1/n^2$. On the other hand, substituting m/n into the minimum polynomial for α shows that there exists a constant $c_\alpha > 0$ such that $|\alpha - m/n| > c_\alpha/n^d$.

A famous question of number theory was whether this lower bound could be improved, and Roth (1955) gave the "best possible" such result: For any fixed $\epsilon > 0$ there exists a constant $c_{\alpha,\epsilon} > 0$ such that

$$\left|\alpha - \frac{m}{n}\right| \geq \frac{c_{\alpha,\epsilon}}{n^{2+\epsilon}}.$$

Suppose that $F(x, y) \in \mathbb{Z}[x, y]$ is a binary homogenous form without repeated factors.[7] Using Roth's Theorem we then have, for any coprime integers m and n,

$$\begin{aligned} |F(m,n)| &\gg_F n^{\deg(F)} \prod_{\alpha:\ F(\alpha,1)=0} \left|\alpha - \frac{m}{n}\right| \\ &\gg_{F,\epsilon} n^{\deg(F)-2-\epsilon}. \end{aligned} \tag{12}$$

(The meaning of "$A \gg_F B$" may be unfamiliar to many readers. This simply means that there exists a constant $c_F > 0$, depending only on F, such that we have "$A \geq c_F B$"; similarly, "$A \gg_{F,\epsilon} B$" means that there is an analogous inequality with a constant $c_{F,\epsilon} > 0$ depending only on F and ϵ. This notation saves a lot of writing in analytic number theory.) We leave it to the reader to verify that this statement is actually equivalent to Roth's Theorem.

The *abc*-conjecture implies something that is somewhat stronger than Roth's Theorem: For any coprime integers m and n,

$$\prod_{p|F(m,n)} p \gg_{F,\epsilon} (\max\{|m|, |n|\})^{\deg(F)-2-\epsilon}. \tag{13}$$

Note that $|F(m,n)| \geq \prod_{p|F(m,n)} p$ (if $F(m,n) \neq 0$), so Roth's Theorem (in the form (12)) follows immediately. Notice also that by taking $F(x, y) = xy(x + y)$ we recover the original *abc*-conjecture. Thus this conjecture is *equivalent* to the *abc*-conjecture, although it appears far stronger.

One can sketch a proof that (13) follows from the *abc*-conjecture as follows: Let $f(t) = F(t, 1)$ and apply Proposition 3. Let $f(t)g(t)$ be the product of the distinct linear factors dividing $a(t)b(t)c(t)$ (where $a(t)$, $b(t)$, and $c(t)$ are as in Proposition 3), and homogenize by taking $t = m/n$ to get an equation $A(m,n) + B(m,n) = C(m,n)$. We may assume without loss of generality that $A(m,n)$, $B(m,n)$, and $C(m,n)$ are all positive, if necessary by rearranging them, and notice that the $\gcd(A, B)$ divides the resultant of $a(t)$ and $b(t)$, so is bounded. Now apply the *abc*-conjecture to this equation, bounding the product of the primes dividing ABC by $|G(m,n)|$ times the product of the primes dividing $F(m,n)$. Notice that the number of linear factors of FG is at most one more[8] than the number of roots of fg, that is, $\leq d + 2$, where d is the maximum of the degrees of a, b, and c by Proposition 3. The result follows from combining these observations with the fact that $\max\{A(m,n), B(m,n), C(m,n)\} \gg \max\{|m|, |n|\})^d$.

Baker's Theorem (Fields Medal 1970)

Alan Baker

In 1929 Siegel showed that for any given $f(x, y) \in \mathbb{Z}[x, y]$ all but finitely many of the integer pairs u and v for which $f(u, v) = 0$ are given by parametrizations. Although it is easy, in practice, to find all of the parametric solutions, Siegel was unable to provide a way to bound those finitely many other integer points (just as Faltings' Theorem does not provide a way to bound the rational points u and v with $f(u, v) = 0$). In 1968 Baker made an extraordinary breakthrough in "*linear forms in logarithms*" which allowed, in many interesting cases, such bounds on the size of integer points. However, his theorem can be stated only in a technical form!

Let $p_1, \ldots, p_n$ be prime numbers. We write $L = \log|\log(p_1^{a_1} p_2^{a_2} \ldots p_k^{a_k})|$, where the a_i are integers.

By the pigeonhole principle we can show that, for any integer $A > 1$, there exist integers $a_1, a_2, \ldots, a_k$ with each $|a_i| \leq A$ such that $L \leq -(k-1)\log A + \log\log(p_1 p_2 \ldots p_k)$. Baker's Theorem (as improved in a recent paper with Wüstholz) gives the lower bound

$$L \geq -(16k)^{2(k+2)}(\log A)\prod_{i=1}^{k} \log p_i.$$

This result seems likely to be far from "best possible". Moreover, the *abc*-conjecture gives

[7] *In other words, if F has degree d, then $F(t, 1)$ is a polynomial of degree $\geq d - 1$, without repeated roots, and $F(x, y) = y^d F(x/y, 1)$.*

[8] *The "one more" because there could be a factor n here corresponding in the abc equation to one of a, b, or c having lower degree than the other two.*

$$L \gg -(\log A)\sum_{i=1}^{k}\log p_i,$$

a remarkable improvement and close to best possible, given the upper bound mentioned above. Moreover, this lower bound on L implies a modified version of the *abc*-conjecture, so these two questions are, in a certain sense, equivalent.

We should note that techniques from this area have been used to attack the *abc*-conjecture. In 1991 Stewart and Yu proved that if $a+b=c$ in positive coprime integers, then

$$c \ll \exp\left(O\left(\left(\prod_{p|abc} p\right)^{2/3}\right)\right).$$

Remove one "exp" and we would be there! This is unfortunately typical of results using these techniques: as beautiful as the results are, they fall short of our goal; still, better some result than nothing.

Motivated by applications to estimates for linear forms in logarithms, Baker recently came up with the following interesting explicit version of the *abc*-conjecture:

$$c \ll N \sum_{\substack{n\le N \\ p|n \Rightarrow p|N}} 1 \quad \text{where } N = \prod_{p|abc} p.$$

Bombieri's Theorem (Fields Medal 1974)

Enrico Bombieri

Let χ be a Dirichlet character[9] (mod q). The Generalized Riemann Hypothesis states that if $L(s,\chi)=0$, then either s is a negative integer (a "trivial zero") or $\mathrm{Re}(s)=1/2$. There seems to be little prospect of proving this statement or anything too similar. However, many of the consequences of the Generalized Riemann Hypothesis follow from the assertion that if $L(s,\chi)=0$, then $\mathrm{Re}(s)$ is not *too* big, or that there are not too many s with $L(s,\chi)=0$, and $\mathrm{Re}(s)$ "large". One version of Bombieri's famous result (1965) may be paraphrased as

The zeros of $L(s,\chi)$ are sparse "far away" from $\mathrm{Re}(s)=1/2$, *for "almost all"[10] χ* (mod q).

By 1930 it had been shown, for a sufficiently small constant $c>0$, that if $L(s,\chi)=0$ with $\mathrm{Re}(s) > 1 - c/\log q$, then s is real, χ is a quadratic real character, and there is at most one such value of q between Q and Q^2 for any sufficiently large Q. Such zeros are known as "Siegel zeros".[11]

In 1995 Granville and Stark proved, assuming the *abc*-conjecture, that $L(s,\chi)$ has no Siegel zeros for all χ (mod q) with $q \equiv 3 \pmod 4$.

Wiles' Theorem (IMU Plaque 1998)

Andrew Wiles

Wiles did not prove Fermat's Last Theorem directly. Instead, he attacked a famous old conjecture about elliptic curves called the "Taniyama conjecture"[12] and proved enough of it to deduce Fermat. Recently others have completed the proof of Taniyama's conjecture. We can give here only a brief, somewhat inadequate, description of the conjecture.

Above we saw how the curve $x^2+y^2=1$ could be parametrized by $x=2t/(1+t^2)$ and $y=(1-t^2)/(1+t^2)$ where $t\in\mathbb{C}$. There are many other types of parametrizations possible: for example, we saw how to find infinitely many points on the curve $C: x^3+y^3=1729$ by using a map that sends a point on C to a "larger" point on C, in other words, a map $\phi: C \to C$ that is a rational function in the co-ordinates of the point.[13] One can generalize by saying that a curve C "parametrizes" a curve X if there is such a map $\phi: C \to X$ that is a rational function in the coordinates of the point on C.

Taniyama's conjecture (now a theorem) states that *every* cubic curve can be parametrized by a "modular" curve: The modular curves $\{X_0(N)\}_{N=1,2,3,\ldots}$ are a very special set of curves that come up naturally in a somewhat different context. For use in $a+b=c$ equations we look at the elliptic curve

$$E:\ y^2 = x(x-a)(x+b);$$

we now know that this can be parametrized by the curve $X_0(N)$, where

$$N = N_E \text{ is approximately } \prod_{p|abc} p.$$

(Here "approximately" means that the ratio of the two sides is a rational with small numerator and denominator.)

[9] *A homomorphism $(\mathbb{Z}/q\mathbb{Z})^* \to \mathbb{C}$.*

[10] *That is, 100%.*

[11] *An unfortunate reward for Siegel after much remarkable work showing how unlikely they are to exist!*

[12] *The vague statement of the conjecture that we give is close to the original statement of Taniyama. This was subsequently made more precise by Shimura, who proved that it was true in infinitely many examples. Arguably this conjecture only became as widely known as it deserved because of the works and influence of Weil, and thus this conjecture has confusingly been credited to various subsets of these three names!*

[13] *Moreover, ϕ had degree four, explaining the explosion in the size of the numbers involved.*

There may be many parametrizations $\phi : X_0(N_E) \to E$. Let ϕ_E be one of the ones of smallest degree. A fantastic theorem of Weil shows that all such ϕ can be written as the composition of ϕ_E with some other maps (which are automorphisms). Thus it is of interest to find ϕ_E, or at least to determine its degree. It turns out that

$$\deg(\phi_E) = cN_E^{1+o(1)},$$

(By "$o(1)$" we mean some number that $\to 0$ as $N \to \infty$.) Put like this, one sees that the *abc*-conjecture is *equivalent* to the conjecture

$$\deg(\phi_E) \ll N_E^{2+o(1)}.$$

The result of Stewart and Yu mentioned above tells us that, unconditionally,

$$\deg(\phi_E) \ll \exp\left(N_E^{2/3+o(1)}\right).$$

The *abc*-conjecture: The Future

We have seen that the *abc*-conjecture is equivalent to extensions of several of the most important theorems in number theory: Roth's Theorem, Faltings' Theorem, Baker's Theorem, and Wiles' Theorem.[14] Resolving the *abc*-conjecture would therefore have an extraordinary impact on our understanding of number theory. Proving it or disproving it would be amazing. The least desirable state of affairs would be to find out that the *abc*-conjecture is undecidable, and thus so are these extensions of so many of the important questions in the subject!

We are in the process of writing a book explaining in detail how the *abc*-conjecture relates to all of these problems and thus trying to map out possible future directions of several important themes in number theory. We shall include sketches of the proofs of Roth's and Faltings' Theorems, since, when approached from an appropriate direction, these indicate the slightly different philosophy of arithmetic first proposed by Vojta [Vo], which we develop from the perspective of Belyĭ maps. Our intent is to keep the style of this article in much of the book.

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Note: Photograph of Klaus Roth courtesy of the London Mathematical Society, with permission from the Royal Society. Photograph of Enrico Bombieri by H. Landshoff, used with permission of the IAS.

[14] *One audience member pointed out that number theorists thus won several Fields Medals in striving for the same result!*

Leopold Vietoris (1891–2002)

Heinrich Reitberger

On April 9, 2002, shortly before his 111th birthday, Leopold Vietoris died in a sanitarium at Innsbruck after a brief illness. The mathematical community has lost a well-known researcher. Vietoris was the recipient of several high awards.

Biography

L. Vietoris was born in Radkersburg (Styria) on June 4, 1891. After his graduation from the "Benediktinergymnasium" in Melk, he studied mathematics and descriptive geometry at the University and the Technical University in Vienna. In his sixth semester he heard a lecture on topology by W. Gross in 1912 based on the axioms of accumulation points by F. Riesz—extended by Gross. At the same time W. Rothe at the Technical University raised the question of the notion of manifold. Vietoris planned to create a geometrical notion of manifold with topological means. He was drafted in 1914 but continued working on his own on this problem. In September 1914 he was wounded, and after his recovery he was sent to the southern front. In 1916, while an army mountain guide, he obtained his first results, which he expanded during a three-month stay in Vienna (spring semester 1918), where he read for the first time Hausdorff's classic (published in 1914). On November 4, 1918, he became an Italian prisoner of war. Due to decent treatment, he was able to complete his thesis, which after his release he submitted to G. v. Escherich and W. Wirtinger in December 1919 at the University of Vienna. Before that, he had passed the exam for high-school teachers. During the following period of teaching he received a postcard from Escherich congratulating him on his thesis and offering him an assistant position at the Technical University in Graz. Two years later Vietoris received his Habilitation in Vienna on the recommendation of H. Hahn.

In 1925 Vietoris started working in combinatorial topology. He spent three semesters as a Rockefeller fellow with L. E. J. Brouwer in Amsterdam, where P. Alexandrov and K. Menger (whom he knew as a student from Vienna) were staying at the same time. It was during this stay that he began writing the papers on algebraic topology for which he is best known (Mayer-Vietoris sequence and so forth). In 1927 he followed a call to Innsbruck as associate professor, in 1928 he went back to the Technical University in Vienna as full professor, and in 1930 he finally settled in Innsbruck.

In the autumn of 1928 Leopold Vietoris married Klara Riccabona. She later died after giving birth to their sixth daughter. In 1936 he married Maria Riccabona, Klara's sister, who thenceforth was a mother to her nieces and a devoted spouse. She died shortly before her husband.

Foundations of General Topology[1]

To avoid Hausdorff's countability axioms, Vietoris added to the neighborhood axioms his separation axiom of "regularity"; defined filter base ("Kranz" = wreath), directed set ("orientierte Menge"), nets, and the related convergence concept; and introduced the modern notion of compactness (under the name "lückenlos" = without gaps).

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[1] *See also [Rei97], [Rei02].*

Discussing the notion of directed set in 1937, G. Birkhoff [Bir37] wrote the condition "(D3) given $\alpha \in A$, $\beta \in A$, there exists $\gamma \in A$ satisfying $\gamma > \alpha$ and $\gamma > \beta$" and remarked, "It is primarily condition (D3) which was due to Moore and Smith, and which distinguishes directed sets from other 'partially ordered sets'". Indeed, (D3) occurred as the "composition property" in a paper of E. H. Moore and H. L. Smith [MS22][2], but priority belongs to Vietoris, who introduced this concept as "oriented set" in [Vie21, p. 184]. Interestingly enough, Birkhoff quoted this paper, concerning the separation axioms on p. 174, but seems not to have read any further!

Whereas Moore and Smith considered only generalized sequences with numerical values, Vietoris studied right from the start "sets of second order", i.e., systems of sets under Zermelo's axioms, indexed by a directed set, and gave the definition: *A set of second order is called a "Kranz" [wreath], if the intersection of any two elements contains again an element* $\neq \emptyset$. With respect to inclusion, a "Kranz" forms a directed system of sets, and vice versa, the remainders $R(B) := \{x \in M : b < x \, \forall b \in B\} \neq \emptyset$ of a directed set form a "Kranz". So Vietoris developed in parallel today's theory of convergence for generalized set sequences (nets) and filter bases through comparison with the directed set of neighborhoods.

Although Birkhoff reinvented the notion of filter base in 1935 [Bir35], it is H. Cartan who has generally been thought of as the creator of the concept on the basis of his 1937 papers [Car37a, Car37b].

Vietoris was thus the father of the modern convergence concepts (and more (see below)), yet his name is not mentioned in the "Historical Notes" in Bourbaki's *General Topology*. One explanation may be that in the—otherwise excellent—encyclopedia article "Relations between the different branches of topology", published in 1930 by Tietze and Vietoris [Vie31], the notions of "Kranz" and "orientierte Menge" are missing!

H. Cartan wrote in his second note on filters [Car37b] that "Chevalley and Weil have led me to remark that the definition of a compact space by the property of Borel-Lebesgue is equivalent to the following: *E is compact if every filter on E has at least one cluster point.*" In [Vie21], Vietoris had defined this modern notion of compactness—but under the redundant general assumption of regularity, as Urysohn remarked—under the name "lückenlose Menge" (set without gaps) through an analogous property of nets and had given the characterization by filter bases: *A wreath without last element always has a proper cluster set.* Vietoris also gave other equivalent formulations but not the one by the covering property. This general notion of compactness was then called "bicompact" by Alexandrov and Urysohn from 1923 onwards.

Of the theorems that Vietoris proved for compact spaces in [Vie21], he himself considered "Satz (27)" to be his most important result: *Two closed disjoint sets A and B have two enclosing sets*[3] *that have no point in common* (in modern terminology: a compact space is normal). It is remarkable that this separation property (later Tietze's normality) was mentioned here for the first time and proved for compact sets! For the proof, Vietoris showed that the sets U_α enclosing A form a filter base, as do the sets V_β enclosing B, and the sets $U_\alpha \cap V_\beta$ if nonempty. To reach a contradiction, he used the regularity; compare the verbatim same proof in Bourbaki's *General Topology*, 9.2, Prop. 2.

Vietoris started his work [Vie21] with the neighborhood axioms (including Hausdorff's separation property) and added Axiom (E): *A neighborhood U_x of a point x always contains a neighborhood W_x of x such that each point of the complement of U_x, including one of its neighborhoods, lies in the complement of W_x.* In a footnote he indicated that Axiom (E) is not mentioned by Hausdorff, who had instead two countability axioms. Today's somewhat different definition of regularity is due to

Ph.D. Students of Leopold Vietoris

Kurt Hellmich,
Funktionen, deren Werte Mengen sind (1939)
Martha Petschacher,
Tafeln hypergeometrischer Funktionen (1946)
Hiltrud Jochum,
Die Cayleyschen Formeln in der Kreisgeometrie und die Brennpunkte in der Gaußschen Ebene (1952)
Johann Leicht,
Zur intuitionistischen Algebra und Zahlentheorie (1952)
Walter Dürk,
Der Strukturkomplex $t_1 t_2 = b^2$ (1953)
Helmut Grömer,
Über den Begriff der Wahrscheinlichkeit (1954)
Eva Ambach,
Der Größenfehler einer durch das Adamssche Interpolationsverfahren gewonnenen Näherungslösung einer Differentialgleichung (1957)
Gerhard Riege,
Das Axiom von Pasch in konvexen Räumen (1957)
Fortunat Pescolderung,
Über eine Fehlerabschätzung zur numerischen Integration gewöhnlicher Differentialgleichungen (1958)
Egon Steuer,
Zur Kreisgeometrie ebener algebraischer Kurven (1960)

[2] *Previous works of E. H. Moore already contain the suggestion of a general convergence theory but not condition (D3)!*

[3] *An enclosing set of a set A contains a neighborhood of each point of A.*

Photograph courtesy of Heinrich Reitberger.

Leopold Vietoris

Tietze in 1923. As Urysohn remarked, the term "regularity" goes back to Alexandrov.[4]

The attempts to create a convenient notion of manifold led Vietoris to look for a spatial structure on the power set of a topological space. In "Regions of second order" [Vie22] he defined on the collection of all nonempty closed subsets $\mathbf{CL}(S)$ of a topological space $(S, \mathcal{T})$ a topology as follows (compare Nadler [Nad78]). For each finite collection $U_1, \dots, U_n \in \mathcal{T}$, let $\langle U_1, \dots, U_n \rangle$ denote the set of all A in $\mathbf{CL}(S)$ such that $A \subset \cup_{i=1}^n U_i$ and $A \cap U_i \neq \emptyset$ for each $i = 1, \dots, n$; the sets $\langle U_1, \dots, U_n \rangle$ form the base of a topology on $\mathbf{CL}(S)$. In the case of a compact connected metric space X this "Vietoris topology"on $\mathbf{CL}(X)$ coincides with topology induced by the so-called "Hausdorff metric". Recently, this metric has again become important, for example in fractal image compression—so to speak, a jump from "hyperspace to cyberspace"!

Algebraic Topology

Algebraic topology develops methods for deciding with algebraic tools whether two topological spaces are homeomorphic. The applications range from simple-sounding questions, such as whether a product like the one in the complex numbers exists also in higher dimensions, to the theory of knots and its use in particle physics and biochemistry. Since Poincaré's time topologists have tried to find appropriate invariants—first for simplicial complexes, then more generally for metric spaces, as Vietoris showed us [Vie27][5], and finally for general spaces by means of coverings.

Now we come to the so-called *Vietoris complex*. Let X be a metric space. An (ordered) n-dimensional ϵ-simplex σ^n of X is an $(n+1)$-tuple of points $e_0, e_1, \dots, e_n$ in X such that the distance of any two is less than ϵ. Let G be an abelian group. A formal linear combination $\sum_i g_i \sigma_i^n$ of ϵ-simplices with coefficients $g_i \in G$ is called an ϵ-chain in X. The boundary of an ϵ-simplex $\sigma^n = [e_0, \dots, e_n]$ is defined by

$$\partial \sigma^n := \sum_i (-1)^i [e_0, \dots, \widehat{e_i}, \dots, e_n].$$

This is again an ϵ-chain. The boundary of any ϵ-chain is defined by linear extension. The ϵ-chains with zero boundary are called ϵ-cycles. An ϵ-chain x^n is called η-homologous to zero in X, written $x^n \sim_\eta 0$, if $x^n = \partial y^{n+1}$ for an η-chain y^{n+1} in X. Vietoris called a sequence $z^n = (z_1^n, \dots, z_k^n, \dots)$ of ϵ_k-cycles z_k^n in X *fundamental* if $\epsilon_k \to 0$ (for $k \to \infty$) and for all $\epsilon > 0$ there exists $N(\epsilon)$ such that for all $l, m > N(\epsilon)$, we have $z_l^n \sim_\epsilon z_m^n$, that is, $z_l^n - z_m^n \sim_\epsilon 0$ in X. The fundamental sequences form a group $Z_n(X, G)$. A fundamental sequence z^n is called homologous to zero if for all $\epsilon > 0$ there exists an N such that $z_k^n \sim_\epsilon 0$ for all $k \geq N$.

The quotient group

$$H_n(X, G) = Z_n(X, G)/\{\text{null sequences}\},$$

the *n-th homology group*, was the central object for the further studies of Vietoris[6] (cf. Hirzebruch [Hir99] and Mac Lane [ML86]).

First an anecdote: Until World War Two, the Vietoris complex and V(ietoris)-cycles were part of the standard knowledge of all topologists (cf. [Lef42]). Twenty years ago the complex was reinvented by E. Rips while studying hyperbolic metric groups, and M. Gromov used it in his fundamental works on these groups. Finally in 1995, J.-Cl. Hausmann saw that this concept goes back to Vietoris, and so he called it the *Vietoris-Rips complex*.

An important tool to determine the homology groups of a space is a process to compute them from simpler pieces. This is given by the *Mayer-Vietoris sequence*—the best-known result connected with the name Vietoris.

Theorem (Mayer-Vietoris sequence). *Let K_1 and K_2 be subcomplexes of a simplicial complex K. Then the sequence of homology groups*

$$\dots \to H_q(K_1 \cap K_2) \to H_q(K_1) \oplus H_q(K_2) \to H_q(K_1 \cup K_2) \to H_{q-1}(K_1 \cap K_2) \to \cdots$$

is an exact sequence.

Concerning the genesis of this theorem, we may let the principals speak for themselves. Mayer [May29]: "I was introduced to topology by my colleague Vietoris, whose lectures in 1926–7 I attended at the local university. In many talks about this field Vietoris gave me a lot of hints for which I am very grateful." Vietoris [Vie30]: "W. Mayer, whom I told about the problem as well as the conjectured result and a way to its solution, has solved the question, as far as it concerns Betti numbers, in a somewhat different way in these Monatshefte. In what follows, I will return to my original idea and use it for the solution in the general case." Thus

[4] *For R^2 the regularity property results already from an axiom of R. L. Moore, as mentioned by Chittenden.*

[5] *A short version appeared in* Proc. Amsterdam *29 (1986), 1008-13.*

[6] *Vietoris commented that these studies were inspired by an oral remark of Brouwer.*

Vietoris calculated the homology *groups* and not just the Betti numbers (i.e., the ranks of the groups).

In May 1946 J. Leray introduced today's central notions of sheaf, sheaf cohomology, and spectral sequence. His motivation was the following situation [Die89]: Let X and Y be topological spaces and $f : X \to Y$ a continuous map. The main problem is (after Leray) to relate the homology of X and the homology of Y, perhaps under some restrictions on f. Apparently Leray was unaware in 1946 that Vietoris had obtained such a result twenty years earlier together with the definition of homology groups for the case of compact metric spaces [Vie27].

Indeed, Leray first turned his attention to topology in earnest during World War Two, when access to the literature was problematic. The story, as related in [BHL00], is that Leray was imprisoned during the war as a French officer in a camp in the Waldviertel (Lower Austria) as head of the "prisoner university" Edelbach-Allentsteig. To avoid being forced to work for the German army, Leray remained silent about his knowledge of fluid dynamics and instead represented himself as a topologist.

We now come to the second part of Vietoris's paper: the *mapping theorem* (in the formulation of S. Smale, who generalized it in 1957).

Theorem (Vietoris-Begle). *Let X, Y be compact metric spaces, $f : X \to Y$ surjective and continuous. Suppose that for all $0 \le r \le n-1$ and all $y \in Y$ the reduced homology groups $\tilde{H}_r(f^{-1}(y))$ vanish (in [Vie27] Vietoris used the coefficient group $G := \mathbf{Z}/2\mathbf{Z}$). Then the induced homomorphism*

$$f_* : \tilde{H}_r(X) \to \tilde{H}_r(Y)$$

is an isomorphism for $r \le n-1$ and an epimorphism for $r = n$.

The fibers are assumed to be *acyclic* ("without holes"), in other words, they have the same homology as a single point. For further explanation we consider the situation in topological vector spaces: For a nonempty subset A we have

$$\text{convex} \Longrightarrow \text{starshaped} \Longrightarrow \text{contractible}$$
$$\Longrightarrow \textit{acyclic} \Longrightarrow \text{connected}.$$

In 1950, E. G. Begle extended the theorem to compact Hausdorff spaces. For the historical developments, especially the application of the mapping theorem to derive fixed-point theorems for correspondences, see [Rei01].

Functional and Differential Equations

In his paper [Vie44], Vietoris reduced the functional equations for the trigonometric functions to the equation

(1) $A(x+\xi) = A(x)A(\xi)$

for a complex function $A(x) = \exp\{u(x) + i\varphi(x)\}$, where u and φ are real functions of a real variable x, satisfying

(2) $u(x+\xi) = u(x) + u(\xi)$,

(3) $\varphi(x+\xi) \equiv \varphi(x) + \varphi(\xi) \pmod{2\pi\mathbf{Z}}$.

By using a Hamel basis, he found a new solution to (3), simpler than an earlier one by van der Corput. In 1957 Vietoris used the Cauchy functional equation (3) to give a remarkable proof—as Aczél says—of the limit $\lim_{x\to 0}(\sin x)/x = 1$.

In a series of papers, Vietoris treated the solution of ordinary differential equations by mechanical means, beginning with a modification of the Picard method of successive iterations.

Probability

The object of Vietoris's papers on probability theory was the introduction of nine axioms governing the "eher"-relation $\le$, where $a_A \le b_B$ corresponds to the intuitive idea "outcome a in trial A is not more probable than outcome b in trial B", and the derivation of the laws of classical probability from these. His approach to probability is the same as B. O. Koopman's. Alluding to the problem of obtaining original sources in wartime, Vietoris pointed out in a footnote that he had not seen Koopman's paper and only learned about it later from a review.

Positive Trigonometric Sums

Vietoris proved important inequalities in three papers *Über das Vorzeichen gewisser trigonometrischer Summen* [Vie58, Vie59, Vie94], the last having been written at the youthful age of 103 years!

Theorem. *Let $a_0, a_1, \dots, a_n$ and t be real numbers. If*

(1) $a_0 \ge a_1 \ge \cdots \ge a_n > 0$ and

(2) $a_{2k} \le \frac{2k-1}{2k} a_{2k-1}$ $(1 \le k \le \frac{n}{2})$, then

(3) $$\sum_{k=1}^{n} a_k \sin kt > 0 \quad \text{and}$$
$$\sum_{k=0}^{n} a_k \cos kt > 0 \quad (0 < t < \pi).$$

Putting $a_0 = 1, a_k = \frac{1}{k}$ $(k = 1, \dots, n)$ gives the Fejér-Jackson inequality $\sum_{k=1}^{n} \frac{1}{k} \sin kt > 0$ $(0 < t < \pi)$ and the W. H. Young inequality $1 + \sum_{k=1}^{n} \frac{1}{k} \cos kt > 0$ $(0 < t < \pi)$.

R. Askey reports in [Ask98] his surprise in seeing (3) for the first time and in learning that the Fejér inequality is not sharp. Then he discusses some problems suggested by Vietoris's inequalities and shows how one of them leads to the derivation

of the hypergeometric summation formula and to other summation formulas.

Applications

By conferring honorary doctor degrees of technical sciences, the Technical University of Vienna in 1984 and the Technical Faculty of the Innsbruck University in 1994 acknowledged the contributions of Vietoris to practical applications. These concern his works on orientation in mountainous terrain by differential geometric means, the strength of the alpine ski, and the physics of block glaciers.

Final Remarks

Leopold Vietoris's fundamental contributions to general as well as algebraic topology, and also to other branches of the mathematical sciences, have made him immortal in the world of science. As a person, he was outstandingly humble and grateful for his well-being, which he also wished and granted his fellow humans. He devoted his spare time to his large family, religious meditation, music, and his beloved mountains. On the other hand, administrative duties were not Vietoris's favorite tasks, as he pointed out in a letter to L. E. J. Brouwer in 1947: "As dean I am overwhelmed with administrative matters to such an extent that I often have to hold my lectures inadequately prepared and don't have any time for scientific research. Luckily, the term will soon be over and then I hope to be a scientist again and not a bureaucrat." In research Vietoris was a "lone fighter": Only one of his more than seventy mathematical papers has a coauthor. Half of the papers were written after his sixtieth birthday.

A long life has fulfilled itself. Beside the grief comes our thankfulness!

Acknowledgements

I thank Ottmar Loos, who, following G. Lochs, currently occupies Vietoris' professorial chair, and the editors for their help with the English version of this obituary and many other helpful suggestions. A German obituary that includes a complete list of Vietoris's publications will appear in the *Jahresbericht der Deutschen Mathematiker-Vereinigung* **104** (2002).

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VIGRE Turns Three

Rick Durrett

Three years ago the National Science Foundation (NSF) embarked on an ambitious plan to change how the United States trains its mathematicians and statisticians. VIGRE (short for Vertical Integration of Research and Education in the Mathematical Sciences, and pronounced "vigor") is a program of grants to mathematics departments, its goal being to increase the number of well-prepared U.S. citizens, nationals, and permanent residents who pursue careers in the mathematical sciences. In four years of competitions, thirty-five awards have been made ranging in size from $400,000 to $1 million per year. The VIGRE program thus represents a sizeable (and growing) part of the budget of the NSF's Division of Mathematical Sciences (DMS).

In order to "share information on the success and challenges of the VIGRE initiative and plans for its future", a workshop was held May 3–4, 2002, in Reston, Virginia. The program was organized by Richard Brualdi (University of Wisconsin), Robert Greene (University of California, Los Angeles), and Gary Mullen (Pennsylvania State University). This meeting was sponsored by four professional societies (AMS, the American Statistical Association, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics) whose representatives took care of the meeting details. The meeting attracted representatives from sixty to seventy mathematics and statistics departments, many of whom received partial support of their local expenses from an NSF grant. A full report, being prepared by the workshop presenters and to be posted on the Web, will contain a complete account of the presentations and the discussions in the breakout sessions. Our brief account here will focus on the main issues raised at the meeting as seen through the eyes of the coordinator of the Cornell VIGRE grant.

The meeting began early on Friday afternoon with an overview of the goals and implementation of the VIGRE program given by Henry Warchall, a DMS program officer who is on the VIGRE management team. As Warchall explained, VIGRE was designed to fix a badly leaky educational pipeline. From 1993 to 1999, the most recent years for which there is data, the number of U.S. mathematics majors dropped by 23 percent and the number of U.S. students in Ph.D. programs dropped by 27 percent. In 1998, a blue-ribbon panel chaired by retired General William Odom concluded that the talent drain was threatening not only the nation's leading position in mathematics worldwide but also its ability to innovate in related disciplines.

The recommendations of the Odom report[1] led to the VIGRE program, whose goals are to make the study of mathematical sciences more attractive for undergraduate and graduate students and to render undergraduate, graduate, and postdoctoral training more effective and broadly applicable. VIGRE provides funds to Ph.D.-granting departments for undergraduate research stipends, graduate research traineeships, and enhanced postdoctoral research opportunities. Institutions receiving VIGRE funds are required to carry out educational activities that result in: (1) integration

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[1] *Report of the Senior Assessment Panel of the International Assessment of the U.S. Mathematical Sciences, NSF publication 98-95.*

of research with education at all levels, (2) enhanced interaction among students, postdoctoral fellows, and faculty members, (3) broad educational experiences that prepare students and postdocs for a wide range of career opportunities, (4) close mentoring of students and postdoctoral fellows, and (5) improvement of communication skills and teaching skills of students and postdoctoral fellows.

The second session in the meeting was a panel discussion on "Exemplary Practices". Richard Hain offered his thoughts on mentoring based on his experiences at Duke University. "Undergraduate research provides an ideal vehicle for mentoring, as well as an effective way of getting students interested in continuing their educational studies." Duke tries to recruit undergraduates into the Research Experiences for Undergraduates (REU) program at the beginning of the junior year. A mentor can then direct students towards courses that will help provide background before the actual research is undertaken in the summer between the junior and senior years. During the senior year, students typically continue their projects through reading courses and finish with a paper or senior thesis.

"In mentoring graduate students, it is important to keep the overall goals in mind—decreasing the time to degree, improving retention rates, broadening education, and improving teaching and communication skills," Hain said. Many mentoring roles have traditionally been filled by the thesis advisor. However, many places, including Duke, are finding it very useful to assign to incoming students mentors who can help guide the students through the oral or written exams that come early in the program and through the process of finding a thesis adviser.

The mentoring of postdocs in VIGRE programs is designed to prepare postdocs to take on and balance a wide spectrum of activities: performing research, finding new problems and directions, writing proposals, teaching introductory and advanced courses, and serving their departments and the mathematics community as a whole (e.g., reviewing papers and proposals). In the past many postdocs learned these skills through an association with a senior faculty member with related research interests. The VIGRE program has led in most cases to explicitly assigned mentors. At the University of California at Los Angeles (UCLA), for example, postdocs have one mentor for teaching and one for research. In addition to one-on-one mentoring, a number of programs have grant-writing workshops for postdocs and graduate students.

James Meiss from the University of Colorado, Boulder, discussed broadening the education of students in the mathematical sciences. The VIGRE program in the Applied Mathematics Department there is organized around "tetrahedra". Its Web page, which has a rotating labeled tetrahedron, states, "the vertices represent faculty, postdoctoral fellows, graduate students, and undergraduates, while the faces represent the modes of interaction among the members: teaching, researching, learning, communicating."

There are four tetrahedra that parallel the concentration areas of the department: nonlinear waves, dynamical systems, multigrid computation, and fast algorithms. Each group fosters collaborative research, runs a seminar series to encourage interaction and discussion at multiple levels, and disseminates research ideas into course projects. Testimonials on the Colorado Web page indicate that undergraduate research experiences have changed students' career plans to include mathematical research and that postdocs have benefited not only through faculty interaction with their research but also through the supervision of undergraduate projects.

The research program is only one of a number of ways that students in Boulder have experiences beyond those traditional in mathematics education. Internships with nearby national laboratories or high-technology companies are another broadening activity for students at all levels. Sophomore classes now require a series of projects that demand group interaction, often involve modeling or experimentation, and lead to written reports. Each undergraduate is required to have a minor in an area with significant mathematical applications. A graduate student must complete a yearlong sequence of courses at the graduate level in some area of application. In many cases this has led to graduate students doing research with an advisor from another department.

At the University of Arizona, as Michael Tabor described, a special feature of graduate training is a system of Research Tutorial Groups (RTGs) for first-year students. It is designed to facilitate the transition between consumer (of coursework) to producer (of research). In the fall semester, students are exposed to a variety of topics through blocks of seminars (essentially a hybrid between a "case study" and a minicourse). In the spring semester the students choose to pursue one of these topics with the faculty involved. The semester ends with all the students presenting their findings at a small research conference. The RTGs lead to vertical integration when research projects are co-advised by postdocs and advanced graduate students. Another benefit Tabor points out is that "better mentoring, and monitoring, of students come about through meaningful activities in which the students and their mentors are intellectually engaged, such as the RTGs."

A distinctive feature of the Arizona VIGRE program is competitive proposal writing by graduate students seeking to continue VIGRE support beyond

their first year. Students must submit a proposal laying out a clear plan of study, research, and vertical integration activities. A first draft is reviewed by a faculty committee, and an assigned faculty member discusses the proposal with the student, who then resubmits a revised proposal for final consideration.

The VIGRE activities at Duke, Colorado, and Arizona, while exemplary, do not begin to exhaust the innovative ideas that have been developed in response to the VIGRE programs. Many VIGRE programs have extensive Web pages to solicit applications for postdocs and graduate fellowships and to advertise their successes. These Web pages can be accessed from `http://www.vigre.org/`, which is maintained as a community service by the mathematics department at Penn State. A survey of those descriptions shows that, like ice skaters at the Olympics, universities implement the required elements of the VIGRE program (postdoctoral positions, graduate fellowships, and undergraduate research) in ways that showcase their particular strengths.

UCLA builds on its already close cooperation between pure and applied mathematics and the new national Institute for Pure and Applied Mathematics to achieve vertical integration and broadening through research groups in both traditional and emerging areas and through strengthening its ongoing internships with industry and government laboratories. UCLA also provides an example of VIGRE revitalizing existing parts of the curriculum. For a long time, UCLA has had "graduate participating seminars" that involve graduate students, postdocs, and permanent faculty and that can last one term or more or can continue indefinitely. Before VIGRE there were an average of twelve of these involving a total of thirteen students. In spring 2002 there were twenty-one involving sixty-one students.

At the University of Washington in Seattle, a VIGRE award shared by the Departments of Applied Mathematics, Mathematics, and Statistics seeks to extend the collaborations that have developed due to the recently implemented Bachelor of Science Program in Applied and Computational Mathematical Sciences.

At Penn State, the VIGRE grant supports the already successful MASS (Mathematics Advanced Study Semesters) program for undergraduates, which each year brings undergraduates from around the country to spend a semester at Penn State, where they are literally immersed into the study of mathematics. They take three core mathematics courses, do individual research projects ranging from theoretical mathematics to computer implementation, and participate each week in a two-hour interdisciplinary seminar and a one-hour colloquium.

A number of universities have implemented seminars and working groups in response to the VIGRE program. At the University of Georgia, five research groups in different areas of mathematics (prime number races, ropelength of knots, wavelets and applications, time scales, and flag varieties) are the main vehicle for vertical integration. At the University of Michigan, there is a VIGRE seminar aimed at advanced undergraduates and graduate students with talks related to diverse applications of mathematics and career possibilities in the mathematical sciences. Open problem seminars are designed to help postdocs and advanced graduate students to develop their own independent research agendas. Two "Pro-Seminars", one for first-year graduate students and one for postdocs, help incoming graduate students learn the ropes of graduate school and help young faculty to develop professional "street smarts" about submitting papers for publication and applying for grants.

At the University of Illinois at Urbana-Champaign, two types of peer groups have been formed to carry out mentoring and interpersonal, professional support. Across Level Peers (ALPs) brings together undergraduate students, graduate students, and faculty of all types in order to pursue wide-ranging agendas focused on topics in mathematics, both in teaching and research. Research Among Peers (RAPs), which includes graduate students, postdoctoral associates, and other faculty, focuses on specific research interests and is a source for forming research ideas, studying various topics, and presenting completed work.

Our final examples concern the optional component of VIGRE grants (outreach to grades K–12) and the mandatory one that comes with no funding attached: curriculum review. At Cornell, the benefits of our VIGRE grant are felt by local high-school students through the Math Explorer's Club, organized by Bob Strichartz, who has for a number of years run a successful REU program. The club has four six-week sessions during the school year, Saturdays from 10:30 a.m. to 1:00 p.m. In the first one-hour period students are presented with a mathematical idea, problem, or exploration as part of a six-week module. This is followed by a half-hour break at which refreshments are served. The final hour is devoted to problem-solving or computer laboratory activities.

At the University of Chicago, VIGRE funds help support four outreach programs. The Young Scholar's Program brings large numbers of students in grades 7–12 to the University of Chicago for a summer mathematics enrichment program. SESAME (Seminars for Elementary Specialists And Mathematics Educators) is a three-year, 270-hour program for elementary-school teachers in the Chicago Public Schools. Around twenty high-school teachers attend a seminar program in algebra and

Departments Awarded VIGRE Grants

1999
Carnegie Mellon University*
Columbia University
Harvard University
North Carolina State University
Pennsylvania State University
Princeton University
Rutgers University*
U. of Arizona
U. of California, Berkeley, Mathematics Dept.*
U. of Colorado, Boulder
U. of Michigan, Ann Arbor
U. of Washington, Seattle
U. of Wisconsin, Madison

* = terminated after three years

2000
Brown University
Cornell University
Duke University
New York University
Purdue University
Rensselaer Polytechnic Institute
SUNY Stony Brook
Texas A&M University
U. of California, Los Angeles
U. of Chicago
U. of Illinois, Chicago
U. of Illinois, Urbana-Champaign
Yale University

2001
Indiana University
Iowa State University
U. of Georgia
U. of Texas, Austin
U. of Utah

2002
Georgia Institute of Technology
Ohio State University
U. of California, Davis
U. of California, Berkeley, Statistics Dept.

geometry. The Summer Seminar in Calculus, which involves twenty high-school teachers and twenty high-school students, focuses on the calculus and its applications.

To quote the current solicitation for proposals (NSF 02-120), "a prerequisite to a VIGRE proposal is a thorough review of existing undergraduate and graduate curricula, with attention to how well the curricula prepare students for the diverse career opportunities now available to mathematical scientists." An example of the substantial changes that can occur is the program at Columbia University, where the core curriculum has been restructured to provide all mathematics graduate students—independently of their ultimate specializations—with a broad, yet tightly interwoven, introduction to the basic themes and techniques of modern mathematics. The material is covered in a series of six one-year courses: modern geometry, complex analysis, analysis and probability, groups and representations, algebraic topology, and commutative algebra/algebraic number theory and algebraic geometry. All first-year students are required to take three of the six courses and pass qualifying exams on them. Second-year students are strongly encouraged to attend the courses they did not take the first year.

As the many examples cited above should indicate, the VIGRE program has in its three years of operation inspired a tremendous amount of innovation in mathematics education and research at all levels. The more than 100 postdocs offered each year under VIGRE grants have turned the buyer's market seen in the mid-1990s into a seller's market where well-trained Ph.D.'s in mathematics who are U.S. citizens (or nationals or permanent residents) can expect to receive several job offers. The presentations of the three postdocs at the Reston meeting gave a more personal view of the benefits of the VIGRE postdoc program. It is unlikely that these three postdocs constitute a random sample because they come from the same institutions as the meeting organizers. However, their stories show that (i) VIGRE postdocs derive considerable benefits from the mentoring, reduced teaching loads, and travel money associated with their positions, and (ii) the citizenship requirements of the VIGRE program do not condemn us to hiring second-rate talent.

Jon Jacobsen is an example of a person whose career received a significant boost from his VIGRE postdoc. With the goal of being a high-school mathematics teacher, he entered the mathematics program at California Polytechnic State University at San Luis Obispo in 1988. During his early field experience in his junior year he found out that teaching was not for him, so he stayed and received a Master's degree, and later went to graduate school at the University of Utah. When he graduated in 1999, he had two options: a job at a small liberal arts school in Wisconsin and a VIGRE postdoc at Penn State. He took the VIGRE postdoc, and, after three years of interacting with researchers in the William G. Pritchard Fluid Mechanics Laboratory and having the experience of developing a new course to introduce the art of mathematical modeling through experiment, his second job search was a much different experience. Twenty-five applications (roughly the same number as in 1999) resulted in fifteen interviews at the AMS annual

meeting, several campus visits, and finally a tenure-track job at Harvey Mudd College.

Skip Garibaldi, a VIGRE postdoc at UCLA, knows first hand the difference between an ordinary postdoc and a VIGRE postdoc, since he had the former for one year and then the latter for two years. Two of his comments exemplify the difference: About the ordinary postdoc he said, "I found that simultaneously teaching two unrelated courses left me little time for research," and about the VIGRE postdoc he said, "the $2,500 for travel gave me the freedom to attend many more conferences than I would have otherwise." The "graduate participating seminars" mentioned above were an important part of Garibaldi's VIGRE experience. The visit of Jean-Pierre Serre to UCLA in the winter of 2001 led to a three-way collaboration between Garibaldi, his research adviser Alexander Merkurjev, and Serre. They wrote a book to be published by the AMS. Garibaldi quipped in the recent *Science* article on the VIGRE meeting (see pages 1389–90 in the May 24, 2002 issue): "You can't get much above Serre, and you can't get much below me, so that's an example of vertical integration."

Dan Knopf was a VIGRE postdoc at University of Wisconsin, Madison (UW), for 1999–2002. He too says that he benefited from the reduced teaching load, travel funds, mentoring from senior faculty, and the department's VIGRE seminars. What is unique about his experience is that he designed and implemented the undergraduate research component of the UW VIGRE program: the UW Minimal Surfaces Lab. Readers can find more about this effort on the UW VIGRE Web page. This experience taught Knopf lessons that many of us have wrestled with in other contexts: "There is a delicate balance between the need to teach the students enough background, and the goal of giving them an opportunity for independent investigation. Too much structure risks turning the experience into a course; too little risks leaving the students floundering." Beginning in the fall of 2002, Dan Knopf will be at the University of Iowa.

VIGRE fellowships provide support for a large number of graduate students. Under most grants, students get two years of support in the first two or three years of graduate school when they are hard at work on their basic courses and later trying to find a thesis direction. At the undergraduate level, the additional 600 students supported by VIGRE have nearly tripled the number previously supported by the NSF; 300 are supported through REUs and sixty through individual grants. Statistics are not yet available to document the effect of the VIGRE program on the pipeline, but individual reports indicate significant increases both in the number of mathematics majors and the number of undergraduates continuing to graduate school to study mathematics.

Despite the impressive successes of the VIGRE program, not all members of the mathematics community agree with how it is being implemented. In a Saturday afternoon panel session, Benedict Gross, the VIGRE director at Harvard, which successfully completed its third year review, quipped: "Like the pill whose name it resembles, the purpose of the VIGRE grant is varied. Is it intended to increase the population, to restore strained relationships, or just to have more fun? In some cases it does have a side effect of raising blood pressure as departments try to decipher ambiguous signals from the NSF." One of the reasons for Gross's frustration can be seen in the response to Harvard's preceptor program, a new postdoctoral program for mathematicians especially interested in undergraduate teaching and advising developed in response to the VIGRE program. At the meeting he explained that the VIGRE site visit team thought that the preceptor program was a great idea, while an external committee reviewing his department had exactly the opposite opinion.

Calvin Moore is chair of the mathematics department at the University of California, Berkeley, whose VIGRE grant was terminated after three years. He also spoke in the panel discussion and has written an extensive analysis of the VIGRE program, which is a component of the workshop report. Here we present excerpts beginning with his comments on the Berkeley grant in particular and proceeding to the VIGRE program as a whole. Remarks within quotes are Moore's words. I have written the unquoted transitional material.

"It is clear that attempts to increase the number of students studying mathematics have to start at least at the undergraduate level, particularly in attracting students to major in mathematics. One of the small number of problems that I decided to focus on as chair was that of increasing the number of undergraduate majors in mathematics. Four years ago we had 167 majors (this counts only juniors and seniors), and as of this week (June 11, 2002) we had 556 declared junior and senior level majors."

As Moore explains in his write-up, this impressive growth in the number of majors came from improving the advising system, initiating systematic outreach activities, and encouraging double majors. "The introduction of our undergraduate research seminars, which was spurred by VIGRE, provided a significant incentive, especially to the very best students, to become math majors. In addition to providing stipends for students, we were able to use VIGRE funds to allow our majors to travel to conferences to present the results of their work both in our programs, and in other REU programs. We are only able to offer at present 15–20 percent of our majors enrollment in an undergraduate research seminar because of faculty resource

limitations. If VIGRE were to command that many or most majors have such an experience, we would not be able to comply, and it is not clear that every major would benefit from such an experience."

At the graduate level the Berkeley VIGRE grant also suffered because of the large size of the program. Moore described the situation as follows: "We have about $5M in all forms of financial support for our graduate students, and our VIGRE grant, which was defunded by NSF after three years, provided $250K, or about 5 percent of the total. This was an extraordinarily useful form of money, but ultimately its impact on the overall graduate program was not large. It provided fellowships for ten out of a total of about thirty first-year domestic graduate students, who would have otherwise been supported by a teaching appointment. This no doubt bothered the VIGRE management team that their money was not having a more visible impact."

When asked by the VIGRE site visit team, "What would produce a significant impact at Berkeley?", Moore's response was that "$1M in graduate fellowships would certainly have an impact—for instance, twenty first-year fellowships and twenty 'dissertation year' fellowships." In his essay he hastens to add: "But there are catches here—first of all, VIGRE would never give us this kind of money, and second of all, I would not want it. My problem with it would be that we have to do long-term planning of our graduate enrollments and that requires a reasonably steady base of resources. From recent experiences, we would face the prospect of having $1M pulled out of our graduate student support budget essentially on a moment's notice. That would leave us in an untenable position, and being so dependent on one source would open the whole program up to all manner of subtle and not so subtle influences from the funding agency as to program structure and educational philosophy."

Another issue surrounding graduate education, which has been raised throughout the country, is the restriction of VIGRE funds to U.S. citizens. In Moore's words, "The strongest and best-prepared graduate students who enter our program are either international students, or domestic students who come to us with NSF or other kinds of fellowships or are students whom we can propose in the campus-wide competition for university fellowships and who will be successful in that competition. The fact is, the students supported on VIGRE at Berkeley are generally, but not always, the students who are among the least well-prepared and the ones most at risk. Thus the VIGRE students are not an elite group of the best students, as the NSF had perhaps imagined they would be."

Finally on the subject of mentoring: "We arrange for several different kinds of mentoring of our graduate students—peer mentoring by more senior graduate students and mentoring by faculty advisors in the years before a student settles down with a dissertation supervisor. We also cultivate a degree of self-reliance in our students, a characteristic which we believe is essential for success as a mathematician. In the general spirit of our department which has few stated requirements, such mentoring is not required, but is recommended and is readily available. Students ultimately have to make a decision for themselves. As judged from the reviews of our VIGRE project, this kind of approach appears not to be the correct mold for VIGRE."

Turning to the VIGRE program as a whole, Moore has the following thoughts: "Let me conclude with some general observations flowing from these more specific comments. The VIGRE program, it seems to me, has created something of an adversarial relationship between the mathematics community and the Division of Mathematical Sciences at NSF. A small group of program officers in Washington have become, in effect, inspector generals of mathematics education and training. Is this the proper role for NSF to be playing?

"I take the fundamental goal of the VIGRE program to be the laudable one of increasing the number of students studying mathematics and pursuing careers based on this training. However, it seems that NSF has decided in advance how to achieve this goal and has constructed a program that does not give sufficient recognition to the diversity of departments and institutional goals, and the diversity of programs and of the students enrolled in them.

"A second and related problem is that VIGRE guidelines call for changes in departmental programs, even when there is no reason for change or when some significant changes have already been made. Finally, and most important, there has been an absence of any broad engagement by NSF with the mathematical sciences community in a discussion of the goals and implementation of the VIGRE program and of the resulting problems just described.

"One immediate step that should be taken by NSF is to conduct a thorough review of the VIGRE program. This review should engage the mathematical sciences community, should address questions about the proper role of NSF, issues of flexibility within general program goals, the balance of support for graduate students and postdoctoral fellows between VIGRE and other programs, and, most important, should address the mechanisms and process for review and evaluation of VIGRE projects. As the VIGRE program has stated goals concerning work-force issues, its effectiveness in advancing these goals should be assessed as part of the review."

In response to Calvin Moore's remarks and to this article in general, Philippe Tondeur, director of the Division of Mathematical Sciences[2], had the following to say: "The report of successful VIGRE activities at this meeting was extremely gratifying. The considerable space given above to expressions of dissatisfaction with the VIGRE activity seems out of proportion to the positive response from most participants in the meeting and in most parts of the mathematical sciences community. I would like to take this opportunity to review the context of this effort of the mathematical sciences community.

"VIGRE was designed to stimulate innovative educational projects that address declining enrollments in mathematics and statistics graduate programs. The idea was to give as much freedom as possible to the imagination of the proposing departments in formulating plans to address serious concerns about mathematical sciences training of students and postdoctoral fellows in the U.S. The long-range goal of the VIGRE activity is to increase the number of well-trained U.S. citizens, nationals, and permanent residents who pursue careers in the mathematical sciences, and to more systematically involve research mathematicians and statisticians in the training of the next generation of scientists. The restriction to funding U.S. citizens, nationals, and permanent residents in training programs such as IGERT (Integrative Graduate Education and Research Training), REU, NSF postdocs, NSF graduate fellowships, and VIGRE is an expression of NSF policy, as governed by the National Science Board. The evidence at hand so far is overwhelming that a significant proportion of the mathematics and statistics community is reassessing and improving its efforts to recruit, mentor, and retain students and postdocs. In recent years the career opportunities for mathematically trained scientists have become more diverse, and the mathematical sciences community has also increased activities to broaden mathematical education. The VIGRE activity in particular has attracted great interest both at the NSF leadership level and in the academic community in the U.S. as well as abroad.

"This initiative of DMS, developed with input from the mathematical sciences community, is one of the factors which have led NSF to declare the mathematical sciences a priority area. This has and will have profound implications on its current and future budgets. There is increasing recognition that the mathematical sciences are becoming crucial components of scientific training and research in many areas, and that in some cases they play a transformational role in the evolution of other science areas. DMS continues to expand its partnerships with other sciences at NSF, both in research and training. The educational broadening aspects of VIGRE form an integral part of this expansion. DMS has crafted programs that directly respond to the needs and interests of the mathematical sciences community in all its aspects, namely fundamental mathematical sciences advances, connections to the sciences and engineering, and the educational and training aspects of our professional activities. Manifestations of this include a significant growth in all core programs, an expanding Focused Research Group activity, and the funding of three new mathematical sciences institutes. It has been exhilarating to be able to serve the mathematical sciences in a period of such heightened attention to its fundamental pursuits."

[2]*Philippe Tondeur ended his term as director on July 31, 2002. His successor is William Rundell of Texas A&M University.*

WHAT IS . . .

A Building?

Kenneth S. Brown

Buildings were introduced by Jacques Tits to provide a geometric framework for understanding certain classes of groups. The definition evolved gradually during the 1950s and 1960s and reached a mature form about 1965. My treatment will be based on Tits's 1965 definition, in which a building is a simplicial complex with certain properties. It is possible to give a more modern answer to "What is a building?", which is equivalent but looks very different; see [2].

Buildings are made up of apartments, also called *thin buildings* or *Coxeter complexes*; these correspond to Coxeter groups. A *Coxeter group* is a group generated by elements of order 2, subject to relations that give the orders of the pairwise products of the generators. The simplest example is the dihedral group D_{2m} of order $2m$, with presentation

$$D_{2m} = \langle s, t \mid s^2 = t^2 = (st)^m = 1 \rangle .$$

The infinite dihedral group

$$D_\infty = \langle s, t \mid s^2 = t^2 = 1 \rangle$$

is also a Coxeter group; there is no relation for the product st because it has infinite order. Readers who have studied Lie theory have seen Weyl groups, which are the classical examples of Coxeter groups. The symmetric group S_4 on four letters, for instance, is the Weyl group of type A_3, with presentation

$$S_4 = \langle s, t, u \mid s^2 = t^2 = u^2 = (st)^3 = (tu)^3 = (su)^2 = 1 \rangle .$$

Every finite Coxeter group can be realized in a canonical way as a group of orthogonal transformations of Euclidean space, with the generators of order 2 acting as reflections with respect to hyperplanes. Thus D_{2m} acts on the plane, with s and t acting as reflections through lines that meet at an angle of π/m. And S_4 admits a reflection representation on 3-space, obtained by starting with the obvious action of S_4 on $\mathbb{R}^4$ and restricting to the subspace $x_1 + x_2 + x_3 + x_4 = 0$. More geometrically, we get this action by viewing S_4 as the group of symmetries of a regular tetrahedron.

Given a finite Coxeter group W and its reflection representation on Euclidean space, consider the set of hyperplanes whose reflections belong to W. If we cut the unit sphere by these hyperplanes, we get a cell decomposition of the sphere. The cells turn out to be (spherical) simplices, and we obtain a simplicial complex $\Sigma = \Sigma(W)$ triangulating the sphere. This is the Coxeter complex associated with W.

For D_{2m} acting on the plane, Σ is a circle decomposed into $2m$ arcs. For the action of S_4 on 3-space, Σ is the triangulated 2-sphere shown in Figure 1. There are six reflecting hyperplanes, which cut the sphere into twenty-four triangular regions. Combinatorially, Σ is the barycentric subdivision of the boundary of a tetrahedron, as indicated in the picture. (One face of an inscribed tetrahedron is visible.) The vertex labels will be explained below.

A similar but more complicated construction yields a Coxeter complex associated with an arbitrary Coxeter group W. For example, $\Sigma(D_\infty)$ is a triangulated line, with the generators s and t acting as affine reflections with respect to the endpoints of an edge.

In general, a simplicial complex Σ is said to be a *Coxeter complex* if it is isomorphic to $\Sigma(W)$ for some Coxeter group W. Such complexes are glued together to make buildings. Here is the canonical example of a building: Let k be a field and let $\Delta = \Delta(k^n)$ be the abstract simplicial complex whose vertices are the nonzero proper subspaces of the vector space k^n and whose simplices are the chains

$$V_1 < V_2 < \cdots < V_r$$

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The author is grateful to Bill Casselman for drawing Figure 1.

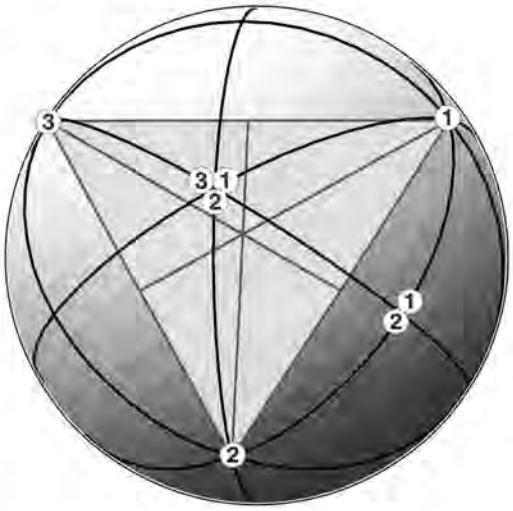

Figure 1. The Coxeter complex of type A_3.

of such subspaces. Every simplex σ is contained in a subcomplex, called an apartment, which is isomorphic to the Coxeter complex associated with the symmetric group on n letters. To find such an apartment, choose a basis $e_1, e_2, \ldots, e_n$ of k^n such that every subspace V_i that occurs in σ is spanned by some subset of the basis vectors. We then get an apartment containing σ by taking *all* simplices whose vertices are spanned by subsets of the basis vectors.

Figure 1 shows an apartment for the case $n = 4$. The labels on the vertices indicate which basis vectors span the corresponding subspace. Thus the vertex labeled 2 is the line spanned by e_2, the vertex labeled 12 is the plane spanned by e_1 and e_2, and the vertex labeled 123 is the 3-dimensional space spanned by e_1, e_2, and e_3. These three subspaces form a chain, so they span a 2-simplex in Δ.

For a second example of a building, take any simplicial tree with no endpoints (i.e., every vertex is incident to at least two edges). Any subcomplex isomorphic to a triangulated line is an apartment, isomorphic to the Coxeter complex associated with the infinite dihedral group.

With these two examples at hand, we are ready to give the official axiomatic definition. The reader is warned in advance that it is not easy to get a feel for the axioms without seeing them used to prove a few things.

A *building* is a simplicial complex that can be expressed as the union of subcomplexes Σ, called *apartments*, satisfying the following axioms:

- **(B0)** Each apartment is a Coxeter complex.
- **(B1)** Any two simplices are contained in an apartment.
- **(B2)** Given two simplices σ, τ and two apartments Σ, Σ' containing them, there is an isomorphism $\Sigma \to \Sigma'$ fixing σ and τ pointwise.

We allow σ and τ to be empty in **(B2)**, so any two apartments are isomorphic.

It is straightforward to verify that trees without endpoints are in fact buildings. Checking the axioms in our first example, however, is more challenging; see [1, IV.2, Exercise 2] for an outline of one way to do this, based on the Jordan-Hölder theorem.

I said at the beginning that buildings arose from connections between geometry and group theory. "Geometry" here refers to incidence geometry: projective geometry, polar geometry,.... For example, the building $\Delta(k^n)$, which can be viewed as a simplicial encoding of $(n-1)$-dimensional projective space, is closely related to the projective general linear group $\mathrm{PGL}_n(k)$. The fundamental theorem of projective geometry is a precise result in this direction. One of the great achievements of Tits is a vast generalization of this result, proved in [3], which classifies thick, irreducible, spherical buildings of dimension at least 2. Roughly speaking, they are all associated with simple algebraic or classical groups. [A building is *thick* if every simplex of codimension 1 is a face of at least three maximal simplices. It is *irreducible* if it cannot be expressed as the simplicial join of lower-dimensional buildings. And it is *spherical* if the apartments are finite complexes, and hence triangulated spheres.]

In this essay I have given an old-fashioned answer to the question "What is a building?", with hardly any hint as to what has happened since 1965. Lest the reader get the wrong impression, let me close by saying that buildings and their applications continue to be an active area of research. For one thing, connections between buildings, group theory, and geometry are still of great interest. Kac-Moody theory has been one catalyst here. Secondly, buildings arise in conjunction with a variety of other areas of mathematics. Indeed, a search of the recent literature reveals papers about random walks and potential theory on buildings, harmonic maps into buildings, buildings associated with manifolds of nonpositive curvature,.... All indications are that buildings will continue to be a rich and fertile source of mathematical work.

References

[1] Kenneth S. Brown, *Buildings*, Springer-Verlag, New York, 1989.

[2] Mark Ronan, *Lectures on Buildings*, Perspectives in Mathematics, vol. 7, Academic Press, Boston, MA, 1989.

[3] Jacques Tits, *Buildings of Spherical Type and Finite BN-pairs*, Lecture Notes in Mathematics, Vol. 386, Springer-Verlag, Berlin, 1974.

Comments and suggestions may be sent to whatis-notices@ams.org.

The World of Blind Mathematicians

A visitor to the Paris apartment of the blind geometer Bernard Morin finds much to see. On the wall in the hallway is a poster showing a computer-generated picture, created by Morin's student François Apéry, of Boy's surface, an immersion of the projective plane in three dimensions. The surface plays a role in Morin's most famous work, his visualization of how to turn a sphere inside out. Although he cannot see the poster, Morin is happy to point out details in the picture that the visitor must not miss. Back in the living room, Morin grabs a chair, stands on it, and feels for a box on top of a set of shelves. He takes hold of the box and climbs off the chair safely—much to the relief of the visitor. Inside the box are clay models that Morin made in the 1960s and 1970s to depict shapes that occur in intermediate stages of his sphere eversion. The models were used to help a sighted colleague draw pictures on the blackboard. One, which fits in the palm of Morin's hand, is a model of Boy's surface. This model is not merely precise; its sturdy, elegant proportions make it a work of art. It is startling to consider that such a precise, symmetrical model was made by touch alone. The purpose is to communicate to the sighted what Bernard Morin sees so clearly in his mind's eye.

A sighted mathematician generally works by sitting around scribbling on paper: According to one legend, the maid of a famous mathematician, when asked what her employer did all day, reported that he wrote on pieces of paper, crumpled them up, and threw them into the wastebasket. So how do blind mathematicians work? They cannot rely on back-of-the-envelope calculations, half-baked thoughts scribbled on restaurant napkins, or hand-waving arguments in which "this" attaches "there" and "that" intersects "here". Still, in many ways, blind mathematicians work in much the same way as sighted mathematicians do. When asked how he juggles complicated formulas in his head without being able to resort to paper and pencil, Lawrence W. Baggett, a blind mathematician at the University of Colorado, remarked modestly, "Well, it's hard to do for anybody." On the other hand, there seem to be differences in how blind mathematicians perceive their subject. Morin recalled that, when a sighted colleague proofread Morin's thesis, the colleague had to do a long calculation involving determinants to check on a sign. The colleague asked Morin how he had computed the sign. Morin said he replied: "I don't know—by feeling the weight of the thing, by pondering it."

Blind Mathematicians in History

The history of mathematics includes a number of blind mathematicians. One of the greatest mathematicians ever, Leonhard Euler (1707–1783), was blind for the last seventeen years of his life. His eyesight problems began because of severe eyestrain that developed while he did cartographic work as director of the geography section of the St. Petersburg Academy of Science. He had trouble with his right eye starting when he was thirty-one years old, and he was almost entirely blind by age fifty-nine. Euler was one of the most prolific mathematicians of all time, having produced around 850 works. Amazingly, half of his output came after his blindness. He was aided by his prodigious memory and by the assistance he received from two of his sons and from other members of the St. Petersburg Academy.

The English mathematician Nicholas Saunderson (1682–1739) went blind in his first year, due to smallpox. He nevertheless was fluent in French, Greek, and Latin, and he studied mathematics. He was denied admission to Cambridge University and never earned an academic degree, but in 1728 King George II bestowed on Saunderson the Doctor of Laws degree. An adherent of Newtonian philosophy, Saunderson became the Lucasian Professor of Mathematics at Cambridge University, a

position that Newton himself had held and that is now held by the physicist Stephen Hawking. Saunderson developed a method for performing arithmetic and algebraic calculations, which he called "palpable arithmetic". This method relied on a device that bears similarity to an abacus and also to a device called a "geoboard", which is in use nowadays in mathematics teaching. His method of palpable arithmetic is described in his textbook *Elements of Algebra* (1740). It is possible that Saunderson also worked in the area of probability theory: The historian of statistics Stephen Stigler has argued that the ideas of Bayesian statistics may actually have originated with Saunderson, rather than with Thomas Bayes [St].

Several blind mathematicians have been Russian. The most famous of these is Lev Semenovich Pontryagin (1908–1988), who went blind at the age of fourteen as the result of an accident. His mother took responsibility for his education, and, despite her lack of mathematical training or knowledge, she could read scientific works aloud to her son. Together they fashioned ways of referring to the mathematical symbols she encountered. For example, the symbol for set intersection was "tails down", the symbol for subset was "tails right", and so forth. From the time he entered Moscow University in 1925 at age seventeen, Pontryagin's mathematical genius was apparent, and people were particularly struck by his ability to memorize complicated expressions without relying on notes. He became one of the outstanding members of the Moscow school of topology, which maintained ties to the West during the Soviet period. His most influential works are in topology and homotopy theory, but he also made important contributions to applied mathematics, including control theory. There is at least one blind Russian mathematician alive today, A. G. Vitushkin of the Steklov Institute in Moscow, who works in complex analysis.

France has produced outstanding blind mathematicians. One of the best known is Louis Antoine (1888–1971), who lost his sight at the age of twenty-nine in the first World War. According to [Ju], it was Lebesgue who suggested Antoine study two- and three-dimensional topology, partly because there were at that time not many papers in the area and partly because "dans une telle étude, les yeux de l'esprit et l'habitude de la concentration remplaceront la vision perdue" ("in such a study the eyes of the spirit and the habit of concentration will replace the lost vision"). Morin met Antoine in the mid-1960s, and Antoine explained to his younger fellow blind mathematician how he had come up with his best-known result. Antoine was trying to prove a three-dimensional analogue of the Jordan-Schönflies theorem, which says that, given a simple closed curve in the plane, there exists a homeomorphism of the plane that takes the curve into the standard circle. What Antoine tried to prove is that, given an embedding of the two-sphere into three-space, there is a homeomorphism of three-space that takes the embedded sphere into the standard sphere. Antoine eventually realized that this theorem is false. He came up with the first "wild embedding" of a set in three-space, now known as Antoine's necklace, which is a Cantor set whose complement is not simply connected. Using Antoine's ideas, J. W. Alexander came up with his famous horned sphere, which is a wild embedding of the two-sphere in three-space. The horned sphere provides a counterexample to the theorem Antoine was trying to prove. Antoine had proved that one could get the sphere embedding from the necklace, but when Morin asked him what the sphere embedding looked like, Antoine said he could not visualize it.

Everting the Sphere

Morin's own life story is quite fascinating. He was born in 1931 in Shanghai, where his father worked for a bank. Morin developed glaucoma at an early age and was taken to France for medical treatment. He returned to Shanghai, but then tore his retinas and was completely blind by the age of six. Still, he has a stock of images from his sighted years and recalls that as a child he had an intense interest in optical phenomena. He remembers being captivated by a kaleidescope. He had a book about colors that showed how, for example, red and yellow mix together to produce orange. Another memory is that of a landscape painting; he remembers looking at the painting and wondering why he saw three dimensions even though the painting was flat. His early visual memories are especially vivid because they were not replaced by more images as he grew up.

After he went blind, Morin left Shanghai and returned to France permanently. There he was educated in schools for the blind until age fifteen, when he entered a regular *lycée*. He was interested in mathematics and philosophy, and his father, thinking his son would not do well in mathematics, steered Morin toward philosophy. After studying at the École Normale Supérieure for a few years, Morin

Leonhard Euler

became disillusioned with philosophy and switched to mathematics. He studied under Henri Cartan and joined the Centre National de la Recherche Scientifique as a researcher in 1957. Morin was already well known for his sphere eversion and had spent two years at the Institute for Advanced Study by the time he finished his Ph.D. thesis in singularity theory in 1972, under the direction of René Thom. Morin spent most of his career teaching at the Université de Strasbourg and retired in 1999.

Photograph courtesy of John M. Sullivan, University of Illinois.

Bernard Morin with one of Stewart Dickson's models, at the International Colloquium on Art and Mathematics in Maubeuge, France, in September 2000.

It was in 1959 that Stephen Smale proved the surprising theorem that all immersions of the n-sphere into Euclidean space are regularly homotopic. His result implies that the standard embedding of the two-sphere into three-space is regularly homotopic to the antipodal embedding. This is equivalent to saying that the sphere can be everted, or turned inside out. However, constructing a sphere eversion following the arguments in Smale's paper seemed to be too complicated. In the early 1960s, Arnold Shapiro came up with a way to evert the sphere, but he never published it. He explained his method to Morin, who was already developing similar ideas of his own. Physicist Marcel Froissart was also interested in the problem and suggested a key simplification to Morin; it was for the collaboration with Froissart that Morin created his clay models. Morin first exhibited a homotopy that carries out an eversion of the sphere in 1967.

Charles Pugh of the University of California at Berkeley used photographs of Morin's clay models to construct chicken wire models of the different stages of the eversion. Measurements from Pugh's models were used to make the famous 1976 film *Turning a Sphere Inside Out*. Created by Nelson Max, now a mathematician at Lawrence Livermore National Laboratory, the film was a tour de force of computer graphics available at that time. Morin actually had two different renditions of his sphere eversion, and at first he was not sure which one appeared in the film. He asked some of his colleagues who had seen the film which rendition was depicted. "Nobody could answer," he recalled.

Since the making of Max's film, other sphere eversions have been developed, and new movies depicting them have been made. One eversion was created by William Thurston, who found a way to make Smale's original proof constructive. This eversion is depicted in the film *Outside In*, made at the Geometry Center [OI]. Another eversion originated with Rob Kusner of the University of Massachusetts at Amherst, who suggested that energy-minimization methods could be used to generate Morin's eversion. Kusner's idea is depicted in a movie called *The Optiverse*, created in 1998 by the University of Illinois mathematicians John M. Sullivan, George Francis, and Stuart Levy [O]. Sculptor and graphics animator Stewart Dickson used the *Optiverse* numerical data to make models of different stages of the optiverse eversion, for a project called "Tactile Mathematics" (one aim of the project is to create models of geometric objects for use by blind people). Some of the optiverse models were given to Morin during the International Colloquium on Art and Mathematics in Maubeuge, France, in September 2000. Morin keeps the models in his living room.

Far from detracting from his extraordinary visualization ability, Morin's blindness may have enhanced it. Disabilities like blindness, he noted, reinforce one's gifts and one's deficits, so "there are more dramatic contrasts in disabled people," he said. Morin believes there are two kinds of mathematical imagination. One kind, which he calls "time-like", deals with information by proceeding through a series of steps. This is the kind of imagination that allows one to carry out long computations. "I was never good at computing," Morin remarked, and his blindness deepened this deficit. What he excels at is the other kind of imagination, which he calls "space-like" and which allows one to comprehend information all at once.

One thing that is difficult about visualizing geometric objects is that one tends to see only the outside of the objects, not the inside, which might be very complicated. By thinking carefully about two things at once, Morin has developed the ability to pass from outside to inside, or from one "room" to another. This kind of spatial imagination seems to be less dependent on visual experiences than on tactile ones. "Our spatial imagination is framed by manipulating objects," Morin said. "You act on objects with your hands, not with your eyes. So being outside or inside is something that is really connected with your actions on objects." Because he is so accustomed to tactile information, Morin can, after manipulating a hand-held model for a couple of hours, retain the memory of its shape for years afterward.

Geometry: Pure Thinking

At a meeting at the Mathematisches Forschungsinstitut Oberwolfach in July 2001, Emmanuel Giroux presented a lecture on his latest work entitled

"Contact structures and open book decompositions". Despite Giroux's blindness—or maybe because of it—he gave what was probably the clearest and best organized lecture of the week-long meeting. He sat next to an overhead projector, and as he put up one transparency after another, it was apparent that he knew exactly what was on every transparency. He used his hands to schematically illustrate his precise description of how to attach one geometric object to the boundary of another. Afterwards some in the audience recalled other lectures by Giroux, in which he described, with great clarity, certain mathematical phenomena as evolving like the frames in a film. "In part it's my way of doing things, my style" to try to be as clear as possible, Giroux said. "But also I'm often extremely frustrated because other mathematicians don't explain what they are doing at the board and what they write." Thus the clarity of his lectures is in part a reaction against hard-to-understand lectures by sighted colleagues, who can get away with being less organized.

Giroux has been blind since the age of eleven. He notes that most blind mathematicians are or were working in geometry. But why geometry, the most visual of all areas of mathematics? "It's pure thinking," Giroux replied. He explained that, for example, in analysis, one has to do calculations in which one keeps track line-by-line of what one is doing. This is difficult in Braille: To write, one must punch holes in the paper, and to read one must turn the paper over and touch the holes. Thus long strings of calculations are hard to keep track of (this burden may ease in the future, with the development of "paperless writing" tools such as refreshable Braille displays). By contrast, "in geometry, the information is very concentrated, it's something you can keep in mind," Giroux said. What he keeps in mind is rather mysterious; it is not necessarily pictures, which he said provide a way of representing mathematical objects but not a way of thinking about them.

In [So], Alexei Sossinski points out that it is not so suprising that many blind mathematicians work in geometry. The spatial ability of a sighted person is based on the brain analyzing a two-dimensional image, projected onto the retina, of the three-dimensional world, while the spatial ability of a blind person is based on the brain analyzing information obtained through the senses of touch and hearing. In both cases, the brain creates flexible methods of spatial representation based on information from the senses. Sossinski points out that studies of blind people who have regained their sight show that the ability to perceive certain fundamental topological structures, like how many holes something has, are probably inborn. "So a blind person who has regained his eyesight can at first not distinguish between a square and a circle," Sossinski writes. "He just sees their topological equivalence. On the other hand he sees immediately that a torus is not a ball." In a private communication, Sossinski also noted that sighted people sometimes have misconceptions about three-dimensional space because of the inadequate and misleading two-dimensional projection of space onto the retina. "The blind person (via his other senses) has an undeformed, directly 3-dimensional intuition of space," he said.

As noted in [Ja], attempts to understand spatial ability have a long history going back at least to the time of Plato, who believed that all people, blind or sighted, have the same ability to understand spatial relations. Based on the ability of the visually impaired to learn shapes through touch, Descartes, in *Discours de la méthode* (1637), argued that the ability to create mental representational frameworks is innate. In the late eighteenth century, Diderot, who involved blind people in his research, concluded that people can gain a good sense of three-dimensional objects through touch alone. He also found that changes in scale presented few problems for the blind, who "can enlarge or shrink shapes mentally. This spatial imagination often consisted of recalling and recombining tactile sensations [Ja]." In recent decades, much research has been devoted to investigating the spatial abilities of blind people. The prevailing view was that the blind have weaker or less efficient spatial abilities than the sighted. However, research such as that presented in [Ja] challenges this view and appears to indicate that, for many ordinary tasks such as remembering a walking route, the spatial abilities of blind and sighted people are the same.

Challenges of Analysis

Not all blind mathematicians are geometers. Despite the formidable challenges analysis presents to the blind, there are a number of blind analysts, such as Lawrence Baggett, who has been on the faculty of the University of Colorado at Boulder for thirty-five years. Blind since the age of five, Baggett liked mathematics as a youngster and found he could do a lot in his head. He never learned the standard algorithm for long division because it was too clumsy to carry out in Braille. Instead, he figured out his own ways of doing division. There were not many textbooks in Braille, so he depended on his mother and his classmates reading to him. Initially he planned to become a lawyer "because that's what blind people did in those days." But once he was in college, he decided to study mathematics.

Baggett says he has never been very good in geometry and cannot easily visualize complicated topological objects. But this is not because he is blind; in visualizing, say, a four-dimensional sphere, he said, "I don't know why being able to see makes it any easier." When he does mathematics, he

Lawrence Baggett.

sometimes visualizes formulas and schematic, suggestive pictures. When he is tossing around ideas in his head, he sometimes makes Braille notes, but not very often. "I try to say it aloud," he explained. "I pace and talk to myself a lot." Working with a sighted colleague helps because the colleague can more easily look up references or figure out what a bit of notation means; otherwise, Baggett said, collaboration is the same as between two sighted mathematicians. But what about, say, going to the blackboard to draw a picture or to do a little calculation? "They do that to me too!" Baggett said with a laugh. The collaborators simply describe in words what is on the board.

Baggett does not find his ability to calculate in his head to be extraordinary. "My feeling is that sighted mathematicians could do a lot in their heads too," he remarked, "but it's handy to write on a piece of paper." A story illustrated his point. At a meeting Baggett attended in Poland in the dead of winter, the lights in the lecture hall suddenly died. It was completely dark. Nevertheless, the lecturer said he would continue. "And he did integrals and Fourier transforms, and people were following it," Baggett recalled. "It proved a point: You don't need the blackboard, but it's just a handy device."

Blind mathematics professors have to come up with innovative methods for teaching. Some write on the blackboard by writing the first line at eye level, the next at mouth level, the next at neck level, and so on. Baggett uses the blackboard, but more for pacing the lecture than for systematically communicating information the students are expected to write down. In fact, he tells them not to copy what he writes but rather to write down what he says. "My boardwork is just an attempt to make the class as much like a normal lecture as possible," he remarked. "Many of [the students] decide they have to learn a different way in my class, and they do." He makes up exams in TEX and has a Web page for homework problems and other information. For grading, he can use graders "but I lose personal feedback," so he uses a variety of schemes, such as having students present oral reports on their work. It is clear that Baggett's devotion to teaching and concern for students overcome any limitations imposed by his disability.

Means of Communicating

When he was growing up in Argentina in the 1950s, Norberto Salinas, who has been blind since age ten, found, just as Baggett did, that the standard profession for blind people was assumed to be law. As a result, there was no Braille material in mathematics and physics. But his parents would read aloud and record material for him. His father, a civil engineer, asked friends in mathematics and physics at the University of Buenos Aires whether his son could take the examination to enter the university. After Salinas got the maximum grade, the university agreed to accept him. In a contribution to a Historia-Mathematica online discussion group about blind mathematicians, Eduardo Ortiz of Imperial College, London, recalled examining Salinas in an analysis course at University of Buenos Aires. Salinas communicated graphical information by drawing pictures on the palm of Ortiz's hand, a technique that Ortiz himself later used when teaching blind students at Imperial. Salinas taught mathematics in Peru for a while and then went to the United States to get his Ph.D. at the University of Michigan. Today he is on the faculty of the University of Kansas.

Salinas said that he would often translate taped material into Braille, a step that helped him to absorb the material. He developed his own version of a Braille code for mathematical symbols and in the 1960s helped to design the standard code for representing such symbols in Spanish Braille. In the United States, the standard code for mathematical symbols in Braille is the Nemeth code, developed in the 1940s by Abraham Nemeth, a blind mathematics and computer science professor now retired from the University of Detroit. The Nemeth code employs the ordinary six-dot Braille codes to express numbers and mathematical symbols, using special indicators to set mathematical material off from literary material. Standard Braille was clearly not intended for technical material, for it does not provide representations for even the most common technical symbols; even integers must be represented by the codes for letters ($a = 1, b = 2, c = 3$, etc.). The Nemeth code can be difficult to learn because the same characters that mean one thing in literary Braille have different meanings in Nemeth. Nevertheless it has been extremely important in helping blind people, especially students, gain access to scientific and technical materials. Salinas and John Gardner, a blind physicist at Oregon State University, have developed a new code called GS8, which uses eight dots instead of the usual six. The two

additional dots, which are reserved for mathematical notation, provide the possibility of representing 255 characters rather than the sixty-three that are possible in standard Braille. In addition, the syntax of GS8 is based on LaTeX, making it feasible to convert GS8 documents into LaTeX, and vice versa.

Computers have opened up a whole world of communication possibilities for blind people. Screen reader programs, such as Jaws or SpeakUp, translate text on-screen into spoken words using speech synthesizers. Unfortunately, these programs generally do not work well with text containing mathematical symbols, and some blind mathematicians tend to use the programs only for reading email or surfing the Web (which is becoming more complicated for the blind due to the heavy use of graphics). A blind computer scientist at Cornell University, T. V. Raman, has developed a program called AsTeR, which accepts a TeX file as input and as output produces an audio file that contains a synthesized vocalization of the document, mathematics and all. Gardner has developed a program called TRIANGLE that has a speech synthesizer that is more basic than AsTeR and also includes a program for converting between LaTeX and the GS8 code.

Some blind mathematicians actually read TeX source files directly; Giroux does so using a refreshable Braille touch-screen. He said it is more comfortable to have an audio recording of a paper, but before having a recording made, he wants to know whether the paper is really interesting to him. Reading TeX files provides quick and direct access to the documents. Of course, TeX files are meant to be read by computers rather than humans and are therefore cumbersome and verbose. Nevertheless, Giroux said that their easy availability through electronic preprint servers and journals represents "huge progress" in his ability to stay in touch with current research. Books are a bigger problem than papers; although TeX is the standard way of publishing mathematics books, obtaining the TeX files from publishers is not a straightforward process.

Mathematics Accessible to the Blind

It is easy to understand how well-meaning people who know little about mathematics might assume that the subject's technical notation would create an insurmountable barrier for blind people. But in fact, mathematics is in some ways more accessible for the blind than other professions. One reason is that mathematics requires less reading because mathematical writing is compact compared to other kinds of writing. "In mathematics," Salinas noted, "you read a couple of pages and get a lot of food for thought." In addition, blind people often have an affinity for the imaginative, Platonic realm of mathematics. For example, Morin remarked that sighted students are usually taught in such a way that, when they think about two intersecting planes, they see the planes as two-dimensional pictures drawn on a sheet of paper. "For them, the geometry is these pictures," he said. "They have no idea of the planes existing in their natural space." Because blind students do not use drawings, it is natural for them to think about the planes in an abstract way.

The most famous blind American mathematician right now may be Zachary J. Battles, whose extraordinary story was even covered in *People* magazine. Blind almost from birth and adopted from a South Korean orphanage when he was three years old, Battles went on to earn a bachelor's degree in mathematics and a bachelor's and master's in computer science from Pennsylvania State University. He also traveled to Ukraine twice to teach English as a second language and worked as a mentor for other disabled students. He is now studying mathematics at the University of Oxford on a Rhodes Scholarship. Like so many other blind mathematicians, Battles is an inspiration to the sighted and the blind alike.

—Allyn Jackson

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"But What Good Came of It at Last?"* How to Assess the Value of Undergraduate Research

Ani Adhikari and Deborah Nolan

Every year a variety of special programs introduce undergraduates to research in the mathematical sciences. There is a general belief that such programs are good—many undergraduates apply, and being admitted is something of an academic distinction.

But with millions of dollars and tremendous effort being poured into these programs, a general belief in their worth is not enough. Granting agencies, and the rest of us, need a little more substance. Assessment plans have become a required element of most program proposals. But oh, that assessment section — scattered, vague, hurriedly cobbled together on the day before the proposal is due. We took a look online at several evaluation plans for the undergraduate research components in NSF (National Science Foundation) VIGRE (Vertical Integration of Research and Education in the Mathematical Sciences) proposals. What we saw hardly inspired confidence. One plan promised only "the usual student evaluations, with some supplementary questions." Another was reluctant to promise anything: "The perceived desirability for the student of these choices of employment or further education will be given where possible." And a third simply assumed what the results would be: "Qualitatively, there will be an enormous number of benefits to the department, industry, and the profession itself."

All these proposals were funded. But wishy-washy evaluation plans lead to wishy-washy assessments, making it hard to decide whether the programs are worthwhile.

As a pair of statisticians who ran a summer seminar-type program for a number of years, we had to do better. In this article we provide strategies for assessing the value of the undergraduate research experience and include the evaluation of our own program as a case study.

The structure of our evaluation scheme can be adapted to a variety of programs. The most direct application is to short-term intervention programs which involve a selection process for the participants. Some examples of these are the Research Experience for Undergraduates (REU) where students work on research problems, either singly or in small groups, under the supervision of faculty; summer math programs where students take seminars or "reading" courses and write expository papers; and intensive short courses. Our example evaluation plan can also be used, with modifications, for "in house" programs where all participants are from the host institution. These include research apprenticeships and seminars and other innovative programs such as those funded by several VIGRE grants.

Planning the Evaluation

The first rule of evaluations is: Plan ahead. Not only is this good for the evaluation, it can also benefit the program. For one thing, it forces the program's goals to be absolutely clear from the outset. Only when a program has a clear objective is it possible to design an evaluation to show whether and to what extent that objective was met. For example, "We want to encourage our students to go to graduate school," is not the same as, "We want to help our students to become research mathematicians." Evaluating the latter involves more long-term

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**Little Peterkin's question to his grandfather in* After Blenheim *by Robert Southey. Grandad's answer: "*Why, that I cannot tell," said he,/ "But 'twas a famous victory."

tracking than the former. Planning ahead can be good for the program in other ways—if organizers feel that an important question cannot be answered clearly under the proposed design, then perhaps the design needs a change.

Most evaluations try to answer some form of the question "Did the program work?" A sensible answer can be obtained only if the right questions are asked. We recommend listing the evaluation's goals early. Common examples are: to secure continued funding, to improve the program for the future, or to see if the program achieved a particular objective. All these are different, and having them clearly in mind helps to define the scope of the assessment and to sharpen its focus.

Every evaluation requires some fundamental decisions about its structure. We discuss the most common decisions in turn.

When to Ask

When and how often surveys are conducted depends heavily on the nature of the program. However, the basic timeline laid out here is common to most programs.

The effect of a program is best determined by comparing its participants to a "control group" who were not in the program. This is not always easy, as we will discuss later. But at the very least, an evaluation should try to determine whether it caused any change in its own participants. Baseline information gives a picture of the participant before the program—background, prior knowledge of areas which the program is trying to address, expectations of program, and so on. Some of this may be available in application materials, though applications are not entirely reliable. Students tend to fill them up with only what they feel will get them into the program. Anonymous questionnaires at the start of the program help to reduce this bias. These should carry an identification code so that each person's answers can be matched with answers given at the end of the program. We found the baseline information about our program participants very revealing. It dispelled many preconceived notions about our students, as we will point out in our case study.

Almost every program asks participants for feedback near the end of the program. This should not be put off until after the program is over, because once people have left, it is easy for them to "forget" to return their evaluation forms. All participants should be surveyed: students, faculty, and graduate student assistants if any. Measures such as test scores and grades can be included if appropriate, but the main emphasis as always is on the questions. These should go beyond eliciting cries of, "I loved it!" and should cover specific issues. Examples are: whether or not the program met the participant's expectations; whether in the view of the participant the program met its goals; the assessment of program details; and suggestions for changes in the future. Some questions should be designed for comparison with baseline information. Finally, an open-ended "Other comments?" section is highly recommended. The answers can reveal unanticipated flaws or benefits. We got everything from complaints about the quality of the pillows in the dorm to revelations about adversities our program had helped to overcome.

Long-term effects of the program can be detected only by following the students' progress for some time after the program is over. Exactly how much time will depend on the goals of the program. Many programs may carry out just one follow-up evaluation, but others may need to carry out several. Follow-up evaluations typically focus on participants' work after the program, but they can also reveal more. We found, for example, that our participants stayed friends and valued the support they got from each other for years after the program.

Whom to Ask

Typically the main source of information is the students who participated in the program. However, while many undergraduates can provide detailed and thoughtful comments, they can hardly be expected to come up with unbiased assessments of their own performance. It pays to get a second opinion, for corroboration and balance.

Faculty advisors such as those who wrote letters of recommendation for the student are an excellent resource. The most helpful information comes from those who continue to have some contact with the student after the intervention. They can comment on the effect of the program on the student and can provide comparisons with others who were not in the program. Programs which anticipate a long-term effect will need input from those who can judge the quality of the student's future work. Graduate advisors and employers are the most obvious people to ask, and we found them very willing to answer.

We tried to be careful about issues of privacy and confidentiality when asking for such evaluations. Before every follow-up survey we asked each student for permission to approach faculty and other advisors. Permission was almost always granted, but we had to be cautious about making conclusions in the cases where it was withheld.

Other sources of information are worth keeping in mind. For example, test scores and grades may provide useful information, especially if there is a way to compare them to those of students who were not in the program. Relevant information may also be found in published tables containing rates of entry into graduate programs, percentages of students of various demographic groups, and so on.

Many departments maintain such data; examples of tables are in [3].

We cannot over-emphasize the importance of staying in touch. Students move, graduate, drop out, spend time in the Peace Corps—there are countless decisions they can make about moving forward. And only the rare student remembers an undergraduate research program during these moves. The task of keeping in touch therefore falls on the program staff. A database of contact information should include current addresses, phone numbers, email addresses, and most importantly, permanent contact information for parents or guardians of students. Parents are much less likely to relocate than their dorm-sheltered children. We found them very well-disposed to help us regain contact with "lost" participants. The contact database should be brought up to date from time to time even when no survey is imminent. For example, in the case of programs which anticipate a long-term effect, contact must be made with students when they make decisions about the next stage of education or employment. If a program anticipates surveying mentors or others, information for these people has to be added.

What to Ask

Exactly what gets asked during an evaluation depends so heavily on the program that we felt it most useful to provide an example by briefly describing the evaluation of our own program. See the case study below. Changes required for other programs will, in most cases, be clear to organizers. Later we discuss adaptations appropriate for programs that are very different from ours. For excellent general information, consult Davis and Humphreys [2].

What to Do with the Answers

Once the responses come in, evaluators are usually faced with large piles of forms or megabytes of email which have to be sifted through and summarized. The summary must state, preferably right at the beginning, the number of people who were surveyed as well as the number who responded. After all, even a statement that starts with, "All the respondents said..." loses some of its punch if it turns out that only a small percent of the surveyed students bothered to say anything.

As statisticians we are familiar with numerous complex and ingenious methods for summarizing data. We think, however, that in evaluations such as the ones described here, the simplest methods are usually the most revealing. They are also easy to implement.

Standard numerical summaries such as percents and averages are the most common. It is worth noting that percents should be avoided if the total number is small—"4 of the 6 students" is better than "66.67 percent of the students". And averages can hide variability—if half the students give something a 0 rating while the other half give it 10, then "the average rating was 5" is not a useful statement. Percents are better. Bar graphs are handy for displaying uneven distributions. They are easier to understand than standard deviations or interquartile ranges, and they can be superimposed to show changes, for example, from one year to the next.

Restricting the summaries to one-dimensional ones can lose a lot of information. A student's response to two questions (possibly from different questionnaires administered at different times) can be displayed in a table of percents which show how the answers to the two questions vary together. That is, the percents reported should be conditional ones such as: "Among the students who gave a rank of 1 or 2 at baseline, 20 percent gave a rank of 4 or 5 at the end of the program." These percents can also be displayed in a bar graph, where one bar would represent each baseline rank and the height of the bar would give the proportion of "rank 4 or 5 at the end of the program" among the students who gave that baseline rank. Of course the heights of the bars will not add up to 100 percent.

The SMI/SIMS Case Study

Our own experience in evaluating special programs for undergraduates grew from running the Mills Summer Mathematics Institute (SMI) and later the Berkeley Summer Institute in the Mathematical Sciences (SIMS). These programs ran for six weeks each summer from 1991 to 1997. Each year about twenty undergraduate women participated. The programs were designed to prepare and motivate them to attend graduate school and pursue careers in the mathematical sciences. The students were selected through a nationwide application process. For more information on the programs see [4]; details of our evaluation appear in [1] and on the Web at `http://www.stat.berkeley.edu/users/sims/`.

The questions we addressed in the evaluation were formulated by considering both the concerns of reviewers for the NSF and the goals and possible side benefits of the program. The main issues were:

- What was the impact of the program on the student's decision to apply to graduate school?
- What was the program's success rate for students entering and completing advanced degrees in the mathematical sciences?
- How does the success rate compare to other rates of attendance and completion of graduate school?
- Did the program improve a student's self-confidence?

- Did the program increase a student's knowledge about and preparation for graduate school?
- Do students use the network of peers, graduate students, and faculty formed at the program?
- How does the program compare to an REU?
- What impact did the program have on the faculty and graduate students?

To answer these questions, we devised an evaluation plan that included:

- a baseline survey of students on the first day of the program;
- an end-of-program evaluation;
- a two-year-out survey of students as they made decisions about and entered graduate school;
- a survey of the faculty who wrote letters of recommendation for the students;
- a four-year-out survey of students when they would be well into graduate school;
- a survey of their graduate advisors, where applicable.

In addition, we surveyed faculty and graduate students who worked with the students in the program, and we collected information on the numbers of undergraduates going on to graduate school at the participants' home institutions.

Brevity is a virtue in questionnaires, so student questionnaires were approximately two pages long, and the faculty surveys were under one page. In addition to open-ended questions, there were several questions that asked the respondent to rate some aspect of the program on a numerical scale. Some questions in the baseline and end-of-program surveys were the same in order to make comparisons (with phrases like "Do you expect..." in the baseline survey being replaced by "Did you find..." in the later questionnaire). The two-year and four-year surveys had similar questions for comparison purposes as well. In addition, some questions on the faculty survey mirrored those on the student survey to allow comparison of the faculty member's perception with the student's.

We phrased these questions carefully to minimize bias in the response. Two examples appear in the box; in each, the student was asked to provide a rating on a scale of 1 (little or none) to 5 (a great deal). Notice the words "if any" in the first and "from your perspective" in the second which neutralize the questions.

An important benefit of the baseline survey is to get an accurate reading of who the participants are and to check whether prior assumptions about the participants are grounded in reality. Our baseline evaluation produced a revealing example of false assumptions. Entry to the program was based on an application process, and a natural query was revealed in an NSF review of the program's proposal: "For such an expensive and selective program should the success rates in turning out top notch female graduate students be higher?" To answer this question it was necessary to have some idea of the proportion of participants who firmly intended to go to graduate school even before they applied to the program. The anonymous baseline survey produced results that laid to rest the assumption that most of the students were predisposed towards graduate school; indeed, only seven of the twenty respondents were definitely planning to attend graduate school and expected financial support in the form of a fellowship or assistantship. With this concrete information at hand it was easier to measure the success of the program.

To what extent, if any, did the program affect your:

Self-confidence	1	2	3	4	5
Motivation to do graduate work	1	2	3	4	5
Knowledge about what graduate school is like	1	2	3	4	5

From your perspective, how important was it that the program involved only women as:

Students	1	2	3	4	5
Graduate students	1	2	3	4	5
Faculty	1	2	3	4	5

We conducted all our two-year and four-year surveys by email. Eighty percent (thirty-four out of forty-three) of the participants returned completed questionnaires, a very high response rate for a survey involving a long-term component. Of course the majority said that the program had a great impact on their motivation to do graduate work, but the detailed answers were more interesting. Over two-thirds reported a great increase in self-confidence after the program, and almost as many strongly agreed with the statement, "My work in the program showed me I enjoyed doing challenging math." Two students strongly disagreed and said that the program showed them that graduate school was not their goal; even though this is a negative lesson, it is better learned in the summer than in the first year of a Ph.D. program.

Surprisingly, more than half the students strongly agreed with the statement that the program "showed them how to learn advanced math." Given that the students were selected specifically for their ability to do mathematics, this proportion is very high and shows how work in the program differed from standard undergraduate fare.

But the main message from the students was that they were deeply impressed by the women on the faculty and by the group of talented women who had all gathered in the program to do mathematics. Over

80 percent of the respondents have stayed in touch with other students in the program, and over 70 percent have stayed in touch with program faculty. The students' opinion is best summarized by one of their own: "Until attending the SMI, I had only one female math professor. Ever. I think now I have a great advantage in having discovered some positive female role models in mathematics...I found the program...to be extremely helpful to seeing myself as a mathematician."

Just about 75 percent of the faculty mentors responded and provided valuable input on the effect of the program: Over 80 percent of the faculty respondents in the short-term survey said the program was very good for the student, and indeed, about 50 percent said that the program was a shot in the arm for their department as a whole. When asked whether participating in the program distinguished this student from other women math majors in their department, two themes recurred in their answers. They noticed a tremendous increase in the self-confidence and in the mathematical maturity of the student upon her return. This shows the benefit of surveying faculty as well as students: While students may be able to tell us they feel more confident, a professor is surely a better judge of mathematical maturity. The faculty were also able to provide us with information on the proportion of their students who go on to graduate school.

Adaptations: Small Programs and "In-house" Programs

The details of an assessment depend partly on the size of the program and the composition of its participant group. Specific issues arise in programs which have a small number of participants and in those which involve students from only a single institution.

Many REUs have fewer than ten participants each summer. In programs as small as these, yearly percentages are not meaningful. Instead, data from more than one year can be aggregated. Of course, responses should be pooled according to the same relative participation time, e.g., one year out of the program or first year in graduate school.

In addition, small programs typically involve closer interaction between students and faculty than programs with many participants. When a student works on a research project one-on-one or in a small group with a professor, the student-faculty interaction is very different from the classroom or seminar format, and the nature of the interaction is an important element of the program. The effectiveness of these programs may be best assessed through in-depth personal interviews rather than questionnaires. These interviews may, for example, be conducted in person at the end of the program or over the phone one to two years after participation. They should not be conducted by the faculty or directors of the program as doing so could bias student response. Someone outside the program, preferably someone who is trained in interviewing people, should conduct the interviews.

Programs where the students are from the host institution, such as many of those supported by VIGRE, have a big advantage in evaluation. Because the students are local, it is easier to maintain a database of past participants and to observe participants after the program. For example, a student's choice of future course work and course grades can be excellent sources of information. In addition, a control group of students who are similar to program participants can be found in recent graduates or peers at the home institution.

Difficulties

Even with enormous effort put into the design of an evaluation and its questionnaires, it is not always possible to get clean and unambiguous results. We found two major problems.

Nonresponse

People do not like to fill out questionnaires. Indeed, even the most enthusiastic participant may need some prodding before he or she will answer questions on an evaluation form and send the form back. To reduce nonresponse bias, we recommend the following.

- Keep the contact database up to date.
- Keep the questionnaires short and have an email or Web-based version. This means that the questions have to be very well chosen, and some work may have to go into creating a Web form. But the increase in response rate that results from forms that are easy to fill out and return is well worth the effort.
- Follow up nonrespondents. This means sending reminders, and reminders of reminders, by every means available — phone, email, and letters. This task is time-consuming and can be disheartening, but it is part of the difficulty of carrying out any survey.

In spite of all efforts, most surveys still suffer from some nonresponse, and the response rate needs to be reported in the analysis of the evaluation.

Lack of Comparison

Ideally, an evaluation would compare the performance of program participants to what their performance would have been had they not taken part in the program. This is of course impossible. It is also often difficult, if not impossible, to compare the performance of program participants to that of a control group, that is, students who were not in the program. The main problem lies in ensuring that participants and controls are similar in every respect other than the program.

For example, if entry into the program is the result of a competitive application process, it is not easy even to identify a control group. Students who did not apply to the program are clearly different; so are those who applied but were rejected. In any case, neither of these groups will be highly motivated to respond to questionnaires sent by a program they did not attend. In the absence of a reliable set of student controls, we strongly recommend getting information from external sources such as mentors (usually faculty), who know the participants as well as other students with similar backgrounds. This is a good way of obtaining the comparisons which are crucial for a meaningful evaluation. Available data, such as tables on the number of graduates from a student's institution who go on to graduate school or academic careers, may also be used as comparison figures for success rates.

Summary

Evaluations can provide concrete evidence of whether or not a program has achieved its stated goals. Such evidence can be used to improve the program, to support requests for continued funding of the program, and to give granting agencies something to which new programs can be compared.

Our experience shows that serious evaluation of undergraduate research programs is hard work but well worth the effort. We found that our evaluations influenced others to adopt successful aspects of our program and to start similar programs. A thoughtful and comprehensive evaluation, such as we have described here, helps not only to validate an innovative program but also to chart a course for future improvements of the program and, ultimately, for the way the U.S. trains undergraduates in mathematics. Updated information about our assessment materials is available on the Web at `http://www.stat.berkeley.edu/~sims/`.

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Book Review

Conned Again, Watson: Cautionary Tales of Logic, Math, and Probability

Reviewed by Jim Tattersall

Conned Again, Watson: Cautionary Tales of Logic, Math, and Probability
Colin Bruce
Perseus Publishing, 2002 (softcover)
304 pages, $15.00, ISBN 0-73-820589-3

Readers familiar with [1] and [2] by Colin Bruce will be pleased to learn that once again the game is afoot. This book is a collection of tales in which Sherlock Holmes solves mysteries that require mathematical deduction. The intent is twofold: to apprise the reader of common logical or mathematical deceptions and to embed those deceptions into detective stories featuring the well-known characters Sherlock Holmes and Doctor Watson. With this book the author accomplishes both goals with high marks.

When it comes to fulfilling the expectations of avid devotees of Sherlock Holmes, the author has set an arduous task for himself. Even though Holmes is a master of deductive reasoning, there are very few significant mathematical references in the adventures of Sherlock Holmes. Among the exceptions is a single instance where Holmes calculates the speed of a moving train using the fact that the telegraph posts he and Watson pass by are sixty yards apart [3]. In addition, two of Holmes' well-known maxims are relatively mathematical in nature, "Eliminate all which is impossible, then what remains however improbable must be the truth" [4] and "It is a capital mistake to theorize before you have all the evidence" [5]. In one of the early adventures, *A Study in Scarlet*, Watson rates Holmes' knowledge of various subjects and implies that his knowledge of the physical sciences and mathematics is somewhere between moribund and nonexistent. There are limited references in Sir Arthur Conan Doyle's stories to statistics or probability. As close as we come to an instance that is remotely connected to the theory of probability is when Watson in *The Adventure of Shoscombe Old Place* admits to spending half his pension playing the ponies [6]. One of the few statistical references occurs in *The Sign of the Four*, when Holmes remarks, "While the individual man is an insoluble puzzle, in the aggregate he becomes a mathematical certainty. You can, for example, never foretell what any one man will do, but you can say with precision what an average number will be up to. Individuals vary, but percentages remain constant. So says the statistician" [7]. The only descriptive statistics that appear in the Doyle adventures with any regularity usually come from either *Bradshaw's Railway Guide* or *Whitaker's Almanack*.

The flimflammery in the book at hand is presented in an informative and interesting manner and introduced into the text with a deft hand. The

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stories, set in the 1890s, convincingly incorporate details concerning the London environs from that period. Banter between Holmes and Watson while they are at their Baker Street lodgings or when they are out on a case is remarkably well reconstructed by the author and is consistent with the dialogues recorded by Doyle. We are dealing with a more alert and mathematically sophisticated Holmes than found in the Doyle stories. The current author's portrayal of Holmes as an erudite scholar of statistics, logic, and game theory is carried off well. Holmes goes to great lengths to provide Watson and the reader with clear explanations and illustrations of how not to be duped by fallacious reasoning or to succumb to a con man's tale. It appears that our beloved Holmes has become a pedagogue in his old age.

Appearances by well-known secondary Doyle characters such as Inspector Lestrade, Mycroft Holmes, and Mrs. Hudson add to the atmosphere of authenticity. A fabricated Dr. Penbury, Watson's supposed partner in general practice, makes a cameo appearance in "The Case of the Perfect Accountant". Mr. Barnum Rollman makes a remarkable return from the dead and is featured in two of the stories. An intriguing inclusion of the Reverend Charles Dodgson, better known to the rest of the world as Lewis Carroll, gives a mathematical boost and depth to several of the stories. The author also introduces us to a new cast of characters: villains such as McFarlane, the con man who swindles Watson's cousin James; clients like the Marquis of Whitebridge, an inveterate gambler; and Madam Zelda, High Priestess of the Great Faith, who has a sizable fortune to bequeath.

In "The Case of the Unfortunate Businessman" the author illustrates several deceptions highlighting, in particular, the fallacy of mistaking relative for absolute savings. An understanding of the concepts noted in this chapter will serve consumers well in the marketplace. "The Case of the Gambling Nobleman" points out what can happen when people ignore the small probability of a large loss. The birthday paradox and mistaking a uniform distribution for a random one are highlighted in "The Case of the Surprise Heir". The reader will find an interesting connection between the drunkard's walk, Pascal's triangle, and the normal distribution in "The Case of the Ancient Mariner". Bayesian logic, using the knowledge of the present to predict the future, is featured in "The Execution of Andrews". Holmes goes to great lengths in "Three Cases of Relative Horror" to explain several dilemmas that arise in game theory. Other cases deal with cryptology, fair division, Newcomb's law, statistical justice, and the prisoner's dilemma. A most beneficial aspect of the book is a final section referred to as the "Afterword" where the author suggests further reading and recaps the main objectives of each chapter.

The dénouements are well thought out and satisfying but not quite as suspenseful as those found in the Doyle stories. In addition, ancillary characters, which add mystique to the Doyle stories, are not as well developed in this book. They are no match for the characters found in the Sherlockian canon, where one can encounter sinister villains the likes of Professor James Moriarty, celebrated author of "The Dynamics of an Asteroid", and Doctor Grimsby Roylott, amateur herpetarian. Missing also are sympathetic damsels-in-distress such as Mary Morstan, Violet Hunter, and the Stoner sisters. Nor will readers find characters the likes of Irene Adler, Sir Henry Baskerville, Dr. Thorneycroft Huxtable, M.A., and Reginald Musgrave, M.P.

To be fair, the author's main objective is not character development. Rather, he aims to use the stories to illustrate mathematical and logical points. In this respect, the author succeeds admirably. The depth present in the Doyle stories is replaced by some very interesting mathematical vignettes that should appeal to the scientific mind. The stories are entertaining and the mathematics is for real. This book is a good addition to Sherlockian lore and would make an excellent supplement to a liberal-arts-based mathematics course or a quantitative reasoning course. And it's just a good book to sit down and read. For subsequent reading, I suggest the canon [8] or [9], the official publication of the Baker Street Irregulars. For those who prefer more mathematics and less dialogue, I highly recommend [10].

Acknowledgments

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Book Review

The Annotated Flatland: A Romance of Many Dimensions

Reviewed by A. K. Dewdney

The Annotated Flatland: A Romance of Many Dimensions
Edwin A. Abbott, with Introduction and Notes by Ian Stewart
Perseus Publishing, 2001
ISBN 0-738-20541-9, 160 pages, $30.00

I must confess at the outset to never having been a great fan of *Flatland*. Yet this new edition, decorated with insightful and helpful notes by Ian Stewart, has added a new depth (or is it thickness?) to the novel. Stewart is a fan of *Flatland* and has recently published a fantasy sendup called *Flatterland*.

Imagine then a lesson from Euclid brought to life by a nineteenth-century Englishman, teacher, and ordained minister. The characters are line segments, triangles of various persuasions, and polygons, some of them multisided enough to masquerade as circles. How do they move about in their plane world? No one, not Abbott, not Stewart, nor I, knows. Yet move they do, with passions and pleasures no less real, for all their lack of anatomy, than our own.

Writing a work of science fiction (Stewart identifies the work as pre-science fiction) that is based on certain rigid premises, such as dwelling entirely in the plane and being a polygon of one kind or another, entails certain consequences which it becomes the delight of the author to explore. That the premises lead sometimes to an awkward physics

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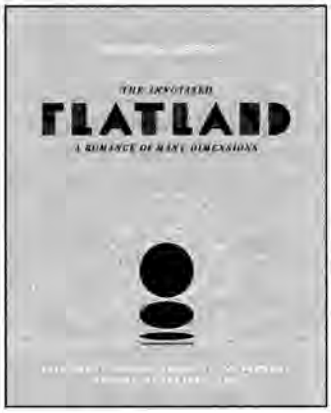


or society becomes a challenge to be surmounted, sometimes by a clever twist of plot, sometimes by the creaking of heavy backstage machinery that barely saves the situation. Most works of science fiction get over their premises in the first few pages, thereafter launching into the plot. But for the average Victorian reader, Flatland had to be explained very carefully, and Abbott was therefore led to write a natural history, rather than a science (or pre-science) fiction novel. Natural history was a popular topic in nineteenth-century England, including accounts of travels in exotic lands, many of them imperial territories and possessions.

But Abbott's was a natural history with a difference. Here was a land that everyone had visited in school, being subjected to plane figures, theorems, and constructions from Euclid. But it was also, under Abbott's hand, a land of passion and violence, not to mention extreme political incorrectness. Shortly after *Flatland* appeared, according to one of Stewart's notes, some readers objected to Abbott's characterization of Flatland females. Males could be many-sided, social rank increasing with the number of sides, but females were digons, their

sides coincident, mere segments. According to Stewart, Abbott was merely satirizing Victorian views of women, not expressing his own. Although the class structure reminds me more strongly of Imperial India, satire or lack of it may be a red herring. Abbott had made his choices and pressed on, tongue in cheek, to see what would come out of it all. Thus women, who were lower in caste than the narrowest "irregular" triangle and (apparently) completely without brains, nevertheless possessed a deadly penetrating power in their infinitesimal heads or tails, being able to pierce the side of any triangle or other polygon with instantly fatal effect. To warn others of their dangerous presence, women must utter "peace cries" and constantly wiggle their behinds. Hmmm.

The central metaphor of *Flatland* is of course the ability to appreciate higher, as well as lower, dimensions. As a teacher, Abbott had discovered a marvelous door to this world. He first explains how things in Flatland appear to Flatlanders and then demonstrates their utter helplessness in imagining something higher. The real target is you, the reader. Can you put yourself in a Flatlander's shoes? (Excuse me, they have no feet.) If so, you will discover that you have no more knowledge of the fourth dimension than a Flatlander does of the third. Yet you may embrace the analogy far enough to know in which direction the Flatlander must point, even if his arm (if he had one) must leave the plane entirely. Aha! If you were to point in the direction of a fourth dimension, would your arm not also disappear?

It is particularly helpful to be accompanied on this voyage by a presence on the sidelines, someone who can explain the twists and turns of dimensionality as cleverly and completely as Stewart. And besides four-dimensional spacetime and space-filling curves, there is the cellular automaton (which demonstrates a substrate for thought, thanks to von Neumann), Hilbert space (which has infinitely many dimensions), geometrical construction, and much else. Indeed, for those with a thirst for more dimensions and more about them, there is an excellent essay at the end of the book entitled "The Fourth Dimension in Mathematics".

Our three-dimensional companion also provides ample historical material from his two-dimensional space beside the text. There are crucial notes on Abbott's personal and professional life, many notes about historical figures, from British Prime Ministers to noted scientists of the day, whimsical observations on calendars, verse in scientific papers, sex in Flatland, and enough other entertaining material to divert the reader from drier stretches of the work.

The hero of the story is one A. Square who happens to be a square and therefore of higher caste, somewhere between a merchant and a physician. Thanks to a visit from a mysterious spherical being from three dimensions, Mr. Square has the mathematical equivalent of a religious experience and ultimately gets locked up for proclaiming his gospel. He witnesses a sphere manifesting in Flatland as a circle that gradually widens until it reaches its fullest extent, thereafter diminishing. A perfect being able to change its size at will, what else could it be but semidivine? As Stewart explains, however, Abbott himself took no spiritual message from his own book. As a minister he was at pains to point out (elsewhere) that seemingly miraculous powers, by themselves, do not warrant worship.

Abbott lays his chapters out with methodical precision. In the first he sketches the two-dimensional nature of Flatland, and in most of this he goes to great lengths to explain how Flatlanders see only lines. In Chapter 2 he discusses the climate and houses of Flatland. The houses are pentagonal because square (or worse, triangular) houses would have sharp corners that might do injury to passers-by. Instead of gravity created by large, nearby bodies, there is a "constant attraction to the South" (felt keenly by many English people even today). Thus rain must fall from the North. By this point in my original reading of the book, I can recall feeling distinctly disoriented, not to say puzzled, by such a peculiar way of arranging things. Yet, with no central planet, what else can Abbott do if he wants to have rain? There seems no reason why rain could not fall into Flatland from the third dimension, for this is the origin of all light in Flatland!

Chapter 3 sketches the inhabitants of Flatland as line segments (females), isosceles triangles (low-caste workers and soldiers), equilateral triangles ("middle class"), squares and pentagons ("professional class"), hexagons and higher ("nobility"). At the highest level of society are the near-circles ("priestly order"). A curious progression is made by the sons of regular polygons, who enjoy one more side than their fathers had. But the poor isosceles triangles are doomed to remain isosceles unless, by dint of perseverance and high achievement, an isosceles father will have an equilateral son (shades of Lamarck). "The birth of a True Equilateral triangle from Isosceles parents [sic] is the subject for rejoicing in our country for many furlongs round." There is social unrest among the lower classes, of course, but revolutions are nipped in the bud by a curious law of compensation: "Thus, in the most brutal and formidable of the soldier class—creatures almost on a level with women in their lack of intelligence—it is found that, as they wax in the mental ability necessary to employ their tremendous penetrating power to advantage, so do they wane in the power of penetration itself."

Chapter 4 is about women. To what I have already said, I might only add that, although brainless, they

suffer from being confined too much and are wont to rebel. "Hence, in their fits of fury, they remember no claims and recognize no distinctions. I have actually known a case where a woman has exterminated her whole household and half an hour afterwards, when her rage was over and the fragments swept away, has asked what became of her husband and children." Abbott has the bit in his teeth by now, perhaps relishing the public reaction to this shocking state of affairs.

In Chapter 5, Abbott must get around the inability of Flatlanders to recognize each other, especially to discern social class in encounters. They "feel" each other (without hands), and Abbott goes on at great length about the social conventions that arise from this practice: "Let me ask you to feel Mr. So-and-so." And on it goes. Flatlanders have an exquisite sense of touch that permits them to distinguish between the rather small differences in the angles of a pentagon and a hexagon. Not content with his earlier treatment of vision, Abbott returns to the subject by invoking yet another Deus ex Machina, a pervasive fog that causes farther surfaces to appear fainter.

The next three chapters concern history and an earlier use of colour to identify individuals. But then—you guessed it—things got out of hand, with lower classes painting themselves as upper, resulting in the "Chromatic Sedition," a move by the lower classes to erase all social distinctions. The revolt was put down with great violence and loss of life, something rather common in these pages.

But loss of life is an aspect of mortality and I cannot continue this review without a digression into the population biology of Flatland, a subject neglected by Abbott. There is a danger to the stability of Flatland society in the tendency for n-sided polygons (n-gons) to have $(n+1)$-sided sons.

Neglecting the scalene rabble and the isosceles workers for the moment, let there be m regular polygons with three or more sides, the average being x. In the next generation there will be $2m$ such polygons, with an average of $(2x+1)/2$ sides, unless, of course, not all polygons reproduce in every generation. The tendency to exponential growth in this class, along with a gradual but inexorable increase in average sidedness, will nevertheless be inevitable. The isosceles and scalene classes will grow apace, but the number of sides will remain the same at three. Losses due to violence and graduation to the polygon class will reduce this number slightly, but Abbott gives no discussion of mortality in general. Perhaps he has no need to, since the plane of Flatland is infinite and populations have no natural limits.

The danger to Flatland society is now clear. If the increase in x goes unchecked, the sidedness gap $x-3$ must grow with every generation, and stability of the society is in doubt. Is there yet another "Natural Law" that Abbott forgot to mention? In order to prevent the number x from increasing forever, the relative distribution of individuals within sidedness classes must remain the same over time. For this to happen, the distribution should be monotone decreasing in the direction of higher sidedness, there always being the same ratio of priests to those in lower classes for example. The number $f(n)$ of n-gons may increase with every generation, but the ratio $f(n+1)/f(n)$ must remain approximately constant at c, with $c<1$.

Now the number of n-gons will increase to $r(n)f(n)$ at the next generation, where r is the fecundity of that class. It follows that the fecundity r, as a function of n, must decline with increasing n, because the ratio of two populations at the next generation will be the same:

$$\frac{r(n+1)f(n+1)}{r(n)f(n)} = c$$

so that

$$\frac{r(n+1)}{r(n)} < c\frac{f(n)}{f(n+1)} = c(1/c) = 1,$$

The Greatest Circle (for so I call the highest priest) reproduces once in a blue moon. Indeed, Abbott implicitly recognizes this situation, stating that "as the race climbs higher in the scale of development, ... the race shall become less fertile." For some reason, he then spoils everything by declaring that development accelerates, with the number of sides increasing by leaps and bounds with every generation.

I had not intended to analyze the situation at such length, but such is the seductive charm of the Flatland setting that readers may well think of puzzles of their own. Should any prove insoluble, the validity of Abbott's Flatland will fall under the shadow of a grave inconsistency.

By Chapter 11, Abbott arrives at the priestly class and admits that the preceding natural history is but a preface to A. Square's "initiation into the mysteries of space". Before launching into the book's ultimate plot, he takes a last swipe at the woefully incomplete explanations of how Flatlanders get along or accomplish anything without hands or feet. He, through the person of his hero, A. Square, must neglect things like "the nature of our hills and mines, our trees and vegetables ..." in favour of the main event. This is just as well, since I cannot imagine what he could say about them. Unfortunately Abbott is not quite done with his natural history and societal exposition.

The priestly class is hardly religious, but administrative. In this and the subsequent chapter, we discover that the priestly class has succeeded in convincing the rest of Flatland society that configuration is everything, that individual effort leads

to no improvement in one's status. The doctrine has drawbacks, of course, and when Abbott's hero states that some scalene fellows plead in court that their crimes were the result of their poor configuration, Stewart leaps in with a discussion of the "nature versus nurture" question in our own three-dimensional society, comparing the scalene's plea to that of the drunk driver: "I couldn't help it, Your Honour, I was drunk."

Finally, in Chapter 13, Abbott settles to the main event, beginning with a visit to Lineland in a dream of A. Square's. Lineland is inhabited by line segments. Has he found the Planet of the Women? Not so. Yet every man has two wives in a world that permits no proximity whatever between male and female. Courtship (and, presumably, fertilization) is carried out entirely by sound, all inhabitants of Lineland being given to song. In this way Abbott gets around the difficulty that proximate courtship would create. Things get sillier than this in Lineland, but Abbott hastens on to the next chapter, in which his hero must explain to the King of Lineland the nature of Flatland. A. Square pleads with the King to imagine an extra dimension, all to no avail.

I was wrong. Finally, in Chapter 15, Abbott settles to the main event. It is the turn of the millennium (1999 in the Flatland era). In the midst of a geometry lesson for his hexagonal grandson, A. Square demonstrates how an array of squares three on a side has nine (the square of three) squares in it. But then the bright little fellow recalls that Grandpa has been teaching him to cube numbers, as well. "I suppose three cubed must mean something in Geometry. What does it mean?" The child tries to construct a higher dimension and Grandpa must send him off to bed with, "If you would talk less nonsense, you would remember more sense." Presently A. Square and his wife have a visitor from the third dimension, a sphere who asks to be left alone with the hero.

The sphere appears as a circle and therefore exercises great authority over our hero, who is nevertheless hard pressed to imagine what the circle means by being able to see into Square's house from a third dimension. The sphere describes the sleeping servants and other household contents of Square's house without having visited any of the rooms. Failing to convince Square that he comes from a higher dimension, the alien visitor proceeds in Chapter 17 to a demonstration of the reality of the third dimension. He filches an accounting book from a closed cupboard without opening the door. Square is even more horrified when the sphere pokes him from the inside.

The hero throws himself against the figure, judging him to be an evil magician. In the next chapter the sphere reacts by plucking Square right out of Flatland. Giddily, Square witnesses the spherical surface, as well as the contents of his own house. Technically, Square should be capable only of views that are one-dimensional cross-sections of these views, but by now the reader is swept up in the drama. If there is any place in the book where technical objections fall by the wayside, it is here. The two float through the third dimension until they can see the General Assembly Hall of the States of Flatland. As it happens, the administrators are in the midst of passing a law that dictates death or imprisonment for anyone preaching the "gospel of the third dimension." Apparently the Sphere has been visiting other households. However, even a visit by the sphere to the council chamber itself changes nothing. The presiding circle instructs those present to take no notice. This happens every millennium, it turns out.

There are further adventures in Spaceland, including a visit to various three-dimensional solids and an extended conversation with the Sphere in which Square asks whether spaces higher than three might exist. The Sphere pooh-poohs this idea, thereby granting Square a kind of moral and intellectual superiority by default. In the end, only Square knows the truth, but he is imprisoned for it. He writes from prison.

Abbott also writes from a prison of sorts. He has followed his premises, adding more or less arbitrary ideas (further premises) that allow a humanlike existence to his subjects. If the narrative creaks and groans under these burdens, Abbott nevertheless carries it off to the point of convincing the naive reader that perhaps higher dimensions do exist, which is all he set out to do. In this edition, Stewart is the tour operator, clearly enamored of this place and keen to give us the widest possible view. He includes every conceivable scrap of history and mathematics that bears on the strange adventures of A. Square.

With me, Stewart succeeds as well. How else did I become motivated to explore the population biology of Flatland? How else to explain my renewed interest in the subject of two-dimensional existence?

Lafforgue and Voevodsky Receive Fields Medals

Laurent Lafforgue

Vladimir Voevodsky

On August 20, 2002, two Fields Medals were awarded at the opening ceremonies of the International Congress of Mathematicians (ICM) in Beijing, China. The medalists are LAURENT LAFFORGUE and VLADIMIR VOEVODSKY.

The Fields Medals are presented in conjunction with the ICM, which is held every four years at different locations around the world. Although there is no formal age limit for recipients, the medals have traditionally been presented to mathematicians not older than 40 years of age, as an encouragement for future achievement. The medal is named after the Canadian mathematician John Charles Fields (1863–1932), who organized the 1924 ICM in Toronto. At a 1931 meeting of the Committee of the International Congress, chaired by Fields, it was decided that the $2,500 left over from the Toronto ICM "should be set apart for two medals to be awarded in connection with successive International Mathematical Congresses." In outlining the rules for awarding the medals, Fields specified that the medals "should be of a character as purely international and impersonal as possible." During the 1960s, in light of the great expansion of mathematics research, the possible number of medals to be awarded was increased from two to four. Today the Fields Medal is recognized as the world's highest honor in mathematics.

Previous recipients are: Lars V. Ahlfors and Jesse Douglas (1936); Laurent Schwartz and Atle Selberg (1950); Kunihiko Kodaira and Jean-Pierre Serre (1954); Klaus F. Roth and René Thom (1958); Lars Hörmander and John W. Milnor (1962); Michael F. Atiyah, Paul J. Cohen, Alexandre Grothendieck, and Stephen Smale (1966); Alan Baker, Heisuke Hironaka, Sergei P. Novikov, and John G. Thompson (1970); Enrico Bombieri and David B. Mumford (1974); Pierre R. Deligne, Charles L. Fefferman, Grigorii A. Margulis, and Daniel G. Quillen (1978); Alain Connes, William P. Thurston, and Shing-Tung Yau (1982); Simon K. Donaldson, Gerd Faltings, and Michael H. Freedman (1986); Vladimir Drinfeld, Vaughan F. R. Jones, Shigefumi Mori, and Edward Witten (1990); Jean Bourgain, Pierre-Louis Lions, Jean-Christoph Yoccoz, and Efim Zelmanov (1994); Richard Borcherds, William Timothy Gowers, Maxim Kontsevich, and Curtis T. McMullen (1998).

The medals are awarded by the International Mathematical Union, on the advice of a selection committee. The selection committee for the 2002 Fields Medalists consisted of: James Arthur, Spencer Bloch, Jean Bourgain, Helmut Hofer, Yasutaka Ihara,

H. Blaine Lawson, Sergei Novikov, George Papanicolaou, Yakov Sinai (chair), and Efim Zelmanov.

Laurent Lafforgue

Laurent Lafforgue was born on November 6, 1966, in Antony, France. He graduated from the École Normale Supérieure in Paris (1986). He became a *chargé de recherche* of the Centre National de la Recherche Scientifique (CNRS) (1990) and worked on the Arithmetic and Algebraic Geometry team at the Université Paris-Sud, where he received his doctorate (1994). In fall 2000 he was promoted to *directeur de recherche* of the CNRS in the mathematics department of the Université Paris-Sud. Shortly thereafter he became a permanent professor of mathematics at the Institut des Hautes Études Scientifiques in Bures-sur-Yvette, France.

Laurent Lafforgue has made an enormous advance in the Langlands Program by proving the global Langlands correspondence for function fields. The Langlands Program, formulated by Robert Langlands in the 1960s, proposes a web of relationships connecting Galois representations and automorphic forms. The influence of the Langlands Program has grown over the years, with each new advance hailed as an important achievement.

The roots of the Langlands program are found in one of the deepest results in number theory, the Law of Quadratic Reciprocity, which was first proved by Carl Friedrich Gauss in 1801. This law allows one to describe, for any positive integer d, the primes p for which the congruence $x^2 \equiv d \bmod p$ has a solution. Despite many proofs of this law (Gauss himself produced six different proofs), it remains one of the most mysterious facts in number theory. The search for generalizations of the Law of Quadratic Reciprocity stimulated a great deal of research in number theory in the nineteenth century. Landmark work by Emil Artin in the 1920s produced the most general reciprocity law known up to that time. One of the original motivations behind the Langlands Program was to provide a complete understanding of reciprocity laws.

The global Langlands correspondence for GL_n proved by Lafforgue provides a complete understanding of reciprocity laws for function fields. Lafforgue established, for any given function field, a precise link between the representations of its Galois groups and the automorphic forms associated with the field. He built on work of 1990 Fields Medalist Vladimir Drinfeld, who in the 1970s proved the global Langlands correspondence for GL_2.

Vladimir Voevodsky

Vladmir Voevodsky was born on June 4, 1966, in Russia. He received his B.S. in mathematics from Moscow State University (1989) and his Ph.D. in mathematics from Harvard University (1992). He held visiting positions at the Institute for Advanced Study, Harvard University, and the Max-Planck-Institut für Mathematik before joining the faculty of Northwestern University in 1996. In 2002 he was named a permanent professor in the School of Mathematics at the Institute for Advanced Study in Princeton, New Jersey.

Vladimir Voevodsky made one of the most outstanding advances in algebraic geometry in the past few decades by developing new cohomology theories for algebraic varieties. This achievement has its roots in the work of 1966 Fields Medalist Alexandre Grothendieck. Grothendieck suggested that there should be objects, which he called "motives", that are at the root of the unity between number theory and geometry.

One of the most important of the generalized cohomology theories is topological K-theory, developed chiefly by another 1966 Fields Medalist, Michael Atiyah. An important result in topological K-theory is the Atiyah-Hirzebruch spectral sequence, developed by Atiyah and Friedrich Hirzebruch, which relates singular cohomology and topological K-theory.

For about forty years mathematicians worked hard to develop good cohomology theories for algebraic varieties; the best understood of these was the algebraic version of K-theory. A major advance came when Voevodsky, building on a little-understood idea proposed by Andrei Suslin, created a theory of "motivic cohomology". In analogy with the topological setting, there is a relationship between motivic cohomology and algebraic K-theory. In addition, Voevodsky provided a framework for describing many new cohomology theories for algebraic varieties. One consequence of Voevodsky's work, and one of his most celebrated achievements, is the solution of the Milnor Conjecture, which for three decades was the main outstanding problem in algebraic K-theory. This result has striking consequences in several areas, including Galois cohomology, quadratic forms, and the cohomology of complex algebraic varieties.

—Allyn Jackson

Madhu Sudan Receives Nevanlinna Prize

Madhu Sudan

On August 20, 2002, the Rolf Nevanlinna Prize was awarded at the opening ceremonies of the International Congress of Mathematicians (ICM) in Beijing, China. The prizewinner is MADHU SUDAN.

In 1982 the University of Helsinki granted funds to award the Nevanlinna Prize, which honors the work of a young mathematician (less than 40 years of age) in the mathematical aspects of information science. The prize is presented every four years in conjunction with the ICM. Previous recipients of the Nevanlinna Prize are: Robert Tarjan (1982), Leslie Valiant (1986), Alexander Razborov (1990), Avi Wigderson (1994), and Peter Shor (1998).

The Nevanlinna Prize is awarded by the International Mathematical Union on the advice of a selection committee. The selection committee for the 2002 prize consisted of: Andrei Agrachev, Ingrid Daubechies, Wolfgang Hackbusch, Michael O. Rabin (chair), and Alexander Schrijver.

Madhu Sudan was born on September 12, 1966, in Madras (now Chennai), India. He received his B. Tech. degree in computer science from the Indian Institute of Technology in New Delhi (1987) and his Ph.D. in computer science at the University of California at Berkeley (1992). He was a research staff member at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York (1992–7). He is currently an associate professor in the Department of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology.

Madhu Sudan has made important contributions to several areas of theoretical computer science, including probabilistically checkable proofs, nonapproximability of optimization problems, and error-correcting codes.

Sudan has been a main contributor to the development of the theory of probabilistically checkable proofs. Given a proof of a mathematical statement, the theory provides a way to recast the proof in a form where its fundamental logic is encoded as a sequence of computer bits. A "verifier" can, by checking only some of the bits, determine with high probability whether the proof is correct. What is extremely surprising, and quite counterintuitive, is that the number of bits the verifier needs to examine can be made extremely small. The theory was developed in papers by Sudan, S. Arora, U. Feige, S. Goldwasser, C. Lund, L. Lovász, R. Motwani, S. Safra, and M. Szegedy. For this work, these authors jointly received the 2001 Gödel Prize of the Association for Computing Machinery.

Also together with other researchers, Sudan has made fundamental contributions to understanding the nonapproximability of solutions to combinatorial optimization problems. This work connects to the fundamental outstanding question in theoretical computer science: Does P equal NP? A problem is in P if there is a polynomial-time algorithm that solves it. A problem is in NP if it has the property that a proposed solution can be checked in polynomial-time but that no polynomial-time algorithm is known to solve it. What Sudan and others showed is that, for certain combinatorial optimization problems, approximating an optimal solution is just as hard as finding an optimal solution. This result is closely related to the work on probabilistically checkable proofs.

The third area in which Sudan made important contributions is error-correcting codes. A class of widely used codes is the Reed-Solomon codes (and their variants), which were invented in the 1960s. For forty years it was assumed that the codes could correct only a certain number of errors. By creating a new decoding algorithm, Sudan demonstrated that the Reed-Solomon codes could correct many more errors than previously thought possible.

—Allyn Jackson

2002 JPBM Communications Award

The Joint Policy Board for Mathematics (JPBM) Communications Award was established in 1988 to reward and encourage journalists and other communicators who, on a sustained basis, bring accurate mathematical information to nonmathematical audiences. The 2002 award was presented to HELAMAN FERGUSON and CLAIRE FERGUSON at the 50th anniversary meeting of the Society for Industrial and Applied Mathematics (SIAM) in Philadelphia in July 2002.

The JPBM provides a forum for joint projects of the AMS, SIAM, and the Mathematical Association of America. Previous recipients of the JPBM Communications Award are Keith J. Devlin (2001), Sylvia Nasar (2000), Ian Stewart (1999), Constance Reid (1998), Philip J. Davis (1997), Gina Kolata (1996), Martin Gardner (1994), Joel E. Schneider (1993), Ivars Peterson (1991), Hugh Whitemore (1990), and James Gleick (1988).

The citation for the 2002 award states: "The JPBM Communications Award is presented to the Fergusons, who together have dazzled the mathematical community and a far wider public with exquisite sculptures embodying mathematical ideas, along with artful and accessible essays and lectures elucidating the mathematical concepts.

"Helaman Ferguson began his studies as an apprentice to a stone mason, then studied painting at Hamilton College and sculpture in graduate school. He received his Ph.D. in mathematics from the University of Washington in Seattle and taught the subject for seventeen years at Brigham Young University. He now lives and works in Laurel, Maryland, where he has set up an extensive studio in his home. In addition to selling his works, he designs algorithms for operating machinery and for scientific visualization. He has exhibited and sold his sculptures worldwide.

"Claire Ferguson has worked closely with Helaman as curator, expositor, and publicist on his mathematical sculptures. She is author of the book *Helaman Ferguson, Mathematics in Stone and Bronze*. She is also an artist in her own right and has won scholarships and prizes for her work."

—Allyn Jackson

Photograph by Lois Sellers, SIAM.

2002 JPBM Communications Award winners Helaman and Claire Ferguson (left), accepting the award from SIAM president Tom Manteuffel (right).

Mathematics People

Ramanan Receives Third World Academy of Sciences Award

The Third World Academy of Sciences (TWAS) has presented its 2001 Award in Mathematics to SUNDARARAMAN RAMANAN of the Tata Institute of Fundamental Research, Mumbai, India, for contributions to algebraic geometry and differential geometry, in particular for his study of the moduli spaces of vector bundles on curves.

The TWAS annually awards five prizes of $10,000 each to scientists from developing countries who have made outstanding contributions to the advancement of basic sciences: biology, chemistry, mathematics, physics, and basic medical sciences.

—From a TWAS announcement

2002 Dirac Medals Awarded

The 2002 Dirac Medals of the Abdus Salam International Centre for Theoretical Physics (ICTP) have been awarded to ALAN GUTH (Massachusetts Institute of Technology), ANDREI LINDE (Stanford University), and PAUL STEINHARDT (Princeton University) for the development of the concept of inflation in cosmology. The award citation reads: "Although the history of the very early universe has not been firmly established, the idea of inflation has already had notable observational successes, and it has become the paradigm for fundamental studies in cosmology. While the possibility of an exponential expansion of the early universe had been noted before, it was Guth who realized that inflation would solve some of the major problems confronting the big bang cosmology. Difficulties with the original inflationary model were recognized by Guth and others, and were overcome with the introduction of 'new' inflation by Linde and Steinhardt (with Albrecht). Linde went on to propose other promising versions of inflationary theory, such as chaotic inflation. The greatest success of inflationary theory has been in accounting for the existence of inhomogeneities in the universe and predicting their spectrum, done by Guth (with Pi), Steinhardt (with Bardeen and Turner), as well as Hawking and Starobinsky."

The ICTP awarded its first Dirac Medal in 1985. Given in honor of P. A. M. Dirac, the medal is awarded annually on Dirac's birthday, August 8, to an individual who has made significant contributions to theoretical physics and mathematics. The medalists also receive a prize of US$5,000. An international committee of distinguished scientists selects the winners from a list of nominated candidates. The Dirac Medal is not awarded to Nobel Laureates or Wolf Foundation Prize winners.

—From an ICTP announcement

Petters Awarded First Blackwell-Tapia Prize

ARLIE O. PETTERS of Duke University has been chosen as the recipient of the first Blackwell-Tapia Prize of the Mathematical Sciences Research Institute (MSRI) and Cornell University. He works in mathematical physics, and his major research interests include the development of a rigorous mathematical theory of light deflection in gravitational fields and the investigation of the observational consequences of the theorems in such a theory.

The prize, honoring David Blackwell and Richard A. Tapia, will be presented every other year to a mathematical scientist who has contributed significantly to his or her field of expertise and who has served as a role model

for mathematical scientists and students from underrepresented minority groups or who has contributed in other significant ways to addressing the problem of the underrepresentation of minorities in mathematics.

—From an MSRI announcement

B. H. Neumann Awards Given

The B. H. Neumann Awards for 2002 have been awarded by the Board of the Australian Mathematics Trust to ROGER CURNOW, University of Canberra, and SHEILA WILLIAMS, University of Queensland. 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

German Mathematical Society Media Prize

The Deutsche Mathematiker-Vereinigung (DMV, German Mathematical Society) awarded its first Media Prize on July 25, 2002, to GERO VON RANDOW, editor of the science section of the Sunday edition of the *Frankfurter Allgemeine Zeitung* (FAZ). The FAZ is one of the leading newspapers in Germany. The citation for the prize reads: "In recognition of his prominent oeuvre as a journalist and writer, which has in particular advanced the appreciation of mathematics among the general public, the DMV awards to Gero von Randow the 2002 Media Prize." The prize carries a cash award of 5,000 euros (about US$5,000).

—Allyn Jackson

China Finishes First in International Mathematical Olympiad

The team from China won six gold medals and compiled a team score of 212 at the 2002 International Mathematical Olympiad (IMO) held in Glasgow, Scotland, July 19–30, 2002. Russia also finished with six gold medals and a team score of 204, and the United States followed with four gold medals, one silver medal, and one honorable mention for a team score of 171.

The six members of the U.S. team, all high-school students, were PO-RU LOH (Madison, Wisconsin), gold medalist; TIANKAI LIU (Saratoga, California), gold medalist; RICKY LIU (Newton, Massachusetts), gold medalist; DANIEL KANE (Madison, Wisconsin), gold medalist; ANDERS KASEORG (Charlotte, North Carolina), silver medalist; and ALEX XUE (Chandler, Arizona), honorable mention. Po-Ru Loh tied for second place overall in total number of individual points.

The team was chosen on the basis of the students' performance in the 2002 USA Mathematical Olympiad. The students attended a four-week Mathematical Olympiad Summer Program at the University of Nebraska, Lincoln, over the past summer under the leadership of Titu Andreescu, director of the American Mathematics Competitions. The USA Mathematical Olympiad is a program of the Mathematical Association of America and is sponsored by the Akamai Foundation and the University of Nebraska. More information is available on the official scoring site of the IMO at `http://www.imo2002.com/`.

—Elaine Kehoe

Mathematics Opportunities

American Mathematical Society Centennial Fellowships

Invitation for Applications for Awards for 2003–2004
Deadline December 1, 2002

The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. From 1997 to 2001 the fellowship program was aimed at recent Ph.D.'s. Recently the AMS Council approved changes in the rules for the fellowships. The eligibility rules are as follows.

The primary selection criterion for the Centennial Fellowship is the excellence of the candidate's research. Preference will be given to candidates who have not had extensive fellowship support in the past. Recipients may not hold the Centennial Fellowship concurrently with another research fellowship such as a Sloan or NSF Postdoctoral Fellowship. Under normal circumstances the fellowship cannot be deferred. A recipient of the fellowship shall have held his or her doctoral degree for at least three years and not more than twelve years at the inception of the award. 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 2003–2004 is expected to be approximately $57,000, with an additional expense allowance of about $1,600.

The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The trustees have arranged a matching program from general funds in such a way that funds for at least one fellowship are guaranteed. Due to a change in eligibility criteria and an increase in the stipend beginning in 2002–2003, it is expected that two fellowships will be awarded. A list of previous fellowship winners can be found at `http://www.ams.org/secretary/prizes.html`.

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, 2002**. Awards will be announced in February 2003 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 Professional Services 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

Call for Nominations for the 2003 Fermat Prize

The Fermat Prize for Mathematics Research is awarded every two years by Université Paul Sabatier under the sponsorship of Astrium SAS. The prize is intended to recognize research in fields in which Pierre de Fermat made significant contributions, particularly statements of variational principles, foundations of probability and analytical geometry, and number theory. Candidates should be under the age of 45, and the work should have been done within the past five years.

The deadline for nominations is **June 30, 2003**. For more information, see `http://www.ups-tlse.fr/ACTUALITES/Sciences/Prix_Fermat_2003/Areglement.html`.

—From a Université Paul Sabatier announcement

Research Opportunities for U.S. Graduate Students in Japan, Korea, and Taiwan

The National Science Foundation (NSF) and the National Institutes of Health (NIH) are cosponsoring summer research programs in Japan, Korea, and Taiwan for U.S. graduate students during the summer of 2003. These summer

programs provide U.S. graduate students in science and engineering with firsthand research experience in Japanese, Korean, and Taiwanese research environments; an introduction to the science and science policy infrastructure of the respective countries; and language and cultural training. The primary goals of the programs are to introduce students to Japanese, Korean, and Taiwanese 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 programs will last approximately eight weeks, from mid-June to August, and are administered in the United States by the NSF and the NIH. 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 and that also are represented among the potential host institutions. International travel costs to and from Japan, Korea, or Taiwan; in-country living costs (accommodations, food, and professional travel); and an allowance of $2,500 for each participant will be provided.

The deadline for application materials to be postmarked is **December 1, 2002**. All application materials (including forms from the applicant and from those recommending him or her) should be sent to the NSF East Asia and Pacific Program (NSF/EAP), Room 935, Division of International Programs, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230. For more information visit the NSF website, `http://www.nsf.gov/pubs/2002/nsf02007/nsf02007.htm`.

—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, 2003**. The fellowship year runs from July 1, 2003, to June 30, 2004. For more information see the AAUW's website at `http://www.aauw.org/3000/fdnfelgra/selectprof.html`, or contact the AAUW Educational Foundation, 1111 Sixteenth St. N.W., Washington, DC 20036; telephone 800-326-2289; fax 202-872-1425; email: `info@aauw.org`.

—From an AAUW announcement

AWM Workshop for Women Graduate Students and Postdocs

The Association for Women in Mathematics (AWM) has announced that a workshop for women in mathematics will be held June 16–17, 2003, in conjunction with the joint meeting of the Canadian Applied and Industrial Mathematics Society and the Society for Industrial and Applied Mathematics (SIAM) in Montreal, Quebec, Canada, June 16–20, 2003. The workshop will feature minisymposia on research areas selected from mathematical biology, modeling, control, optimization, scientific computing, and partial differential equations and applications. The deadline for receipt of applications is **January 24, 2003**.

The AWM holds a series of workshops for women graduate students and recent Ph.D.'s in conjunction with major mathematics meetings. The workshops are supported by the Office of Naval Research and the Air Force Office of Scientific Research. For further information see the AWM website at `http://www.awm-math.org/`.

—AWM announcement

News from the Institut Mittag-Leffler

The academic year 2003–2004 at the Institut Mittag-Leffler, Djursholm, Sweden, will be devoted to noncommutative geometry. The organizing committee consists of F. Van Oystaeyen, Antwerpen; M. Artin, MIT; A. Connes, IHÉS; A. Laudal, Oslo; Y. Manin, Bonn; and C. Procesi, Rome.

The application deadline for postdoctoral fellowships is **January 31, 2003**. Applications should be sent to Marie-Louise Koskull, Institut Mittag-Leffler, Auravägen 17, SE-182 60 Djursholm, Sweden. For further information consult the institute's homepage, `http://www.ml.kva.se/`.

—Institut Mittag-Leffler announcement

For Your Information

NRC Forms Committee on Research Studies

The National Research Council (NRC) of the National Academy of Sciences (NAS) has created a committee of experts in mathematics assessment, curriculum development, curricular implementation, and teaching to assess the quality of the studies on the effectiveness of the thirteen sets of mathematics curriculum materials developed with National Science Foundation (NSF) support. A selection of evaluations of non-NSF-supported materials will be used for comparison purposes.

The current committee, chaired by Jere Confrey (University of Texas, Austin), is charged with the first phase of a potentially multiphased review process. Confrey said, "We have been asked to prepare a short consensus report summarizing the results of our work, which includes creating an extensive bibliography of studies, mapping those studies according to their characteristics, and then advising if the quality of the evidence merits a full review." The committee is seeking a broad set of studies that are studying one or more of the thirteen NSF curricula as a central variable, that meet the methodological canons for acceptable inquiry associated with that methodology, and that have identified authorship and affiliation so as to give credibility to the work. The committee is soliciting evaluation studies such as the following: studies with specific student outcomes; content analysis studies; studies of classroom implementation and school environment; and studies of teacher knowledge, teacher characteristics, and professional development. These classifications will be expanded as committee members identify additional relevant categories. Carole Lacampagne, director of the Mathematical Science Education Board (MSEB), stated, "We have not limited ourselves to published studies, because summative studies of these curricula are often recently completed, but as with all NRC work, the reports must meet scholarly expectations."

The committee hosted a two-day workshop in Washington, DC, September 17–18, 2002. The meeting was intended to permit the committee to hear from various curricular designers, researchers, evaluators, mathematicians, and practitioners on their points of view concerning the evaluation of effectiveness. Panel members were asked to respond to the question: How would you define and/or evaluate effectiveness of a K–5, 6–8 or 9–12 NSF-supported curriculum, and what evidence would be needed? They were asked to identify primary and secondary variables, methods of examining and measuring those variables, research designs, and other relationships under investigation. "These are complex questions," said Confrey, "as curricular design and implementation involve many people's participation; are measured by a myriad of local and national forms of assessment; and are used across highly variable settings, differing in values, resources, cultural contexts, and forms of organization. It is imperative for us as a nation to get smarter and more sophisticated in how to conduct and evaluate such studies and to learn from our current work." Confrey added, "I believe that this NRC work can lead toward resolution of some of the debates by bringing together people and studies from a variety of perspectives and working for a common framework to establish a solid research-based foundation to improve curriculum development and evaluation and to aid schools and districts making decisions." Michael Feuer, director of the Center for Education at the NRC, added, "As long as there is a commitment to increasing the scientific evidence on questions of education, work such as this will be needed and is directly in line with the responsibilities of the NRC to provide advice to the nation."

Suggestions of studies for review should be sent to CLacampagne@nas.edu.

—NRC announcement

Corrections

Thanks to the vigilance of Irving Adler (who tried the method out and ran into a snag), I have noticed that one of the translations in my article "Learning from Liu Hui?" in the August 2002 issue (page 787) was faultily transcribed. It should have read as follows:

> 術曰。令一丈自乘為實。半相多。令自乘。倍之。減實。半其餘。以開方除之。所得，減相多之半 。 即戶廣 。 加相多之 半 。 即戶高。
>
> Method: Let the 10 feet multiply itself to make the product. Halve the difference, and let it multiply itself. Double it, subtract from the product. Halve the excess. Find the side of the square. From what you obtain, subtract the halved difference, and that is the breadth of the door. Add the halved difference, and that is the height of the door.

In other words, if the height of the door is h and the breadth is b, with diagonal d (here given as 10 feet), with "the difference" being $(h - b)$, the procedure is equivalent to the modern expressions:

$$\sqrt{\frac{1}{2}\left(d^2 - 2\left(\frac{h-b}{2}\right)^2\right)} - \frac{h-b}{2} = b$$

$$\sqrt{\frac{1}{2}\left(d^2 - 2\left(\frac{h-b}{2}\right)^2\right)} + \frac{h-b}{2} = h.$$

Thank you, Irving Adler. It is reassuring to know that some readers do follow through the mathematics in articles, though perhaps not everyone has such a distinguished lifetime background in science and mathematics education.

—Christopher Cullen

The August 2002 *Notices*, page 818, carried an announcement about the Adams Prize, stating that the prize commemorates the discovery of the planet Neptune by John Couch Adams. The actual achievement of Adams was to predict the position of the conjectured new planet mathematically, but Adams was not involved in the subsequent observational discovery of Neptune.

The September 2002 *Notices* carried an article about the School of Mathematics at the Institute for Advanced Study. On page 899 there is a list of all past and present faculty of the school. The list should have indicated that Abraham Pais is now deceased.

—Allyn Jackson

About the Cover

An Exotic Coxeter Complex

This month's cover was suggested by Ken Brown's article on buildings. It shows the Coxeter complex associated to a Kac-Moody group with Cartan matrix

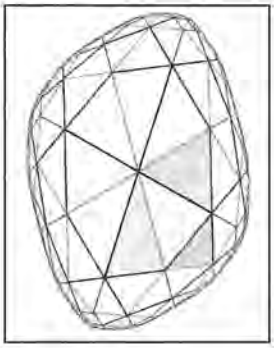
$$\begin{bmatrix} 2 & -1 & -1 \\ -2 & 2 & -1 \\ -1 & -1 & 2 \end{bmatrix}$$

whose Coxeter numbers are 4, 3, and 3. The three generators of the Weyl group of this Kac-Moody algebra act by skew-reflections in three real dimensions, and the Tits cone is the orbit of the Weyl chamber, which is a simplicial cone and the fundamental domain for the Weyl group's action.

The transforms of this chamber are also simplicial cones, and the illustration on the cover shows a slice through these. The fundamental domain is gray, and its transforms by the generators are also marked. Edges between chambers are colored according to the generator involved in the transition between them.

The Kac-Moody algebra involved is not symmetrizable. This means that the boundary of the Tits cone is not an ellipse. According to Kac & Vinberg (*Mat. Zametki* **1** (1967), pp. 347–54) the boundary is not even C^2. Its detailed structure, and its relationship with the structure of the Kac-Moody group, seem to be unknown. This is not unusual in the subject of non-symmetrizable Kac-Moody algebras, which are well situated in *terra incognita*.

—Bill Casselman (covers@ams.org)



Inside the AMS

Fan China Exchange Program Names Awardees

The Fan China Exchange Program awards grants to support collaborations between Chinese and U.S./Canadian researchers. Institutions in the U.S. or Canada apply for the funds to support a visitor from China, or vice versa. These funds are made available through a generous gift made to the AMS by Ky and Yu-Fen Fan in 1999.

Two rounds of applications have been completed. The seven awards made so far by the Fan fund are listed below. Listed first is the host and the sponsoring institution, then the visitor's name, and the anticipated length of the visit.

ROE GOODMAN, Rutgers University, U.S.; LIQUN ZHANG, Academia Sinica, China (03/2003–04/2003)

BENEDICT GROSS, Harvard University, U.S.; CHONG-QING CHENG, Nanjing University, China (2 months during 2002–2003)

RONALD S. IRVING, University of Washington, U.S.; QUANSHUI WU, Fudan University, China (05/2003–06/2003)

JEFFREY REMMEL, University of California, San Diego, U.S.; Y. C. CHEN, Nankai University, China (August 2002)

DAVID A. VOGAN, Massachusetts Institute of Technology, U.S.; SHUQIN ZHANG, Yang Chow University, China (10/2002)

MIN WU, Institute of Mathematics, Hubei University, China; NAIHUAN JING, North Carolina State University, U.S. (12/2002–02/2003)

LO YANG, Academy of Mathematics and System Sciences, Chinese Academy of Sciences, China; HAIM BREZIS, Rutgers University, U.S. (November 2002)

AMS Email Support for Frequently Asked Questions

A number of non-user-specific electronic addresses have been established for contacting the AMS staff. The following is an updated list of those addresses together with a description of the types of inquiries that may be made through each address. This list is also available on the AMS's website at `http://www.ams.org/ams/email.html`.

abs-info@ams.org
for questions regarding a particular abstract.

abs-submit@ams.org
for information on how to submit abstracts for AMS meetings and MAA sessions at January Joint Mathematics Meetings. Type HELP as the subject line.

acquisitions@ams.org
to contact the AMS Acquisitions Department.

ams@ams.org
to contact the Society's headquarters in Providence, Rhode Island.

amsdc@ams.org
to contact the Society's office in Washington, DC.

amsmem@ams.org
to request information about membership in the AMS or about dues payments, or to ask any general membership questions; may also be used to submit address changes.

bookstore@ams.org
for inquiries related to the online AMS Bookstore.

classads@ams.org
to submit classified advertising for the *Notices*.

cust-serv@ams.org
for general information about AMS products (including electronic products); to send address changes, place credit card orders for AMS products, or conduct any general correspondence with the Society's Customer Services Department.

development@ams.org
for information about giving to the AMS, including the Epsilon Fund.

eims-info@ams.org
to request general information about deadlines and rates for *Employment Information in the Mathematical Sciences* (EIMS).

ejour-submit@ams.org
to submit papers to *Representation Theory* and *Conformal Geometry and Dynamics*, electronic journals of the AMS. Each submission must be accompanied by the journal template. A copy of the template is available by sending email to `ejour-submit@ams.org`. Put the word TEMPLATE in the subject field of the email message. To get additional help, put the word HELP in the subject field in a separate mail message.

emp-info@ams.org
for information on AMS employment and career services.

eprod-support@ams.org
for technical questions regarding AMS electronic products and services.

era-submit@ams.org
for authors to submit research announcements to *Electronic Research Announcements of the AMS*.

mathcal@ams.org
to send information to be included in the "Mathematics Calendar" section of the *Notices*.

mathrev@ams.org
for questions and correspondence concerning the Mathematical Reviews database.

meet@ams.org
to request general information about Society meetings and conferences.

meetreg-request@ams.org
to request email meeting registration forms.

meetreg-submit@ams.org
to submit completed email registration forms.

mmsb@ams.org
for meeting registration and housing information.

msn-support@ams.org
for technical questions regarding MathSciNet.

notices@ams.org
to send correspondence to the managing editor of the *Notices*, including items for the news columns. The editor (notices@math.tamu.edu) is the person to whom to send articles. Requests for permission to reprint from the *Notices* should be sent to reprint-permission@ams.org (see below).

notices-ads@ams.org
to submit display ads electronically to the *Notices*.

notices-booklist@ams.org
to submit suggestions for books to be included in the Book List in the *Notices*.

notices-letters@ams.org
to submit letters and opinion pieces to the *Notices*.

notices-whatis@ams.org
to comment on or send suggestions for topics for the WHAT IS...? column to the *Notices*.

paoffice@ams.org
to contact the AMS Public Awareness Office.

president@ams.org
to contact the president of the American Mathematical Society.

prof-serv@ams.org
to send correspondence about AMS professional programs and services.

pub@ams.org
to send correspondence to the AMS Publication Division.

pub-submit@ams.org
to submit accepted electronic book and journal manuscripts to AMS publications (other than *Abstracts*).

reprint-permission@ams.org
to request permission to reprint material from Society publications.

sales@ams.org
to inquire about reselling or distributing AMS publications, or to send correspondence to the AMS sales department.

secretary@ams.org
to contact the secretary of the American Mathematical Society.

sos@ams.org
for information about AMS services to publishers.

statements@ams.org
to correspond regarding a balance due shown on a monthly statement.

survey@ams.org
for information or questions about the AMS-ASA-IMS-MAA *Annual Survey of the Mathematical Sciences* or to request reprints of *Survey* reports.

tech-support@ams.org
to contact the Society's typesetting Technical Support group.

textbooks@ams.org
to request examination copies or to inquire about using AMS publications as course texts.

webmaster@ams.org
for general information or for assistance in accessing and using the AMS website.

Deaths of AMS Members

JOSEPH ARKIN, retired, U.S. Military Academy, West Point, died on August 5, 2002. Born on May 25, 1923, he was a member of the Society for 38 years.

JOHN DYER-BENNET, professor emeritus, of Northfield, MN, died on March 19, 2002. Born on April 17, 1915, he was a member of the Society for 65 years.

DANIEL J. EWY, professor emeritus, California State University, Fresno, died on April 15, 2002. Born on June 21, 1918, he was a member of the Society for 54 years.

JOHN T. HAMILTON, retired, of Huntsville, AL, died in August 2002. He was a member of the Society for 5 years.

PHILLIP S. JONES, professor emeritus, University of Michigan, Ann Arbor, died on June 27, 2002. Born on February 26, 1912, he was a member of the Society for 58 years.

MORRIS MORDUCHOW, professor emeritus, Polytechnic University, NY, died on May 27, 2002. Born on September 25, 1921, he was a member of the Society for 56 years.

KYU-OH NAMKOONG, of Woodstown, NJ, died on July 8, 2002. He was a member of the Society for 31 years.

LAURENT SCHWARTZ, retired, of Paris, France, died on July 4, 2002. Born on March 5, 1915, he was a member of the Society for 52 years.

W. T. TUTTE, professor emeritus, of Waterloo, Ontario, Canada, died on May 2, 2002. Born on May 14, 1917, he was a member of the Society for 53 years.

JILL S. YAQUB, retired, of Columbus, OH, died on May 6, 2002. Born on December 17, 1931, she was a member of the Society for 40 years.

Reference and Book List

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

Contacting the *Notices*

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

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

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

Upcoming Deadlines

October 9, 2002: Full proposals for NSF Distinguished International Postdoctoral Research Fellowships. Contact Lynne Walling, Program Director, Division of Mathematical Sciences, Room 1025, National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22230; telephone 703-292-8104; email: `lwalling@nsf.gov`; or see `http://www.nsf.gov/pubs/2001/nsf01154/nsf01154.txt/`.

October 15, 2002: Proposals for NSA grant and sabbatical programs. See `http://www.nsa.gov/programs/msp/grants.html`; telephone: 301-688-0400; email: `msp@math.umbc.edu`; postal address: Mathematical Sciences Program, National Security Agency, ATTN: R51A, Suite 6557, Ft. George G. Meade, MD 20755-6557.

October 15, 2002: Applications for spring semester of Math in Moscow and for AMS scholarships. See `http://www.mccme.ru/`

Where to Find It

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

AMS Bylaws—*November 2001, p. 1205*

AMS Email Addresses—*November 2002, p. 1275*

AMS Ethical Guidelines—*June/July 2002, p. 706*

AMS Officers 2000 and 2001 (Council, Executive Committee, Publications Committees, Board of Trustees)—*June/July 2002, p. 705*

AMS Officers and Committee Members—*October 2002, p. 1108*

Backlog of Mathematics Research Journals—*September 2002, p. 963*

Conference Board of the Mathematical Sciences—*September 2002, p. 955*

Information for *Notices* Authors—*June/July 2002, p. 697*

Mathematics Research Institutes Contact Information—*August 2002, p. 828*

National Science Board—*February 2002, p. 237*

New Journals for 2001—*June/July 2002, p. 698*

NRC Board on Mathematical Sciences and Staff—*April 2002, p. 492*

NRC Mathematical Sciences Education Board and Staff—*May 2002, p. 583*

NSF Mathematical and Physical Sciences Advisory Committee—*March 2002, p. 345*

Program Officers for Federal Funding Agencies—*October 2002, p. 1103 (DoD, DoE); November 2002, p. 1278 (NSF Education Program Officers)*

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

October 18, 2002: Applications for NSF Postdoctoral Research Fellowships. See the NSF website at http://www.fastlane.nsf.gov/d11/D11Menu.htm.

November 1, 2002: Proposals for ONR Young Investigator Program. See the ONR website, http://www.onr.navy.mil/sci_tech/industrial/yip_announce.htm.

November 1, 2002: Entries for AWM essay contest. See http://www.awm-math.org/biographies/contest.html, or contact Victoria Howle, email: vehowle@sandia.gov.

November 1, 2002: Applications for NSF International Research Fellow Awards. Contact Susan Parris, 703-292-8711, email: sparris@nsf.gov; or visit the website http://www.nsf.gov/sbe/int/fellows/start.htm.

November 7, 2002: Applications for NSF Graduate Fellowships. See the website http://www.orau.org/nsf/nsffel.htm, telephone (toll-free) 866-353-0905, email: nsfgrfp@orau.gov.

November 15, 2002: Applications for Postdoctoral Fellowships and General Memberships at MSRI. See http://www.msri.org/; or contact MSRI, 1000 Centennial Drive, Berkeley, CA 94720-5070.

December 1, 2002: Applications for AMS Centennial Fellowships. See http://www.ams.org/employment/centflyer.html, or contact: Professional Services Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904; telephone 401-455-4107; email: prof-serv@ams.org.

December 1, 2002: Submissions for Sunyer i Balaguer Prize. Contact Centre de Recerca Matemàtica, Fundació Ferran Sunyer i Balaguer, Apartat 50, E-08193 Bellaterra, Spain. World Wide Web: http://www.crm.es/info/ffsb.htm; email: crm@crm.es.

December 1, 2002: Applications for NSF/NIH East Asia and Pacific Program. See "Mathematics Opportunities" in this issue.

December 16, 2002: Applications for AMS Epsilon Fund. See http://www.ams.org/careers-edu/epsilon.html; or contact Professional Services Department, AMS, 201 Charles Street, Providence, RI 02904; telephone 800-321-4267, ext. 4105; email: prof-serv@ams.org.

December 31, 2002: Nominations for Alan T. Waterman Award. Contact Susan E. Fannoney, telephone: 703-292-8096, email: sfannone@nsf.gov.

January 10, 2003: Applications for AAUW Selected Professions Fellowships. See "Mathematics Opportunities" in this issue.

January 24, 2003: Applications for AWM Workshop for Women Graduate Students and Postdocs. See "Mathematics Opportunities" in this issue.

January 31, 2003: Applications for postdoctoral fellowships at Institut Mittag-Leffler. See "Mathematics Opportunities" in this issue.

February 1, 2003: Applications for NSF/AWM Travel Grants for Women. See http://www.awm-math.org/travelgrants.html, telephone: 301-405-7892, email: awm@math.umd.edu.

March 1, 2003: Nominations for Third World Academy of Science Prizes. See the website http://www.ictp.trieste.it/~twas/twas_prizes.html.

April 18, 2003: Full proposals for NSF IGERT program. See the website http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf02145/.

May 1, 2003: Applications for NSF/AWM Travel Grants for Women. See http://www.awm-math.org/travelgrants.html, telephone: 301-405-7892, email: awm@math.umd.edu.

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

June 30, 2003: Nominations for the Fermat Prize for Mathematics Research. See "Mathematics Opportunities" in this issue.

NSF Mathematics Education Staff

The Directorate for Education and Human Resources (EHR) of the National Science Foundation (NSF) sponsors a range of programs that support educational projects in mathematics, science, and engineering. Listed below are the names, telephone numbers, and email addresses of those EHR program officers whose field is in the mathematical sciences or mathematics education. These individuals can provide information about the programs they oversee, as well as information about other EHR programs of interest to mathematicians. The mailing address is: Directorate for Education and Human Resources, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230. The World Wide Web address is http://www.nsf.gov/ehr/.

Division of Elementary, Secondary, and Informal Education

John (Spud) Bradley
703-292-5091
jbradley@nsf.gov

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Karen King
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kking@nsf.gov

Monica Mitchell
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Monica Neagoy
703-292-8613
mneagoy@nsf.gov

Mark Saul
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msaul@nsf.gov

Diane Spresser
703-292-5188
dspresse@nsf.gov

Division of Research, Evaluation, and Communication

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ehamilto@nsf.gov

Finbarr (Barry) Sloane
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fsloane@nsf.gov

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eteles@nsf.gov

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703-292-5140
lzia@nsf.gov

Division of Graduate Education

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703-292-4628
jhlightb@nsf.gov

Division of Human Resource Development

Roosevelt Johnson
703-292-8640
ryjohnso@nsf.gov

Book List

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

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

The Algorithmic Beauty of Seaweeds, Sponges and Corals, by Jap Kaandorp and Janet Kübler. Springer-Verlag, January 2001. ISBN 3-540-67700-3.

* *The Annotated Flatland: A Romance of Many Dimensions*, Edwin A. Abbott; introduction and notes by Ian Stewart. Perseus Publishing, November 2001. ISBN 0-7382-0541-9. (Reviewed in this issue.)

The Bit and the Pendulum: How the New Physics of Information Is Revolutionizing Science, by Tom Siegfried. John Wiley & Sons, February 2000. ISBN 0-471-39974-4. (Reviewed August 2002.)

The Book of Nothing: Vacuums, Voids, and the Latest Ideas about the Origins of the Universe, by John D. Barrow. Pantheon Books, April 2001. ISBN 0-375-42099-1. (Reviewed June/July 2002.)

Codes and Ciphers: Julius Caesar, the Enigma, and the Internet, by Robert Churchhouse. Cambridge University Press, January 2002. ISBN 0-521-81054-X.

The Colossal Book of Mathematics: Classic Puzzles, Paradoxes, and Problems, by Martin Gardner. W. W. Norton & Company, August 2001. ISBN 0-393-02023-1. (Reviewed October 2002.)

Conned Again, Watson! Cautionary Tales of Logic, Math, and Probability, by Colin Bruce. Perseus Publishing, January 2001. ISBN 0-7382-0345-9. (Reviewed in this issue.)

Conquering Statistics: Numbers without the Crunch, by Jefferson Hane Weaver. Perseus Publishing, paperback edition, August 2001. ISBN 0-732-820495-1.

Conversations with a Mathematician: Math, Art, Science, and the Limits of Reason, by Gregory J. Chaitin. Springer, November 2001. ISBN 1-85233-549-1.

Curve Ball: Baseball, Statistics, and the Rules of Chance in the Game, by Jim Albert and Jay Bennett. Copernicus-Springer Verlag, July 2001. ISBN 0-387-98816-5.

Damned Lies and Statistics: Untangling Numbers from the Media, Politicians, and Activists, by Joel Best. University of California Press, May 2001. ISBN 0-520-21978-3.

Does God Play Dice? The New Mathematics of Chaos, by Ian Stewart. Blackwell, revised second edition, January 2002. ISBN 0-631-23251-6.

The Dream Machine: J. C. R. Licklider and the Revolution That Made Computing Personal, by M. Mitchell Waldrop. Viking Press, 2001. ISBN 0-670-89976-3.

* *Entanglement: The Greatest Mystery in Physics*, by Amir D. Aczel. Four Walls Eight Windows, October 2002. ISBN 1-56858-232-3.

The Essential John Nash, Harold Kuhn and Sylvia Nasar, editors. Princeton University Press, December 2001. ISBN 0-691-09527-2.

Euclid's Window: The Story of Geometry from Parallel Lines to Hyperspace, by Leonard Mlodinow. Free Press, April 2001. ISBN 0-684-86523-8. (Reviewed May 2002.)

Flatterland: Like Flatland, Only More So, by Ian Stewart. Perseus Publishing, April 2001. ISBN 0-7382-0675-X. (Reviewed April 2002.)

Fooled by Randomness: The Hidden Role of Chance in the Markets and Life, by Nassim Nicholas Taleb. Texere, October 2001. ISBN 1-587-99071-7.

The Fractal Murders, by Mark Cohen. Muddy Gap Press, May 2002. 0-9718986-0-X.

Fragments of Infinity: A Kaleidoscope of Math and Art, by Ivars Peterson. John Wiley & Sons, October 2001. ISBN 0-471-16558-1. (Reviewed October 2002.)

A Gardner's Workout: Training the Mind and Entertaining the Spirit, by Martin Gardner. A K Peters, June 2001. ISBN 1-56881-120-9.

Geometry: Our Cultural History, by Audun Holme. Springer, April 2002. ISBN 3-540-41949-7.

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

Go To: The Story of the Math Majors, Bridge Players, Engineers, Chess Wizards, Scientists and Iconoclasts Who Were the Hero Programmers of the Software Revolution, by Steve Lohr. Basic Books, October 2001. ISBN 0-465-04225-2.

The Hilbert Challenge, by Jeremy J. Gray. Oxford University Press, December 2000. ISBN 0-198-50651-1. (Reviewed September 2002.)

The Honors Class, by Benjamin Yandell. A K Peters, December 2001. ISBN 1-56881-141-1. (Reviewed September 2002.)

How the Other Half Thinks: Adventures in Mathematical Reasoning, by Sherman Stein. McGraw-Hill, July 2001. ISBN 0-07-137339-X. (Reviewed September 2002.)

How the Universe Got Its Spots, by Janna Levin. Princeton University Press, April 2002. ISBN 0-691-09657-0.

It Must Be Beautiful: Great Equations of Modern Science, Graham Farmelo, editor. Granta Books, February 2002. ISBN 1-862-07479-8.

The Lady Tasting Tea: How Statistics Revolutionized Science in the Twentieth Century, by David Salsburg. W. H. Freeman & Co, April 2001. ISBN 0-716-74106-7.

Lebesgue's Theory of Integration: Its Origins and Development, by Thomas Hawkins. AMS, September 2001. ISBN 0-8218-2963-7.

The Mathematical Explorer, by Stan Wagon. Electronic book, Wolfram Research, Inc., 2001. (Reviewed June/July 2002.)

Mathematical Vistas, by Peter Hilton, Derek Holton, and Jean Pedersen. Springer-Verlag, January 2002. ISBN 0-387-95064-8.

A Mathematician Grappling with His Century: The Autobiography of Laurent Schwartz, translated from the French by L. Schneps. Birkhäuser, 2001. ISBN 3-7643-6052-6.

The Mathematician Sophus Lie: It Was the Audacity of My Thinking, by Arild Stubhaug. Springer, 2002. ISBN 3-540-42137-8.

Mathematics and the Roots of Postmodern Thought, by Vladimir Tasic. Oxford University Press, 2001. ISBN 0-195-13967-4.

Mathematics Galore! Masterclasses, Workshops, and Team Projects in Mathematics and Its Applications, by C. J. Budd and C. J. Sangwin. Oxford University Press, June 2001. ISBN 0-19-850769-0 (hardcover), 0-19-850770-4 (paperback). (Reviewed September 2002.)

Mathematics in a Postmodern Age: A Christian Perspective, Russell W. Howell and W. James Bradley, editors. Wm. B. Eerdmans Publishing Company, May 2001. ISBN 0-802-84910-5.

The Measure of the World, by Denis Guedj. University of Chicago Press, October 2001. ISBN 0-226-31030-2.

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

A New Kind of Science, by Stephen Wolfram. Wolfram Media, Inc., May 2002. ISBN 1-579-55008-8.

Niels Henrik Abel and His Times: Called Too Soon by Flames Afar, by Arild Stubhaug; translated by R. Daly. Springer-Verlag, May 2000. ISBN 3-540-66834-9. (Reviewed August 2002.)

Political Numeracy: Mathematical Perspectives on Our Chaotic Constitution, by Michael Meyerson. W. W. Norton & Company, March 2002. ISBN 0-393-04172-7.

Puzzlers' Tribute: A Feast for the Mind, Tom Rodgers and David Wolfe, editors. A K Peters, December 2001. ISBN 1-56881-121-7.

The Quest for the Quantum Computer, by Julian Brown. Touchstone Books, August 2001. ISBN 0-684-87004-5.

Radical Equations: Math Literacy and Civil Rights, by Robert P. Moses and Charles E. Cobb Jr. Beacon Press, February 2001. ISBN 0-8070-3126-7. (Reviewed March 2002.)

The Rainbow Bridge: Rainbows in Art, Myth, and Science, by Raymond L. Lee Jr. and Alistair B. Fraser. Pennsylvania State University Press and SPIE Press, 2001. ISBN 0-271-01977-8.

The Riddle of the Compass, by Amir Aczel. Harcourt Brace, August 2001. ISBN 0-151-00506-0.

Science and an African Logic, by Helen Verran. University of Chicago Press, January 2002. ISBN 0-226-85389-6 (cloth), 0-226-85391-8 (paper).

The Science of Conjecture: Evidence and Probability before Pascal, by James Franklin. Johns Hopkins University Press, June 2001. ISBN 0-8018-6569-7.

Signs of Life: How Complexity Pervades Biology, by Richard Solé and Brian Goodwin. Basic Books, January 2001. ISBN 0-465-01927-7.

Spaceland, by Rudy Rucker. Tor Books, June 2002. ISBN 0-765-30366-3.

Statisticians of the Centuries, edited by C. C. Heyde and E. Seneta. Springer, September 2001. ISBN 0-387-953283-7.

The Story of Mathematics, by Richard Mankiewicz. Princeton University Press, February 2001. ISBN 0-691-08808-X. (Reviewed April 2002.)

Such Silver Currents: The Story of William and Lucy Clifford, 1845–1929, by M. Chisholm. Lutterworth Press, March 2002. ISBN 0-7188-3017-2.

Things a Computer Scientist Rarely Talks About, by Donald Knuth. Center for the Study of Language and Information, July 2001. ISBN 1-57586-327-8.

Thinks, by David Lodge. Viking Press, May 2001. ISBN 0-670-89984-4.

Triangle of Thoughts, by Alain Connes, André Lichnerowicz, and Marcel Paul Schützenberger. AMS, July 2001. ISBN 0-8218-2624-X. (Reviewed March 2002.)

Turing and the Universal Machine: The Making of the Modern Computer, by Jon Agar. Totem Books, June 2001. ISBN 1-840-46250-7.

Understanding Mathematics for Aircraft Navigation, by James S. Wolper. McGraw-Hill, May 2001. ISBN 0-07-137572-4.

The Unfinished Revolution: Human-Centered Computers and What They Can Do for Us, by Michael L. Dertouzos. Harperbusiness, January 2001. ISBN 0-066-62067-8.

The Universal History of Computing: From the Abacus to the Quantum Computer, by Georges Ifrah; translated from the French and with notes by E. F. Harding, Sophie Wood, Ian Monk, Elizabeth Clegg, and Guido Waldman. John Wiley & Sons, November 2000. ISBN 0-471-39671-0. (Reviewed in two

parts, January 2002 and February 2002.)

The Universal History of Numbers: From Prehistory to the Invention of the Computer, by Georges Ifrah; translated from the French by David Bellos, E. F. Harding, Sophie Wood, and Ian Monk. John Wiley & Sons, December 1999. ISBN 0-471-37568-3. (Reviewed in two parts, January 2002 and February 2002.)

The Universe in a Nutshell, by Stephen Hawking. Bantam Books, November 2001. ISBN 0-553-80202-X. (Reviewed May 2002.)

What Is Mathematics? An Elementary Approach to Ideas and Methods, by Richard Courant and Herbert Robbins; second edition, revised by Ian Stewart. Oxford University Press, August 1996. ISBN 0-195-10519-2. (Reviewed December 2001.)

What Shape Is a Snowflake?, by Ian Stewart. W. H. Freeman & Co., November 2001. ISBN 0-716-74794-4.

The Zen of Magic Squares, Circles, and Stars: An Exhibition of Surprising Structures across Dimensions, by Clifford A. Pickover. Princeton University Press, January 2001. ISBN 0-691-07041-5.

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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 funnctions 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 _____

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Address *through next June* _____ **Home Phone**

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Current Institutional Affiliation **Work Phone**

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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.*

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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

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If unsuccessful for this position, would you like to be considered for a temporary position?

☐ Yes ☐ No If yes, please check the appropriate boxes.

☐ Postdoctoral Position ☐ 2+ Year Position ☐ 1 Year Position

List the names, affiliations, and e-mail addresses *of up to four individuals who will provide letters of recommendation if asked. Mark the box provided for each individual whom you have already asked to send a letter.*

☐ _____

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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.

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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

AMERICAN MATHEMATICAL SOCIETY

D.R. Fulkerson Prize

Call for nominations

The Fulkerson Prize Committee invites nominations for the Delbert Ray Fulkerson Prize, sponsored jointly by the Mathematical Programming Society and the American Mathematical Society. The Fulkerson Prize is for outstanding papers in the area of discrete mathematics. The prize will be awarded at the XVIIIth International Symposium on Mathematical Programming to be held in Copenhagen, Denmark, August 18–22, 2003.

Eligible papers should represent the final publication of the main result(s) and should have been published in a recognized journal or in a comparable, well-refereed volume intended to publish final publications only, during the six calendar years preceding the year of the Symposium (thus, from January 1997 through December 2002). The prizes will be given for single papers, not series of papers or books, and in the event of joint authorship the prize will be divided.

The term 'discrete mathematics' is interpreted broadly and is intended to include graph theory, networks, mathematical programming, applied combinatorics, applications of discrete mathematics to computer science, and related subjects. While research work in these areas is usually not far removed from practical applications, the judging of papers will only be based on their mathematical quality and significance.

Previous winners of the Fulkerson Prize are listed below. Further information about the Fulkerson Prize can be found at `www.mathprog.org/prz/fulkerson.htm`.

The Fulkerson Prize Committee consists of Gerard Cornuejols (Carnegie-Mellon University), Andrew M. Odlyzko (University of Minnesota), and David P. Williamson (IBM Almaden Research Center), chair.

Please send your nominations (including reference to the nominated article and an evaluation of the work) by January 31, 2003, to the chair of the committee. Electronic submissions are preferred.

David P. Williamson
Re: Fulkerson Prize
IBM Almaden Research Center, K53/B1
650 Harry Rd.
San Jose, CA 95120 USA
e-mail: `dpw@almaden.ibm.com`

Previous winners of the Fulkerson Prize:

1979: Kenneth Appel and Wolfgang Haken; Richard M. Karp; Paul D. Seymour
1982: L.G. Khachiyan/D.B. Iudin and A.S. Nemirovskii; G.P. Egorychev/D.I. Falikman; Martin Grotschel, Laszlo Lovasz, and Alexander Schrijver
1985: Jozsef Beck; H.W. Lenstra Jr.; Eugene M. Luks
1988: Eva Tardos; Narendra Karmarkar
1991: Alfred Lehman; Nikolai E. Mnev; Martin Dyer, Alan Frieze, and Ravi Kannan
1994: Lou Billera; Neil Robertson, Paul D. Seymour, and Robin Thomas; Gil Kalai
1997: Jeong Han Kim
2000: Michel X. Goemans and David P. Williamson; Michele Conforti, Gerard Cornuejols, and M. R. Rao

AMS
AMERICAN MATHEMATICAL SOCIETY

Mathematics Calendar

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

November 2002

*4-8 **Galois Theory Conference in honor of John Thompson's 70th birthday**, University of Florida, Gainesville, Florida.

Topic: Interactions between group theory and algebra/geometry/number theory, showing the ubiquity and power of the basic principle of Galois theory.

Organizer: H. Voelklein; email: helmut@math.ufl.edu. Please contact for further information or help with reservations.

Supporter: The conference is supported by NSA, NSF and the University of Florida.

Information:http://www.math.ufl.edu/~helmut/galconf.html.

*21-23 **Contemporary Algebra and Algebraic Geometry: Red Raider Mini-Symposium**, Texas Tech University, Lubbock, Texas.

Description: The Mini-Symposium will feature distinguished lectures by R. Griess, W. Fulton, J. Lepowsky, G. Margulis and E. Zelmanov with a counterpart of five lectures by outstanding early career mathematicians including F. Bleher, M. Mustata, C. Polini and H. Schenck.

Support: Travel support is available for a limited number of participants. Graduate students, recent PhD's, women and underrepresented minorities are especially encouraged to apply for travel support.

The Mini-Symposium is sponsored by the Paul Whitfield Horn Professor Endowment at Texas Tech University, the National Science Foundation, and the National Security Agency.

Information: For more information and to register, visit: http://www.math.ttu.edu/redraider/ or contact L. Juan at ljuan@math.ttu.edu.

December 2002

*9-12 **2002 WSEAS Int. Conf. on ELECTRONICS, CONTROL & SIGNAL PROCESSING**, Singapore, Singapore.

Topics: Symposium on Electronics, Symposium on Control, Symposium on Signal Processing .

Call for Papers:

Description: Like in all WSEAS Sponsored Conferences, all the accepted papers will be simultaneously published not only in the usual conference proceedings, but also as chapters in the WSEAS Press Book Series or as papers in WSEAS Transactions (Journals). The Proceedings and WSEAS Press Book Series will be edited by WSEAS Press (Athens, Greece).

Chairman and Editors: See the web.

Information: http://www.wseas.org/conferences/2002/singapore/ecs/ or visit: http://www.wseas.org/. (Please, do not reply to the email address: call_for_papers@wses.org, but to the one that you can find in the web pages of the conferences).

February 2003

*10-13 **SIAM Conference on Computational Science and Engineering (CSE03)**, Hyatt Regency Islandia Hotel & Marina, San Diego, California.

Description: SIAM is conducting this conference on CS&E to draw attention to the tremendous range of major computational efforts on large problems in science and engineering, to promote the interdisciplinary culture required to meet these large-scale challenges, and to encourage the training of the next generation of computational scientists.

This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found on the last page of each issue.

An announcement will be published in the *Notices* if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in every third issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

In general, announcements of meetings and conferences held in North America carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the *Notices* in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.

In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence **six months** prior to the scheduled date of the meeting.

The complete listing of the Mathematics Calendar will be published only in the September issue of the *Notices*. The March, June, and December issues will include, along with new announcements, references to any previously announced meetings and conferences occurring within the twelve-month period following the month of those issues. New information about meetings and conferences that will occur later than the twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the twelve-month period.

The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available electronically through the AMS website on the World Wide Web. To access the AMS website, use the URL: http://www.ams.org/.

March 2003

28-30 **Southeast Geometry Conference**, College of Charleston, Charleston, South Carolina.

Description: Researchers and graduate students are invited to attend the 14th annual Southeast Geometry Conference. Those wishing to present a 40-minute research talk, or seeking support, should contact the organizers as soon as possible, and in any case by February 14, 2003. Topics: All areas of geometry, including, but not limited to, algebraic, differential and symplectic geometry, and applications to mathematical physics

Organizers: A. Calini (calinia@cofc.edu), T. Ivey (iveyt@cofc.edu), A. Kasman (kasmana@cofc.edu).

Information: T. A. Ivey, Assistant Professor, Dept. of Math.; College of Charleston, 66 George Street, Charleston, SC 29424-0001; office: Bell 220C; phone: 843-953-7276; email: ivey@math.cofc.edu; http://math.cofc.edu/faculty/ivey/.

May 2003

25-29 **Dynamical Systems, Denton 2003**, University of North Texas, Denton, Texas.

Information: The URL of the conference is http://www.towiem.com/.

June 2003

23-25 **SIAM Conference on Mathematics for Industry: Challenges and Frontiers**, The Metropolitan Hotel, Toronto, Ontario, Canada.

Description: SIAM's conference on Mathematics for Industry focuses attention on the many and varied opportunities to promote applications of mathematics to industrial problems. Since the SIAM community encompasses enormous talent for integrating and enriching both industrial work and academic research, this conference will stress interactions within the context of mathematical models and complex systems, and will encourage other mathematical themes of interest to industry, government, business and finance.

Information: email: meetings@siam.org.

23-28 **Tools for Mathematical Modelling**, Saint-Petersburg State Technical Universit, Saint-Petersburg, Russia.

Conference Chair: G. Osipenko, St. Petersburg Technical Univ., math@math.hop.stu.neva.

Topics: A list of possible topics includes (but is not limited to) the following: mathematical modelling, fuzzy theory, control theory, mathematical physics, computer algebra, computer simulation, design techniques, numerical methods, parallel and distributed algorithms, computer modelling in dynamical systems, mathematical models in biology, medicine etc., applications to physics, mechanics, electrotechnics and electronics, dynamic economic models, general macro-economic models, market models, tools for mathematical education.

Scientific Program: The Program will consist of one hour lectures to be given by plenary speakers and parallel sessions for short 20-minute communications by participants on their recent research. Detailed schedule will be printed in the conference program.

Working Languages: The working languages are English and Russian.

Deadlines: For special sessions organizers: June 30, 2002. For registration and abstract submission: March 30 2003. The deadline for hotel reservations is 30 January, since 2003 is the 300th anniversary of St. Petersburg and many visitors and guests are expected.

Information: For more information contact the meeting secretariat or the organizing committee at Lidiya Linchuk, MATHTOOLS'2003, Dept. of Mathematics, State Technical University, Polytechnicheskaya st., 29, St. Petersburg 195251, Russia, lidiya_linchuk@mail.ru.

July 2003

*14-15 **Mathematics of Computation and Approximation: A Conference in Honour of the 65th Birthday of Professor Ian Sloan**, University of New South Wales, Sydney, Australia.

Information: http://www.maths.unsw.edu.au/conference/.

August 2003

*4-9 **4th International Algebraic Conference**, Lviv, Ukraine.

Description: The Conference is organized jointly by the Lviv Ivan Franko National University, Kyiv Taras Shevchenko National University, Pidstryhach Institute for Applied Problems of Mechanics and Mathematics National Academy of Sciences of Ukraine.

Program Committee: Chairman: Yu. A. Drozd.

Members: V. I. Andriychuk (Lviv), V. I. Arnautov (Chisinau), V. A. Artamonov (Moscow), O. D. Artemovych (Lviv), T. O. Banakh (Lviv), A. A. Bovdi (Uzhgorod), M. S. Chernikov (Kyiv), V. Dlab (Ottawa), R. I. Grigorchuk (Moscow), P. M. Gudivok (Uzhgorod), E. Hrushovski (Jerusalem), A. I. Kashu (Chisinau), V. V. Kirichenko (Kyiv), M. Ya. Komarnytsòkyi (Lviv), J. Krempa (Warsaw), L. A. Kurdachenko (Dnipropetrovsk), L. P. Lyman (Sumy), V. V. Lyubashenko (Kyiv), A. V. Mikhalev (Moscow), B. V. Novikov (Kharkiv), A. Yu. Ol'shanskii (Moscow), I. V. Protasov (Kyiv), C. Ringel (Bielefeld), A. V. Roiter (Kyiv), Yu. M. Ryabukhin (Chisinau), V. V. Sergejchuk (Kyiv), L. O. Shemetkov (Gomel), I. P. Shestakov (Novosibirsk), A. Skowronski (Torun), V. I. Sushchansky (Kyiv), P. D. Varbanez (Odesa), A. V. Yakovlev (St. Petersburg), V. I. Yanchevskii (Minsk), M. M. Zarichnyi (Lviv).

Information: http://www.all-hotels.com.ua/addz2.php3?Lang=1&sCity=4; http://www.piligrim.lviv.ua/ukraine/page6_en.html. You can get further information and the first announcement by topos@franko.lviv.ua.

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.

November 2003

*10-13 **SIAM Conference on Geometric Design & Computing**, Elliott Grand Hyatt, Seattle, Washington.

Information: email: meetings@siam.org.

September 2004

*14-18 **Third International Conference on Boundary Integral Methods: Theory and Applications**, Brunel University, West London, United Kingdom.

Description: As well as discussing recent developments in the theory and numerical analysis of boundary integral equations, the conference will strive to encompass applications of contemporary relevance such as direct and inverse (medium and high) frequency scattering, electromagnetics and moving boundary problems in hydrodynamics. Continuing progress in key computational techniques such as multipole, wavelets and panel clustering, together with innovative algorithm design will be an additional theme.

Conference Organizing and Scientific Committee: S. Amini (Univ. of Salford), S. Chandler-Wilde (Brunel Univ., Chair), K. Chen (Univ. of Liverpool), P. Davies (Univ. of Strathclyde), I. Graham (Univ. of Bath), P. Martin (Colorado School of Mines).

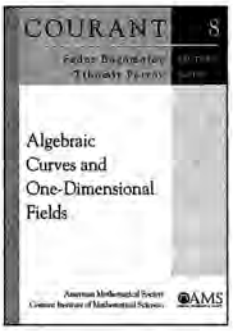
Information: http://www.brunel.ac.uk/~mastsnc/bimta3.html.

New Publications Offered by the AMS

Algebra and Algebraic Geometry

Recommended Text

Independent Study



Algebraic Curves and One-Dimensional Fields

Fedor Bogomolov and **Tihomir Petrov**, *New York University–Courant Institute of Mathematical Sciences, NY*

Algebraic curves have many special properties that make their study particularly rewarding. As a result, curves provide a natural introduction to algebraic geometry. In this book, the authors also bring out aspects of curves that are unique to them and emphasize connections with algebra.

This text covers the essential topics in the geometry of algebraic curves, such as line bundles and vector bundles, the Riemann-Roch Theorem, divisors, coherent sheaves, and zeroth and first cohomology groups. The authors make a point of using concrete examples and explicit methods to ensure that the style is clear and understandable.

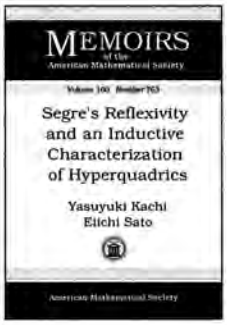
Several chapters develop the connections between the geometry of algebraic curves and the algebra of one-dimensional fields. This is an interesting topic that is rarely found in introductory texts on algebraic geometry.

This book makes an excellent text for a first course for graduate students.

Contents: Algebraic Preliminaries; From algebra to geometry; Geometry of dimension one; Divisors and line bundles; Vector bundles, coherent sheaves, and cohomology; Vector bundles on $\mathbb{P}^1$; General theory of curves; Elliptic curves; The Riemann-Roch theorem; Curves over arithmetic fields; Bibliography; Index.

Courant Lecture Notes, Volume 8

November 2002, 214 pages, Softcover, ISBN 0-8218-2862-2, LC 2002028230, 2000 *Mathematics Subject Classification*: 13J10, 13A18, 13B22, 14H05, 14H52, 14H60, 14F05, 14C40, 32L10, **All AMS members $22**, List $27, Order code CLN/8N



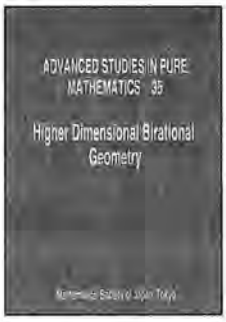
Segre's Reflexivity and an Inductive Characterization of Hyperquadrics

Yasuyuki Kachi, *University of Tennessee, Knoxville*, and **Eiichi Sato**, *Kyushu University, Fukuoka, Japan*

Contents: Introduction; The universal pseudo-quotient for a family of subvarieties; Normal bundles of quadrics in X; Morphisms from quadrics to Grassmannians; Pointwise uniform vector bundles on non-singular quadrics; Theory of extensions of families over Hilbert schemes; Existence of algebraic quotient—proof of Theorem 0.3; Appendix. Deformations of vector bundles on infinitesimally rigid projective varieties with null global i-forms; References.

Memoirs of the American Mathematical Society, Volume 160, Number 763

November 2002, 116 pages, Softcover, ISBN 0-8218-3225-5, LC 2002074589, 2000 *Mathematics Subject Classification*: 14E30, 14E05, 14J35, **Individual member $30**, List $50, Institutional member $40, Order code MEMO/160/763N



Higher Dimensional Birational Geometry

Shigefumi Mori, *Kyoto University, Japan*, and **Yoichi Miyaoka**, *University of Tokyo, Japan*, Editors

A publication of the Mathematical Society of Japan.

This volume contains four papers written by participants of the international conference on Higher Dimensional Algebraic Varieties held at the Research Institute of Mathematical Sciences (RIMS) at Kyoto University (Japan). Rather than an ordinary proceedings of the conference, the editors have compiled a selection of independent, full expositions on topics of fundamental importance in algebraic geometry: moduli spaces of abelian

surfaces, rational curves on algebraic varieties, 3-dimensional flips, and the theory of elliptic fibrations.

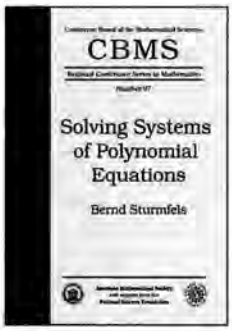
The authors-including a Fields medalist and the founder of fundamental results in algebraic geometry—discuss the topics fully, giving complete proofs of new results, technical preparations, and an historical overview. The book is suitable for graduate students and research mathematicians interested in algebraic geometry.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: K. Cho, Y. Miyaoka, and **N. I. Shepherd-Barron,** Characterizations of projective space and applications to complex symplectic manifolds; **K. Hulek** and **G. K. Sankaran,** The geometry of Siegel modular varieties; **S. Mori,** On semi-stable extremal neighborhoods; **N. Nakayama,** Local structure of an elliptic fibration.

Advanced Studies in Pure Mathematics, Volume 35

October 2002, 295 pages, Hardcover, ISBN 4-931469-19-1, 2000 *Mathematics Subject Classification*: 14-06; 14Dxx, 14Exx, 14Jxx, 14Kxx, **All AMS members $64,** List $80, Order code ASPM/35N



Solving Systems of Polynomial Equations

Bernd Sturmfels, *University of California, Berkeley*

A classic problem in mathematics is solving systems of polynomial equations in several unknowns. Today, polynomial models are ubiquitous and widely used across the sciences. They arise in robotics, coding theory, optimization, mathematical biology, computer vision, game theory, statistics, and numerous other areas.

This book furnishes a bridge across mathematical disciplines and exposes many facets of systems of polynomial equations. It covers a wide spectrum of mathematical techniques and algorithms, both symbolic and numerical.

The set of solutions to a system of polynomial equations is an algebraic variety—the basic object of algebraic geometry. The algorithmic study of algebraic varieties is the central theme of computational algebraic geometry. Exciting recent developments in computer software for geometric calculations have revolutionized the field. Formerly inaccessible problems are now tractable, providing fertile ground for experimentation and conjecture.

The first half of the book gives a snapshot of the state of the art of the topic. Familiar themes are covered in the first five chapters, including polynomials in one variable, Gröbner bases of zero-dimensional ideals, Newton polytopes and Bernstein's Theorem, multidimensional resultants, and primary decomposition.

The second half of the book explores polynomial equations from a variety of novel and unexpected angles. It introduces interdisciplinary connections, discusses highlights of current research, and outlines possible future algorithms. Topics include computation of Nash equilibria in game theory, semi-definite programming and the real Nullstellensatz, the algebraic geometry of statistical models, the piecewise-linear geometry of valuations and amoebas, and the Ehrenpreis-Palamodov theorem on linear partial differential equations with constant coefficients.

Throughout the text, there are many hands-on examples and exercises, including short but complete sessions in Maple®, MATLAB®, Macaulay 2, Singular, PHCpack, CoCoA, and SOSTools. These examples will be particularly useful for readers with no background in algebraic geometry or commutative algebra. Within minutes, readers can learn how to type in polynomial equations and actually see some meaningful results on their computer screens.

Prerequisites include basic abstract and computational algebra. The book is designed as a text for a graduate course in computational algebra.

This item will also be of interest to those working in applications.

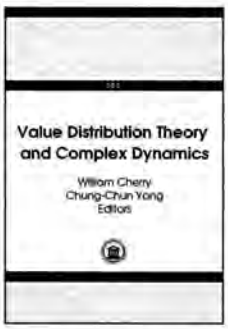
® Waterloo Maple, Inc., Ontario, Canada.
® MATLAB, The MathWorks, Inc., Natick, MA.
Singular is a free software distributed under the GNU license. ©Department of Mathematics, and Centre for Computer Algebra, University of Kaiserslautern, Germany.
Macaulay 2, © Daniel R. Grayson and Michael E. Stillman (1993-2001) and is distributed under the GNU license.
PHCpack ©1998, Katholieke Universiteit Leuven, Department of Computer Science, Heverlee, Belgium.
CoCoA, A. Capani, G. Niesi, L. Robbiano, a system for doing Computations in Commutative Algebra, available via anonymous ftp from: http://cocoa.dima.unige.it.
SOSTools is a MATLAB® toolbox and freely available under the GNU license at http://www.cds.caltech.edu/sostools or http://www.aut.ee.ethz.ch/~parrilo/sostools.

Contents: Polynomials in one variable; Gröbner bases of zero-dimensional ideals; Bernstein's theorem and fewnomials; Resultants; Primary decomposition; Polynomial systems in economics; Sums of squares; Polynomial systems in statistics; Tropical algebraic geometry; Linear partial differential equations with constant coefficients; Bibliography; Index.

CBMS Regional Conference Series in Mathematics, Number 97

October 2002, 152 pages, Softcover, ISBN 0-8218-3251-4, LC 2002027951, 2000 *Mathematics Subject Classification*: 13P10, 14Q99, 65H10; 12D10, 14P10, 35E20, 52B20, 62J12, 68W30, 90C22, 91A06, **All AMS members $26,** List $32, Order code CBMS/97N

Analysis



Value Distribution Theory and Complex Dynamics

William Cherry, *University of North Texas, Denton,* and **Chung-Chun Yang,** *The Hong Kong University of Science and Technology, China,* Editors

This volume contains six detailed papers written by participants of the special session on value distribution theory and complex dynamics held in Hong Kong

at the First Joint International Meeting of the AMS and the Hong Kong Mathematical Society in December 2000. It demonstrates the strong interconnections between the two fields and introduces recent progress of leading researchers from Asia.

In the book, W. Bergweiler discusses proper analytic maps with one critical point and generalizes a previous result concerning Leau domains. W. Cherry and J. Wang discuss non-Archimedean analogs of Picard's theorems. P.-C. Hu and C.-C. Yang give a survey of results in non-Archimedean value distribution theory related to unique range sets, the *abc*-conjecture, and Shiffman's conjecture. L. Keen and J. Kotus explore the dynamics of the family of $f_\lambda(z) = \lambda \tan(z)$ and show that it has much in common with the dynamics of the familiar quadratic family $f_c(z) = z^2 + c$. R. Oudkerk discusses the interesting phenomenon known as parabolic implosion and, in particular, shows the persistence of Fatou coordinates under perturbation. Finally, M. Taniguchi discusses deformation spaces of entire functions and their combinatorial structure of singularities of the functions.

The book is intended for graduate students and research mathematicians interested in complex dynamics, function theory, and non-Archimedean function theory.

This item will also be of interest to those working in number theory.

Contents: W. Bergweiler, On proper analytic maps with one critical point; **W. Cherry** and **J. T.-Y. Wang**, Non-Archimedean analytic maps to algebraic curves; **P.-C. Hu** and **C.-C. Yang**, Some progress in non-Archimedean analysis; **L. Keen** and **J. Kotus**, On period doubling phenomena and Sharkovskii type ordering for the family $\lambda \tan(z)$; **R. Oudkerk**, The parabolic implosion: Lavaurs maps and strong convergence for rational maps; **M. Taniguchi**, Synthetic deformation space of an entire function.

Contemporary Mathematics, Volume 303

October 2002, 136 pages, Softcover, ISBN 0-8218-2980-7, LC 2002026231, 2000 *Mathematics Subject Classification*: 11D75, 30D05, 30D20, 30D35, 30G06, 32G15, 32H25, 32H30, 37F10, 37F45, **Individual member $23**, List $39, Institutional member $31, Order code CONM/303N

Abstract Band Method via Factorization, Positive and Band Extensions of Multivariable Almost Periodic Matrix Functions, and Spectral Estimation

Leiba Rodman, **Ilya M. Spitkovsky**, and **Hugo J. Woerdeman**, *The College of William and Mary, Williamsburg, VA*

Contents: Introduction; Abstract band method: New variations; Toeplitz and Wiener algebras of operator matrices; Positive extensions in Wiener classes of almost periodic matrix functions; Appendix; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 160, Number 762

November 2002, 71 pages, Softcover, ISBN 0-8218-2996-3, LC 2002074588, 2000 *Mathematics Subject Classification*: 42A75, 15A54, 47A68, 47A56, 47A57, 42A82, 47B35, 93E10, 60G12, **Individual member $28**, List $46, Institutional member $37, Order code MEMO/160/762N

Applications

Physical Knots: Knotting, Linking, and Folding Geometric Objects in $\mathbb{R}^3$

Jorge Alberto Calvo, *North Dakota State University, Fargo*, **Kenneth C. Millett**, *University of California, Santa Barbara*, and **Eric J. Rawdon**, *Duquesne University, Pittsburgh, PA*, Editors

The properties of knotted and linked configurations in space have long been of interest to physicists and mathematicians. More recently and more widely, they have become important to biologists, chemists, computer scientists, and engineers. The depth and breadth of their applications are widely appreciated. Nevertheless, fundamental and challenging questions remain to be answered.

Based on a Special Session at the AMS Sectional Meeting in Las Vegas (NV) in April 2001, this volume discusses critical questions and introduces new ideas that will stimulate multi-disciplinary applications.

Some of the papers are primarily theoretical; others are experimental. Some are purely mathematical; others deal with applications of mathematics to theoretical computer science, engineering, physics, biology, or chemistry. Connections are made between classical knot theory and the physical world of macromolecules, such as DNA, geometric linkages, rope, and even cooked spaghetti.

This book introduces the world of physical knot theory in all its manifestations and points the way for new research. It is suitable for a diverse audience of mathematicians, computer scientists, engineers, biologists, chemists, and physicists.

This item will also be of interest to those working in geometry and topology.

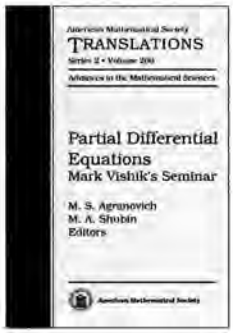
Contents: J. Simon, Physical knots; **R. Randell**, The space of piecewise-linear knots; **J. A. Calvo**, Characterizing polygons in $\mathbb{R}^3$; **E. J. Rawdon** and **R. G. Scharein**, Upper bounds for equilateral stick numbers; **K. C. Millett**, An investigation of equilateral knot spaces and ideal physical knot configurations; **T. Deguchi** and **M. K. Shimamura**, Topological effects on the average size of random knots; **A. Dobay**, **P.-E. Sottas**, **J. Dubochet**, and **A. Stasiak**, Bringing an order into random knots;

E. J. J. van Rensburg, The probability of knotting in lattice polygons; **E. J. J. van Rensburg**, Knotting in adsorbing lattice polygons; **P. Pieranski** and **S. Przybyl**, In search of the ideal trefoil knot; **Y. Diao** and **C. Ernst**, The crossing numbers of thick knots and links; **R. Kusner**, On thickness and packing density for knots and links; **J. M. Sullivan**, Approximating ropelength by energy functions; **R. Langevin** and **J. O'Hara**, Conformal geometric viewpoints for knots and links I; **O. Gonzalez**, **J. H. Maddocks**, and **J. Smutny**, Curves, circles, and spheres; **G. Dietler**, **P. Pieranski**, **S. Kasas**, and **A. Stasiak**, The rupture of knotted strings under tension; **L. H. Kauffman** and **S. Lambropoulou**, Classifying and applying rational knots and rational tangles; **D. Roseman**, Untangling some spheres in $\mathbb{R}^4$ by energy minimizing flow; **M. Soss** and **G. T. Toussaint**, Convexifying polygons in 3D: A survey; **R. Connelly**, **E. D. Demaine**, and **G. Rote**, Infinitesimally locked self-touching linkages with applications to locked trees; **L. H. Kauffman**, Biologic.

Contemporary Mathematics, Volume 304

November 2002, 342 pages, Softcover, ISBN 0-8218-3200-X, LC 2002027976, 2000 *Mathematics Subject Classification*: 57M25, 49Q10, 53A04, 57M27, 82D60, 82B41, 92C05, 52C25, 53A30, 74C99, **Individual member $53**, List $89, Institutional member $71, Order code CONM/304N

Differential Equations



Partial Differential Equations

M. S. Agranovich, *Moscow Institute of Electronics and Mathematics, Russia*, and **M. A. Shubin**, *Northeastern University, Boston, MA*, Editors

Mark Vishik's Partial Differential Equations seminar held at Moscow State University was one of the world's leading seminars in PDEs for over 40 years. This book celebrates Vishik's eightieth birthday. It comprises new results and survey papers written by many renowned specialists who actively participated over the years in Vishik's seminars.

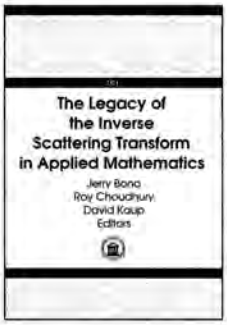
Contributions include original developments and methods in PDEs and related fields, such as mathematical physics, tomography, and symplectic geometry. Papers discuss linear and nonlinear equations, particularly linear elliptic problems in angles and general unbounded domains, linear elliptic problems with a parameter for mixed order systems, infinite-dimensional Schrödinger equations, Navier–Stokes equations, and nonlinear Maxwell equations. The book ends on a historical note with a paper about Vishik's seminar as a whole and a list of selected talks given from 1964 through 1989.

The book is suitable for graduate students and researchers in pure and applied mathematics and mathematical physics.

Contents: A. Babin and **A. Figotin**, Multilinear spectral decomposition for nonlinear Maxwell equations; **R. Denk** and **L. Volevich**, Elliptic boundary value problems with large parameter for mixed order systems; **A. Dynin**, Feynman integral for functional Schrödinger equations; **B. Fedosov**, On normal Darboux coordinates; **A. Fursikov**, Real process corresponding to the 3D Navier-Stokes system, and its feedback stabilization from the boundary; **A. Komech**, **A. Merzon**, and **P. Zhevandrov**, A method of complex characteristics for elliptic problems in angles, and its applications; **S. B. Kuksin**, On exponential convergence to a stationary measure for nonlinear PDEs, perturbed by random kick-forces, and the turbulence-limit; **V. P. Palamodov**, Impedance tomography, inverse scattering, and phase space analysis; **A. Volpert** and **V. Volpert**, Normal solvability and properness of elliptic problems; **M. S. Agranovich**, Mark Vishik's seminar at Moscow state university; **M. Shubin**, List of selected talks at M. I. Vishik's seminar in Moscow.

American Mathematical Society Translations—Series 2 (*Advances in the Mathematical Sciences*), Volume 206

November 2002, 278 pages, Hardcover, ISBN 0-8218-3303-0, LC 91-640741, 2000 *Mathematics Subject Classification*: 35-XX, **Individual member $65**, List $109, Institutional member $87, Order code TRANS2/206N



The Legacy of the Inverse Scattering Transform in Applied Mathematics

Jerry Bona, *University of Illinois, Chicago*, and **Roy Choudhury** and **David Kaup**, *University of Central Florida, Orlando*, Editors

Swift progress and new applications characterize the area of solitons and the inverse scattering transform. There are rapid developments in current nonlinear optical technology: Larger intensities are more available; pulse widths are smaller; relaxation times and damping rates are less significant. In keeping with these advancements, exactly integrable soliton equations, such as 3-wave resonant interactions and second harmonic generation, are becoming more and more relevant in experimental applications. Techniques are now being developed for using these interactions to frequency convert high intensity sources into frequency regimes where there are no lasers. Other experiments involve using these interactions to develop intense variable frequency sources, opening up even more possibilities.

This volume contains new developments and state-of-the-art research arising from the conference on the "Legacy of the Inverse Scattering Transform" held at Mount Holyoke College (South Hadley, MA). Unique to this volume is the opening section, "Reviews". This part of the book provides reviews of major research results in the inverse scattering transform (IST), on the application of IST to classical problems in differential geometry, on algebraic and analytic aspects of soliton-type equations, on a new method for studying boundary value problems for integrable partial differential equations (PDEs) in two dimensions, on chaos in PDEs, on advances in multi-soliton complexes, and on a unified approach to integrable systems via Painlevé analysis.

continued

This conference provided a forum for general exposition and discussion of recent developments in nonlinear waves and related areas with potential applications to other fields. The book will be of interest to graduate students and researchers interested in mathematics, physics, and engineering.

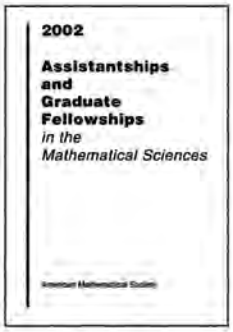
This item will also be of interest to those working in applications.

Contents: **D. J. Kaup**, The legacy of the IST; **V. Zakharov**, Application of inverse scattering method to problems of differential geometry; **V. S. Gerdjikov**, Algebraic and analytic aspects of soliton type equations; **A. S. Fokas**, Differential forms, spectral theory, and boundary value problems; **Y. C. Li**, Chaos in partial differential equations; **N. N. Akhmediev**, **A. A. Sukhorukov**, and **A. Ankiewicz**, Multi-soliton complexes; **S. R. Choudhury**, A unified approach to integrable systems via Painlevé analysis; **V. S. Buslaev** and **C. Sulem**, Asymptotic stability of solitary waves for nonlinear Schrödinger equations; **A. de Bouard** and **A. Debussche**, Finite-time blow-up in the additive supercritical stochastic nonlinear Schrödinger equations: The real noise case; **O. I. Bogoyavlenskij**, Method of symmetry transforms for ideal magnetohydrodynamics equilibrium equations; **R. Young**, The p-system I: The Riemann problem; **G. J. Morrow** and **S. Chakravarty**, Statistical analysis of collision-induced timing shifts in a wavelength-division-multiplexed optical soliton-transmission system; **R. Grimshaw**, **G. A. Green**, and **B. A. Malomed**, Cuspons and peakons vis-a-vis regular solitons and collapse in a three-wave system; **S. Chakravarty** and **R. G. Halburd**, First integrals and gradient flow for a generalized Darboux-Halphen system; **L. Casian** and **Y. Kodama**, Blow-ups of the Toda lattices and their intersections with the Bruhat cells; **M. Kovalyov**, Superposition principle for oscillatory solutions of integrable systems; **H. Steudel**, Scattering at truncated solitons and inverse scattering on the semiline.

Contemporary Mathematics, Volume 301

October 2002, 338 pages, Softcover, ISBN 0-8218-3161-5, LC 2002027974, 2000 *Mathematics Subject Classification*: 35Q51, 35Q53, 35Q55, 35Q58, 35A20, 35C05, **Individual member $47**, List $79, Institutional member $63, Order code CONM/301N

General and Interdisciplinary



Assistantships and Graduate Fellowships 2002

Review of a previous edition:

This directory is a tool for undergraduate mathematics majors seeking information about graduate programs in mathematics. Although most of the information can be gleaned from the Internet, the usefulness of this directory for the prospective graduate student is the consistent format for comparing different mathematics graduate programs without the hype. Published annually, the information is up-to-date, which is more than can be said of some Websites. Support for graduate students in mathematics is a high priority of the American Mathematical Society, which also provides information for fellowships and grants they offer as well as support from other societies and foundations. The book is highly recommended for academic and public libraries.

—American Reference Books Annual

This publication is an indispensable source of information for students seeking support for graduate study in the mathematical sciences. Providing data from a broad range of academic institutions, it is also a valuable resource for mathematical sciences departments and faculty.

Assistantships and Graduate Fellowships brings together a wealth of information about resources available for graduate study in mathematical sciences departments in the U.S. and Canada. Information on the number of faculty, graduate students, and degrees awarded (bachelor's, master's, and doctoral) is listed for each department when available. Stipend amounts and the number of awards available are given, as well as information about foreign language requirements. Numerous display advertisements from mathematical sciences departments throughout the country provide additional information.

Also listed are sources of support for graduate study and travel, summer internships, and graduate study in the U.S. for foreign nationals. Finally, a list of reference publications for fellowship information makes *Assistantships and Graduate Fellowships* a centralized and comprehensive resource.

November 2002, approximately 128 pages, Softcover, ISBN 0-8218-3230-1, 2000 *Mathematics Subject Classification*: 00-XX, **Individual member $13**, List $22, Order code ASST/2002N

Séminaire Bourbaki
Volume 1999/2000, Exposés 865–879

A publication of the Société Mathématique de France.

The talks at Bourbaki seminars are devoted to the most important research topics of current interest. This volume contains 15 lectures (given in 1999/2000) on the following subjects: group theory, infinite dimensional algebras, algebraic geometry, arithmetic geometry, Langlands correspondence, probability, partial differential equations, operator algebras, model theory, and polynomial functors.

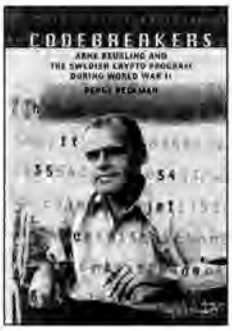
Distributed by the AMS in the United States, Canada, and Mexico. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: Résumés des exposés; *Novembre 1999:* **C. Kassel**, L'ordre de Dehornoy sur les tresses; **J.-F. Le Gall**, Exposants critiques pour le mouvement brownien et les marches aléatoires [d'après Kenyon, Lawler et Werner]; **M. Reid**, La correspondance de McKay; **T. Rivière**, Ginzburg-Landau vortices: the static model; **G. Skandalis**, Progrès récents sur la conjecture de Baum-Connes. Contribution de Vincent Lafforgue; *Mars 2000:* **É. Bouscaren**, Théorie des modèles et conjecture de Manin-Mumford [d'après Ehud Hrushovski]; **B. Edixhoven**, Rational elliptic curves are modular [after

Breuil, Conrad, Diamond and Taylor]; **V. Kharlamov**, Variétés de Fano réelles [d'après C. Viterbo]; **G. Laumon**, La correspondance de Langlands sur les corps de fonctions [d'après Laurent Lafforgue]; **E. Looijenga**, Motivic measures; *Juin 2000:* **E. Frenkel**, Vertex algebras and algebraic curves; **S. S. Kudla**, Derivatives of Eisenstein series and generating functions for arithmetic cycles; **T. Pirashvili**, Polynomial functors over finite fields [after Franjou, Friedlander, Henn, Lannes, Schwartz, Suslin]; **V. Turaev**, Faithful linear representations of the braid groups; **P. Van Moerbeke**, Random matrices and permutations, matrix integrals and integrable systems.

Astérisque, Number 276

January 2002, 433 pages, Softcover, ISBN 2-85629-110-4, 2000 *Mathematics Subject Classification*: 20F36, 20F60, 20F10, 57M07, 06F15, 03E55, 08A50, 60J65, 05C70, 14-XX, 35Jxx, 35Qxx, 49Jxx, 58E15, 81T13, 19K99, 22E50, 03C60, 14K15, 11G10, 03C45, 11F80, 11G18, 14G35, 53D12, 14P25, 11Fxx, 14Fxx, 22Exx, 14Exx, 14F42, 17B67, 17B68, 81T40, 14H10, 14H60, 14G40, 11G15, 11F27, 11F30, 11G50, 11F46, 19D55, 55S10, 16G10, 57M99, 15A52, 37K10, **Individual member $90**, List $100, Order code AST/276N



Codebreakers

Arne Beurling and the Swedish Crypto Program during World War II

Bengt Beckman

From Reviews of the Swedish Edition:

The present volume is an excellent illustration of the best kind of popularization of a complex, technical subject, in this case, Swedish wartime cryptanalysis. Bengt Beckman ... a grey eminence with Sweden's Sigint organization ... has been permitted to twitch the company veil and show what his colleagues got up to during World War II ... the reader is gently introduced to the basic ideas of cryptanalysis before coming face-to-face with the Geheimschreiber *... Merlin the Magician, in the shape of Arne Beurling ... uncover[ed] the structure of the underlying cryptosystem and ... [was able to] identify its vulnerabilities, thus ensuring a steady flow of decrypts ... The resulting intelligence was used in framing Swedish wartime policy in the fields of defense, diplomacy, economic negotiations, and counterespionage ... The abiding presence of Arne Beurling is felt throughout the book. It therefore fittingly closes with a portrait of this brilliant but quirky hero seen throughout the eyes of colleagues, students, and friends.*

—Cryptologia

The book contains a well of information ... including detailed accounts of how several of the breaks were performed ... The Swedish cryptanalytical achievements are top class and therefore, it is only appropriate to put Sweden in the same league as the other cryptographic 'superpowers' at the time: Poland, England, and the USA ... The book is well written and at times, reads like a good thriller ... contains new and unpublished information ...

—Cryptologia

One of the greatest accomplishments in the history of cryptography occurred in 1940 when a Swedish mathematician broke the German code used for strategic military communications. This story has all the elements of a classic thriller: a desperate wartime situation; a moody and secretive mathematical genius with a talent for cryptography; and a stunning mathematical feat, mysterious to this day. Arne Beurling, the man who inherited Einstein's office at Princeton's Institute for Advanced Study, was the figure who played this role at a crucial moment in world history.

Though the cracking of the code from the *Geheimschreiber* (G-Schreiber) device is every bit as impressive as the breaking of the Enigma code by the Poles and English, this secret has been kept for over 50 years! Through the eyes of a former head of Sweden's signal intelligence organization, Bengt Beckman, the reader will learn about the events leading up to the breakthrough and make the acquaintance of not only a remarkable mathematician, but also a remarkable human being.

Arne Beurling was a leading international figure who achieved beautiful results in mathematical analysis. By the arrival of World War II, he was one of the most powerful and original mathematicians in the world and widely considered a genius. During his military service, he demonstrated a flair for code and was well known within Swedish cryptology circles. The natural choice of the Swedish intelligence service was to place Beurling at the center of the group charged with breaking the G-Schreiber code. His single-handed effort "broke the unbreakable". Using only teleprinter tapes and cipher text, he deciphered the code that the Germans believed impossible to crack—in two weeks!

The feat, in a word, was astonishing. Many wonder how he did it. But Beurling took his secret to the grave, retorting when asked, "A magician does not reveal his secrets."

The author, Bengt Beckman, for many years was the head of the cryptanalysis department of the Swedish signal intelligence agency. In writing this book, he made extensive use of its archives. He also interviewed many people who participated in the Swedish wartime intelligence effort. He describes in detail Beurling's attack on the G-Schreiber system as well as attacks on several other wartime crypto systems, noting high points from the history of Swedish cryptology.

The book will appeal to a broad audience of readers, from historians and biography buffs to mathematicians to anyone with a passing interest in cryptology and cryptanalysis.

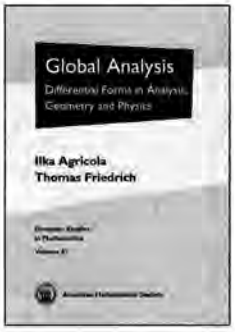
This English edition has been translated by Kjell-Ove Widman, Director of Sweden's Mittag-Leffler Insitute.

Contents: Map; *Part 1:* An 18th century cipher; The world's first ciphering machine; Damm, Hagelin, and Gyldén; Radio signal interception and cryptanalysis before 1939; War; Enter Arne Beurling; The Russian Baltic Navy; Mysterious signals; Teleprinters; Beurling's Analysis; The G-Schreiber and the apps; Continued cryptanalysis; Exit Gyldén—but Beurling comes back; The douple transposition; Operation Barbarossa; The work place; Contents; The birth of the FRA; Brilliant results—despite everything; Downturn and leakage; The Red Army and the Arctic Sea; The doubly enciphered Russian code; Stella Polaris; Gradual loss of German traffic; Borelius pays a visit to the Germans; Information—but of what value?; Norway; The last years of the war; The Swedes' own crypto systems; Arne Beurling 1943–1945; *Part 2:* Arne Beurling; Through the eyes of a woman; A magical friendship; Sources; Index of names.

December 2002, approximately 289 pages, Hardcover, ISBN 0-8218-2889-4, LC 2002026234, 2000 *Mathematics Subject Classification*: 01A70, 94A60, 01A60, 94-03, **All AMS members $31**, List $39, Order code SWCRYN

Geometry and Topology

Recommended Text



Global Analysis

Differential Forms in Analysis, Geometry and Physics

Ilka Agricola and **Thomas Friedrich**, *Humboldt University, Berlin, Germany*

From a Review of the German edition:

Drawing on his great experience in research, writing books, teaching, and working with students, Friedrich presents once more a clearly written, smoothly readable self-contained textbook. The mathematical material and approaches are well motivated, enriched by valuable considerations and reflections. Proofs are elegant, not too technical and carefully performed ... Each chapter finishes with exercises designed to increase comprehension ... For any student who has passed the linear algebra course and calculus, this book offers an excellent opportunity to learn global analysis and its applications to mathematical physics.

—Mathematical Reviews

This book is devoted to differential forms and their applications in various areas of mathematics and physics. Well-written and with plenty of examples, this introductory textbook originated from courses on geometry and analysis and presents a widely used mathematical technique in a lucid and very readable style. The authors introduce readers to the world of differential forms while covering relevant topics from analysis, differential geometry, and mathematical physics.

The book begins with a self-contained introduction to the calculus of differential forms in Euclidean space and on manifolds. Next, the focus is on Stokes' theorem, the classical integral formulas and their applications to harmonic functions and topology. The authors then discuss the integrability conditions of a Pfaffian system (Frobenius's theorem). Chapter 5 is a thorough exposition of the theory of curves and surfaces in Euclidean space in the spirit of Cartan. The following chapter covers Lie groups and homogeneous spaces. Chapter 7 addresses symplectic geometry and classical mechanics. The basic tools for the integration of the Hamiltonian equations are the moment map and completely integrable systems (Liouville-Arnold Theorem). The authors discuss the Newton, Lagrange, and Hamilton formulations of mechanics. Chapter 8 contains an introduction to statistical mechanics and thermodynamics. The final chapter deals with electrodynamics. The material in the book is carefully illustrated with figures and examples, and there are over 100 exercises.

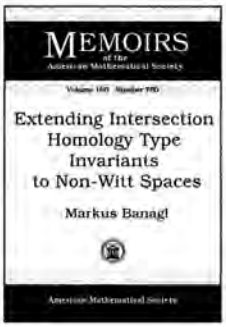
Readers should be familiar with first-year algebra and advanced calculus. The book is intended for graduate students and researchers interested in delving into geometric analysis and its applications to mathematical physics.

This item will also be of interest to those working in analysis.

Contents: Elements of multilinear algebra; Differential forms in $\mathbb{R}^n$; Vector analysis on manifolds; Pfaffian systems; Curves and surfaces in Euclidean 3-space; Lie groups and homogeneous spaces; Symplectic geometry and mechanics; Elements of statistical mechanics and thermodynamics; Elements of electrodynamics; Bibliography; Symbols; Index.

Graduate Studies in Mathematics, Volume 52

November 2002, approximately 360 pages, Hardcover, ISBN 0-8218-2951-3, 2000 *Mathematics Subject Classification*: 53-01; 57-01, 58-01, 22-01, 74-01, 78-01, 80-01, 35-01, **All AMS members $47**, List $59, Order code GSM/52N



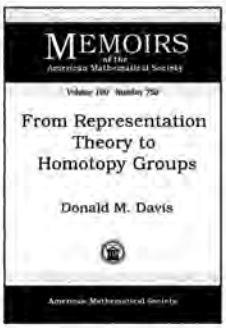
Extending Intersection Homology Type Invariants to Non-Witt Spaces

Markus Banagl, *University of Wisconsin, Madison*

Contents: Introduction; The algebraic framework; Ordered resolutions; The cobordism group Ω_*^{SD}; Lagrangian structures and ordered resolutions; Appendix A. On signs; Bibliography.

Memoirs of the American Mathematical Society, Volume 160, Number 760

November 2002, 83 pages, Softcover, ISBN 0-8218-2988-2, LC 2002074586, 2000 *Mathematics Subject Classification*: 55N33, 57N80, 57R20, 32S60; 32S45, 57Q50, **Individual member $29**, List $48, Institutional member $38, Order code MEMO/160/760N



From Representation Theory to Homotopy Groups

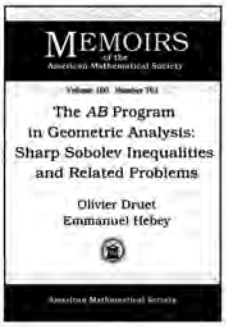
Donald M. Davis, *Lehigh University, Bethlehem, PA*

This item will also be of interest to those working in algebra and algebraic geometry.

Contents: Introduction; Representation theory and ψ^2 in K-theory; Nice form for ψ^2 in $PK^1(E_8)_{(5)}$ and $PK^1(X)$; Determination of $\nu_1^{-1}\pi_{2m}(E_8;5)$; Determination of $\nu_1^{-1}\pi_{2m-1}(E_8;5)$; Calculation of $\nu_1^{-1}\pi_*(E_8;3)$; LiE program for computing λ^2 in $R(E_8)$; Analysis of F_4 and E_7 at the prime 3; References.

Memoirs of the American Mathematical Society, Volume 160, Number 759

November 2002, 50 pages, Softcover, ISBN 0-8218-2987-4, LC 2002074585, 2000 *Mathematics Subject Classification*: 55T15, **Individual member $25**, List $41, Institutional member $33, Order code MEMO/160/759N



The *AB* Program in Geometric Analysis: Sharp Sobolev Inequalities and Related Problems

Olivier Druet and **Emmanuel Hebey**, *University of Cergy-Pontoise, France*

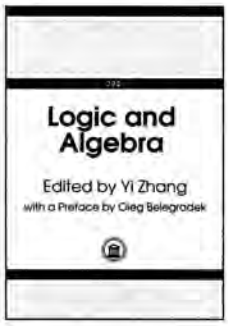
This item will also be of interest to those working in analysis.

Contents: Euclidean background; Statement of the *AB* program; Some historical motivations; The H_1^2-inequality—Part I; The H_1^2-inequality—Part II; PDE methods; The isoperimetric inequality; Bibliography.

Memoirs of the American Mathematical Society, Volume 160, Number 761

November 2002, 98 pages, Softcover, ISBN 0-8218-2989-0, LC 2002074587, 2000 *Mathematics Subject Classification*: 58E35, **Individual member $29**, List $48, Institutional member $38, Order code MEMO/160/761N

Logic and Foundations



Logic and Algebra

Yi Zhang, *University of Michigan, Ann Arbor*, Editor

This volume outlines current developments in model theory and combinatorial set theory and presents state-of-the-art research. Well-known researchers report on their work in model theory and set theory with applications to algebra.

The papers of J. Brendle and A. Blass present one of the most interesting areas of set theory. Brendle gives a very detailed and readable account of Shelah's solution for the long-standing problem of Con($\mathfrak{d} < \mathfrak{a}$). It could be used in an advanced graduate seminar on set theory.

Papers by T. Altinel, J. T. Baldwin, R. Grossberg, W. Hodges, T. Hyttinen, O. Lessmann, and B. Zilber deal with questions of model theory from the viewpoint of stability theory. Here, Zilber constructs an ω-stable complete theory of "pseudo-analytic" structures on algebraically closed fields. This result is part of his program of the model-theoretic study of analytic structures by including Hrushovski's method in the analytic context.

The book presents this and further developments in model theory. It is geared toward advanced graduate students and researchers interested in logic and foundations, algebra, and algebraic geometry.

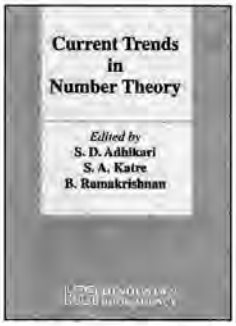
This item will also be of interest to those working in algebra and algebraic geometry.

Contents: J. Brendle, Mad families and iteration theory; **A. Blass**, Nearly adequate sets; **J. D. Hamkins**, How tall is the automorphism tower of a group?; **J. Stavi** and **J. Väänänen**, Reflection principles for the continuum; **B. Zilber**, A theory of a generic function with derivations; **O. Belegradek**, Poly-regular ordered abelian groups; **V. Tolstykh**, On the logical strength of the automorphism groups of free nilpotent groups; **T. Altinel**, Classification of the simple groups of finite Morley rank; **O. Lessmann**, Homogeneous model theory: Existence and categoricity; **R. Grossberg**, Classification theory for abstract elementary classes; **J. T. Baldwin**, Forking and multiplicity in first order theories; **T. Hyttinen**, Groups acting on geometries; **W. Hodges**, Relative categoricity in linear orderings; **M. Di Nasso** and **Y. Zhang**, Nonstandard analysis and an application to the symmetric group on natural numbers; **M. Di Nasso** and **M. Forti**, On the ordering of the nonstandard real line; **A. Bovykin** and **R. Kaye**, Order-types of models of Peano arithmetic.

Contemporary Mathematics, Volume 302

September 2002, 285 pages, Softcover, ISBN 0-8218-2984-X, LC 2002027665, 2000 *Mathematics Subject Classification*: 03E17, 03E35, 03E50, 03C35, 03C45, 03C60, 03C98, 03C62, 20E32, 20B30, **Individual member $41**, List $69, Institutional member $55, Order code CONM/302N

Number Theory



Current Trends in Number Theory

S. D. Adhikari, *Harish-Chandra Research Institute, Allahabad, India*, **S. A. Katre**, *University of Pune, India*, and **B. Ramakrishnan**, *Harish-Chandra Research Institute, Alahabad, India*, **Editors**

A publication of the Hindustan Book Agency.

The book gives a glimpse of current research in combinatorial, algebraic, and analytic aspects of number theory. The articles are refereed and expanded versions of talks given at the International Conference on Number Theory held at the Harish-Chandra Research Institute (Allahaba, India). Also included are some articles on arithmetic algebraic geometry.

Distributed worldwide except in India by the American Mathematical Society.

Contents: S. D. Adhikari and **G. Coppola**, On the average of the sum-of-odd-divisors function; **A. K. Agarwal**, Rogers-Ramanujan identities; **I. Baoulina**, On the problem of explicit evaluation of the number of solutions of the equation $a_1x_1^2 + \ldots + a_nx_n^2 = bx_1 \cdots x_n$ in a finite field; **E. Ghate**, An introduction to congruences between modular forms; **S. A. Katre**, The cyclotomic problem; **S. Kobayashi**, The local root number of elliptic curves; **M. Manickam**, On skew-holomorphic Jacobi forms; **A. Mukhopadyay**, The view-obstruction problem; **V. K. Murty**, The addition law on hyperelliptic Jacobians; **M. R. Murty**, Sieving using Dirichlet series; **D. S. Nagaraj**, Higher circular ℓ-units of Anderson and Ihara; **S. Nakajima**, On automorphism groups of algebraic curves; **V. C. Nanda**, Special

integral bases with restricted coefficients for extensions of Dedekind domains; **A. Narasimhan**, Zeta functions for curves defined over finite fields; **I. B. S. Passi**, Algebraic elements in group rings; **N. Sanat**, Reflection representation and theta correspondence; **J. Sengupta**, Some aspects of the central critical value of automorphic L-functions; **P. Shastri**, Integral points on the circle $X^2 + Y^2 = c$; **T. N. Shorey**, An equation of Goormaghtigh and diophantine approximations; **R. Tandon**, Base change, distinguishedness and a theorem of Saito; **D. S. Thakur**, Elliptic curves in function field arithmetic; **R. Thangadurai**, On certain zero-sum problems in finite Abelian groups; **T. C. Vasudevan**, Modular forms and functional equations; **T. N. Venkataramana**, Lefschetz properties of subvarieties of Shimura varieties.

Number 11

April 2002, 270 pages, Hardcover, ISBN 81-85931-33-X, 2000 *Mathematics Subject Classification*: 11N37, 11P81, 05A17, 11G25, 11T24, 11F33, 11T22, 11G05, 11G07, 11G40, 11F11, 11F50, 11H06, 11T71, 14Q05, 11N35, 14H25, 14H05, 14H30, 13F05, 14G10, 20C07, 16U99, 15A23, 20G40, 11F66, 11F67, 11R04, 11R27, 11D61, 22E50, 11G09, 20D60, 11M06, 11R42, 14G35; 05A15, 05A19, 11F67, 11T24, 11R18, 52A20, 11Y16, 14G15, 11M41, 11G20, 14H30, 14H37, 13B22, 11S99, 11F11, 11F25, 22E55, 11F70, 11B75, 11F46, 11F41, **All AMS members $32**, List $40, Order code HIN/11N

Recommended Text

Supplementary Reading

Spectral Methods of Automorphic Forms

Second Edition

Henryk Iwaniec, *Rutgers University, Piscataway, NJ*

From a review of the first edition:

The material and exposition are well-suited for second-year or higher graduate students ... This clear and comprehensive book concerning the spectral theory of GL(2) *automorphic forms belongs on many a bookshelf.*

—Mathematical Reviews

Automorphic forms are one of the central topics of analytic number theory. In fact, they sit at the confluence of analysis, algebra, geometry, and number theory. In this book, Henryk Iwaniec once again displays his penetrating insight, powerful analytic techniques, and lucid writing style.

The first edition of this volume was an underground classic, both as a textbook and as a respected source for results, ideas, and references. The book's reputation sparked a growing interest in the mathematical community to bring it back into print. The AMS has answered that call with the publication of this second edition.

In the book, Iwaniec treats the spectral theory of automorphic forms as the study of the space $L^2(H\Gamma)$, where H is the upper half-plane and Γ is a discrete subgroup of volume-preserving transformations of H. He combines various techniques from analytic number theory. Among the topics discussed are Eisenstein series, estimates for Fourier coefficients of automorphic forms, the theory of Kloosterman sums, the Selberg trace formula, and the theory of small eigenvalues.

Henryk Iwaniec was awarded the 2002 AMS Cole Prize for his fundamental contributions to analytic number theory. Also available from the AMS by H. Iwaniec is *Topics in Classical Automorphic Forms*, Volume 17 in the Graduate Studies in Mathematics series.

The book is designed for graduate students and researchers working in analytic number theory.

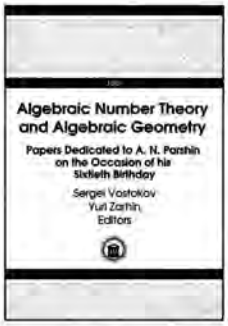
This item will also be of interest to those working in analysis.

This book is co-published by the AMS and Revista Matemática Iberoamericana (RMI), Madrid, Spain.

Contents: Harmonic analysis on the Euclidean plane; Harmonic analysis on the hyperbolic plane; Fuchsian groups; Automorphic forms; The spectral theorem. Discrete part; The automorphic Green function; Analytic continuation of the Eisenstein series; The spectral theorem. Continuous part; Estimates for the Fourier coefficients of Maass forms; Spectral theory of Kloosterman sums; The trace formula; The distribution of eigenvalues; Hyperbolic lattice-point problems; Spectral bounds for cusp forms; Classical analysis; Special functions; References; Subject index; Notation index.

Graduate Studies in Mathematics, Volume 53

December 2002, 220 pages, Hardcover, ISBN 0-8218-3160-7, LC 2002027749, 2000 *Mathematics Subject Classification*: 11F12, 11F30, 11F72, **All AMS members $39**, List $49, Order code GSM/53N



Algebraic Number Theory and Algebraic Geometry

Papers Dedicated to A. N. Parshin on the Occasion of his Sixtieth Birthday

Sergei Vostokov, *St. Petersburg University, Russia*, and **Yuri Zarhin**, *Pennsylvania State University, University Park*, Editors

A. N. Parshin is a world-renowned mathematician who has made significant contributions to number theory through the use of algebraic geometry. Articles in this volume present new research and the latest developments in algebraic number theory and algebraic geometry and are dedicated to Parshin's sixtieth birthday. Well-known mathematicians contributed to this volume, including, among others, F. Bogomolov, C. Deninger, and G. Faltings.

The book is intended for graduate students and research mathematicians interested in number theory, algebra, and algebraic geometry.

This item will also be of interest to those working in algebra and algebraic geometry.

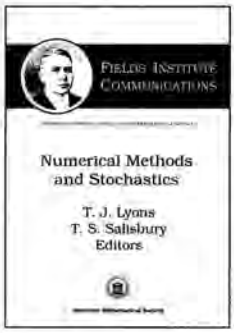
Contents: V. Abrashkin, Ramification theory for higher dimensional local fields; **F. Bogomolov** and **Y. Tschinkel**, Unramified correspondences; **M. V. Bondarko**, Local Leopoldt's problem for ideals in totally ramified p-extensions of complete discrete

valuation fields; **A. Buium**, Quotients of algebraic varieties by Zariski dense equivalence relations; **C. Deninger**, A note on arithmetic topology and dynamical systems; **G. Faltings**, A relation between two moduli spaces studied by V. G. Drinfeld; **G. van der Geer** and **T. Katsura**, An invariant for varieties in positive characteristic; **F. Lorenz** and **S. Vostokov**, Honda groups and explicit pairings on the modules of Cartier curves; **A. Merkurjev**, Algebraic oriented cohomology theories; **Y. G. Zarhin**, Hyperelliptic Jacobians without complex multiplication, doubly transitive permutation groups and projective representations; **I. Zhukov**, Ramification of surfaces: Artin-Schreier extensions.

Contemporary Mathematics, Volume 300

October 2002, 220 pages, Softcover, ISBN 0-8218-3267-0, LC 2002074698, 2000 *Mathematics Subject Classification*: 11S15, 11S31, 14E22, 14F20, 14H30, 14H40, 14K10, 14K99, 14L05, **Individual member $35**, List $59, Institutional member $47, Order code CONM/300N

Probability



Numerical Methods and Stochastics

T. J. Lyons, *University of Oxford, UK*, and **T. S. Salisbury**, *York University, Toronto, ON, Canada*, Editors

This volume represents the proceedings of the Workshop on Numerical Methods and Stochastics held at The Fields Institute in April 1999. The goal of the workshop was to identify emerging ideas in probability theory that influence future work in both probability and numerical computation. The book focuses on new results and gives novel approaches to computational problems based on the latest techniques from the theory of probability and stochastic processes.

Three papers discuss particle system approximations to solutions of the stochastic filtering problem. Two papers treat particle system equations. The paper on "rough paths" describes how to generate good approximations to stochastic integrals. An expository paper discusses a long-standing conjecture: the stochastic fast dynamo effect. A final paper gives an analysis of the error in binomial and trinomial approximations to solutions of the Black-Scholes stochastic differential equations.

The book is intended for graduate students and research mathematicians interested in probability theory.

Contents: D. Crisan, Numerical methods for solving the stochastic filtering problem; **D. Crisan** and **T. Lyons**, Optimal filtering on discrete sets; **P. Del Moral** and **J. Jacod**, The Monte-Carlo method for filtering with discrete-time observations: Central limit theorems; **A. Guionnet**, Approximations of Markovian non linear partial differential equations by particle systems; **A. Guionnet**, Non-Markovian limit diffusions and spin glasses; **S. B. Hazra** and **F. G. Viens**, Towards pathwise stochastic fast dynamo in magneto-hydrodynamics; **T. J. Lyons**, System control and rough paths; **J. B. Walsh** and **O. D. Walsh**, Embedding and the convergence of the binomial and trinomial tree schemes.

Fields Institute Communications, Volume 34

December 2002, approximately 128 pages, Hardcover, ISBN 0-8218-1994-1, LC 2002027936, 2000 *Mathematics Subject Classification*: 60-06; 65C30, 65C35, **Individual member $29**, List $49, Institutional member $39, Order code FIC/34N

American Institute of Mathematics

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The Fellowship will support an outstanding new PhD pursuing research in an area of pure mathematics. It will cover 60 months full-time research as well as funds for travel and equipment. Mail applications and nominations to:

AIM Five-Year Fellowship
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All materials should be received by December 31, 2002 for consideration of an award to be made by January 31, 2003. This Fellowship is for new PhDs: candidates expecting to receive a PhD in the year 2003 are eligible to apply. An application consists of a cover letter, a vita, 3 letters of reference, and a research plan.

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CALIFORNIA

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Department of Mathematics

Harvey Mudd College invites applications for a tenure-track professorship at the assistant or associate professor level. Preference will be given to candidates whose research is in applied mathematics (e.g., applied dynamical systems, asymptotic methods, fluid dynamics, mathematical biology, numerical methods, PDE's, scientific computing). Excellence in teaching is absolutely essential, as is evidence of a strong and ongoing research program. Candidates must be willing to supervise undergraduate research and work with others in the development of departmental programs.

Harvey Mudd College is a highly selective undergraduate institution of science, engineering and mathematics with a median SAT score approaching 1500 and one year of high school calculus 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 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, and should 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 January 10, 2003.

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 Andrew J. Bernoff
Chair, Search Committee
Department of Mathematics
Harvey Mudd College
Claremont, CA 91711-5990

STANFORD UNIVERSITY
Department of Mathematics

The department expects to make one or more Szegö Assistant Professor appointments. These appointments are for a term of three years beginning in September 2003. Applicants are expected to show outstanding promise in research as well as strong interest and ability in teaching. They must have received the Ph.D. prior to the start of the appointment but not before 2000. Candidates should send a letter of application with a curriculum vitae and list of publications, a teaching statement and supporting information including a teaching letter if possible, and three letters of recommendation to: Szegö Search Committee, Department of Mathematics, Stanford University, Stanford, CA 94305, by December 15, 2002. Stanford is an Affirmative Action/Equal Opportunity Employer and welcomes applications from women and minorities.

STANFORD UNIVERSITY
Department of Mathematics

The department is considering applications for tenure-track or tenured faculty appointments. The research fields to be considered are: (1) analysis, (2) algebra, number theory or logic, (3) geometry or topology, (4) combinatorics, (5) applied mathematics or probability; in the last

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 2002 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 advertising.

Upcoming deadlines for classified advertising are as follows: December 2002 issue–September 26, 2002; January 2003 issue–October 28, 2002; February 2003 issue–November 22, 2002; March 2003 issue–January 8, 2003; April 2003 issue–January 28, 2003; May 2003 issue–February 27, 2003 issue.

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 02904. Advertisers will be billed upon publication.

case there are also possibilities for joint appointments with other departments.

Candidates should send a letter of application with a curriculum vitae, a list of publications, and a cover sheet clearly stating the following information: name, area of specialization, institution, date of Ph.D., and Ph.D. advisor. Also, the candidate should arrange to have at least three letters of recommendation (junior candidates only) and evidence of commitment to excellence in teaching sent to: Search Committee, Department of Mathematics, Stanford University, Stanford, CA 94305, by January 1, 2003. Stanford is an Affirmative Action/Equal Opportunity Employer. Women and minorities are particularly encouraged to apply.

UNIVERSITY OF CALIFORNIA, IRVINE
Irvine, CA 92697-3875
Department of Mathematics

Applications are invited for four tenured or tenure-track positions for appointment effective July 1, 2003, or later. A distinguished record in both research and teaching is required for tenured positions. Tenure-track applicants must demonstrate a strong record and potential in research and teaching. Areas of particular interest are (A) algebra, algebraic geometry, number theory, representation theory; (B) dynamical systems, ergodic theory; (C) geometry, topology; (D) applied mathematics, PDE, stochastic analysis, harmonic analysis. Application materials should be sent to the Recruiting Committee at the above address with one area (A)-(D) indicated on the envelope. The application materials should include (1) a curriculum vitae (with email address), (2) selected reprints and preprints, (3) contact information for 3 references for tenured applicants or 4 reference letters for tenure-track applicants, and (4) a research plan for tenure-track applicants. Electronic submissions are not accepted. Applications are welcome at any time. The review process starts November 30, 2002, and will continue until all positions are filled. The University of California, Irvine, is an Equal Opportunity Employer committed to excellence through diversity.

UNIVERSITY OF CALIFORNIA, IRVINE
Irvine, CA 92697-3875
Department of Mathematics

Applications are invited for several three-year Visiting Assistant Professor positions in the following areas of research: (A) applied and computational mathematics, (B) analysis and PDE (includes mathematical physics), (C) geometry and topology (includes geometric analysis), (D) logic and set theory, (E) probability, (F) algebra and number theory (includes algebraic and arithmetic geometry). Candidates must possess a Ph.D. Strong promise in research and teaching is required. Current annual salary is set at $46,300. Teaching load: 5 quarter-courses per year. Designate area by A-F. Applicants should send résumé, preprints, and three letters of recommendation to: Visiting Assistant Professor Search Committee at the above address. Electronic submissions not accepted.

The deadline for application is November 30, 2002, or until the positions are filled. The University of California, Irvine, is an Equal Opportunity Employer committed to excellence through diversity.

UNIVERSITY OF CALIFORNIA,
LOS ANGELES
Institute for Pure and
Applied Mathematics
Associate Director

IPAM is a relatively new (inaugurated August 2000) NSF-funded national research institute in the mathematical sciences, centrally located on the UCLA campus. Its mission is to foster interdisciplinary collaborations between mathematics and other scientific fields. Generally, there are two quarter-long programs per year, plus several shorter programs throughout the year. Each program will have significant participation from both mathematicians and other scientists and will consist of tutorials, workshops, and an Oberwolfach-like culminating retreat. There is also a summer student industrial research program. IPAM has funding to support both senior and junior mathematicians, including graduate students, as long-term in-residence members or as workshop participants.

To complete the senior management team, IPAM is seeking an associate director (AD) to work with the director and the staff on all IPAM activities. The term of appointment will be 2 years, beginning July 1, 2003. It is anticipated that applicants from academic institutions will be prepared to arrange leaves of absence, with funding to be arranged between IPAM and their home institutions.

The AD is expected to be an active and established research mathematician, with experience in conference organization and administration. A willingness to work with scientists from other fields is a necessity. It is expected that the primary responsibility of the AD will be running individual programs and coordinating with the organizing committees. Other duties include assisting with setting institute policies, planning future programs, sitting as ex-officio member on various institute boards, working with affiliates and sponsors, liaison with the NSF, and other special projects as required. The selected candidate will be encouraged to continue his or her personal research program within the context of the responsibilities to the institute.

Applications should be sent to: Associate Director Search Committee, IPAM, University of California at Los Angeles, 460 Portola Plaza, Los Angeles, CA 90095-7121; or email to: ad-search@ipam.ucla.edu. Applications should include a CV, names of possible references (whose letters should be solicited by the applicants and sent to IPAM directly), and a short statement of their vision for their service at IPAM. Further information on IPAM can be obtained at http://www.ipam.ucla.edu/. Deadline for submission of applications is January 15, 2003.

UNIVERSITY OF CALIFORNIA,
LOS ANGELES
Department of Mathematics

Subject to availability of resources and administrative approval, the following positions are available for the 2003-04 academic year.

1. Several tenure-track and senior positions in all areas of mathematics.

2. Several E. R. Hedrick Assistant Professorships. Salary is $53,200. Three-year appointment. Teaching load: four quarter-courses per year, which may include one advanced course in the candidate's field.

3. Several Research Assistant Professorships in Computational and Applied Mathematics (CAM). Salary is $53,200. Three-year appointment. Teaching load: normally reduced to two or three quarter-courses per year by research funding as available; may include one advanced course in the candidate's field.

4. Several Adjunct Assistant Professorships or Lectureships in the Program in Computing (PIC). Applicants for the adjunct position must show very strong promise in teaching and research in an area related to computing. Teaching load: four one-quarter programming courses each year and one seminar every two years. One-year initial appointment, with the option of applying for renewal for a second year and possibly longer, up to a maximum service of four years. Salary is $56,800. Applicants for the lectureship must show very strong promise in the teaching of programming. An M.S. in computer science or equivalent degree is preferred. Teaching load: six one-quarter programming courses per year. One-year appointment, probably renewable one or more times, depending on the needs of the program. Salary is $43,152 or more, depending on experience.

5. Several VIGRE Assistant Professorships. Hedrick, CAM, or PIC applicants who are U.S. citizens or permanent residents may also apply for a VIGRE Assistant Professor position. Three-year appointment. Salary is $53,200. The successful recipient will receive a summer stipend of $6,500 for two summers and $2,500 per year for

travel, equipment, and supplies for three years. Teaching load: 3 courses per year.

6. Several Adjunct Assistant Professorships and Research Postdocs. Up to one-year appointment, with the possibility of renewal. Strong research and teaching background required. Salary $48,900–$53,200. Teaching load for adjuncts: five quarter-courses per year.

7. Several visiting instructorships.

For more details, see http://www.math.ucla.edu/~search/. To apply, complete the application on the website, or send e-mail to search@math.ucla.edu, or write to: Staff Search, Department of Mathematics, University of California, Los Angeles, CA 90095-1555. Preference will be given to applications completed by January 6, 2003.

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.

UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Statistics and Applied Probability

Invites applications for a Lecturer with Potential Security of Employment position, to begin July 1, 2003. Qualifications: excellence in teaching and a Ph.D. in statistics or a closely related field. Primary duties include (but are not limited to) teaching and advising of undergraduate students. Please send résumé, one-page statement of teaching and research objectives, and three letters of recommendation to: Lecturer Search Committee, Department of Statistics and Applied Probability, University of California, Santa Barbara, CA 93106-3110. The selection process will begin December 1, 2002, and will continue until the position is filled. Women and minorities are particularly encouraged to apply. An EE/AO Employer.

UNIVERSITY OF CALIFORNIA, SANTA CRUZ
Mathematics Department

The mathematics department at UCSC expects to have one or more Youngs Visiting Assistant Professorships effective summer or fall 2003.

We invite applications from qualified mathematicians in all fields. Appointees are expected to teach and pursue their research. Available for periods of two years, with a possible extension to a third year depending on teaching performance. Minimum qualifications: Ph.D. (or equivalent expected by 6/30/03) in mathematics or a closely related field. Demonstrated excellence in research and teaching. Salary range: $46,300–$51,700 (subject to range adjustment). Deadline: January 13, 2003. Applicants should send curriculum vitae; a summary of research and teaching experience; and three letters of recommendation, with at least one letter addressing teaching experience and ability (all letters will be treated as confidential documents).

All applications should be sent to: Recruitment Committee, Mathematics Department, Kerr Hall, University of California, Santa Cruz, CA 95064. Please refer to provision #T03-02. Inquiries (not applications) can be sent to mathrcr@cats.ucsc.edu. UCSC is an EEO/AA Employer.

CONNECTICUT

YALE UNIVERSITY
Department of Mathematics

Yale University applications accepted for Gibbs Instructorships/Assistant Professorships for Ph.D. with outstanding promise in research in pure mathematics. Appointments are for two/three years, starting July 2003. The teaching load for Gibbs Instructors/Assistant Professors will be kept light so as to allow ample time for research. This will consist of 3 one-semester courses per year. Part of the duties may consist of a one-semester course at the graduate level in the general area of the instructor's research. Applications and supporting materials must be received by January 1, 2003. Offers will be made during February. Salary at least $51,800. Applications are available at: http://www.math.yale.edu/. Applications and supporting materials may be sent via U.S. mail to: The Gibbs Committee, Department of Mathematics, Yale University, P.O. Box 208283, New Haven, CT 06520-8283; or via email to: gibbs.committee@math.yale.edu. Applications from women and members of minority groups are welcome. Yale is an Affirmative Action/Equal Opportunity Employer.

GEORGIA

GEORGIA INSTITUTE OF TECHNOLOGY
School of Mathematics

The School of Mathematics at Georgia Tech expects to have several tenure-track and visiting positions available beginning fall 2003 and will consider applications in pure and applied mathematics and statistics at all ranks. Preference will be given to candidates who complement existing strengths in the School of Mathematics while adding expertise in new areas consistent with the goals and directions of the school. Candidates should have strong research and teaching records or potential.

The school will also consider applications for NSF VIGRE Postdoctoral Fellowships. These are non-tenure-track positions, normally renewable annually to a maximum of three years. Eligibility is limited to U.S. citizens, nationals, and permanent residents who will have a Ph.D. and not be beyond 18 months from the completion of their degree at the time of the appointment. The academic-year salary for these positions is $45,000, with an additional $6,500 for research support in each of the first and second summers, and a $7,500 travel allowance over the term of the appointment. Preference will be given to applicants deemed likely to benefit from a mentoring relationship with one or more members of the current faculty of the school. Review of applications for all positions will begin in September 2002 and will continue until all positions have been filled. Candidates 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. Georgia Tech, an institution of the University System of Georgia, is an Equal Opportunity/Affirmative Action Employer.

ILLINOIS

ILLINOIS WESLEYAN UNIVERSITY
Bloomington, IL 61701
Department of Mathematics and Computer Science

The Department of Mathematics and Computer Science at Illinois Wesleyan University invites applications for a tenure-track assistant professor in mathematics. Employment would begin in August 2003, and the teaching load would be six courses per year. All candidates should have a Ph.D. in statistics or probability and a dedication to excellent teaching in a liberal arts environment where undergraduate research is encouraged. We are seeking candidates who have an interest in working with students who want to become actuaries. The opportunity to participate in university-wide general education programs is available for interested faculty.

Illinois Wesleyan University is a highly selective undergraduate university of approximately 2,000 students located in Bloomington, Illinois, a community of about 120,000. This year the average ACT for Illinois Wesleyan's entering class of freshmen was 28. In recent years as many as 4% of the undergraduate population at Illinois Wesleyan University have declared majors in mathematics. The department maintains a healthy balance between applied mathematics and pure mathematics.

Faculty areas of professional expertise include algebra, approximation theory, differential equations, number theory, dynamical systems, electrical engineering, linear algebra, logic, operations research, topology, topos theory, numerical analysis and wavelet analysis. The Department of Mathematics and Computer Science is located in the Center for Natural Science Learning and Research, a $25,000,000 facility opened in 1995. The department operates five computer labs for students, which have around 80 SunSPARC and iMac computers. For additional information on the mathematics curriculum, facilities, and faculty interests, see http://www.iwu.edu/~mathcs/.

Candidates for the position should submit a letter of application, a curriculum vitae, an AMS Standard Cover Sheet, a teaching statement and a research statement, and have three letters of recommendation sent separately to: Melvyn Jeter, Department of Mathematics and Computer Science, Illinois Wesleyan University, P.O. Box 2900, Bloomington, IL 61702-2900. Preliminary interviews for this position will be held at the Joint Mathematics Meetings in Baltimore, Maryland (January 2003). Applications received after December 13, 2002, may not receive full consideration. Women and minorities are encouraged to apply. Illinois Wesleyan is an Equal Opportunity Employer. For further information see our Jobs webpage at http://www.iwu.edu/~iwujobs/.

NORTHWESTERN UNIVERSITY
2033 Sheridan Road
Evanston, IL 60208-2730
Department of Mathematics
Boas Assistant Professor

Applications are solicited from people whose research is in geometry and geometric topology for two Ralph Boas assistant professorships of three years each starting in September 2003. These positions are connected to the Emphasis Year in Geometry and Topology of String Theory. They are non-tenure-track.

Applications should be sent to the Emphasis Year Committee at the department address and should 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. Inquiries may be sent via email to: hiring@math.northwestern.edu.

Applications are welcomed at any time, but the review process starts December 1, 2002. Northwestern University is an Affirmative Action/Equal Opportunity Employer committed to fostering a diverse faculty; women and minority candidates are especially encouraged to apply.

NORTHWESTERN UNIVERSITY
2033 Sheridan Road,
Evanston, IL 60208-2730
Department of Mathematics

Applications are invited for anticipated tenure-track or tenured positions starting September 2003, pending final approval. 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 should 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. Inquiries may be sent via email to: hiring@math.northwestern.edu. Applications are welcome at any time, but the review process starts in October 2002. Northwestern University is an Affirmative Action/Equal Opportunity Employer committed to fostering a diverse faculty; women and minority candidates are especially encouraged to apply.

SOUTHERN ILLINOIS UNIVERSITY EDWARDSVILLE
Department of Mathematics and Statistics

Southern Illinois University Edwardsville, a comprehensive state university 20 miles from downtown St. Louis, Missouri, invites applications for a tenure-track position in applied mathematics at the rank of assistant professor beginning August 2003. Applicants should have a Ph.D. in some field of mathematics. We will consider applicants who have a strong commitment to teaching and a demonstrated capacity to perform research. Preference will be given to candidates with a strong background in applied mathematics, numerical analysis, or computational mathematics; the successful candidate will teach precalculus, calculus, differential equations, discrete math, numerical analysis, and other upper-level courses in mathematics and applied mathematics.

The Department of Mathematics and Statistics has 17 full-time faculty members and offers undergraduate programs in mathematics, applied mathematics, statistics, actuarial science, and secondary education; and master's programs in mathematics, statistics and operations research, and computational mathematics.

Send a letter of application, curriculum vitae, transcripts (unofficial transcripts are acceptable for now), and three letters of recommendation to:

Chair of Search Committee
Department of Mathematics
and Statistics
Campus Box 1653S
Southern Illinois University
Edwardsville
Edwardsville, IL 62026

Please use the AMS Standard Cover Sheet. Review of applications will begin on December 5, 2002, and will continue until the position is filled. As an Affirmative Action Employer, SIUE offers Equal Employment Opportunity without regard to race, color, creed or religion, age, sex, national origin, or disability.

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 and whose work shows remarkable promise in mathematical research and teaching. The appointment is for two years, with the possibility of renewal for a third year. The teaching obligation is four one-quarter courses per year.

2. VIGRE Dickson Instructor: This is open to mathematicians who are U.S. citizens or permanent residents, have recently completed or will soon complete a doctorate in mathematics, and whose work shows remarkable promise in mathematical research and teaching. The appointment is for three years, and the teaching obligation is three one-quarter courses per year. Additional resources will be available for summer support and travel.

3. 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 for three years, and the teaching obligation is three one-quarter courses per year.

Complete applications consist of (a) an AMS cover sheet; (b) a curriculum vitae (including citizenship information); (c) three or more letters of reference, including one which addresses teaching ability; and (d) a description of previous research and plans for future research, including a brief (200 words or less) summary of your research interests. 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/. The deadline for applications is December 15, 2002. The University of Chicago is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF ILLINOIS AT CHICAGO
Department of Mathematics, Statistics, and Computer Science

The department has active research programs in centrally important areas of pure mathematics, computational and applied mathematics, combinatorics and computer science, statistics, and mathematics education. See http://www.math.uic.edu/ for more information.

Applications are invited for the following positions, effective August 21, 2003.

Tenure-track or tenured positions subject to budgetary approval. Candidates in all areas of interest to the department will be considered. The position, subject to budgetary approval, is initially budgeted at the assistant professor level, but candidates with a sufficiently outstanding research record may be considered at higher levels. Applicants must have a Ph.D. or equivalent degree in mathematics, computer science, statistics, mathematics education or related field; an outstanding research record; and evidence of strong teaching ability. The salary is negotiable.

Research Assistant Professorships/ VIGRE Postdoctoral Fellowships. These are non-tenure-track positions, normally renewable annually to a maximum of three years. Some of these positions are partially funded by a VIGRE grant from the NSF and are open only to U.S. citizens, nationals, or permanent residents. Others are open without this restriction. These positions carry a teaching load of one course per semester and the expectation that the incumbent play a significant role in the research life of the department. The salary for AY 2003–2004 for these positions is $47,000; the salary for AY 2004–2005 may be higher. In each of the first two years, for those eligible, the VIGRE grant provides an additional $6,000 for summer support. Applicants must have a Ph.D. or equivalent degree in mathematics, computer science, statistics, mathematics education or related field, and evidence of outstanding research potential.

Send vita and at least 3 letters of recommendation, clearly indicating the position being applied for and whether you are eligible for a VIGRE fellowship, to: Appointments Committee, Dept. of Mathematics, Statistics, and Computer Science, University of Illinois at Chicago, 851 S. Morgan (M/C 249), Chicago, IL 60607. No email applications will be accepted. To ensure full consideration, materials must be received by November 31, 2002, for the tenured/tenure-track positions, and December 13, 2002, for the postdoctoral fellowships. However, we will continue considering candidates until all positions have been filled. Minorities, persons with disabilities, and women are particularly encouraged to apply. UIC is an AA/EOE.

INDIANA

UNIVERSITY OF NOTRE DAME
Notre Dame, IN 46556
Department of Mathematics
Regular Position in Stochastic Analysis

The Department of Mathematics of the University of Notre Dame invites applications for a position in the field of applied stochastic analysis to start on August 24, 2003. The position is at the tenure-track level, but a tenured appointment may be possible for an exceptional candidate. 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 Steven A. Buechler, 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, 2002. Information about the department is available at http://www.math.nd.edu/math/.

IOWA

GRINNELL COLLEGE
Department of Mathematics and Computer Science
2 Tenure-Track Positions in Mathematics

Two tenure-track positions as assistant professor of mathematics starting fall 2003. Ph.D. in mathematics expected. For one of these positions, we seek applicants whose specialty is an area of analysis; for the other position, all specialties will be considered. Grinnell College is a highly selective liberal arts college that seeks outstanding teacher-scholars for its faculty, rewards excellence in teaching, and is generous in its support of scholarship. For more information see http://www.math.grinnell.edu/2002-math.html. Please include a statement describing your interests in teaching and research in an undergraduate liberal arts environment that emphasizes close student-faculty interaction and values diversity. Send AMS cover sheet, curriculum vitae, undergraduate and graduate transcripts (copies acceptable), and three letters of recommendation to: Mathematics Search Committee, Department of Mathematics and Computer Science, 1116 8th Avenue, Grinnell College, Grinnell, IA 50112. Review of applications will continue until positions are filled.

Grinnell College is an Equal Opportunity/Affirmative Action Employer committed to attracting and retaining highly qualified individuals who collectively reflect the diversity of the nation. No applicant shall be discriminated against on the basis of race, national or ethnic origin, age, gender, sexual orientation, marital status, religion, creed, or disability.

KANSAS

KANSAS STATE UNIVERSITY
Department of Mathematics

Subject to budgetary approval, applications are invited for tenure-track and visiting positions commencing August 3, 2003; 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 and a commitment to excellence in teaching. A Ph.D. in mathematics or a Ph.D. dissertation accepted with only formalities to be completed is required. 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 potential. Offers may begin by December 2, 2002, but applications for positions will be reviewed until February 1, 2003, or until positions are closed. AA/EOE.

MARYLAND

JOHNS HOPKINS UNIVERSITY
Department of Mathematics

The Department of Mathematics invites applications for the Director of Undergradu-

ate Studies at the non-tenure-track rank of lecturer beginning fall 2003. The position is renewable depending on performance. Required qualifications include an M.A. or Ph.D. in mathematics, creative teacher with college teaching experience, ability to work well with others and to play a leading role in curriculum development, and ability to use technology in teaching. The duties will involve administering the basic elementary mathematics courses: Precalculus; Calculus I, II, III; Linear Algebra; and Differential Equations. Responsibilities include supervision and training of teaching assistants, advising undergraduates, and coordinating course enrollment and scheduling with the registrar and Office of Academic Advising. Applicants should send a cover letter, curriculum vitae, and contact information for three professional references to: Department Chair, Lecturer Hiring, Johns Hopkins University, 3400 N. Charles Street, Krieger 404, Baltimore, MD 21218. First-round preference will be given to applications received by November 15, 2002. The Johns Hopkins University is an Affirmative Action/Equal Opportunity Employer and actively encourages interest from minorities and women.

JOHNS HOPKINS UNIVERSITY
Department of Mathematics

The Department of Mathematics invites applications for two positions at the associate or full professor level in the general areas of analysis, algebra, topology, number theory, and mathematical physics beginning fall 2003 or later. Targeted areas of hiring are number theory and mathematical physics. Applicants should send a cover letter, curriculum vitae, and contact information for three professional references to: Chair, Hiring Committee, Johns Hopkins University, 3400 N. Charles Street, Krieger 404, Baltimore, MD 21218. First-round preference will be given to applications received by January 1, 2003. The Johns Hopkins University is an Affirmative Action/Equal Opportunity Employer and actively encourages interest from minorities and women.

MASSACHUSETTS

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 2003-2004. 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 6. 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/`.)

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 6. 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, 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/`.)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mathematics
Applied Mathematics

Applications are invited for a limited number of positions in applied mathematics, including numerical analysis, scientific computation, and physical applied mathematics, starting fall 2003. Available positions include instructorships, lectureships, assistant professorships, and possibly higher levels. Appointments will be made mainly on the basis of demonstrated research accomplishments and potential. Complete applications must be received by January 6. To apply, please send a vita with a description of your recent research and research plans, and arrange to have three letters of reference sent to: Committee on Applied Mathematics, Massachusetts Institute of Technology, Room 2-345, 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/`.)

WILLIAMS COLLEGE
Department of Mathematics and Statistics

The department invites applications for two positions in mathematics and one position in statistics, beginning fall 2003, all at the rank of assistant professor (in exceptional cases, more advanced appointments may be considered). We are seeking highly qualified candidates who have demonstrated excellence in teaching and research and who will have a Ph.D. by the time of appointment.

Williams College is a private, residential, highly selective liberal arts college with an undergraduate enrollment of approximately 2,000 students. The teaching load is two courses per 12-week semester and a winter-term course every other January. In addition to excellence in teaching, an active and successful research program is expected.

To apply, please send a vita and have three letters of recommendation on teaching and research sent to the Hiring Committee, Department of Mathematics and Statistics, Williams College, Williamstown, MA 01267. Teaching and research statements are also welcome. Evaluations of applications will begin on or after November 25 and will continue until the positions are filled. Williams College is dedicated to providing a welcoming intellectual environment for all of its faculty, staff, and students; as an EEO/AA Employer, Williams especially encourages applications from women and underrepresented minorities. For more information on the Department of Mathematics and Statistics, visit `http://www.williams.edu/Mathematics/`.

WORCESTER POLYTECHNIC INSTITUTE
Department Head
Mathematical Sciences

WPI invites applications for the position of department head, mathematical sciences. The department currently comprises 24 full-time faculty, with strong programs in computational math, applied analysis, composite materials, discrete mathematics, optimization, stochastic analysis, and statistics. The department offers outstanding academic programs through the Ph.D. in mathematical sciences, maintains vibrant research programs, and is the home of the Center for Industrial Mathematics and Statistics with strong industry-university alliances. The department enrolls 94 undergraduate and 43 graduate students, supports other degree programs, and occupies a historic building central to the campus.

WPI is a nationally ranked, innovative technical university of engineering, science, management, humanities, arts and social sciences with an enrollment of 2,700 undergraduate and 1,100 full- and part-time graduate students, located in scenic central Massachusetts. Well-known for its project-oriented curriculum, its global perspectives program, and its inclusion of societal/technological elements in the cur-

riculum, the university fosters a spirit of constructive experimentation in educational development.

WPI seeks a dynamic individual with demonstrated leadership ability who can promote continued curricular development, growth of funded research programs, and excellence in scholarship. Applicants must have a strong international reputation and a proven record of scholarly achievement in application-oriented mathematical sciences or a closely allied field matching one of the department's strengths. The department head will be expected to represent the department within both the constituent and academic communities and to coordinate extramural funding activities. The university is midway through a major capital campaign that will significantly benefit the department. Information about the department is available through `http://www.wpi.edu/`.

Interested individuals should send a curriculum vitae and list of references to: Dr. William W. Durgin, Associate Provost for Academic Affairs, Chair, Mathematical Sciences Search Committee, Boynton Hall, Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA 01609. This position will remain open until filled. This is a reposting of the position, with review of applications set to begin September 3, 2002. Worcester Polytechnic Institute is an Equal Opportunity Employer. Qualified women and minorities are strongly encouraged to apply.

MICHIGAN

HILLSDALE COLLEGE
Mathematics and Computer Science
Two positions available: (1) Applied Mathematics and (2) Mathematics

Applications are invited for positions in applied mathematics and in mathematics. Entry-level, tenure-track positions with initial appointments made at the assistant professor level beginning in August 2003.

1. Candidates for applied mathematics position required to have a Ph.D. in mathematics with specialty in applied mathematics and to be willing to teach especially mathematical modeling, differential equations, numerical analysis, and vector analysis, in addition to other undergraduate mathematics courses.

2. Candidates for mathematics position required to have a Ph.D. in mathematics and to be willing to teach various undergraduate mathematics courses.

Candidates for either position must have a strong commitment to excellence in teaching undergraduate mathematics. Duties for each position include a 12-hour (3 course) teaching load per semester, which will include teaching all levels of undergraduate mathematics, academic advising, college service, and continued mathematical activity.

Hillsdale College, founded in 1844, is an independent, coeducational, four-year liberal arts college of 1,200 students. Hillsdale has traditionally upheld two concepts: academic excellence and institutional independence. For additional college information check our website: `http://www.hillsdale.edu/`.

Send a letter of application, which should include a personal statement addressing the applicant's teaching philosophy and qualifications for the position; curriculum vitae; graduate transcript; a short summary of teaching evaluations; and at least three letters of recommendation to: Professor Mark J. Watson, Chair, Department of Mathematics and Computer Science, Hillsdale College, Hillsdale, MI 49242. Review of applications will begin November 1, 2002, and will continue until the positions are filled. EOE.

UNIVERSITY OF MICHIGAN
Department of Mathematics

The department has several openings at the tenure-track or tenured 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, 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, 2002. Inquiries may be made by email to `math-facsearch@umich.edu`. More detailed information regarding the department may be found on our webpage: `http://www.math.lsa.umich.edu/`. The University of Michigan is an Equal Opportunity/Affirmative Action Employer.

NEW HAMPSHIRE

DARTMOUTH COLLEGE
John Wesley Young
Research Instructorship

The John Wesley Young Instructorship is a two-year postdoctoral appointment intended for promising Ph.D.'s whose research interests overlap a department member's. Current departmental interests include areas in algebra, analysis, algebraic geometry, combinatorics, differential geometry, logic and set theory, number theory, probability, 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. Nine-month salary of $43,800 supplemented by summer research stipend of $9,733 for instructors in residence for two months in summer.

To be eligible for a 2003–2005 instructorship, candidate must be able to complete all requirements for the Ph.D. degree before September 2003. Applicants should get a copy of the application information and the required response form 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. Applications received by January 5, 2003, will 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.

DARTMOUTH COLLEGE
Department of Mathematics

The Department of Mathematics seeks to recruit at the senior level in applied mathematics with an initial appointment in the 2003–2004 academic year. The successful candidate will be an acknowledged leader in his/her field with proven ability to work across disciplines and attract outside funding. Applicants with any of a wide variety of interests ranging from traditional applied fields and backgrounds—e.g. signal processing, mathematical statistics, PDE's, as well as new application areas such as informatics, quantum computing, or applied algebra—are encouraged to apply. Various projects are currently funded by the NSF, NIH, NIMH, and DoD. Active collaborations with the medical and engineering schools, and programs in computer science and cognitive neuroscience exist. Collaborations and/or appointments in Dartmouth's M.D./Ph.D. program, as well as Dartmouth's Institute for Secure Technologies Studies, are also possible. Lab space in the new mathematics building will also be available, and future hirings in applied mathematics are anticipated.

Candidates must be committed to outstanding teaching and interaction with students at all levels of undergraduate

and graduate study and be willing to advance applied mathematics across campus. 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 two courses per quarter for two 10-week quarters or one course for each of two quarters and two courses for one quarter. The combination of committed colleagues and talented, responsive students encourages excellence in teaching at all levels.

To apply, a copy of the application information and required response form may be obtained online from our website at http://www.math.dartmouth.edu/recruiting/. Or send a letter of application; curriculum vitae; a brief statement of research results and interests; and four letters of reference, at least one of which specifically addresses teaching, to: Donna Black, Recruiting Secretary, Department of Mathematics, Dartmouth College, 6188 Bradley Hall, Hanover, NH 03755-3551. Applications received by December 6, 2002, 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, Professor of Mathematics and Computer Science, Dartmouth College, Hanover, NH 03755, or via email at Daniel.Rockmore@Dartmouth.edu.

DARTMOUTH COLLEGE
Department of Mathematics

The Department of Mathematics anticipates a tenure-track opening with initial appointment in the 2003–2004 academic year. The position is an assistant professorship in number theory or "applicable mathematics". The work of candidates in applicable mathematics should straddle the line of pure and applied mathematics. The successful candidate will be a researcher working in core mathematics who has a proven track record in pursuing both the theoretical development of his/her subject, as well as potential applications. Examples would include (but are not limited to) number theorists with interests in cryptography or coding theory, representation theorists who work in signal processing, combinatorialists with interests in computing, probabilists with interests in statistics, as well as more classical applied mathematicians. Various projects are currently funded by the NSF and DoD. Active collaborations with the medical and engineering schools, and programs in computer science and cognitive neuroscience exist. Collaborations and/or appointments in Dartmouth's M.D./Ph.D. program, as well as Dartmouth's Institute for Secure Technologies Studies, are also possible. In number theory, we have interests in both algebraic and analytic number theory.

Candidates for the position must be committed to outstanding teaching and interaction with students at all levels of undergraduate and graduate study, and must demonstrate an exceptional potential for research. Candidates with several years of experience should be able to give evidence of a research program that has achieved peer recognition and which promises future research leadership in the mathematical community. Candidates who do not have this level of experience must have demonstrated the potential for future mathematical research leadership in their Ph.D. work. 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 two courses per quarter for two 10-week quarters or one course for each of two quarters and two courses for one quarter. The combination of committed colleagues and bright, responsive students encourages excellence in teaching at all levels.

To apply, get a copy of the application information and the required response form at http://www.math.dartmouth.edu/recruiting/. Or send a letter of application; curriculum vitae; a brief statement of research results and interests; and four letters of reference, at least one of which specifically addresses teaching, to: Donna Black, Recruiting Secretary, Department of Mathematics, Dartmouth College, 6188 Bradley Hall, Hanover, NH 03755-3551. Applications received by January 5, 2003, will receive first consideration. Dartmouth College is committed to Affirmative Action and encourages applications from African Americans, Asian Americans, Hispanics, Native Americans, and women. Inquiries about the progress of the selection process may be directed to Dwight Lahr, Recruiting Chair.

NEW JERSEY

INSTITUTE FOR ADVANCED STUDY
School of Mathematics

The School of Mathematics has a limited number of memberships, some with financial support, for research in mathematics at the Institute during the 2003–2004 academic year. Candidates must have given evidence of ability in research comparable at least with that expected for the Ph.D. degree. The special program for the year will focus on analysis and nonlinear PDE's. Carlos Kenig will be the Distinguished Visiting Professor, and he will be in residence for the year. For a brief description of the program and information about application materials and deadline, please consult "Activities" and "How To Apply" on our homepage at http://www.math.ias.edu/.

NEW YORK

THE COURANT INSTITUTE
Department of Mathematics

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, write to: Visiting Membership Committee, Courant Institute of Mathematical Sciences, 251 Mercer Street, New York, NY 10012-1185. Forms may also be obtained directly from the Web at http://www.cims.nyu.edu/information/brochure/visiting.html or by sending email to vm-apply@cims.nyu.edu. Applications and supporting documents are due by December 15 for appointments to begin the following academic year.

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

NORTH CAROLINA

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

Applications are invited for a tenure-track position at the assistant professor level in algebra, commencing in fall 2003. Candidates must have a doctorate in mathematics; a strong ongoing research program in representation theory, Lie theory, and/or algebraic combinatorics; and a commitment to effective teaching at the undergraduate and graduate levels. Preference will be given to candidates with postdoctoral experience. 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: Algebra 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. Bernard Mair, bamair@math.ncsu.edu, (919) 515-3796. Complete applications received before December 31, 2002, will receive full consideration.

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

Applications are invited for a tenure-track position in the general area of analysis. We are particularly interested in candidates in harmonic analysis, complex analysis, functional analysis, or other analysis areas related to modern partial differential equations or numerical analysis, but we encourage candidates in all areas of analysis to apply. Priority will be given to exceptionally promising research mathematicians whose research complements some of our core research groups in Lie theory, mathematical physics, differential equations, applied analysis, numerical analysis, inverse problems, control theory, and probability. 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 must have a doctorate in mathematics, a strong ongoing research program, and a commitment to effective teaching at the undergraduate and graduate levels. Applicants should send a vita, research plan, and three letters of recommendation to: 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. Bernard Mair, bamair@math.ncsu.edu, (919) 515-3796. Complete applications received before December 31, 2002, will receive full consideration.

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

Applications are invited for a tenure-track position at the assistant professor level beginning fall 2003. 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. Bernard Mair, bamair@math.ncsu.edu, (919) 515-3796. Complete applications received before December 31, 2002, will receive full consideration.

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

Applications are invited for an anticipated tenure-track position at the assistant professor level in partial differential equations. Candidates must have a doctorate in mathematics, a strong ongoing research program in partial differential equations, and a commitment to effective teaching at the undergraduate and graduate levels. Preference will be given to candidates with postdoctoral experience. 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: PDE Search Committee, Department of Mathematics, NC State University, Box 8205, Raleigh, NC 27695-8205. NC State is an Equal Opportunity and Affirmative Action Employer. ADA Accommodations: Dr. Bernard Mair, bamair@math.ncsu.edu, (919) 515-3796. Complete applications received before December 31, 2002, will receive full consideration.

NORTH CAROLINA STATE UNIVERSITY
Department of Mathematics

Applications are invited for an anticipated tenure-track position at the assistant professor level in numerical analysis. Applicants must have a doctorate in mathematics, a strong ongoing research program, and a commitment to effective teaching at the undergraduate and graduate levels. Preference will be given to candidates in optimization who demonstrate research productivity beyond the Ph.D. The numerical analysis group at NC State University is large, active, and deeply involved in interdisciplinary research. The 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, 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. Bernard Mair, bamair@math.ncsu.edu, (919) 515-3796. Complete applications received before December 31, 2002, will receive full consideration.

WAKE FOREST UNIVERSITY
Department of Mathematics

Applications are invited for two tenure-track positions in mathematics at the assistant professor level beginning August 2003. We seek one person whose research is in analysis and one person whose research is in combinatorics or number theory. Duties include teaching at the undergraduate and graduate levels and continuing research. A Ph.D. in mathematics or equivalent is required. The department has 18 members and offers a B.A., B.S., and M.A. in mathematics and a B.S. in each of mathematical business and mathematical economics. Send letter of application and résumé to: R. D. Carmichael, Department of Mathematics, Wake Forest University, P.O. Box 7388, Winston-Salem, NC 27109-7388. AA/EO Employer.

OHIO

MATHEMATICAL BIOSCIENCES INSTITUTE
Department of Mathematics

The Mathematical Biosciences Institute (MBI) is accepting applications for postdoctorate positions beginning in September 2003, and renewable for up to 3 years. The deadline for applications is January 15, 2003. Short- and long-term visitors may apply at any time. To access the application form or for more information, visit the MBI website at http://mbi.osu.edu/ or call 614-292-3648.

THE OHIO STATE UNIVERSITY
Department of Mathematics

The Department of Mathematics at The Ohio State University expects to have tenure-track/tenured positions and several visiting positions available, effective autumn quarter 2003. Candidates in all areas of pure and applied mathematics are invited to apply. 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 present evidence of excellence in research and teaching.

Please send a CV and at least three letters of recommendation to:

Professor Peter March, Chair
Department of Mathematics
The Ohio State University
231 W. 18th Avenue
Columbus, OH 43210

The Ohio State University is an Equal Opportunity/Affirmative Action Employer. Women, minorities, veterans, and individuals with disabilities are encouraged to apply.

OKLAHOMA

OKLAHOMA STATE UNIVERSITY
Department of Mathematics

The department anticipates filling 2 or more tenure-track or tenured positions beginning fall 2003. Applicants should have outstanding research potential and have made major contributions beyond their doctoral research. Candidates should also be committed to excellence in undergraduate and graduate education; the usual teaching load is 6 hours per semester. The department seeks accomplished individuals in any field of mathematics, but preference may be given to enhancing one of our existing research groups, particularly analysis or complex and algebraic geometry.

The department also invites applications from recent recipients of the Ph.D. for several temporary postdoctoral positions beginning fall 2003. These are one-year appointments which are typically renewed for a second year. Appointment to these positions does not preclude future consideration for a tenure-track position. The duties include research and teaching, with a normal teaching load of 6 hours each semester. Mathematicians with research interests close to those of the permanent faculty may receive preference.

All applicants should submit a curriculum vitae, abstracts of completed research, a statement regarding teaching experience, and 4 letters of recommendation to the address below. One letter of recommendation should appraise the applicant's teaching abilities. Applicants should use the AMS standardized form Academic Employment in Mathematics, Application Cover Sheet, and indicate their subject area using the AMS subject classification numbers. Full consideration will be given to applications received by December 1, 2002. Electronic applicants are encouraged; information about this may be found at: http://www.math.okstate.edu/~jobs/.

Oklahoma State University is located in Stillwater in north central Oklahoma, about an hour by car from both Tulsa and Oklahoma City. The department boasts a dynamic faculty, with 32 tenured or tenure-track members engaged in mathematics research and education. An active Ph.D. program, support for colloquium and other visitors, approximately 8–10 postdoctoral fellows, as well as involvement of undergraduates in research experiences create a lively atmosphere in the department. The department has received national recognition for the faculty's contributions to mathematical research and education. More information on the department is available at http://www.math.okstate.edu/.

Oklahoma State University is an Equal Opportunity/Affirmative Action Employer. Women and minorities are encouraged to apply.

Send application and supporting materials to:

Appointments Committee Chair
Department of Mathematics
401 Math Sciences Bldg.
Oklahoma State University
Stillwater, OK 74078-1058

OREGON

UNIVERSITY OF OREGON
Department of Mathematics

Applications are invited for one tenure-track assistant or associate professor in the Department of Mathematics, beginning September 2003. Qualifications are a Ph.D. in the mathematical sciences, an excellent record of research accomplishment, and evidence of teaching ability. Applicants from all parts of the mathematical sciences are encouraged to apply. See http://darkwing.uoregon.edu/~math/employment.html.

Competitive salary with excellent fringe benefits. Mail complete vita and at least three letters of recommendation to: Search Committee, 1222 Department of Mathematics, University of Oregon, Eugene, OR 97403-122, Attention: J. Perkins. Application materials may NOT be submitted electronically.

Closing date is January 6, 2003. Women and minorities are encouraged to apply. The University of Oregon is an EO/AA/ADA Institution committed to diversity.

UNIVERSITY OF OREGON
Department of Mathematics

Applications are invited for one tenure-track assistant or associate professor in the Department of Mathematics in the areas of numerical analysis and/or applied analysis, beginning September 2003. Qualifications are a Ph.D. in the mathematical sciences, an excellent record of research accomplishment in the required fields, and evidence of teaching ability. See http://darkwing.uoregon.edu/~math/employment.html.

Competitive salary with excellent fringe benefits. Mail complete vita and at least three letters of recommendation to: Professor Yuan Xu, Chair of Applied Analysis Search Committee, 1222 Department of Mathematics, University of Oregon, Eugene, OR 97403-122. Application materials may NOT be submitted electronically.

Closing date is January 6, 2003. Women and minorities are encouraged to apply. The University of Oregon is an EO/AA/ADA Institution committed to diversity.

UNIVERSITY OF OREGON
Department of Mathematics

The Department of Mathematics at the University of Oregon announces a tenure-track position in mathematics education at the assistant or associate professor level, starting fall 2003. Qualifications: either a Ph.D. in mathematics and documented interest in mathematics education at the elementary or secondary level or a Ph.D. or Ed.D. in mathematics education with a very strong background and interest in mathematics. In addition the candidate must have some involvement in the education of future school teachers and excellence in teaching undergraduate mathematics. See http://darkwing.uoregon.edu/~math/employment.html.

Please send your application materials, including full CV and at least three letters of recommendation from people well acquainted with your qualifications, to: Professor J. Brundan, Mathematics Education Hiring Committee, Department of Mathematics, 1222 University of Oregon, Eugene, OR 97403-1222. Application materials may NOT be submitted electronically.

Closing date for applications is January 13, 2003. Women and minorities are encouraged to apply. The University of Oregon is an EO/AA/ADA Institution committed to diversity.

PENNSYLVANIA

CARNEGIE MELLON UNIVERSITY
Center for Nonlinear Analysis
Department of Mathematical Sciences

The Center for Nonlinear Analysis expects to make several postdoctoral appointments for 2002–03 in the area of applied analysis. These will be one- or two-year joint appointments by the Center and Department of Mathematical Sciences. Recipients will teach at most two courses

per year. Applicants should send a vita, list of publications, a statement describing current and planned research, and at least three letters of recommendation to the committee. The deadline for applications is January 17, 2003. All communications should be addressed to: Postdoctoral Appointments Committee, Department of Mathematical Sciences, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

PENN STATE UNIVERSITY/ COMMONWEALTH COLLEGE
Department of Mathematics

The Commonwealth College invites applications for tenure-track positions at the rank of assistant professor at three of its campuses beginning in August 2003. Tenure and promotion in the college are based on the following: innovative teaching of courses ranging primarily over the first two years of college mathematics; recognized research and scholarly contributions to mathematics and mathematics pedagogy; and service to the campus, college, university, and the community at large. Applicants must complete the Ph.D. degree in a mathematical science by the time the appointment begins and will be selected on the basis of their potential for achieving tenure and promotion. To learn more about the campuses and the positions, please visit `http://cwchome.psu.edu/` and choose the "Careers with Us" link.

Applicants should submit a resumé including a list of publications, a statement on teaching and research, and the complete contact information for three references, including email addresses, to:

The Pennsylvania State University
Commonwealth College
Faculty Searches
111 Old Main, Box NOTICES-TT
University Park, PA 16802

Applications will also be accepted via email at: `cwcsearch@psu.edu`. Review of applications will begin November 1, 2002, and will continue until the positions are filled. Penn State is committed to Affirmative Action, Equal Opportunity, and the diversity of its work force.

WESTMINSTER COLLEGE
Department of Mathematics and Computer Science
Tenure-Track Position

Applications are invited for a tenure-track position in mathematics beginning in August 2003. Successful candidates must possess a Ph.D. for appointment at the rank of assistant professor, be committed to excellence in teaching in an undergraduate liberal arts environment, and be prepared to engage in continuing scholarly activity. The department seeks candidates with broad intellectual interests. Opportunities include teaching statistics courses and interdisciplinary courses as well as developing new courses and directing undergraduate research.

Westminster College, a coeducational, liberal arts institution, is located in a beautiful rural setting 50 miles northwest of Pittsburgh and 80 miles southeast of Cleveland. For more information please visit our website at `http://www.westminster.edu/`. Applicants should send a letter of application, curriculum vitae, three letters of recommendation, summary of teaching evaluations, and graduate transcripts to: Prof. Barbara T. Faires, Chair, Department of Mathematics and Computer Science, Westminster College, New Wilmington, PA 16172. Applicant review will begin December 1, 2002. EOE.

RHODE ISLAND

BROWN UNIVERSITY

Up to three professorships at the associate professor level with tenure, the appointment to begin July 1, 2003. Exceptionally qualified candidates may be considered for appointment at the level of professor. 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`). For one of the positions, preference will be given to applicants whose field is analysis.

Applicants who wish to be considered for these positions should send a letter of application together with a curriculum vitae and at least five letters of recommendation to: Senior Search Committee, Department of Mathematics, Box 1917, Brown University, Providence, RI 02912. **Applications must be postmarked by December 13, 2002**, 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`. Brown University is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minorities.

BROWN UNIVERSITY
Division of Applied Mathematics
Position in Probability and Statistics

The Division of Applied Mathematics seeks applicants for a position at the assistant or associate professor level in the general areas of probability and statistics. Preference will be given to applicants who combine research in statistical theory and methods with novel applications to science, or applicants who add distinct new dimensions to the research in probability currently in the division. Candidates at the associate professor level are expected to demonstrate substantial contributions in both theory and application. Good communication and teaching skills are expected. Candidates should submit curriculum vitae, representative preprints or reprints, and a concise description of research interests and goals to:

Professor Chi-Wang Shu, Chairman
Division of Applied Mathematics
Brown University
Box F - Attention: Statistics Search
Providence, RI 02912

Additionally, candidates should arrange to have at least three letters of recommendation sent directly to the Search Committee at this address.

To receive full consideration, complete applications should be received by January 15, 2003.

Brown University is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

SOUTH CAROLINA

UNIVERSITY OF SOUTH CAROLINA
Columbia, SC 29208
Department of Mathematics

The Department of Mathematics anticipates filling one or more tenure-track positions, primarily at the assistant professor rank, to begin August 16, 2003. The Ph.D. degree or its equivalent is required, and applicants should have outstanding research potential and have made major contributions beyond their doctoral research. There is also the possibility of a senior-level position for a candidate with outstanding research and funding credentials. The department seeks accomplished individuals in any field of pure and applied mathematics, but preference may be given to enhancing existing strengths within the department. Appointments will be consistent with the department's commitment to excellence in research and in teaching at the undergraduate and graduate levels.

A complete application should include a detailed résumé with a summary of research accomplishments and goals, a completed AMS Standard Cover Sheet (see the *Notices*), and four letters of recommendation. One letter of recommendation should appraise the applicant's teaching abilities. Applications may be sent by email in the form of .pdf or .ps files to `hiring2003@math.sc.edu`. Full consideration will be given to applications received by December 1, 2002. Further information about our department can be obtained on our website `http://www.math.sc.edu/`.

The University of South Carolina is an Affirmative Action/Equal Opportunity Employer, and the department encourages applications from women and minorities.

TEXAS

SOUTHERN METHODIST UNIVERSITY
DEDMAN COLLEGE
Department of Mathematics

Applications are invited for two positions at either the senior level (tenured) or junior level (tenure-track), to begin in the fall semester of 2003. Applicants must have a Ph.D., provide evidence of outstanding research, and have a strong commitment to teaching at all levels. The Department of Mathematics's active doctoral program is in computational and applied mathematics. Current research includes numerical analysis of ordinary and partial differential equations, mathematical software, dynamical systems, fluid dynamics, and nonlinear optics. Applications in other areas of computational and applied mathematics such as numerical linear algebra, geometric integration, inverse problems, nonlinear waves, and mathematical biology are encouraged. Visit `http://www.smu.edu/math/` for more information about the department.

To apply, send a letter of application with a curriculum vitae, a list of publications, and a research and teaching statement to: The Faculty Search Committee, Department of Mathematics, Southern Methodist University, P.O. Box 750156, Dallas, TX 75275-0156. Applicants must also arrange for three letters of recommendation to be forwarded to the Faculty Search Committee. The Search Committee can be contacted by sending email to `mathsearch@mail.smu.edu` (tel: 214-768-2506; fax: 214-768-2355).

To ensure full consideration for the positions, the application must be postmarked on or before December 9, 2002, but the committee will continue to accept applications until the positions are filled. The committee will notify applicants of its employment decision after the positions are filled.

SMU will not discriminate on the basis of race, color, religion, national origin, sex, age, disability, or veteran status. SMU is also committed to nondiscrimination on the basis of sexual orientation.

TEXAS A&M UNIVERSITY
Department of Mathematics

Applications are invited for tenured and tenure-eligible faculty positions beginning fall 2003. 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.

In order to expedite the application process we request that the AMS Application Cover Sheet be used. Applicants should send the completed form, 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
Department of Mathematics

The department will have several visiting appointments available beginning fall 2003. Senior positions may be for a semester or one-year period, and the number available will depend on funding. The Visiting Assistant Professor positions are for a three-year period. 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. Salary and teaching loads are competitive. In addition, as part of our VIGRE grant, we expect to have up to four positions carrying a one-course-per-semester teaching load.

In order to expedite the application process we request that the AMS Application Cover Sheet be used. Applicants should send the completed form, a vita, and letters of recommendation to:

Visiting Faculty Hiring
Department of Mathematics
Texas A&M University
College Station, TX 77843-3368

For full consideration, the complete dossier should be received by January 15, 2003. Further information can be obtained from our website: `http://www.math.tamu.edu/hiring/`.

Texas A&M University is an EOE/AA Employer, and the department encourages applications from women and minorities.

TEXAS TECH UNIVERSITY
Department of Mathematics and Statistics

Applications are invited for at least two tenure-track assistant professor positions beginning fall 2003. Higher-level appointments are possible in exceptional cases. Priority will be given to candidates in the areas of applied mathematics and computation, statistics, and mathematics education. Candidates whose mathematical background and scholarly activities have, or have shown, excellent potential for interdisciplinary collaboration are encouraged to apply.

Strong promise or accomplishment in teaching and scholarly activity and a Ph.D. degree at the time of appointment are required. Texas Tech University is committed to diversity among its faculty. Please send a résumé, a completed AMS Standard Cover Sheet, and three letters of recommendation to: Alex Wang, Hiring Chair, Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79409-1042. Review of applications will begin immediately. Additional information is available at `http://ttmath.ttu.edu/~awang/employ/employ.html`. Texas Tech is an AA/EO Employer.

UNIVERSITY OF TEXAS-PAN AMERICAN
Department of Mathematics

The Department of Mathematics, chaired by Professor Lokenath Debnath, invites applications for tenure-track assistant/associate professor positions. Subject to administrative approval, exceptional candidates may be considered at a higher level. All positions are to be filled effective August 25, 2003. Candidates should have promise of developing a strong research program and have a strong commitment to excellence in teaching and professional service. A doctorate in mathematics or a related area by the date of employment is required, and recent graduates are especially encouraged to apply. All areas of mathematics and mathematical sciences will be considered, but particular attention will be given to the areas of mathematics education, probability and statistics, and applied and computational mathematics.

Applicants should send a vita, three letters of recommendation, all higher-education transcripts, and summaries of research and teaching philosophy to: Dr. Roger Knobel, Search Committee Chair, Department of Mathematics, University of Texas-Pan American, 1201 W. University Drive, Edinburg, TX 78539-2999; email: `knobel@panam.edu`; tel: (956) 381-3452.

Review of applications will begin immediately and will continue until the positions are filled. Salary is competitive and commensurate with qualifications. Additional information about the Department of Mathematics, UTPA, and these positions

may be obtained from the website http://www.math.panam.edu/. Women and minorities are encouraged to apply. The University of Texas-Pan American is an Equal Opportunity/Affirmative Action Employer.

WASHINGTON

WESTERN WASHINGTON UNIVERSITY
Applied Math/Statistics

Tenure-track assistant professor, fall 2003. Ph.D., strong teaching and scholarship required. Salary commensurate with experience. See http://www.wwu.edu/~mathweb/ or call 360-650-3785 for full announcement and application details. WWU is between Seattle and Vancouver, with outstanding recreational opportunities. Apply to: Math Search, Math, WWU, Bellingham, WA 98225-9063, by December 6, 2002. AA/EOE. For disability accommodations call 360-650-3771 (V), 360-650-7696 (TTY).

WEST VIRGINIA

WEST VIRGINIA UNIVERSITY
Department of Mathematics

Applications and nominations are invited for up to two faculty positions starting August 16, 2003, to be part of the Institute for Math Learning. The Department of Mathematics seeks mathematicians or mathematics educators with excellent teaching skills and strong commitment to extending and developing effective, efficient ways of teaching mathematics students, generating new initiatives with the K–12 community, conducting mathematics education research supporting change, and aggressively competing for nationally awarded grants that support the pedagogical dimension of the institute. We are working toward an institute that is regarded for its national leadership in innovative, effective, research-based math learning models. The institute is a part of the Department of Mathematics in the Eberly College of Arts & Sciences, with its own director and with operational governance that allows tenured and tenure-track faculty to be rewarded and recognized for their roles in teaching excellence, in research and scholarship associated with the goals of the institute, and in pedagogy associated with math learning.

All applicants should have professional credentials qualifying for a tenure-track appointment at least at the rank of assistant professor. A truly outstanding individual with the capacity to provide research leadership will be considered for appointment at the rank of associate/full professor as an Eberly Professor, with benefits accorded to the Eberly Family Distinguished Professors in the Eberly College of Arts and Sciences.

West Virginia University is a Land Grant institution in the state of West Virginia, enrolling 22,000 students. It is Doctoral/Research University-Extensive in the Carnegie Classification of Institutions of Higher Education, based on the complexity and breadth of the institution's mission. The Department of Mathematics has 26 full-time faculty members and approximately 30 M.S. and Ph.D. students. The department is housed in newly refurbished facilities which include networked offices and the university's Mathematics Library. The university is located in Morgantown, an award-winning city with a metropolitan population of 80,000. Morgantown has diverse cultural and recreational opportunities, excellent medical facilities, and a favorable location with ready access to the urban areas of Pittsburgh, PA, and Washington, DC.

Applicants should provide a letter of application, a statement of teaching philosophy and any experience and vision you may have related to achieving the goals of the institute, a vita, and the names and contact information of three references. Please send applications, references, and inquiries to:

Sherman D. Riemenschneider
Chair, Department of Mathematics
320 Armstrong Hall, P.O. Box 6310
West Virginia University
Morgantown, WV 26506-6310
(sherm@math.wvu.edu)

Priority will be given to applications received by November 15, 2002.

West Virginia University is an Equal Opportunity/Affirmative Action Employer. Minorities, the disabled, and women candidates are urged to apply.

WISCONSIN

UNIVERSITY OF WISCONSIN-MILWAUKEE
Milwaukee, WI 53201-0413
Department of Mathematical Sciences

The Department of Mathematical Sciences anticipates two openings for tenure-track assistant professorships, starting August 2003, pending budgetary approval. The department invites applications in algebra and statistics. Candidates must have a strong research record, evidence of or strong potential for extramural funding, and a demonstrated commitment to teaching excellence. Responsibilities include: teaching two courses per semester and taking an active role in the undergraduate, master's, and Ph.D. programs. Additional information is available at http://www.math.uwm.edu/.

Applicants should send the AMS Standard Cover Sheet, a vita, a description of their research, and a teaching statement to the Hiring Committee at the above address. Review of applications will begin December 6, 2002, and will continue until the position is filled. At least three letters of recommendation should be sent to the Hiring Committee; at least one letter should address the applicant's teaching experience and capabilities. UW-Milwaukee is an EEO/AA Employer. Applications from female and minority candidates are strongly encouraged.

CANADA

UNIVERSITY OF GUELPH
Department of Mathematics & Statistics

The Department of Mathematics and Statistics at the University of Guelph invites applications for a full-time tenure-track position to start July 1, 2003, or thereafter, at the rank of assistant professor in mathematics. Minimum qualifications are a Ph.D. in mathematics and evidence of strong research and teaching potential at all levels. All areas of mathematics will be considered, but the new faculty member is expected to actively participate in our graduate program in applied mathematics, which currently emphasizes dynamical systems, mathematical biology, numerical analysis and optimization. Salary will be commensurate with qualifications and experience.

Candidates should submit, by December 1, 2002, a curriculum vitae to: O. B. Allen, Chair, Department of Mathematics and Statistics, University of Guelph, Guelph, Ontario, Canada N1G 2W1; fax: (519) 837-0221; email: ballen@uoguelph.ca. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority.

The University of Guelph is committed to an employment equity program that includes special measures to achieve diversity among its faculty and staff. We therefore particularly encourage applications from qualified aboriginal Canadians, persons with disabilities, members of visible minorities, and women.

UNIVERSITY OF TORONTO
Department of Mathematics

The University of Toronto solicits applications for one or more tenured or tenure-track positions in the Department of Mathematics, to begin July 1, 2003. Rank and salary will be commensurate with qualifications. The main areas of research interest are partial differential equations, geometric analysis, applied and computational mathematics, and algebra/number theory; however, exceptional candidates in any field of pure and applied mathematics are encouraged to apply.

It is intended that the successful applicants will be nominated for a Canada Research Chair. Accordingly, candidates are expected to be outstanding mathematicians whose research and teaching will make major contributions to the quality and stature of the department.

Applicants should send their complete CV, including a list of publications, a short statement describing their research programme, all appropriate material about their teaching, and the AMS Standard Cover Sheet. They should also arrange to have at least four letters of reference sent directly to the Search Committee, Department of Mathematics, University of Toronto, 100 St. George Street, Room 4072, Toronto, Ontario, Canada M5S 3G3. Additional information is available at: http://www.math.toronto.edu/jobs/.

Priority will be given to applications received by November 15, 2002. Applications after this date will be considered until the positions have been filled.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications 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.

Any inquiries about the application should be sent to ida@math.toronto.edu.

UNIVERSITY OF TORONTO
Department of Mathematics

The Department of Mathematics, University of Toronto, anticipates openings at the tenure-track or tenured level. Preference will be given to researchers in the area of analysis or algebra. Rank and salary will be commensurate with qualifications.

Candidates are expected to have demonstrated excellence in both teaching and research after the Ph.D.; in particular, a candidate's research and teaching record should show clearly the ability to make major contributions to the quality and stature of the department. The department also has a limited number of distinguished Canada Research Chairs for which extraordinary candidates may be nominated.

Applicants should send their complete CV, including a list of publications, a short statement describing their research programme, all appropriate material about their teaching, and the AMS Standard Cover Sheet. They should also arrange to have at least four letters of reference sent directly to the Search Committee, Department of Mathematics, University of Toronto, 100 St. George Street, Room 4072, Toronto, Ontario, Canada M5S 3G3. At least one letter should be primarily concerned with the candidate's teaching. Additional information is available at: http://www.math.toronto.edu/jobs/.

Priority will be given to applications received by November 15, 2002. Applications after this date will be considered until the position has been filled.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications 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.

Any inquiries about the application should be sent to ida@math.toronto.edu.

UNIVERSITY OF TORONTO
Department of Mathematics

The Department of Mathematics, University of Toronto, anticipates an opening at the tenure-track or tenured level. The preferred area of research is differential/complex geometry. Appointment will be made at the rank of assistant or associate professor, to begin July 1, 2003.

Candidates are expected to have demonstrated excellence in both teaching and research after the Ph.D.; in particular, a candidate's research and teaching record should show clearly the ability to make major contributions to the quality and stature of the department. The department also has a limited number of distinguished junior Canada Research Chairs for which extraordinary candidates may be nominated.

Applicants should send their complete CV, including a list of publications, a short statement describing their research programme, all appropriate material about their teaching, and the AMS Standard Cover Sheet. They should also arrange to have at least four letters of reference sent directly to the Search Committee, Department of Mathematics, University of Toronto, 100 St. George Street, Room 4072, Toronto, Canada M5S 3G3. At least one letter should be primarily concerned with the candidate's teaching. Additional information is available at: http://www.math.toronto.edu/jobs/.

Priority will be given to applications received by November 15, 2002. Applications after this date will be considered until the position has been filled.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications 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.

Any inquiries about the application should be sent to ida@math.toronto.edu.

UNIVERSITY OF TORONTO
Department of Mathematics

The department invites applications for one or more limited-term assistant professorships which may become available, subject to budgetary approval, for a period of one to three years beginning July 1, 2003. Duties consist of teaching and research, and candidates must demonstrate clear strength in both. Preference will be given to candidates with recent doctoral degrees. Salaries commensurate with qualifications.

Applicants should send their complete CV, including a list of publications, a short statement describing their research programme, all appropriate material about their teaching, and the AMS Standard Cover Sheet. They should also arrange to have at least three letters of reference sent directly to the Search Committee, Department of Mathematics, University of Toronto, 100 St. George Street, Room 4072, Toronto, Canada M5S 3G3.

To ensure full consideration, all information should be received by November 15, 2002. Additional information is available at: http://www.math.toronto.edu/jobs/.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications 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 applicants are encouraged to apply; however, Canadians and permanent residents will be given priority.

Any inquiries about the application should be sent to ida@math.toronto.edu.

UNIVERSITY OF TORONTO
Department of Mathematics

The University of Toronto solicits applications for two tenure-track appointments in mathematics. Preference will be given to researchers in these areas: (i) algebra, number theory and cryptography, and (ii) applied PDE's such as mathematical modelling, mathematical finance or pattern recognition. However, exceptional candidates in any field of pure or applied mathematics are encouraged to apply.

The appointments are at the University of Toronto at Mississauga, Erindale College, at the rank of assistant professor, to begin July 1, 2003. Salary commensurate with experience. Candidates are expected to have demonstrated excellence in both teaching and research after the Ph.D.; in particular, a candidate's research record should show clearly the ability to make

significant original and independent contributions to mathematics.

Applicants should send a complete CV, including a list of publications, a short statement describing their research programme, all appropriate material about their teaching, and the AMS Standard Cover Sheet. They should also arrange to have at least four letters of reference sent directly to the Search Committee, Department of Mathematics, University of Toronto, 100 St. George Street, Room 4072, Toronto, Canada M5S 3G3. At least one letter should be primarily concerned with the candidate's teaching. Additional information is available at: http://www.math.toronto.edu/jobs/.

Priority will be given to applications received by November 15, 2002. Applications after this date will be considered until the positions have been filled.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications 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.

ISRAEL

THE WEIZMANN INSTITUTE
Department of Mathematics and Science

A number of fellowships for postdoctoral research in the fields of pure and applied mathematics and computer science, as well as a number of interdisciplinary projects including bioinformatics, neurosciences, computer vision and robotics will be offered by the Weizmann Institute of Science. The deadlines for the submission of applications are January 1 and May 15, 2003. Additional information and application forms are available on the website http://www.weizmann.ac.il/feinberg/ or by writing to Postdoctoral Fellowship Program, Feinberg Graduate School, The Weizmann Institute of Science, Rehovot 76100, Israel; fax: 972-8-934-4114.

SINGAPORE

NATIONAL UNIVERSITY OF SINGAPORE
Department of Mathematics

The Department of Mathematics at NUS invites applications for several tenure-track and visiting positions beginning in July 2003. We will consider outstanding researchers in any field of pure and applied mathematics, particularly those in the areas of scientific computing, optimization and operations research, as well as in financial mathematics, computational biology, mathematical modeling, approximation and simulations.

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 30, 2002, and will continue until positions are filled. For further information about the department, please see http://www.math.nus.edu.sg/.

SWITZERLAND

UNIVERSITY OF NEUCHÂTEL
Institute of Mathematics
Full Professor in Probability Theory

The successful candidate will develop a research team in this field, teach probability theory at the first and second cycles of undergraduate studies (including teaching of stochastic processes in our curriculum of mathematics applied to finance), and might have to collaborate with users of probability/stochastics at the Faculty of Sciences and at the Faculty of Economics.

Salary and duties: according to legal conditions

Position starts: October 1, 2003

Language: French

Positions at the University of Neuchâtel are opened to both women and men. For more information please contact Professor Alain Valette (alain.valette@unine.ch) or consult the website http://www.unine.ch/math/.

Application files, including CV, publication list, research project, and five references (with names, addresses, and e-addresses) must be sent before November 30, 2002, to: Département de l'Instruction publique et des affaires culturelles du Canton de Neuchâtel, Service de l'Enseignement universitaire, Château, CH-2001 Neuchâtel, Switzerland.

TAIWAN

NATIONAL CHUNG CHENG UNIVERSITY
Department of Mathematics
Regular and Visiting Positions

The Department of Mathematics invites applications for regular and visiting positions at either the level of assistant professor or above effective August 1, 2003.

Applications are invited in all areas of mathematics: differential geometry, applied 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, 2003, will be given full consideration. Send all materials to: Dr. C. J. Sung, Chair of the Recruiting Committee, Department of Mathematics, National Chung Cheng University, Ming-Hsiung, Chia-Yi, Taiwan, R.O.C. 62117. Additional department information is available on our website, http://www.math.ccu.edu.tw/; fax: 886-5-272-0497; email: director@math.ccu.edu.tw.

NATIONAL SUN YAT-SEN UNIVERSITY
Kaohsiung, Taiwan
Department of Applied Mathematics

We invite applications for several faculty openings at all levels starting in August 2003. The department is young, active and promising. Last year our university was ranked by the government as one of the nine research universities in the country. Applicants should have a Ph.D. and demonstrate potential for excellent research and teaching. The ability to teach in Chinese Mandarin is essential. Preference will be given to those with complete applications before February 15, 2003. Those who can start in February 2003 are also asked to make a note in his/her application letter. All applicants should send a letter of application, curriculum vitae, transcript, research summary, reprints of publications (technical reports), and three letters of recommendation to: Chairman, Department of Applied Mathematics, National Sun Yat-sen University, Kaohsiung, Taiwan, 804, R.O.C.; email: chairman@math.nsysu.edu.tw; fax: 886-7-5253809; website: http://www.math.nsysu.edu.tw/.

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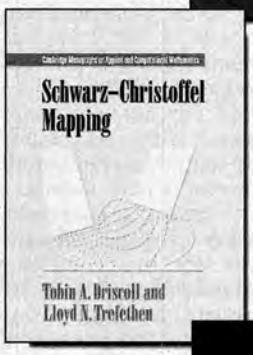

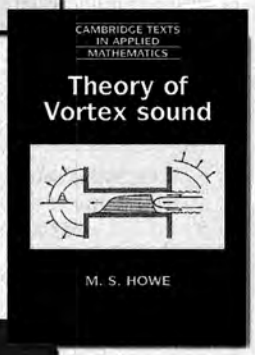

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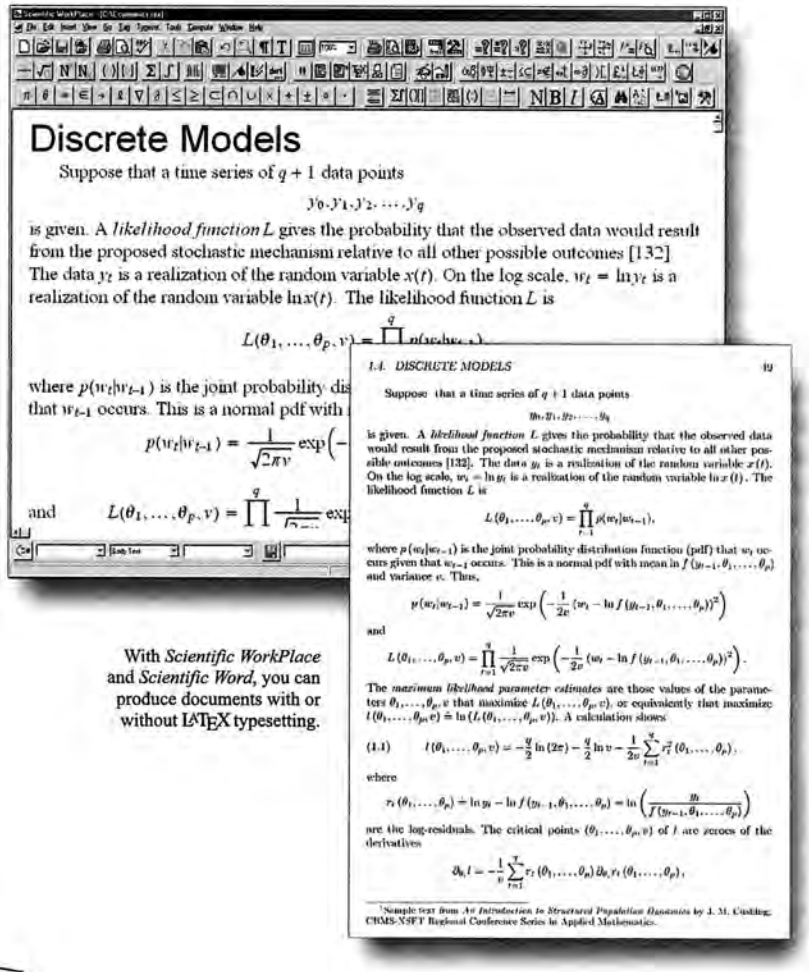

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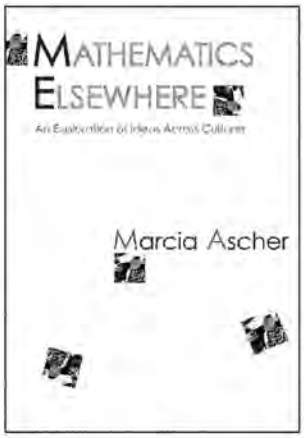

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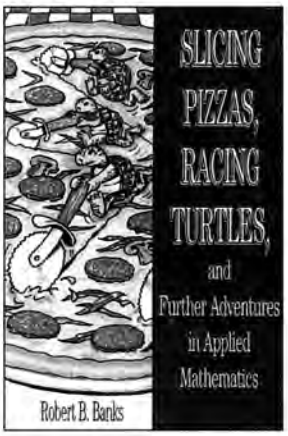

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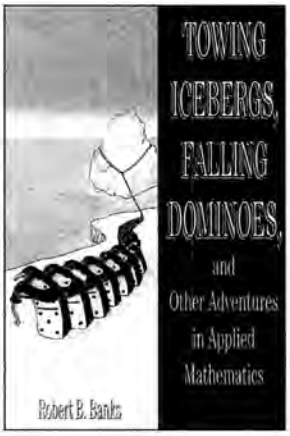

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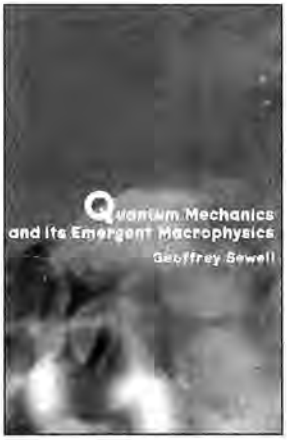

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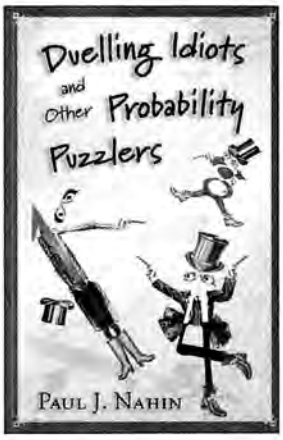

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http://www.ima.umn.edu/complex

Individuals may apply for three classes of membership at the IMA in connection with the 2003-2004 thematic program: IMA postdoctoral memberships, IMA industrial postdoctoral memberships, and general IMA memberships.

IMA POSTDOCTORAL MEMBERSHIPS provide an excellent opportunity for mathematical scientists near the beginning of their career who have a background in or an interest in learning about probability, statistics, and complex systems. IMA postdoctoral memberships run two years starting September 2, 2003. In the second year of the appointment there are a variety of options to enhance career development, including participation in the 2004-2005 academic year program on "Mathematics of Materials and Macromolecules: Multiple Scales, Disorder, and Singularities."

IMA INDUSTRIAL POSTDOCTORAL MEMBERSHIPS are designed to prepare mathematicians for research careers in industry or involving industrial interaction. IMA industrial postdoctoral memberships run two years starting September 2, 2003. They are funded jointly by the IMA and an industrial sponsor, and holders devote 50% effort to the IMA program and 50% effort working with industrial scientists. Industrial sponsors are typically IMA Participating Corporations.

GENERAL IMA MEMBERSHIPS provide an opportunity for mathematicians and scientists employed elsewhere to spend a period of one month to one year in residence at the IMA, and to participate in the 2003-2004 program on "Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering." The residence should fall in the period June 1, 2003 through August 31, 2004. Logistic support such as office space, computer facilities, and secretarial support will be provided, and local expenses may be provided. Preference will be given to supplementary support for persons with sabbatical leaves, fellowships, or other stipends.

All IMA members are provided with an excellent and extremely stimulating research environment and connection with a large community of first class researchers. The postdoctoral memberships, regular and industrial, include a mentorship program, a salary of $45,000 annually, and a travel allowance. Postdoctoral applicants must have completed all requirements for a doctorate by September 2, 2003 and must show evidence of mathematical excellence.

Application forms and instructions are available at http://www.ima.umn.edu/docs/genapp.html. Completed applications, including supporting materials, must be received by the IMA by January 15, 2003. Questions should be directed to applications@ima.umn.edu or by phone to (612) 624-6066.

The University of Minnesota is an equal opportunity educator and employer.

Change of Address

Members of the Society who move or change positions are urged to notify the Providence Office as soon as possible.

Journal mailing lists must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the Combined Membership List). In addition, the AMS maintains records of members' honors, awards, and information on Society service.

When changing their addresses, members are urged to cooperate by supplying the requested information. The Society's records are of value only to the extent that they are current and accurate.

If your address has changed or will change within the next two or three months, please fill out this form, supply any other information appropriate for the AMS records, and mail it to:

Customer Services
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Organizers are invited to submit proposals for conferences to take place in the summer of 2004 as part of the Summer Research Conferences. Staff of the sponsoring societies handle the logistical details, making it possible for organizers to focus exclusively on the scientific aspects of their conference. Funding is provided by a grant from the National Science Foundation.

Deadline for receipt of proposals for 2004 is February 15, 2003. For complete information on proposal preparation and submission, visit **http://www.ams.org/meetings/topics.html**.

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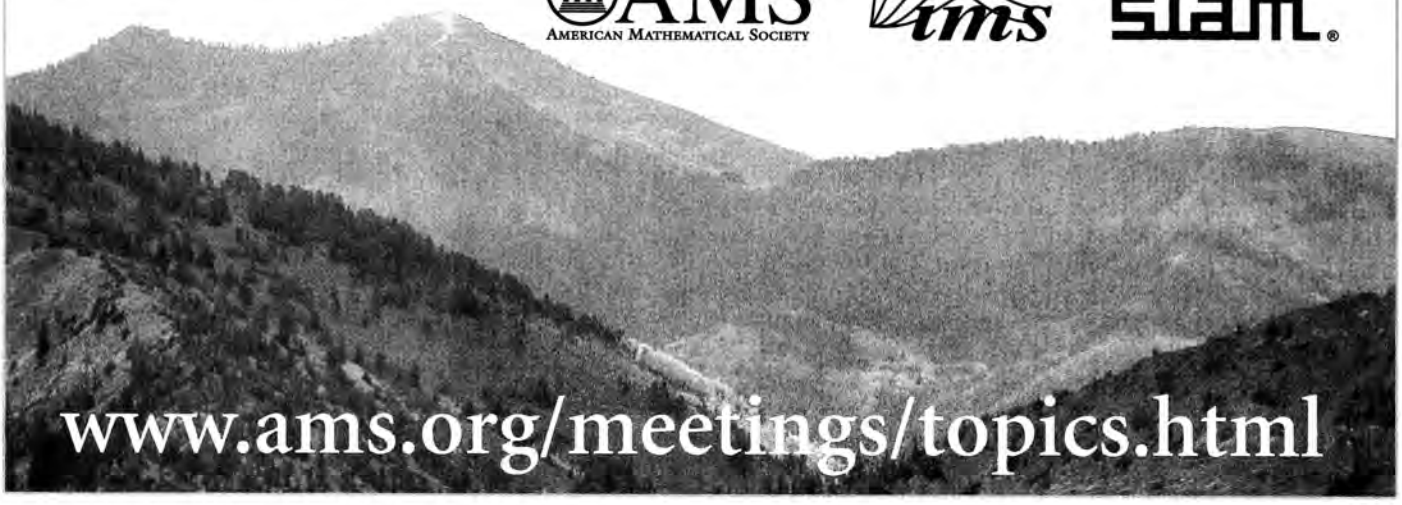


Conferences

2003 Von Neumann Conference

Symposium on Complex Geometry, Calibrations, and Special Holonomy

Mathematical Sciences Research Institute
Berkeley, California
August 11–22, 2003

With the support of an AMS fund established by Dr. and Mrs. Carroll V. Newsom in honor of the memory of John von Neumann, and with the support of the Mathematical Sciences Research Institute, a symposium on Complex Geometry, Calibrations, and Special Holonomy will take place from Monday, August 11, to Friday, August 22, 2003, at the Mathematical Sciences Research Institute, Berkeley, California.

The topic was selected by the AMS von Neumann Symposium Committee, whose members at the time were Mitchell Luskin and Toby Stafford.

Organizing Committee

Robert Bryant, Duke University (Cochair)
Simon Donaldson, Imperial College
H. Blaine Lawson, SUNY at Stony Brook
Richard Schoen, Stanford University
Gang Tian, Massachusetts Institute of Technology (Cochair)

Symposium Overview

The ideas and tools being developed in differential geometry in response to the challenges posed in modern mathematical physics, particularly string theory, will be the focus of the von Neumann symposium to be held at the Mathematical Sciences Research Institute August 11–22, 2003. The program will concentrate on current mathematical developments in complex geometry, calibrations and calibrated cycles, special holonomy, and gauge theory. The symposium has three intended audiences: researchers from related fields interested in an overview of this area, postdoctoral mathematicians and advanced graduate students in this area who wish to gain a broader perspective on the relationships between these topics and their applications to other areas, and senior researchers in the area who wish to broaden their perspective by hearing more about the full scope of the subject.

The program will be organized around four minicourses, one on each of the focus topics of the symposium, each divided into a presentation of background material covered at the level of detail of a survey and more advanced material with an emphasis on applications to other areas. Though the four topics are interrelated, each minicourse will be independent enough of the others to stand on its own as an introduction to the subject. These minicourses will be designed so that a student with a two-semester course in differential geometry at the graduate level will be able to follow the lectures.

The minicourses will be supplemented by research talks for specialists as well as expository presentations intended to be accessible to postdocs and more senior researchers in related fields. Very few of the talks are expected to attract the entire body of participants, so there will be ample time for small group discussions. Further details about the content of the symposium will appear on the MSRI website (`http://www.msri.org/`) and the AMS website (`http://www.ams.org/meetings/`).

The participation of qualified women, underrepresented minorities, and junior scientists (advanced graduate students and recent Ph.D.'s) is especially encouraged. All persons who are interested in participating should submit the following information to AMS Symposium Coordinator, American Mathematical Society, P.O. Box 6887, Providence, RI 02940; or by email to `wsd@ams.org` **no later than March 1, 2003.** Please type or print the following:

1. Full name and mailing address.
2. Phone numbers (including area code) for office, home, and fax.
3. Email address.
4. Your anticipated arrival/departure dates.
5. Scientific background relevant to the symposium topics; please indicate if you are a student or if you received your Ph.D. on or after 7/1/96.
6. The amount of financial assistance requested (or indicate if no support is required).

All requests will be forwarded to the organizing committee for consideration. Letters of invitation with specific offers of support (if applicable) will be mailed in early April, along with a brochure of information, program information known to date, and information on travel and local housing. Participants will be responsible for making their own travel and housing arrangements.

Questions concerning the scientific program should be addressed to the organizers at `bryant@math.duke.edu` or `tian@math.mit.edu`. Questions of a nonscientific nature should be directed to the AMS Symposium Coordinator at the address provided above.

Mathematical Sciences Employment Center

Baltimore Convention Center, Baltimore, Maryland
January 15, 16, 17, and 18, 2003

2003 Employment Center Schedule

Wednesday, January 15

7:30 a.m.–4:00 p.m. Registration and materials pick-up.

9:00 a.m.–9:30 a.m. Short (optional) orientation session.

9:30–4:00 p.m. Submission of Scheduled Employment Register interview request forms for both Thursday and Friday interviews. No request forms can be accepted after 4:00 p.m. Wednesday.

9:30 a.m.–6 p.m. Interview Center open.

No Scheduled Employment Register interviews are held on Wednesday.

Thursday, January 16

7:00 a.m.–8:15 a.m. Distribution of interview schedules for both Thursday and Friday for those participating in the Scheduled Employment Register.

8:15 a.m.–4:40 p.m. Scheduled Employment Register interviews in 4 sessions: *Session 1:* 8:15 a.m.–9:50 a.m., *Session 2:* 10:00 a.m.–11:35 a.m., *Session 3:* 1:00 p.m.–2:35 p.m., *Session 4:* 3:00 p.m.–4:35 p.m.

8:00 a.m.–7:30 p.m. Interview Center open (doors open at 7:30 a.m.; do not schedule before 8:00 a.m.).

Friday, January 17

8:15 a.m.–4:40 p.m. Scheduled Employment Register interviews in 4 sessions: *Session 5:* 8:15 a.m.–9:50 a.m., *Session 6:* 10:00 a.m.–11:35 a.m., *Session 7:* 1:00 p.m.–2:35 p.m., *Session 8:* 3:00 p.m.–4:35 p.m.

8:00 a.m.–7:30 p.m. Interview Center open (doors open at 7:30 a.m.; do not schedule before 8:00 a.m.).

Saturday, January 18

9:00 a.m.–12 noon Interview Center open.

Note: Any participant who plans to use the Scheduled Employment Register must appear at the Employment Center on Wednesday by 4:00 p.m. to turn in the Interview Request/Availability Form. If unexpected delays occur while travelling, contact the AMS at 800-321-4267, ext. 4107.

Overview of the Employment Center

The Employment Center (formerly the Employment Register) serves as a meeting place and information center for employers and Ph.D.-level job seekers attending the Joint Mathematics Meetings. Most applicants and employers began the search process in the fall and are looking for an opportunity to meet in person with those with whom they've already had communication. Some, however, use the Employment Center as a way to make some initial contacts, gather information, and distribute their own information. This is a less effective, but common, use of the program. The Employment Center allows everyone to choose a comfortable level of participation by seeking interviews for any of the open hours or by limiting schedules to certain days or hours.

The Employment Center is a three-day program which takes place on the Wednesday, Thursday, Friday, and Saturday (morning only) of the Joint Meetings. Most participants register in advance (by the October 25 deadline), and their brief résumé or job description is printed in a booklet which is mailed to participants in advance.

The Employment Center houses two services: the computer-scheduled interview tables (the Scheduled Employment Register) and the employer-scheduled interview tables (the Interview Center). Use of the center overall by employers has gone up in recent years. At the 2002 Employment Center, 370 candidates and 151 employers participated, giving an overall applicant-to-employer ratio of 2.4:1 (compared with 341 applicants and 139 employers in 2001, a ratio of 2.5:1). Each applicant ends up with roughly 5 to 15 interviews of various types. Those with the most interviews are those requested most by employers, usually as a result of a careful application process during the months before the Employment Center takes place.

At the January 2003 Employment Center, job candidates will be able to choose how to participate. Two forms of participation will be available:

> All Employment Center services (computer-scheduling system, form posted in *Winter List of Applicants, Winter List of Employers* received by mail, use of Employment Message Center,

availability for employer-scheduled Interview Center).

Message Center and *Winter Lists* only (form posted in *Winter List of Applicants, Winter List of Employers* received by mail, use of Employment Message Center, availability for employer-scheduled Interview Center, BUT NOT use of the computer-scheduling system).

No matter which option is chosen, advance registration works best so that the Applicant Form (received by October 25, 2002) can be printed in the *Winter List* distributed to employers.

Employer forms submitted by registered employers have no connection with the AMS online job ads (EIMS). Submitted forms are not available for browsing on the Web. They are reproduced in the *Winter List* booklet for use by Employment Center participants.

The Mathematical Sciences Employment Center is sponsored by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics; it is managed by members of the AMS staff, with the general guidance of the AMS-MAA-SIAM Committee on Employment Opportunities.

Employers: Choose one or both of these tables:

Computer-scheduled Employment Register table

Employer-scheduled Interview Center table

The Employment Register Computer-Scheduling System

Employers register in advance by the October 25 deadline, and their job listings ("Employer Forms") are printed and distributed in mid-December to applicants. Employers receive the book of brief, numbered applicant résumés in mid-December. Participants decide on Wednesday, January 15, which of the eight sessions (of five interviews each) they will participate in and submit their Availability/Interview Request Forms by 4:00 p.m. Wednesday. Employers can reserve time for other Joint Meetings events by marking "unavailable" for one or more of the eight sessions. Employers can request ten specific applicants per day, assuming they are available for all four sessions that day. Usually those requests will be filled by the scheduling algorithm, provided the applicants are present, except in the case of the few most-requested applicants. The rest of their interviews will be with applicants who ask to see them. Employers should be specific about their requirements on the Employer Form to avoid interviews with inappropriate candidates.

Schedules are distributed for all Thursday and Friday interviews on Thursday morning. The schedule allows 15-minute interviews, with 5 minutes between for note taking. One or more interviewers for the same position(s) may interview at the table separately, together, or in shifts. For follow-up interviews, the scheduled tables will also be available for use until 7:30 p.m. on Thursday and Friday and on Saturday morning from 9:00 a.m. to noon.

Participation in the scheduling program has become optional for applicants, so employers will notice some applicant résumés in the *Winter List of Applicants* with no applicant number. An employer can arrange to interview such an applicant outside of the scheduled interview sessions—for instance, between 4:40 p.m. and 7:30 p.m. Thursday or Friday, or on Saturday morning—or during sessions which they left unscheduled.

Employers who are interviewing for two distinct positions may wish to pay for two tables. See the instructions under "How to Register". Employers should bring school catalogs, corporate reports, or more lengthy job descriptions to the Employment Center early on Wednesday for perusal by applicants prior to interviews.

The Employer-Scheduled Interview Center

The Interview Center allows any employer to reserve a table in an area adjacent to the Employment Center. Employers will arrange their own schedule of interviews, either in advance or on site, by using the Employment Message Center. Employers who have never used the Employment Center before might want to try conducting interviews at this convenient location. Since they will be setting their own schedules, employers will have complete control over whom they'll see, for how long, and when they'll be interviewing. This allows employers to pursue other activities at the Joint Meetings.

The center will be open only during the following hours:

Wednesday, January 15, 2003, 9:30 a.m.–6:00 p.m.
Thursday, January 16, 2003, 8:00 a.m.–7:30 p.m.
Friday, January 17, 2003, 8:00 a.m.–7:30 p.m.
Saturday, January 18, 2003, 9:00 a.m.–noon

The fee for use of this area is the same as the normal employer fee, $220. It is requested that all employers fill out an Employer Form for inclusion in the *Winter List*. This should clarify to Employment Center applicants what type of position is being filled. If an employer is unable to accept new applicants because the deadline has passed, that should be stated on the form.

The *Winter List of Applicants*, containing information about the candidates present at the Employment Center, will be mailed to all employers in advance of the meeting.

Employers scheduling interviews in advance should tell applicants to find the table with the institution's name in the Interview Center (not the numbered-table area). Employers can schedule any time during the open hours listed above. To schedule interviews after arriving in Baltimore, leave messages for Employment Center applicants in the Employment Message Center. Paper forms will be provided to help speed the invitation process. Each employer will be provided with a box in the Message Center where applicants can leave items.

Employers should have at most two interviewers per table at any time due to space limitations. There will be no outlets or electricity available at the interviewing tables.

About the *Winter List of Applicants*

This booklet contains hundreds of résumés of applicants registered by October 25 for the Employment Center. It will be mailed to all employers who register by October 25 who indicate on their Joint Meetings registration form that they would like their materials mailed. Employers should be aware that there will be hundreds of brief résumés to look through and should be sure to obtain the *Winter List of Applicants* as early as possible.

Employers Not Planning to Interview

Employers who do not plan to participate in the Employment Center at all may place a job description in the book of employers. This description must be submitted on the Employer Form, which appears in the back of this issue, with the appropriate box checked indicating that no interviews will take place. A fee of $50 is charged for this service (paid through the Joint Meetings registration form). The form must be received in the Providence office (with payment or purchase order) by the October 25 deadline to appear in the *Winter List of Employers.* Forms received in the Providence office after that deadline will be displayed at the meeting. Those wishing to bring a one-page job description to the Employment Center desk for display during the meetings may do so at no charge.

Employers: How to Register

The interviewer should register and pay for the Joint Mathematics Meetings. They should register for the Employment Center by completing the following steps:

> Indicate on the Joint Meetings registration form (available either electronically after September 2, 2002, at `www.ams.org/amsmtgs/2074_intro.html` or in the back of the October issue of the *Notices*) that you are also paying the Employment Center employer fee. Indicate your choice of tables. Mark all that apply.
>
> Submit an Employer (job listing) Form electronically at www.ams.org/emp-reg, or use the print version in the back of this issue. Be sure the form indicates which type or types of tables will be used. This form will be printed in the *Winter List of Employers.*

It is important to register by the October 25 deadline in order for your form to be included in the *Winter List of Employers.* However, registration will be accepted up to December 19 for the normal fees or on site in Baltimore at the on-site rates. Call 800-321-4267, ext. 4105, with any questions or deadline problems.

Any number of interviewers can sit at a table together or in shifts (however, the limit is two at one time), and their names should be listed on the Employer Form as a reference point for the applicants. Employment Center fees should be paid only for each table required, not for each person.

In a few unusual cases an institution will be conducting interviews in the Employment Center for two or more distinct positions and will not want to conduct these interviews at one table. In that case, two or more Employer Forms should be submitted, and separate tables and employer numbers will be provided. Applicants will then be able to request interviews for the appropriate job by employer number. First and second table fees should be paid.

The fee for all employers to register in advance is $220 for the first table and $65 for each additional table. On-site registration fees (any registrations after 12/19/02) are $300 for the first table and $100 for each additional table. Employers must also register for the Joint Meetings and pay the appropriate Joint Meetings fee.

Employers: Registration on Site

Employers who do not register for the Joint Mathematics Meetings and the Employment Center by December 19 may register on site in Baltimore at the Joint Meetings registration desk. They must bring their receipt to the Employment Center desk between 7:30 a.m. and 4:00 p.m. on Wednesday, January 15, to receive their materials. A typed copy of the Employer Form (found in the back of this issue) can be brought to the Employment Center for posting on site (or the form can be handwritten on site). If registering for the employer-scheduled Interview Center only, registration on Thursday is possible.

Applicants: Use of the computer-scheduled program is now optional

In 2003 applicants will be given flexibility in deciding how to participate in the Employment Center. There are two options:

> All Employment Center services (computer-scheduling system, form posted in *Winter List of Applicants, Winter List of Employers* received by mail, use of Employment Message Center, availability for employer-scheduled Interview Center).
>
> Message Center and *Winter Lists* only (form posted in *Winter List of Applicants, Winter List of Employers* received by mail, use of Employment Message Center, availability for employer-scheduled Interview Center, BUT NOT use of the computer-scheduling system). This option is available at a slightly lower price.

Applicants who participate in the 2003 Employment Center will find themselves talking with employers in two different settings:

1. A computer-scheduling program sets 15-minute interviews at the Employment Register numbered tables. This is the choice that has now become optional for applicants. Applicants do not have to hand in a computer-scheduling form at all.

2. There is also an Interview Center, where employers set their own schedules. These employers do not participate in the scheduling program, so applicants have no

automatic access to interviews with them. They determine their own schedules and make their own appointments privately, either in advance or on site using the Employment Message Center. These interviews have always been "optional" for applicants, since they may turn down any written invitation they receive. Applicants are reminded to respond to all invitations promptly.

The Schedule

For applicants using all services there is a certain scheduling burden placed on them to juggle these simultaneous services. However, computer-scheduled sessions are in small blocks, for a total of eight sessions over the two days of interviews (Thursday and Friday). This allows applicants, once they receive invitations to interview in the Interview Center, to accept, knowing that when they submit the computer schedule request on Wednesday they can mark that they are unavailable for one or more of these sessions without seriously jeopardizing their chances of obtaining scheduled interviews. Likewise, applicants who are scheduled to give a talk can avoid interviews for that time. Applicants are encouraged to schedule their time in advance in this manner and not wait for the computer schedule to be distributed Thursday morning.

Interviews

Applicants should understand that the Employment Center provides no guarantees of interviews or jobs. It is simply a convenient meeting place for candidates and employers who are attending the Joint Meetings. Those who have not yet begun their job search efforts may go unnoticed at the Employment Center (although applicants will likely receive a minimum of between one and three interviews in the scheduled program). Attention generally goes to candidates who already have applied for open positions or to those who are well suited for teaching positions at liberal arts colleges.

Data from recent Employment Centers show that women represent about half of the most sought-after applicants, although they make up less than half of the total Employment Center applicant pool. Those without permanent authorization to work in the United States will find themselves far less requested than U.S. citizens or permanent residents. Newer Ph.D.'s tend to be invited for more interviews than those who have been working longer. Most jobs listed require a doctorate.

Preparations

Candidates just beginning a job search should realize that employers have no method to judge their credentials other than the brief résumé form, and they should make an effort to make it distinct and interesting.

Applicants who register in advance will receive the *Winter List of Employers* in mid-December. If time permits, they should apply for suitable open positions they notice in the *Winter List of Employers* after they receive it. Applicants are advised to bring a number of copies of their vita or résumé so that they may leave them with prospective employers. It is a good idea in the fall for applicants to alert any employer to whom applications are made that they plan to be present at the Joint Meetings. Also, they should bring enough materials with them to accompany requests for interviews they may want to leave in the Message Center boxes of the Interview Center employers.

Applicants are also encouraged to leave some extra copies of their résumés in their own message folders so that interested employers may find them there. Photocopying costs at a convention are high, so applicants should come prepared with a reasonably large number of copies. A brightly colored form in each folder gives applicants an opportunity to present for public perusal some information about their availability during the meetings.

The *Winter List of Applicants* is mailed to all employers in advance, so it is vital that the Joint Meetings registration form, applicant résumé form, and payments be received by the October 25 deadline so the Applicant Form can be printed in the book. This greatly increases an applicant's chances of being invited to the Interview Center.

Applicants should keep in mind that interviews arranged by the Employment Center represent only an initial contact with the employers and that hiring decisions are not ordinarily made during or immediately following such interviews.

Applicants: Register Early

Applicants need to complete the following steps by the advance deadline of October 25, 2002.

1. Pay fees

Register for the Joint Mathematics Meetings (see form in the back of the October issue of the *Notices* or the electronic information available after September 2, 2002, at www.ams.org/amsmtgs/2074_intro.html). You cannot participate in the Employment Center unless you are a meetings participant. Mark one of the two "Employment Center Applicant Fee" boxes on the Joint Meetings registration form and make payments. The fee in advance for applicants is $40; "Message Center and *Winter List* ONLY" registration is $20.

2. Send form

Submit the Applicant Form (a brief résumé form) electronically at `www.ams.org/emp-reg/`, or use the print version in the back of this issue.

After Registration

Submission of the Applicant Form electronically will result in an email acknowledgement almost immediately. For registration and payments, the Meetings Service Bureau acknowledges all payments. When payments AND the Applicant Form have been received, another acknowledgement will go out by email, if possible, or by mail. Please allow a week or so for processing, but after that contact staff (AMS 800-321-4267, ext. 4105) if you do not receive acknowledgement from the Employment Center.

Around December 15 the *Winter List of Employers* will be mailed to all registered applicants unless they request otherwise.

Registering after the Deadline

After October 25 applicants can still register for the Employment Center at the same prices until the final deadline of December 19. However, the Applicant Form will NOT be included in the *Winter List of Applicants* but will be posted on site at the Employment Center (a serious disadvantage). Those who do not register by December 19 must register on site at the Joint Meetings registration desk and pay higher fees ($75 Employment Center fee; however, the "Message Center and *Winter List* ONLY" fee is always just $20).

It is worthwhile to submit the applicant form even if you miss the October 25 deadline. An unexpected delay in publishing may allow your late form to get into the book. At the very least, your printed-out form will be brought to the meetings by staff and displayed there (after all the fees have been paid).

When to Arrive

All participants in the scheduled section of the Employment Center must submit their Interview Request/Availability forms in person between 9:30 a.m. and 4:00 p.m. on Wednesday, January 15, 2003, or they will not be included when the interview-scheduling program runs Wednesday night. Should unexpected delays occur while travelling, contact the AMS at 800-321-4267, ext. 4107. Be sure to keep Employment Center materials with you, because in an emergency you can report your interview requests over the phone.

Applicants: Registering on Site

Feel free to enter the Employment Center area first to consult staff about the decision to register on site and to check on which employers are participating. Full registration on site early Wednesday is allowed for a higher fee but is severely discouraged. Most employers will not notice an Applicant Form which arrives on Wednesday. Therefore, these individuals will receive only a couple of computer-scheduled interviews. Registration on site is advisable only for those who know they will be interviewed in the Interview Center and would like a Message Center folder for employers to leave messages in. This year registering on site for a mailbox only is possible, at the $20 rate, on Wednesday and Thursday.

Instructions for Applicant and Employer Forms

Applicant forms submitted for the Employment Center by the October 25 deadline will be reproduced in a booklet titled *Winter List of Applicants*. Employer forms submitted by the October 25 deadline will be reproduced for the *Winter List of Employers*.

Please use the electronic versions of Applicant and Employer forms (`http://www.ams.org/emp-reg/`). Paper forms should be submitted only by those who do not have access to the AMS website.

If submitting a paper form, please type carefully. **Do not type outside the box or beyond the lines indicated. Extra type will be omitted.**

All forms must be received by the Society by **October 25, 2002**, in order to appear in the *Winter List*. However, meeting registration (and payment of fees) is required before the forms can be processed.

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

EMPLOYER FORM
MATHEMATICAL SCIENCES EMPLOYMENT CENTER
JANUARY 15–18, 2003
BALTIMORE, MARYLAND

1. Forms should be accessed and submitted electronically if possible. The URL for accessing Employment Center information and forms is `http://www.ams.org/emp-reg/`.
2. Paper or electronic forms are due, along with payment and your Advance Registration/ Housing Form, by October 25 (to AMS, P. O. Box 6887, Providence, RI 02940) in order to be included in the *Winter List of Employers*.
3. Please list all potential interviewers, for reference by applicants, but pay fees only for each separate table.
4. Forms will not be processed until registration and payment of fees have been received.

EMPLOYER CODE:

Institution _____

Department _____

Mailing address _____

_____

E-mail address (one only) _____

URL (or other contact info) _____

Name(s) of Interviewer(s) 1. _____

2. _____

3. _____

4. _____

Specialties sought _____

_____

Title(s) of position(s) _____

Number of positions _____

Starting date _____ (Month) / _____ (Year) Term of appointment _____ (Years)

Renewal ☐ Possible ☐ Impossible

Tenure-track position ☐ Yes ☐ No

Teaching hours per week _____

Degree preferred _____ Degree accepted _____

Duties _____

_____

_____

Experience preferred _____

_____

_____

Significant other requirements, needs, or restrictions which will influence hiring decisions _____

_____

_____

This position will be subject to a security clearance which will require U.S. citizenship: ☐ Yes ☐ No

THE EMPLOYER PLANS TO USE THE FOLLOWING SERVICES (check all that apply):

☐ One or more computer-scheduled Interview Tables

☐ One or more self-scheduled Interview Tables

☐ Placing this form for information only (not using a table)

Refreshing Looks into Mathematics and the World

Codebreakers

Arne Beurling and the Swedish Crypto Program during World War II

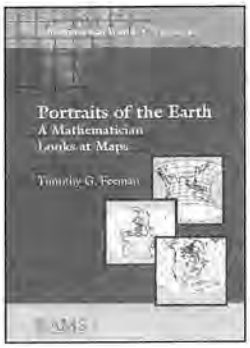
Bengt Beckman

From Reviews of the Swedish Edition:

...an excellent illustration of the best kind of popularization of a complex, technical subject, in this case, Swedish wartime cryptanalysis. Bengt Beckman ... a grey eminence with Sweden's Sigint organization ... has been permitted to twitch the company veil and show what his colleagues got up to during World War II ... the reader is gently introduced to the basic ideas of cryptanalysis before coming face-to-face with the Geheimschreiber ... Merlin the Magician, in the shape of Arne Beurling ... uncover[ed] the structure of the underlying cryptosystem and ... [was able to] identify its vulnerabilities, thus ensuring a steady flow of decrypts ... The resulting intelligence was used in framing Swedish wartime policy in the fields of defense, diplomacy, economic negotiations, and counterespionage ... The abiding presence of Arne Beurling is felt throughout the book. It therefore fittingly closes with a portrait of this brilliant but quirky hero seen throughout the eyes of colleagues, students, and friends.

—Cryptologia

2003; ISBN 0-8218-2889-4; approximately 289 pages; Hardcover; **All AMS members $31**, List $39, Order Code SWCRYNT211



Portraits of the Earth

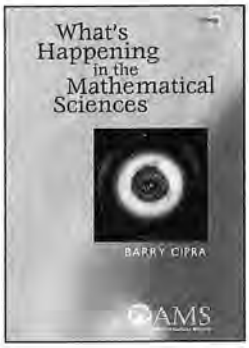
A Mathematician Looks at Maps

Timothy G. Feeman, *Villanova University, PA*

Every map is a tool, a product of human effort and creativity, that represents some aspects of our world or universe ... [This] course was powered by the belief that by exploring the mathematical ideas involved in creating and analyzing maps, students would see how mathematics could help them to understand and explain their world.

***—From the* Preface**

Mathematical World, Volume 18; 2002; ISBN 0-8218-3255-7; approximately 136 pages; Softcover; **All AMS members $21**, List $26, Order Code MAWRLD/18NT211



What's Happening in the Mathematical Sciences, Volume 5

Barry Cipra

Review of the Previous Volumes:

The articles are very well written, and usually include quotes from the mathematicians who were involved in the work in question, giving the whole thing a more "human" feel. This book offers professionals a way to keep abreast of what's going on in the field and also gives us a way to share with our students and colleagues some of the excitement of doing mathematics. Don't miss it.

—MAA Online

What's Happening in the Mathematical Sciences, Volume 5; 2002; ISBN 0-8218-2904-1; 95 pages; Softcover; **All AMS members $15**, List $19, Order Code HAPPENING/5NT211

Also Available from the AMS: Volume 1–4 of What's Happening in the Mathematical Sciences

For many more publications of interest, visit the AMS Bookstore:

www.amsbookstore.org

1-800-321-4AMS (4267), in the US and Canada, or 1-401-455-4000; fax: 1-401-455-4046; email: cust-serv@ams.org.
American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294, USA

9/02

APPLICANT RÉSUMÉ FORM

MATHEMATICAL SCIENCES EMPLOYMENT CENTER
JANUARY 15–18, 2003
BALTIMORE, MARYLAND

1. Forms should be accessed and submitted electronically if possible. The URL for accessing Employment Center information and forms is `http://www.ams.org/emp-reg/`.
2. Paper or electronic forms are due, along with payment and your Advance Registration/ Housing Form, by October 25 (to AMS, P. O. Box 6887, Providence, RI 02940) in order to be included in the *Winter List of Applicants*.
3. Forms will not be processed until registration and payment of fees have been received.

APPLICANT CODE:

Last name _____ First name _____

Mailing address (include zip code) _____

_____

E-mail address (one only) _____

URL (or other contact info) _____

Specialties _____

_____

(use MR classification codes plus text if possible; applicants will be indexed by first number only)

DESIRED POSITION:

Academic: ☐ Research ☐ University Teaching College Teaching: ☐ 4-year ☐ 2-year

Would you be interested in nonacademic employment? ☐ Yes ☐ No Available mo. _____ /yr. _____

Computer skills _____

Significant requirements (or restrictions) which would limit your availability for employment _____

_____

PROFESSIONAL ACCOMPLISHMENTS:

Significant achievements, research or teaching interests _____

_____

_____

_____

_____

Paper to be presented at this meeting or recent publication _____

_____

Degree	Year (expected)	Institution
_____	_____	_____
_____	_____	_____
_____	_____	_____

Number of refereed papers accepted/published _____

PROFESSIONAL EMPLOYMENT HISTORY:

	Employer	Position	Years
1.	_____	_____	_____ to _____
2.	_____	_____	_____ to _____
3.	_____	_____	_____ to _____

References (Name and Institution only)

_____

_____

_____

_____

Work authorization status: (check one) ☐ U.S. Citizen ☐ Non-U.S. Citizen, authorized to work permanently in U.S. ☐ Other

This applicant will be using: ☐ ALL Employment Center services ☐ Message Center and Winter List ONLY

Joint Summer Research Conferences in the Mathematical Sciences

Snowbird Resort
Snowbird, Utah
June 8–July 24, 2003

The 2003 Joint Summer Research Conferences will be held at the Snowbird Resort (`http://summer.snowbird.com/pages/home/default.php`) from June 8 to July 24, 2003. 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 Paul Baum, David Brydges, Tom Dicicco, Charles Doering, Ron Donagi, James A. Fill, William Mark Goldman, Barbara Keyfitz, Mark Gordon Low, Hema Srinivasan, Kenneth Stephenson, and Olof B. Widlund.

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, 2003**.

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 topics; please indicate if you are a student or if you received your Ph.D. on or after 7/1/95.
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 all applicants 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. All participants will be required to pay a nominal registration fee.

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.

Spectral Theory and Inverse Spectral Theory for Jacobi Operators

Sunday, June 8–Thursday, June 10

Svetlana Jitomirskaya, University of California, Irvine
Kenneth T.-R. McLaughlin, University of North Carolina, Chapel Hill
Xin Zhou, Duke University

Goal of the conference: to bring together researchers from two areas: the spectral theory of Jacobi operators and the inverse spectral theory of Jacobi operators. The hope is to provide opportunities for cross-fertilization of ideas between these two areas.

Confirmed participants include: Paul Nevai (Ohio State University), Mourad Ismail (University of Southern Florida), Percy Deift (Courant Institute), Abel Klein (University of California, Irvine), Jinho Baik (Princeton University), Walter Van Assche (Catholic University of Leuven, Belgium), Arno Kuijlaars (Catholic University of Leuven, Belgium), Doron Lubinsky (Georgia Tech), Thomas Kriecherbauer (University of Bochum, Germany), Alexander Kiselev (University of Chicago), Nicholas Ercolani (University of Arizona), Ed Saff (Vanderbilt University), Rowan Killip (University of Pennsylvania), Svetlana Jitomirskaya (University of California, Irvine), Kenneth McLaughlin (University of North Carolina, Chapel Hill, and University of Arizona), Xin Zhou (Duke University).

For further information, please visit the conference website, `http://www.amath.unc.edu/SRC602.html`, maintained by the organizers.

Machine Learning, Statistics, and Discoveries

Sunday, June 22–Thursday, June 26

Xiaotong Shen, Ohio State University
Joseph S. Verducci, Ohio State University

Machine learning is an active and rapidly growing area of research that offers systematic and machine-implementable

approaches to extracting information from vast and complex data sources. The goal of this conference is to assemble researchers from the disciplines of computer science and statistics around the topical themes of support vector machines and other large margin classifiers, boosting and ensemble methods, new extensions of classification and regression, methods for approximate inference, and application areas. We anticipate a lively exchange between the two communities, which we hope will lead to cross-fertilization and new collaborations across traditional academic disciplines. Young researchers, graduate students, and underrepresented groups are encouraged to attend, as they may be the most capable of forming lasting "bridges" across the two cultures in the future.

Mathematics of Finance

Sunday, June 22–Thursday, June 26

Wendell H. Fleming, Brown University
Jean-Pierre Fouque, North Carolina State University
George Papanicolaou, Stanford University
Bozenna Pasik-Duncan, University of Kansas
Stan R. Pliska, University of Illinois at Chicago
K. Ronnie Sircar, Princeton University
George Yin, Wayne State University (Chair)
Qing Zhang, University of Georgia (Cochair)

Research in mathematics of finance has witnessed tremendous progress in recent years. The Black-Scholes model and its various extensions for pricing of options have had an influential impact on financial practice and have led to a revolution in the financial industry. The introduction of stochastic analysis and stochastic control techniques has resulted in a number of important advances. To name just a few, these include the study of valuation of contingent claims in complete and incomplete markets, consumption-investment models with or without constraints, portfolio management for institutional investors such as pension funds and banks, and risk assessment and management using financial derivatives. On the other hand, the applications require and stimulate many new and exciting theoretical discoveries.

As a rapidly expanding and growing discipline, mathematics of finance involves a wide spectrum of techniques that go far beyond the traditional applied mathematics. Stochastic calculus, dynamic programming, and partial differential equations have become indispensable tools to finance, a discipline that previously relied on "a collection of anecdotes, rules of thumb, and shuffling of accounting data." As a major impetus to the development of financial management and economics, the research in mathematics of finance has had a major impact on the global economy. For instance, using stochastic calculus in the pricing of options has become a standard practice nowadays. It can be anticipated that it will continue to stimulate progress in other areas of mathematics in the years to come.

The rapid progress in mathematics of finance has necessitated communication and networking among researchers in different disciplines. To inherit the past and to usher in the future, a Joint Summer Research Conference in mathematics of finance will be sponsored jointly by the AMS, IMS, and SIAM, to be held in June 2003. The main purpose of the proposed conference is to bring together researchers from mathematical sciences, finance, economics, and engineering; to review and update recent advances; and to identify future directions of mathematics of finance. This conference will focus on scientific topics that include but are not limited to valuation of contingent claims and dynamic hedging, consumption-investment models and portfolio management, and risk assessment and management using financial derivatives.

Confirmed invited speakers include: M. Avellaneda, T. Bielecki, R. Carmona, P. Carr, M. Davis, T. Duncan, N. El Karoui, R. Elliott, W. H. Fleming, J.-P. Fouque, X. Guo, F. Hanson, U. G. Haussmann, K. Helmes, D. Hernández-Hernández, Y. Hu, Y. Kabanov, I. Karatzas, J. Ma, W. M. McEneaney, T. Pang, G. Papanicolaou, B. Pasik-Duncan, E. Platen, S. R. Pliska, L. C. G. Rogers, W. Runggaldier, M. Rutkowski, S.-J. Sheu, K. R. Sircar, S. E. Shreve, H. M. Soner, J. L. Stein, L. Stettner, R. Stockbridge, S. Stojanovic, M. Taksar, H. Wang, J. W. Wang, J. Westman, D. D. Yao, G. Yin, J. Yong, Th. Zariphopoloulou, Y. Zeng, Q. Zhang, and X. Y. Zhou.

Hydrodynamic Stability and Flow Control

Sunday, July 6–Thursday, July 10

Peter J. Schmid, University of Washington (Cochair)
James J. Riley, University of Washington (Cochair)

Hydrodynamic stability theory has matured greatly over the last decade and has seen a marked expansion of available tools to tackle complex fluid systems that a few years ago seemed untractable. Similarly, classical control theory has greatly expanded its scope and has provided a range of techniques that hold great promise for many applications in fluid dynamics. The interface of these two fields is expected to spawn new and exciting research directions that will advance our understanding and mastery of complex fluid systems. It is the purpose of this conference to bring together experts in the fields of stability theory and flow control, to foster dialogue, and to illustrate—to expert and novice alike—the utility of an interdisciplinary perspective.

The following broad themes will be covered at this meeting:

1. stability theory of complex flows
2. global and absolute stability theory
3. adjoint techniques in stability, receptivity and flow control
4. optimal and robust control of fluid flow (adjoint and Riccati approach)

The conference will provide a forum for researchers to report recent findings, identify new research directions, and initiate future collaborations. We envision a conference format that encourages discussion and inspires a lively exchange of ideas. Invited speakers with extensive experience will start each day with a review/tutorial lecture that will introduce participants to the field, outline the current state-of-the-art, and touch upon open and

challenging problems. These lectures will be followed by presentations of recent results and novel approaches in the described areas.

Participation of recent Ph.D.'s as well as advanced graduate students is particularly encouraged, as is the participation of minorities and women.

Researchers interested in participation can obtain additional information from the conference website, http://www.amath.washington.edu/~pjs/SRC.html, maintained by the organizers.

Integer Points in Polyhedra, Geometry, Number Theory, Algebra, Optimization

Sunday, July 13–Thursday, July 17

Alexander Barvinok, University of Michigan
Matthias Beck, SUNY Binghamton (Cochair)
Christian Haase, Duke University (Cochair)
Bruce Reznick, University of Illinois, Urbana-Champaign
Michèle Vergne, École Polytechnique Paris
Volkmar Welker, Philipps-Universität Marburg

How many nonnegative integral solutions does a system of linear equations with integer coefficients have?

Questions like the above have applications in a wealth of areas outside mathematics. At the same time, they appear in different disguises in various mathematical fields. For example, the original question has a number theoretical flavor. But in the view of a discrete geometer it "actually" asks for the number of lattice points in a polyhedron. In commutative algebra one would ask for the Hilbert series of a graded ring and in algebraic geometry for the Todd class of a toric variety. The (apparently simpler) question whether there is a solution at all is an integer linear optimization problem.

The proposed conference focuses on these inner mathematical aspects of lattice points. The main motivation is to provide an opportunity to nurture and further develop the interaction between the disciplines.

Our preliminary list of hour speakers includes Sylvain Cappell, Jeff Lagarias, Richard Stanley, Bernd Sturmfels, and Rekha Thomas.

For further information please visit the conference website, http://www.math.binghamton.edu/matthias/scr.html.

Commutative Algebra: Presentations by Young Researchers

Sunday, July 20–Thursday, July 24

Jürgen Herzog, Universität Essen
Craig Huneke, University of Kansas
Roger L. Wiegand, University of Nebraska

The goal of the conference is to bring together young researchers in several areas of commutative algebra in order to provide a showcase for important new ideas and to encourage collaboration among participants. All research talks will be given by mathematically young researchers, primarily those no more than two or three years beyond the Ph.D., and graduate students in their final year of study. The conference will focus on the following topics: (1) homological methods in commutative algebra, (2) characteristic p methods and tight closure, (3) combinatorics and commutative algebra, and (4) representation theory of local rings. Each topic will be introduced by an expository talk, and informal discussions will follow the research talks.

The following individuals have at least tentatively accepted invitations to give research talks: Holger Brenner, Ruhr-Universität Bochum; C-Y. Jean Chan, Purdue University; Catalin Ciuperca, University of California, Riverside; Sara Faridi, Université du Québec à Montréal; Laura Ghezzi, University of Missouri; Russell Goward, Xavier University of Louisiana; Tai Ha, University of Missouri; Wolfgang Hassler, Karl-Franzens Universität Graz/University of Nebraska; Michael Hellus, Universität Leipzig; Abdul Jarrah, New Mexico State University; Graham Leuschke, University of Kansas; Diane Maclagan, Stanford University; Laura Matusevitch, University of California, Berkeley; Uwe Nagel, Universität Paderborn/University of Kentucky; Hidefumi Ohsugi, Rikkyo University; Tim Roemer, Universität Essen; Sindi Sabourin, University of Notre Dame; Sean Sather-Wagstaff, University of Illinois; Hans Schoutens, Ohio State University; Amelia Taylor, Rutgers University; Emanoil Theodorescu, University of Kansas; Adela Vraciu, University of Kansas; Carolyn Yackel, Mercer University.

The following have tentatively agreed to give expository talks and/or lead discussion sessions: Luchezar Avramov, University of Nebraska; Juergen Herzog, Universität Essen; Craig Huneke, University of Kansas; Irena Peeva, Purdue University; Karen Smith, University of Michigan; Roger L. Wiegand, University of Nebraska.

In order to ensure ample time for informal discussions and mathematical interaction, there will be no contributed talks. The total number of research talks will be 30–35. It is expected that some support will be available for those wishing to attend talks and participate in the informal discussions. For further information about the scientific program, contact Roger Wiegand (rwiegand@math.unl.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.

Madison, Wisconsin

University of Wisconsin-Madison

October 12–13, 2002

Meeting #980

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: August 2002
Program first available on AMS website: August 29, 2002
Program issue of electronic *Notices*: October 2002
Issue of *Abstracts*: Volume 23, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

Invited Addresses

Lawrence Ein, University of Illinois at Chicago, *Singularities of pairs and birational geometry.*

Eleny Ionel, University of Wisconsin, *Relations between Gromov-Witten invariants.*

Mikhail Safonov, University of Minnesota, *General properties of solutions to second order elliptic and parabolic equations.*

John M. Sullivan, University of Illinois, Urbana, *Optimal geometry in topology.*

Special Sessions

Arithmetic Algebraic Geometry, **Ken Ono** and **Tonghai Yang**, University of Wisconsin-Madison.

Arrangements of Hyperplanes, **Daniel C. Cohen**, Louisiana State University, **Peter Orlik**, University of Wisconsin-Madison, and **Anne Shepler**, University of California Santa Cruz.

Biological Computation and Learning in Intelligent Systems, **Shun-ichi Amari**, RIKEN, **Amir Assadi**, University of Wisconsin-Madison, and **Tomaso Poggio**, Massachusetts Institute of Technology.

Characters and Representations of Finite Groups, **Martin Isaacs**, University of Wisconsin-Madison, and **Mark Lewis**, Kent State University.

Combinatorics and Special Functions, **Richard Askey** and **Paul Terwilliger**, University of Wisconsin-Madison.

Dynamical Systems, **Sergey Bolotin** and **Paul Rabinowitz**, University of Wisconsin-Madison.

Effectiveness Questions in Model Theory, **Charles McCoy**, **Reed Solomon**, and **Patrick Speissegger**, University of Wisconsin-Madison.

Geometric Methods in Differential Equations, **Gloria Mari Beffa**, University of Wisconsin-Madison, and **Peter Olver**, University of Minnesota.

Group Cohomology and Homotopy Theory, **Alejandro Adem**, University of Wisconsin-Madison, and **Jesper Grodal**, Institute for Advanced Study.

Harmonic Analysis, **Alex Ionescu** and **Andreas Seeger**, University of Wisconsin-Madison.

Hyperbolic Differential Equations and Kinetic Theory, **Shi Jin**, **Marshall Slemrod**, and **Athanassios Tzavaras**, University of Wisconsin-Madison.

Lie Algebras and Related Topics, **Georgia Benkart** and **Arun Ram**, University of Wisconsin-Madison.

Lie Groups and Their Representations, **R. Michael Howe**, University of Wisconsin-Eau Claire, and **Gail D. Ratcliff**, East Carolina University.

Optimal Geometry of Curves and Surfaces, **Jason H. Cantarella**, University of Georgia, and **John M. Sullivan**, University of Illinois, Urbana.

Partial Differential Equations and Geometry, **Sigurd Angenent** and **Mikhail Feldman**, University of Wisconsin-Madison.

Probability, **David Griffeath** and **Timo Seppalainen**, University of Wisconsin-Madison.

Ring Theory and Related Topics, **Don Passman**, University of Wisconsin-Madison.

Several Complex Variables, **Pat Ahern**, **Xianghong Gong**, **Alex Nagel**, and **Jean-Pierre Rosay**, University of Wisconsin-Madison.

Salt Lake City, Utah

University of Utah

October 26–27, 2002

Meeting #981

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: September 2002
Program first available on AMS website: September 16, 2002
Program issue of electronic *Notices*: October 2002
Issue of *Abstracts*: Volume 23, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

Invited Addresses

Yakov Eliashberg, Stanford University, *Comparing symplectic and contact topologies.*

Hart F. Smith, University of Washington, Seattle, *The wave equation and harmonic analysis.*

Michael Ward, University of British Columbia, *The dynamics and stability of localized patterns for a reaction-diffusion system.*

Amie Wilkinson, Northwestern University, *Partially hyperbolic dynamics on 3-manifolds.*

Special Sessions

Analytic Number Theory, **Roger Baker**, **Xian-Jin Li**, and **Andrew D. Pollington**, Brigham Young University.

Area-Minimization and Minimal Surfaces, **Michael Dorff**, **Denise Halverson**, and **Gary R. Lowler**, Brigham Young University.

Geometry and Topology, **Mladen Bestvina**, **Michael Kapovich**, and **Grigory Mikhalkin**, University of Utah.

Nonlinear Elliptic Partial Differential Equations, **David A. Hartenstine**, University of Utah, and **Jon T. Jacobsen**, Harvey Mudd College.

Numerical Solutions of Modeling Problems, **Sun Chow**, Brigham Young University, and **Joseph V. Koebbe**, Utah State University.

Recent Trends in Algebraic Geometry, **Aaron J. Bertram**, University of Utah, and **Christopher Derek Hacon**, University of California Riverside.

Representation Theory of Semisimple Lie Groups, **Dragan Milicic** and **Peter Trapa**, University of Utah.

Time Series, Heavy Tails, and Applications, **Davar Khoshnevisan**, University of Utah, and **Piotr Kokozska**, Utah State University.

Orlando, Florida

University of Central Florida

November 9–10, 2002

Meeting #982

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: September 2002
Program first available on AMS website: September 26, 2002
Program issue of electronic *Notices*: November 2002
Issue of *Abstracts*: Volume 23, Issue 4

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: Expired
For abstracts: Expired

Invited Addresses

Steven J. Cox, Rice University, *Decoding the dance of your dendritic spines.*

James Haglund, University of Pennsylvania, *The q,t-Catalan numbers and the space of diagonal harmonics.*

Marius Mitrea, University of Missouri-Columbia, *Elliptic and parabolic boundary problems in Sobolev-Besov spaces on nonsmooth domains.*

Ricardo H. Nochetto, University of Maryland, College Park, *Title to be announced.*

Special Sessions

Algebraic and Enumerative Combinatorics, **James Haglund**, University of Pennsylvania, and **Jeff B. Remmel**, University of California San Diego.

Asymptotics of Integrable Partial Differential Equations, Riemann-Hilbert Problem and Related Topics, **Ken T. R. McLaughlin**, University of North Carolina at Chapel Hill and University of Arizona, and **Alexander Tovbis**, University of Central Florida.

Commutative Algebra, **Heath M. Martin**, University of Central Florida, and **Stephanie A. Fitchett**, Florida Atlantic University.

Computational Mathematics, **Ricardo H. Nochetto**, University of Maryland, and **Bernardo Cockburn**, University of Minnesota.

Computational Methods in Analysis, **George A. Anastassiou**, University of Memphis.

Financial Mathematics, **Craig A. Nolder** and **Alec N. Kercheval**, Florida State University.

Function Spaces, Singular Integrals and Applications to PDEs, **Marius Mitrea** and **Dorina Mitrea**, University of Missouri-Columbia.

Functional and Harmonic Analysis of Wavelets, Frames and Their Applications, **Deguang Han**, University of Central Florida, and **Manos I. Papadakis**, University of Houston.

Graph Theory, **Robert C. Brigham**, University of Central Florida, **Cun-Quan Zhang**, West Virginia University, and **Yue Zhoa**, University of Central Florida.

Homotopy Theory and Geometric Topology, **Alexander N. Dranishnikov**, **James E. Keesling**, and **Yuli B. Rudyak**, University of Florida.

Invariants of Knots and Low-Dimensional Manifolds, **J. Scott Carter**, University of South Alabama, and **Masahico Saito**, University of South Florida.

Mathematical Neuroscience, **Steve J. Cox**, Rice University, and **Richard Bertram**, Florida State University.

Nonlinear Waves, **Min Chen**, Purdue University, and **Roy Choudhury** and **David J. Kaup**, University of Central Florida.

The Likelihood Inferences in Statistics, **Jian-Jian Ren**, University of Central Florida.

Baltimore, Maryland

Baltimore Convention Center

January 15–18, 2003

Meeting #983

Joint Mathematics Meetings, including the 109th Annual Meeting of the AMS, 86th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: October 2002
Program first available on AMS website: November 1, 2002
Program issue of electronic *Notices*: January 2003
Issue of *Abstracts*: Volume 24, 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

Baltimore Program Updates

Joint AMS-MAA Sessions

What It's Like to Serve as an NSF Program Director, Thursday, 1:00 p.m.–2:00 p.m., organized by **Henry A. Warchall**, National Science Foundation. There will be two 15-minute presentations by former DMS program directors Maria Helena Noronha, California State University, Northridge; and Lynne H. Walling, Department of Mathematics, University of Colorado, Boulder, followed by a 30-minute question-and-answer period. Participants will discuss the experience of serving as a program director in the NSF Division of Mathematical Sciences.

The Math Life, Friday, 2:30 p.m.–3:30 p.m. What goes on inside the head of a mathematician? Did *A Beautiful Mind* get it right? *The Math Life* is a 50-minute documentary film funded by the National Science Foundation that gives a window into the people, problems, and process of mathematical thinking and research. Coproduced by filmmakers Wendy Conquest and Bob Drake, and Dartmouth College mathematics/computer science professor Dan Rockmore, *The Math Life* is aimed at a general audience and through animation, interview, and artistic metaphor promises to reveal everything you always wanted to know about mathematics and mathematicians but were afraid to ask.

Other MAA Sessions

History of Mathematics Special Interest Group (HOM-SIGMAA) Business Meeting and Reception, Wednesday, 6:45 p.m.–8:15 p.m., organized by **Amy Shell-Gellasch**, U.S. Military Academy. This meeting will include a discussion of current and future events as well as a report by the Nominating Committee on the election of officers.

Improving the Persistence of Women in Graduate School, Friday, 9:00 a.m.–10:20 a.m., organized by **Ruth G. Favro**, Lawrence Technological University; **Kristen S. Moore**, University of Michigan, Ann Arbor; and **Sarah-Marie Belcastro**, Xavier University. Case studies of women's positive and negative experiences in graduate school will be presented and discussed by a panel of representatives from mathematics departments with a successful history of retention of underrepresented groups. In addition, the panel will discuss factors that influence retention and attrition of women in mathematics Ph.D. programs as well as a general model for the successful apprenticeship of graduate students. Panelists include **Raymond L. Johnson**, University of Maryland, College Park, who will moderate the panel; **Abbe H. Herzig**, Rutgers University; **Ivelisse M. Rubio**, University of Puerto Rico; and **Judy L. Walker**, University of Nebraska. The session is sponsored by the MAA Committee on the Participation of Women and replaces the panel discussion "Can This Graduate Student Be Saved?" on the same day and time.

NCATE and the Mathematics Community, Friday, 2:00 p.m.–3:20 p.m., organized by **Judith L. Covington**, LSU-Shreveport, and **Marilyn L. Hala**, NCTM. The purpose of this session is to get feedback from the mathematics community on the proposed new mathematics guidelines from NCATE (National Council for Accreditation of Teacher Education Programs). We will discuss the new changes and seek feedback from the audience. Panelists include **Francis Fennell**, Western Maryland College; **Judy S. O'Neal**, North Georgia College & State University; and **Connie S. Schrock**, Emporia State University. The panel is sponsored by the MAA Committee on the Mathematics Education of Teachers (COMET) and the National Council of Teachers of Mathematics (NCTM).

Laptops in the Classroom, Friday, 3:30 p.m.–4:50 p.m., organized by **Donald B. Small**, U. S. Military Academy. We investigate how laptop technology works in the classroom and how it doesn't. The panelists, **Joseph G. Ecker**, Rensselaer Polytechnic Institute; **David L. Finn**, Rose-Hulman Institute of Technology; and **Alex J. Heidenberg**, U.S. Military Academy, will analyze their lessons learned, to be followed by general discussion. The panel will be moderated by **Joseph D. Myers**, U.S. Military Academy, and is sponsored by Project INTERMATH.

Other Organizations

The Society for Industrial and Applied Mathematics (SIAM) has scheduled two additional minisymposia: **Mathematics Education** on Wednesday afternoon, organized by **Terry Herdman**, Virginia Polytechnic Institute and State University; and **Hyperbolic Conservation Laws and Related Topics** on Thursday afternoon, organized by **Barbara Lee Keyfitz**, University of Houston; **Marshall Slemrod**, University of Wisconsin; and **Konstantina Trivisa**, University of Maryland, College Park.

Social Events

United States Military Academy Department of Mathematical Sciences Department Reception, Thursday, 6:30 p.m.–9:00 p.m. Former and present faculty and friends will gather for a no-host dinner on Thursday, January 16, 2003. We will meet initially at the main message board at 6:30 p.m. and proceed to a restaurant yet to be determined. If you plan to attend, please respond directly to the POC, LTC Jack Picciuto, by email at aj3178@usma.edu.

Baton Rouge, Louisiana

Louisiana State University

March 14–16, 2003

Meeting #984

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: January 2003
Program first available on AMS website: January 30, 2003
Program issue of electronic *Notices*: March 2003
Issue of *Abstracts*: Volume 24, Issue 2

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: November 26, 2002
For abstracts: January 22, 2003

Special Sessions

Algebraic Number Theory and K-Theory (Code: AMS SS A1), **Jurgen Hurrelbrink** and **Jorge F. Morales**, Louisiana State University, and **Robert Osburn**, McMaster University.

Applied Mathematics and Materials Science (Code: AMS SS B1), **Robert Lipton**, **Stephen Shipman**, **Blaise Bourdin**, and **Yuri Antipov**, Louisiana State University.

Arrangements in Topology and Algebraic Geometry (Code: AMS SS C1), **Daniel C. Cohen**, Louisiana State University, and **Alexander I. Suciu**, Northeastern University.

Asymptotic Analysis and Generalized Functions (Code: AMS SS M1), **Ricardo Estrada** and **Frank Neubrander**, Louisiana State University.

Commutative Ring Theory (Code: AMS SS D1), **James B. Coykendall**, North Dakota State University.

Frames, Wavelets, and Tomography (Code: AMS SS E1), **Gestur Olafsson**, Louisiana State University.

Graphs and Matroids (Code: AMS SS F1), **Bogdan S. Oporowski** and **James G. Oxley**, Louisiana State University.

Induced Representations: Connections to Graphs, Number Theory, Geometry (Code: AMS SS G1), **J. William Hoffman**, **Robert V. Perlis**, and **Neal W. Stoltzfus**, Louisiana State University.

Low Dimensional Topology (Code: AMS SS H1), **Oliver T. Dasbach**, **Patrick M. Gilmer**, and **Richard A. Litherland**, Louisiana State University.

Mathematical Techniques in Musical Analysis (Code: AMS SS J1), **Judith L. Baxter**, University of Illinois at Chicago, and **Robert Peck**, Louisiana State University.

Q-Series in Number Theory and Combinatorics (Code: AMS SS N1), **Mourad E. H. Ismail**, University of South Florida, and **Stephen C. Milne**, The Ohio State University.

Stochastic Analysis and Applications (Code: AMS SS K1), **H.-H. Kuo** and **P. Sundar**, Louisiana State University.

Stochastics, Quantization, and Segal-Bargmann Analysis (Code: AMS SS L1), **Bruce K. Driver**, University of California San Diego, **Brian C. Hall**, University of Notre Dame, and **Jeffrey J. Mitchell**, Baylor University.

Bloomington, Indiana

Indiana University

April 4–6, 2003

Meeting #985

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: February 2003
Program first available on AMS website: February 20, 2003
Program issue of electronic *Notices*: April 2003
Issue of *Abstracts*: Volume 24, Issue 2

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: December 17, 2002
For abstracts: February 11, 2003

Invited Addresses

Daniel J. Allcock, University of Texas, *Title to be announced.*

Brian D. Conrad, University of Michigan, *Title to be announced.*

Robin A. Pemantle, Ohio State University, *Title to be announced.*

Sijue Wu, University of Maryland, *Title to be announced.*

Special Sessions

Applications of Teichmueller Theory to Dynamics and Geometry (Code: AMS SS K1), **Christopher M. Judge** and **Matthias Weber**, Indiana University.

Differential Geometry (Code: AMS SS L1), **Jiri Dadok**, **Bruce Solomon**, and **Ji-Ping Sha**, Indiana University.

Ergodic Theory and Dynamical Systems (Code: AMS SS A1), **Roger L. Jones** and **Ayse A. Sahin**, DePaul University.

Geometric Topology (Code: AMS SS D1), **Paul A. Kirk** and **Charles Livingston**, Indiana University.

Graph Theory (Code: AMS SS Q1), **Tao Jiang**, **Zevi Miller**, and **Dan Pritikin**, Miami University.

Graph and Design Theory (Code: AMS SS N1), **Atif A. Abueida**, University of Dayton, and **Mike Daven**, Mount Saint Mary College.

Harmonic Analysis in the 21st Century (Code: AMS SS E1), **Winston C. Ou** and **Alberto Torchinsky**, Indiana University.

Holomorphic Dynamics (Code: AMS SS B1), **Eric D. Bedford** and **Kevin M. Pilgrim**, Indiana University.

Mathematical and Computational Problems in Fluid Dynamics and Geophysical Fluid Dynamics (Code: AMS SS H1), **Roger Temam** and **Shouhong Wang**, Indiana University.

Operator Algebras and Free Probability (Code: AMS SS J1), **Hari Bercovici**, Indiana University, and **Marius Dadarlat**, Purdue University.

Particle Models and Their Fluid Limits (Code: AMS SS F1), **Robert T. Glassey** and **David C. Hoff**, Indiana University.

Probability (Code: AMS SS G1), **Russell D. Lyons**, Indiana University, and **Robin A. Pemantle**, Ohio State University.

Recent Trend in the Analysis and Computations of Functional Differential Equations (Code: AMS SS M1), **Paul W. Eloe** and **Qin Sheng**, University of Dayton.

Representations of Infinite Dimensional Lie Algebras and Mathematical Physics (Code: AMS SS P1), **Katrina Deane Barron**, University of Notre Dame, and **Rinat Kedem**, University of Illinois, Urbana.

Weak Dependence in Probability and Statistics (Code: AMS SS C1), **Richard C. Bradley** and **Lanh T. Tran**, Indiana University.

New York, New York

Courant Institute

April 12–13, 2003

Meeting #986

Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: February 2003
Program first available on AMS website: February 27, 2003
Program issue of electronic *Notices*: April 2003
Issue of *Abstracts*: Volume 24, Issue 3

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: December 24, 2002
For abstracts: February 18, 2003

Invited Addresses

Matthias Aschenbrenner, University of California Berkeley, *Title to be announced.*

John Etnyre, University of Pennsylvania, *Title to be announced.*

Hans Foellmer, Humboldt University Berlin, *Title to be announced.*

Wilfrid Gangbo, Georgia Institute of Technology, *Title to be announced.*

Special Sessions

Algebraic Geometry, Integrable Systems, and Gauge Theory (Code: AMS SS C1), **Marcos Jardim** and **Eyal Markman**, University of Massachusetts, Amherst.

Algebraic and Topological Combinatorics (Code: AMS SS E1), **Eva-Maria Feichtner**, ETH, Zürich, Switzerland, and **Dmitry N. Kozlov**, University of Bern, Switzerland; and KTH, Stockholm, Sweden.

Analytical and Computational Methods in Electromagnetics (Code: AMS SS G1), **Alexander P. Stone**, University of New Mexico, and **Peter A. McCoy**, U. S. Naval Academy.

Combinatorial and Statistical Group Theory (Code: AMS SS B1), **Alexei Myasnikov** and **Vladimir Shpilrain**, City College, New York.

Galois Module Theory and Hopf Algebras (Code: AMS SS F1), **Daniel R. Replogle**, College of Saint Elizabeth, and **Robert G. Underwood**, Auburn University.

Hopf Algebras and Quantum Groups (Code: AMS SS A1), **M. Susan Montgomery**, University of Southern California, **Earl J. Taft**, Rutgers University, and **Sarah J. Witherspoon**, Amherst College.

The History of Mathematics (Code: AMS SS D1), **Patricia R. Allaire**, Queensborough Community College, CUNY, and **Robert E. Bradley**, Adelphi University.

San Francisco, California

San Francisco State University

May 3–4, 2003

Meeting #987

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: March 2003
Program first available on AMS website: March 20, 2003
Program issue of electronic *Notices*: May 2003
Issue of *Abstracts*: Volume 24, Issue 3

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: January 14, 2003
For abstracts: March 11, 2003

Invited Addresses

Joe P. Buhler, Reed College, *Title to be announced.*

Raymond C. Heitmann, University of Texas at Austin, *Title to be announced.*

Alexei Y. Kitaev, California Institute of Technology, *Title to be announced.*

Arkady Vaintrob, University of Oregon, *Title to be announced.*

Special Sessions

Q-Series and Partitions (Code: AMS SS B1), **Jim Haglund**, University of Pennsylvania, **Stephen C. Milne**, Ohio State University, and **Neville Robbins**, San Francisco State University.

The History of Nineteenth and Twentieth Century Mathematics (Code: AMS SS A1), **Shawnee McMurran**, California State University, San Bernardino, and **James A. Tattersall**, Providence College.

Seville, Spain

June 18–21, 2003

Meeting #988

First Joint International Meeting between the AMS and the Real Sociedad Matematica Española (RSME).
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: To be announced
Program first available on AMS website: Not applicable
Program issue of electronic *Notices*: Not applicable
Issue of *Abstracts*: Not applicable

Deadlines

For organizers: Expired
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Invited Addresses

Xavier Cabre, Universidad Politècnica de Cataluña, Barcelona, *Title to be announced.*

Charles Fefferman, Princeton University, *Title to be announced.*

Michael Hopkins, Massachusetts Institute of Technology, *Title to be announced.*

Ignacio Sols, Universidad Complutense de Madrid, *Title to be announced.*

Luis Vega, Universidad del Pais Vasco, Bilbao, *Title to be announced.*

Efim Zelmanov, Yale University, *Title to be announced.*

Special Sessions

Affine Algebraic Geometry, **Jaime Gutierrez**, University of Cantabria, **Vladimir Shpilrain**, City College of New York, and **Jie-Tai Yu**, University of Hong Kong.

Algebraic Geometry, **Felix Delgado**, Universidad de Valladolid, and **Andrey N. Todorov**, University of California Santa Cruz.

Algebraic Toplogy, **Alejandro Adem**, University of Wisconsin, **J. Aguade**, Universitat Autònoma de Barcelona, and **Eric M. Friedlander**, Northwestern University.

Banach Spaces of Analytic Functions, **Daniel Girela**, University of Malaga, and **Michael Stessin**, SUNY at Albany.

Biomolecular Mathematics, **Thomas J. Head** and **Fernando Guzman**, SUNY at Binghamton, **Mario Perez**, Universidad de Sevilla, and **Carlos Martin-Vide**, Rovira i Virgili University.

Classical and Harmonic Analysis, **Nets Katz**, Washington University, **Carlos Perez**, Universidad de Sevilla, and **Ana Vargas**, Universidad Autònoma de Madrid.

Combinatorics, **Joseph E. Bonin**, George Washington University, and **Marc Noy**, Universitat Politècnica de Catalunya.

Commutative Algebra: Geometric, Homological, Combinatorial and Computational Aspects, **Alberto Corso**, University

of Kentucky, **Philippe Gimenez**, Universidad de Valladolid, and **Santiago Zarzuela**, Universitat de Barcelona.

Computational Methods in Algebra and Analysis, **Eduardo Cattani**, University of Massachusetts, Amherst, and **Francisco Jesus Castro-Jimenez**, Universidad de Sevilla.

Constructive Approximation Theory, **Antonio Duran**, Universidad de Sevilla, and **Edward B. Saff**, Vanderbilt University.

Control and Geometric Mechanics, **Manuel de Leon**, Instituto de Matemáticas y Física Fundamental, **Alberto Ibort**, Universidad Carlos III, and **Francesco Bullo**, University of Illinois, Urbana.

Differential Galois Theory, **Teresa Crespo** and **Zbigniew Hajto**, Universitat de Barcelona, and **Andy R. Magid**, University of Oklahoma.

Differential Structures and Homological Methods in Commutative Algebra and Algebraic Geometry, **Gennady Lyubeznik**, University of Minnesota, and **Luis Narvaez-Macarro**, Universidad de Sevilla.

Discrete and Computational Geometry, **Ferran Hertado**, Universitat Politècnica de Catalunya, and **William Steiger**, Rutgers University.

Dynamical Systems, **George Haller**, Massachusetts Institute of Technology, **Zbigniew H. Nitecki**, Tufts University, **Enrique Ponce**, Universidad de Sevilla, **Tere M. Seara**, Universitat Politècnica de Catalunya, and **Xavier Jarque**, Universitat Autònoma de Barcelona.

Effective Analytic Geometry over Complete Fields, **Luis-Miguel Pardos**, Universidad de Cantabria, and **J. Maurice Rojas**, Texas A&M University.

Geometric Methods in Group Theory, **José Burillo**, Universitat Politècnica de Catalunya, **Jennifer Tayback**, University of Albany, and **Enric Ventura**, Universitat Politècnica de Catalunya.

History of Modern Mathematics—Gauss to Wiles, **Jose Ferreiros**, Universidad de Sevilla, and **David Rowe**, Universität Mainz.

Homological Methods in Banach Space Theory, **Jesus M. F. Castillo**, Universidad de Extremadura, and **N. J. Kalton**, University of Missouri.

Homotopy Algebras, **Pedro Real**, Universidad de Sevilla, **Thomas J. Lada**, North Carolina State University, and **James Stasheff**, University of North Carolina.

Interpolation Theory, Function Spaces and Applications, **Fernando Cobos**, Universidad Complutense de Madrid, and **Pencho Petrushev**, University of South Carolina.

Lorentzian Geometry and Mathematical Relativity, **Luis J. Alias**, Universidad de Murcia, and **Gregory James Galloway**, University of Miami.

Mathematical Aspects of Semiconductor Modeling and Nano-technology, **Irene Martinez Gamba**, University of Texas, Austin, and **Jose Antonio Carrillo**, Universidad de Granada.

Mathematical Fluid Dynamics, **Diego Cordoba**, CSIC, Madrid, and Princeton University, **Susan Friedlander**, University of Illinois, Chicago, and **Marcos Antonio Fontelos**, Universidad Rey Juan Carlos.

Mathematical Methods in Finance and Risk Management, **Santiago Carrillo Menendez**, Universidad Autònoma de Madrid, **Antonio Falcos Montesinos**, Universidad Cardenal Herrera CEU, **Antonio Sanchez-Calle**, Universidad Autònoma de Madrid, and **Luis A. Seco**, University of Toronto at Mississauga.

Moduli Spaces in Geometry and Physics, **Steven B. Bradlow**, University of Illinois, Urbana-Champaign, and **Oscar Garcia-Prada**, Universidad Autònoma de Madrid.

Nonassociative Algebras and Their Applications, **Efim I. Zelmanov**, Yale University, **Santos Gonzalez**, Universidad de Oviedo, and **Alberto Elduque**, Universidad de Zaragoza.

Nonlinear Dispersive Equations, **Gustavo Ponce**, University of California Santa Barbara, and **Luis Vega**, Universidad del Pais Vascos.

Numerical Linear Algebra, **Lothar Reichel**, Kent State University, and **Francisco Marcellan**, University Carlos III de Madrid.

Operator Theory and Spaces of Analytic Functions, **Jose Bonet**, Universidad Politècnica de Valencia, **Pedro Paul**, Universidad de Sevilla, and **Cora S. Sadosky**, Howard University.

PDE Methods in Continuum Mechanics, **Juan L. Vazquez**, Universidad Autònoma de Madrid, and **J. W. Neuberger**, University of North Texas.

Polynomials and Multilinear Analysis in Infinite Dimensions, **Richard M. Aron**, Kent State University, **J. A. Jaramillo** and **Jose G. Llavona**, Universidad Complutense de Madrid, and **Andrew M. Tonge**, Kent State University.

Quantitative Results in Real Algebra and Geometry, **Carlos Andradas** and **Antonio Diaz-Cano**, Universidad Complutense, **Victoria Powers**, Emory University, and **Frank Sottile**, University of Massachusetts, Amherst.

Recent Developments in the Mathematical Theory of Inverse Problems, **Russell Brown**, University of Kentucky, **Alberto Ruiz**, Universidad Autònoma de Madrid, and **Gunther Uhlmann**, University of Washington.

Riemannian Foliations, **Jesus Antonio Alvarez Lopez**, Universidade de Santiago de Compostela, and **Efton L. Park**, Texas Christian University.

Ring Theory and Related Topics, **Jose Gomez-Torrecillas**, University of Granada, **Pedro Antonio Guil Asensio**, University of Murcia, **Sergio R. Lopez-Permouth**, Ohio University, and **Blas Torrecillas**, University of Almeria.

The Mathematics of Electronmicroscopic Imaging, **Jose-Maria Carazo**, Centro Nacional de Biotecnologia-CSIC, and **Gabor T. Herman**, City University of New York.

Variational Problems for Submanifolds, **Frank Morgan**, Williams College, and **Antonio Ros**, Universidad de Granada.

Boulder, Colorado

University of Colorado

October 2–4, 2003

Meeting #989

Joint Central/Western Sections
Associate secretaries: Susan J. Friedlander and Michel L. Lapidus
Announcement issue of *Notices*: August 2003
Program first available on AMS website: August 21, 2003
Program issue of electronic *Notices*: October 2003
Issue of *Abstracts*: Volume 24, Issue 4

Deadlines

For organizers: March 3, 2003
For consideration of contributed papers in Special Sessions: June 6, 2003
For abstracts: August 12, 2003

Invited Addresses

J. Brian Conrey, American Institute of Mathematics, *Title to be announced.*

Giovanni Forni, Northwestern University, *Title to be announced.*

Juha M. Heinonen, University of Michigan, *Title to be announced.*

Joseph D. Lakey, New Mexico State University, *Title to be announced.*

Albert Schwarz, University of California Davis, *Title to be announced.*

Avi Wigderson, Institute for Advanced Study, *Title to be announced* (Erdős Memorial Lecture).

Special Sessions

Algebras, Lattices and Varieties (Code: AMS SS B1), **Keith A. Kearnes**, University of Colorado, Boulder, **Agnes Szendrei**, Bolyai Institute, and **Walter Taylor**, University of Colorado, Boulder.

Binghamton, New York

SUNY-Binghamton

October 11–12, 2003

Meeting #990

Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: August 2003
Program first available on AMS website: August 28, 2003
Program issue of electronic *Notices*: October 2003
Issue of *Abstracts*: Volume 24, Issue 4

Deadlines

For organizers: March 10, 2003
For consideration of contributed papers in Special Sessions: June 24, 2003
For abstracts: August 19, 2003

Invited Addresses

Peter Kuchment, Texas A&M University, *Title to be announced.*

Zlil Sela, Einstein Institute of Mathematics, *Title to be announced.*

Zoltan Szabo, University of Michigan, Ann Arbor, *Title to be announced.*

Jeb F. Willenbring, Yale University, *Title to be announced.*

Special Sessions

Biomolecular Mathematics (Code: AMS SS A1), **Thomas J. Head** and **Dennis G. Pixton**, SUNY at Binghamton, **Mitsunori Ogihara**, University of Rochester, and **Carlos Martin-Vide**, Universitat Rovira i Virgili.

Chapel Hill, North Carolina

University of North Carolina at Chapel Hill

October 24–25, 2003

Meeting #991

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: August 2003
Program first available on AMS website: September 11, 2003
Program issue of electronic *Notices*: October 2003
Issue of *Abstracts*: Volume 24, Issue 4

Deadlines

For organizers: March 24, 2003
For consideration of contributed papers in Special Sessions: July 19, 2003
For abstracts: September 3, 2003

Bangalore, India

India Institute of Science

December 17–20, 2003

Meeting #992

First Joint AMS-India Mathematics Meeting
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: To be announced
Program first available on AMS website: Not applicable
Program issue of electronic *Notices*: Not applicable

Issue of *Abstracts*: Not applicable

Deadlines

For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Special Sessions

Algebraic and Geometric Methods in Multivariable Operator Theory (Code: AMS SS A1), **Ronald G. Douglas**, Texas A&M University, and **Gadadhar Misra**, Indian Statistical Institute.

Phoenix, Arizona

Phoenix Civic Plaza

January 7–10, 2004

Meeting #993

Joint Mathematics Meetings, including the 110th Annual Meeting of the AMS, 87th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2003
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2004
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 2, 2003
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

Tallahassee, Florida

Florida State University

March 12–13, 2004

Southeastern Section
Associate secretary: John L. Bryant
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 13, 2003
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Athens, Ohio

Ohio University

March 26–27, 2004

Meeting #995

Central Section
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 26, 2003
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Lawrenceville, New Jersey

Rider University

April 17–18, 2004

Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: September 17, 2003
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Houston, Texas

University of Houston

May 13–15, 2004

Sixth International Joint Meeting of the AMS and the Sociedad Matemática Mexicana (SMM).
Associate secretary: John L. Bryant
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced

For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Pittsburgh, Pennsylvania

University of Pittsburgh

November 6–7, 2004

Eastern Section
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 7, 2004
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced

Atlanta, Georgia

Atlanta Marriott Marquis and Hyatt Regency Atlanta

January 5–8, 2005

Joint Mathematics Meetings, including the 111th Annual Meeting of the AMS, 88th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association of Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL).
Associate secretary: Lesley M. Sibner
Announcement issue of *Notices*: October 2004
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2005
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 5, 2004
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

Mainz, Germany

June 16–19, 2005

Second Joint AMS-Deutsche Mathematiker-Vereinigung (DMV) Meeting
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

San Antonio, Texas

Henry B. Gonzalez Convention Center

January 12–15, 2006

Joint Mathematics Meetings, including the 112th Annual Meeting of the AMS, 89th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: John L. Bryant
Announcement issue of *Notices*: October 2005
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2006
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 12, 2005
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

New Orleans, Louisiana

New Orleans Marriott and Sheraton New Orleans Hotel

January 4–7, 2007

Joint Mathematics Meetings, including the 113th Annual meeting of the AMS, 90th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the

National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).
Associate secretary: Susan J. Friedlander
Announcement issue of *Notices*: October 2006
Program first available on AMS website: To be announced
Program issue of electronic *Notices*: January 2007
Issue of *Abstracts*: To be announced

Deadlines

For organizers: April 4, 2006
For consideration of contributed papers in Special Sessions: To be announced
For abstracts: To be announced
For summaries of papers to MAA organizers: To be announced

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** at www.ams.org/meetings/.

Meetings:

Important Information regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 175 in the January 2002 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 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 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. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

Conferences: (See http://www.ams.org/meetings/ for the most up-to-date information on these conferences.)

February 13-18, 2003: AAAS Annual Meeting, Denver, Colorado.

June 8 - July 24, 2003: Joint Summer Research Conferences in the Mathematical Sciences, Snowbird, Utah.

Baltimore Joint Meetings Advance Registration/Housing Form

Name _____
(please write name as you would like it to appear on your badge)

Mailing Address _____

_____

Telephone _____ Fax _____

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

AMS	☐
ASA	☐
ASL	☐
AWM	☐
CMS	☐
MAA	☐
NAM	☐
SIAM	☐
YMN	☐

Joint Mathematics Meetings
Baltimore • January 15–18, 2003

☐ **I DO NOT want my program and badge to be mailed to me on 12/13/02.**

Registration Fees

Joint Meetings	**by Dec 19**	**at mtg**	**Subtotal**
☐ Member AMS, ASL, CMS, MAA, SIAM	$190	$247	
☐ Nonmember	$295	$383	
☐ Graduate Student	$ 35	$ 45	
☐ Undergraduate Student	$ 20	$ 26	
☐ High School Student	$ 2	$ 5	
☐ Unemployed	$ 35	$ 45	
☐ Temporarily Employed	$150	$172	
☐ Developing Countries Special Rate	$ 35	$ 45	
☐ Emeritus Member of AMS or MAA	$ 35	$ 45	
☐ High School Teacher	$ 35	$ 45	
☐ Librarian	$ 35	$ 45	
☐ Nonmathematician Guest	$ 5	$ 5	

$ _____

AMS Short Course: *Public Key Cryptography (1/13–1/14)*

☐ Member of AMS or MAA	$ 80	$100	
☐ Nonmember	$110	$130	
☐ Student, Unemployed, Emeritus	$ 35	$ 50	

$ _____

MAA Short Course:
Mathematics in the Ancient World (1/13–1/14)

☐ 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: $90 for Minicourses #1–6 and $60 for Minicourses #7–16

$ _____

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	$220	$300
Employer— Each Additional Table ☐ Regular ☐ Self-scheduled	$ 65	$100
☐ Employer—Posting Only	$ 50	N/A
☐ Applicant (all services)	$ 40	$ 75
☐ Applicant (Winter List & Message Ctr only)	$ 20	$ 20

$ _____

Events with Tickets

MER Banquet (1/16)	$42	#____Regular	#____Veg
NAM Banquet (1/17)	$45	#____Regular	#____Veg
AMS Banquet (1/18)	$45	#____Regular	#____Veg

$ _____

Other Events (no charge)
☐ Graduate Student Reception (1/15)

Total for Registrations and Events $ _____

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)

Registration for the Joint Meetings is not required for the Short Courses, but it is required for the Minicourses and the Employment Center.

Other Information

Mathematical Reviews field of interest # _____

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☐ **Please do not include my name on any promotional mailing list.**

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Deadlines

For résumés/job descriptions printed in the *Winter Lists*, return this form by:	**Oct. 25, 2002**
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For housing reservations, badges/programs mailed:	**Nov. 15, 2002**
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For advance registration for the Joint Meetings, Employment Center, Short Courses, MAA Minicourses, & Tickets:	**Dec. 19, 2002**
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Baltimore 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 12.5% sales tax. **Guarantee requirements: First night deposit by check (add to payment on reverse of form) or a credit card guarantee.**

☐ Deposit enclosed ☐ 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)** _____

Order of choice	Hotel	Single	Double 1 bed	Double 2 beds	Triple 2 beds	Triple 2 beds w/cot	Quad 2 beds	Quad 2 beds w/cot	Suites Starting rates
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	Brookshire Suites (all suites-rates include breakfast)	$129	$129	$129	$144	$169	$159	$184	$129
	Hyatt Regency Baltimore on the Inner Harbor (hqtrs)	$124	$124	$124	$164	$164	$174	$174	$450
	Student	$114	$114	$114	$154	$154	$164	$164	N/A
	Renaissance Harborplace Hotel	$124	$124	$124	$147	$147	$147	$147	$328
	Student	$113	$113	$113	$136	$136	$136	$136	N/A
	Baltimore Marriott Inner Harbor	$124	$134	$134	$154	$154	$174	$174	$189
	Student	$99	$105	$105	$125	$125	$145	$145	N/A
	Sheraton Inner Harbor	$122	$122	$122	$142	$162	$162	$182	$450
	Student	$110	$110	$110	$130	$150	$150	$170	N/A
	Holiday Inn Inner Harbor	$115	$123	$123	$123	$138	$123	$138	N/A
	Student	$89	$89	$89	$89	$104	$89	$104	N/A
	Wyndham Baltimore Inner Harbor	$114	$124	$124	$144	$156	$164	$176	$214
	Student	$91	$101	$101	$121	$133	$141	$153	N/A
	Radisson Plaza Lord Baltimore	$113	$113	$113	$133	$153	$153	$173	$175
	Student	$90	$90	$90	$110	$130	$130	$150	N/A
	Days Inn Inner Harbor	$109	$119	$119	$119	$129	$119	$129	N/A
	Student	$87	$95	$95	$95	$105	$95	$105	N/A

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☐ Other requests: _____

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☐ I plan to share a room with _____, who is making the reservations.

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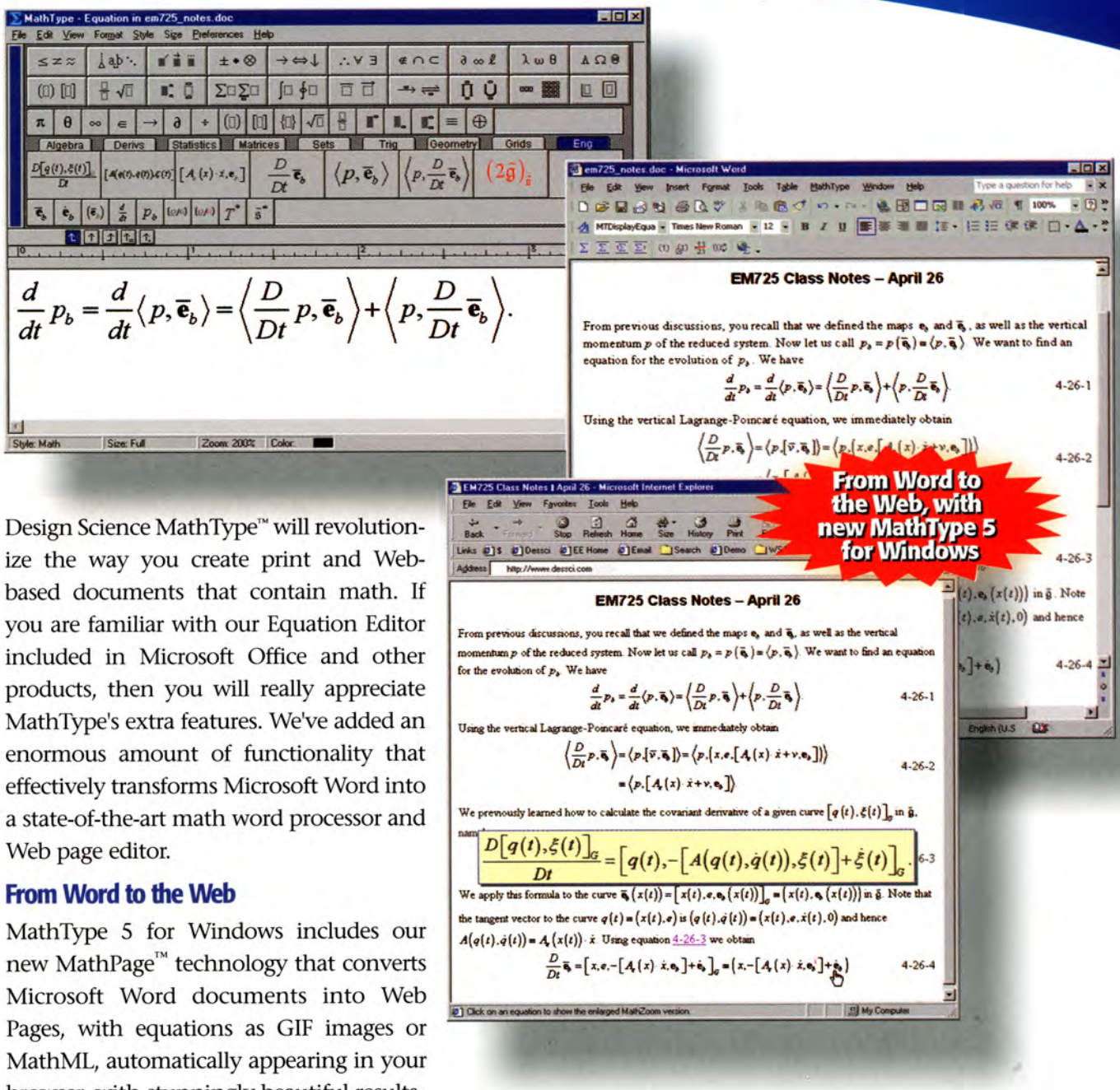

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BURKARD POLSTER, Monash University, Melbourne, Australia

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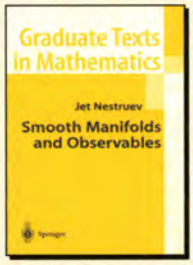

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