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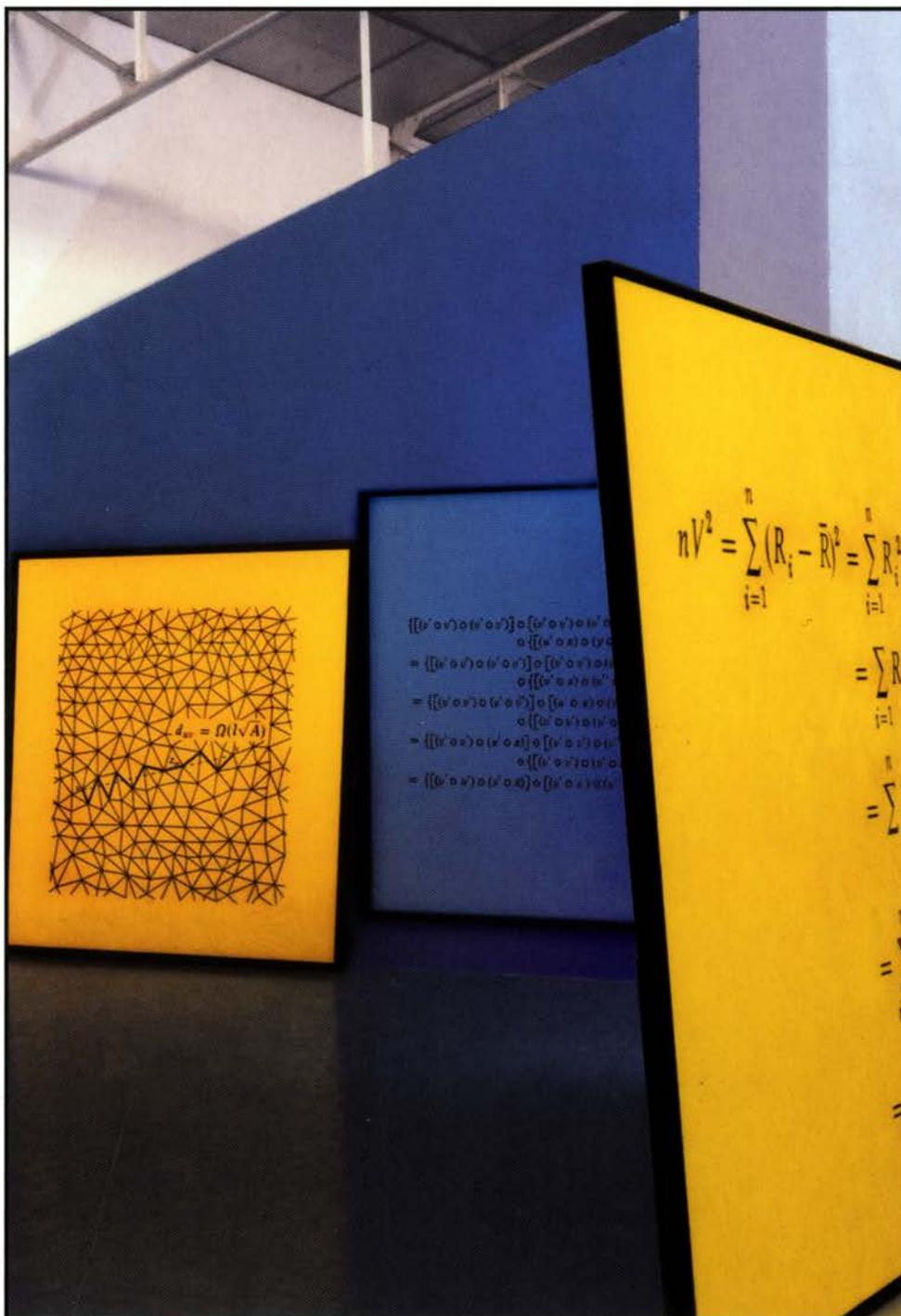
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June/July 2002

Volume 49, Number 6

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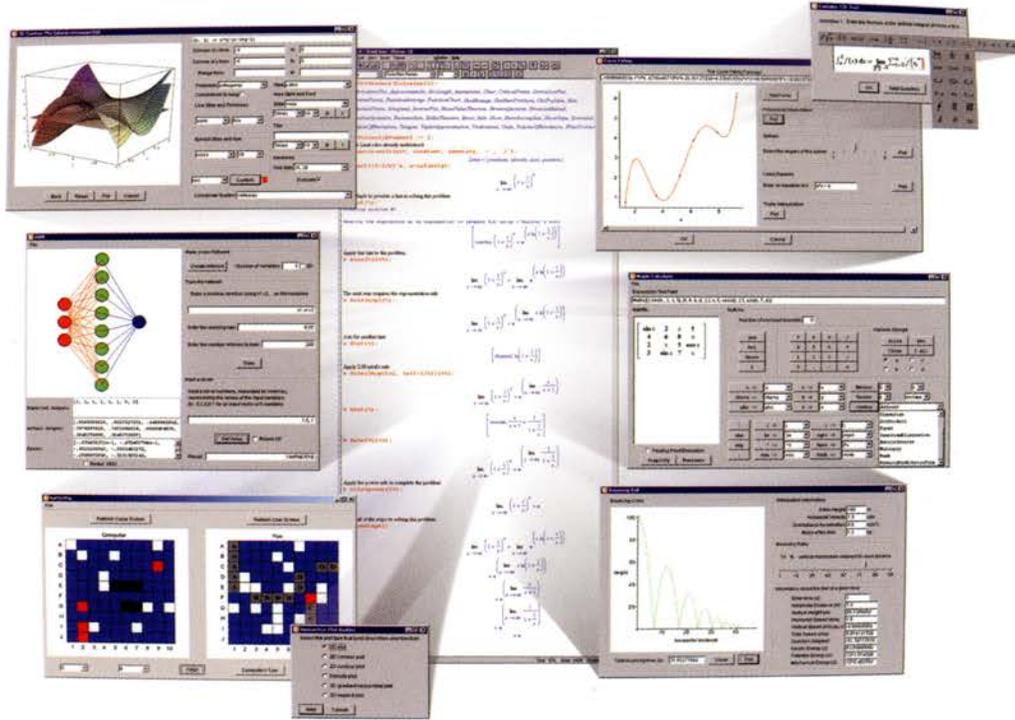
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Applied mathematics (see page 646)

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Recently Published in the Graduate Studies in Mathematics Series

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Jim Agler, *University of California at San Diego*, and John E. McCarthy, *Washington University, St. Louis, MO*

The book begins with a rigorous development of the theory of reproducing kernel Hilbert spaces. The authors then discuss the Pick problem of finding the function of smallest H^∞ norm that has specified values at a finite number of points in the disk. Their viewpoint is to consider H^∞ as the multiplier algebra of the Hardy space and to use Hilbert space techniques to solve the problem. This approach generalizes to a wide collection of spaces. The book includes developments of all the theory that is needed, including operator model theory, the Arveson extension theorem, and the hereditary functional calculus.

Graduate Studies in Mathematics, Volume 44; 2002; 308 pages; Hardcover; ISBN 0-8218-2898-3; List \$49; All AMS members \$39; Order code GSM/44NT267

Classical and Quantum Computation

A. Yu. Kitaev, *California Institute of Technology, Pasadena*, and A. H. Shen and M. N. Vyalyi, *Independent University of Moscow, Russia*

In this concise text, the authors provide solid foundations to the theory—in particular, a careful analysis of the quantum circuit model—and cover selected topics in depth. Some of the results have not appeared elsewhere while others improve on existing works. In less than 300 pages, the authors set forth a solid foundation to the theory, including results that have not appeared elsewhere and improvements on existing works.

The book is complete with problems, solutions, and an appendix summarizing the necessary results from number theory. It is available in both hardcover and softcover editions.

Hardcover:

Graduate Studies in Mathematics, Volume 47; 2002; 257 pages; ISBN 0-8218-2161-X; List \$59; All AMS members \$47; Order code GSM/47NT267

Softcover:

Graduate Studies in Mathematics, Volume 47; 2002; ISBN 0-8218-3229-8; List \$36; All AMS members \$29; Order code GSM/47.SNT267

Introduction to the Theory of Random Processes

N. V. Krylov, *University of Minnesota, Minneapolis*

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With more than 100 problems included, the book can serve as a text for an introductory course on stochastic processes or for independent study.

Graduate Studies in Mathematics, Volume 43; 2002; 230 pages; Hardcover; ISBN 0-8218-2985-8; List \$35; All AMS members \$28; Order code GSM/43NT267

An Introduction to Measure and Integration Second Edition

Inder K. Rana, *Indian Institute of Technology, Powai, Mumbai*

From reviews for the First Edition:

The conversational tone and helpful insights make this a useful introduction to the topic ... The material is presented with generous details and helpful examples at a level suitable for an introductory course or for self-study.

—Zentralblatt MATH

A special feature [of the book] is the extensive historical and motivational discussion ... At every step, whenever a new concept is introduced, the author takes pains to explain how the concept can be seen to arise naturally ... The text can be used for either a one-semester or a one-year course at M.Sc. level ... The book is clearly a labor of love. The exuberance of detail, the wealth of examples and the evident delight in discussing variations and counter examples, all attest to that ... All in all, the book is highly recommended to serious and demanding students.

—Resonance

Integration is one of the two cornerstones of analysis. Since the fundamental work of Lebesgue, integration has been interpreted in terms of measure theory. This introductory text starts with the historical development of the notion of the integral and a review of the Riemann integral. From here, the reader is naturally led to the consideration of the Lebesgue integral, where abstract integration is developed via measure theory. The book is written in an informal style to make the subject matter easily accessible. Concepts are developed with the help of motivating examples, probing questions, and many exercises.

The AMS maintains exclusive distribution rights for this edition in North America and nonexclusive distribution rights worldwide, excluding India, Pakistan, Bangladesh, Nepal, Bhutan, Sikkim, and Sri Lanka.

Graduate Studies in Mathematics, Volume 45; 2002; approximately 456 pages; Hardcover; ISBN 0-8218-2974-2; List \$59; All AMS members \$47; Order code GSM/45NT267

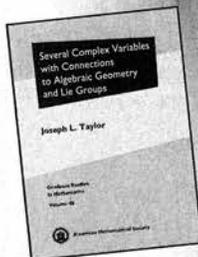
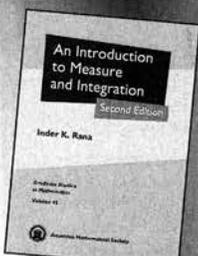
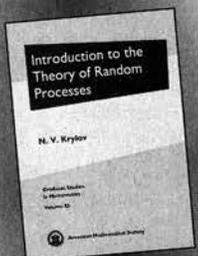
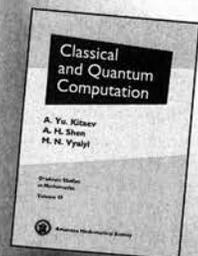
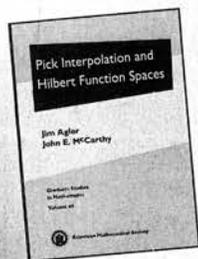
Several Complex Variables with Connections to Algebraic Geometry and Lie Groups

Joseph L. Taylor, *University of Utah, Salt Lake City*

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Of particular interest are the last three chapters, which are devoted to applications of the preceding material to the study of the structure theory and representation theory of complex semisimple Lie groups. There are numerous examples and exercises in each chapter. This modern treatment of a classic point of view would be an excellent text, as well as a useful reference for the expert.

Graduate Studies in Mathematics, Volume 46; 2002; 507 pages; Hardcover; ISBN 0-8218-3178-X; List \$74; All AMS members \$59; Order code GSM/46NT267



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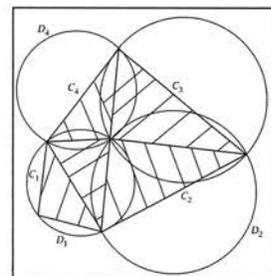
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Theft of Words, Theft of Ideas

Plagiarism has become front-page news in the United States. The two most prominent cases have centered on the historians Stephen Ambrose and Doris Kearns Goodwin, who were accused of copying, without proper attribution, passages from writings by other people. Another recent case, which received less publicity but which is closer to home for mathematicians, concerns the book *Mathematical Mountaintops*, by John L. Casti, a mathematician and author of several popularizations of mathematics. Oxford University Press (OUP) published the book in October 2001. Mathematics journalist Barry Cipra was reading the book in preparation to review it when he noticed similarities to things he himself had written. Some additional digging revealed that many passages in *Mathematical Mountaintops* are nearly identical to passages in works by about fifteen authors (including me). The AMS and the Society for Industrial and Applied Mathematics, which published some of the works involved, complained to OUP on behalf of all the wronged authors. In March 2002 OUP recalled the book. Casti sent to each affected author an apology in which he admitted to “a glaring lapse of professional ethics” and an “outrageous error of judgment.”

The cases of Ambrose, Casti, and Goodwin are examples of plagiarism of words, in which an author copies sentences or paragraphs from someone else's writing, perhaps with a few superficial changes. I would argue that this kind of plagiarism is not a big problem in mathematics. For one thing, what might at first glance look like plagiarism of words may simply reflect the strictures under which mathematicians labor in rendering precise ideas into words. As Edward Rothstein put it in an editorial about the Casti affair (“Plagiarism that Doesn't Add Up,” *New York Times*, March 9, 2002), “in mathematics a theorem will often allow little paraphrase.” In how many ways, he asks, can one refer to something like “an elliptic curve that violates the Taniyama-Shimura-Weil conjecture”?

Nevertheless, plagiarism of words does occur in mathematics; I know of a case in which a mathematician was reading through a paper by someone else and realized that many of his own carefully crafted sentences had been copied without change from a paper he had written. Though odious, this kind of plagiarism does not seriously affect the field of mathematics. That a mathematician would resort to this kind of copying reveals a lack of independent understanding of what he or she is writing about. And in mathematics, unless one understands things for one's self, one does not get very far.

Another example: A paper written by two well known mathematicians had been accepted for publication when another colleague familiar with that paper received a manuscript to referee. This manuscript, bearing the names of two mathematicians at an obscure university, was

word-for-word exactly the same as the original paper; only the authors' names and one sentence in the introduction had been changed. The journal followed the referee's recommendation to reject the manuscript. Given that there are close to 700 mathematics journals worldwide, it is possible that the bogus authors eventually got the paper published under their names. But again, it seems unlikely that those who would attempt such a scam would ever have much influence in the field.

Ideas are the stock in trade of mathematics, and it is when ideas are stolen that true theft has occurred. Plagiarism of ideas is much more pernicious in mathematics than plagiarism of words. A true story: Student A finishes an outstanding doctoral thesis in mathematics at a top university. He is more than willing to talk about his results, and during a visit at another university he spends several hours explaining them to B. Some months later, when A submits his thesis work to a journal, he finds out that B and C have submitted the same results in a paper of their own. Those who know the parties involved are sure that B and C stole A's ideas. But unlike when words are stolen, it is much harder to produce airtight evidence of theft of ideas. The papers end up appearing side by side in the same issue of the journal.

The AMS has a set of Ethical Guidelines (reprinted in this issue, pages 706–707), and the AMS Committee on Professional Ethics is sometimes called upon to examine individual cases. But because plagiarism in mathematics rarely becomes public, it is very difficult to gauge how common these problems are. Much more common are the smaller questions of ethical behavior in writing that confront mathematicians every day. What level of detail is appropriate when giving credit? Sometimes a casual remark in the department tea room can lead to new insights. Should such a remark be acknowledged? In what cases does it suffice to credit only published works and not private conversations? More questions arise in choosing which references to cite. If D publishes a great new theorem and E publishes a tiny generalization, should F in a later paper using D's theorem refer to D, to E, or to both D and E? When $E=F$, it may be tempting for E to refer to only his or her own earlier paper.

Depending on the context in which plagiarism occurs, the theft of words and the theft of ideas can be equally wrong and harmful. Mathematicians like to think their own field is above such things—and usually it is. A public accounting of plagiarism cases in mathematics would be counterproductive. But some individualized steps—such as talking frankly with one's graduate students about ethical behavior in writing—might help. For it is up to individual mathematicians to ensure that, collectively, they do the right thing.

—Allyn Jackson
Senior Writer and Deputy Editor

Letters to the Editor

All Questions Answered

The March–April issue of *American Scientist* contains Gregory J. Chaitin’s article “Computers, paradoxes, and the foundations of mathematics” [90 (2002), no. 2, 164–71] in which he discusses the impossibility of answering certain questions. Just hours after reading that article, I was grateful to receive the March issue of the *Notices* that contained Knuth’s article “All questions answered”. Thank you for the timely article.

—Jay Kangel
Minneapolis, MN

(Received February 23, 2002)

A Beautiful Mind

After returning from a showing of the film *A Beautiful Mind* (see *AMS Notices*, April 2002) my neighbor said to me, “Now I understand better how your mind works.” My response (paraphrased for brevity) was to say, “I have the same profession as the main character of this movie, not the same disease!”

The stereotype of a “crazy” mathematician can be seen in many fictional presentations of mathematics. (Both the recent novel *Uncle Petros and Goldbach’s Conjecture* and *The Bishop Murder Case* from 1929 explicitly argue that math research frequently causes insanity.) Of course, *A Beautiful Mind* is based on the true story of an important mathematician who suffers from paranoid schizophrenia, and so it cannot be faulted for attempting to convey this aspect of his life. In fact, as Butler’s review explains, this film is seen by many as a successful work of art conveying some aspects of this disease to the audience. However, there is a danger that many audience members who have little experience with real mathematicians will confuse the attempt to present schizophrenia with an attempt to present “the mind of a mathematician”. (In addition to the example of my neighbor mentioned

above, I can also use as evidence a quote overheard at the showing of the movie. At one point during the film when Nash’s life seemed especially unenviable, the person sitting behind me said, “Boy, I’m glad that I’m not a genius!” Note that this implies that the film was about what it is like to be smart, not what it is like to suffer from a mental disorder.)

I know many mathematicians who liked this movie and many who did not. In any case, when discussing it with nonmathematicians, I believe we should make certain that they understand that mathematics does not cause insanity and that mathematicians, as a profession, are as sane as anybody else.

—Alex Kasman
College of Charleston, SC

(Received March 11, 2002)

Editor’s Note: The cover illustration of the February 2002 issue depicted Archimedes’ cattle, and some readers inferred that a main point of the associated article by H. W. Lenstra Jr. was to display a new solution to the cattle problem. This inference is incorrect because, as indicated in the article, the solution of the cattle problem is implicit in the 1880 work of A. Amthor. The significant mathematical developments discussed by Lenstra concern the algorithmic efficiency of methods for solving Pell’s equation.

Readers who desire more information specific to the cattle problem may wish to consult a paper by Ilan Vardi [“Archimedes’ cattle problem”, *American Mathematical Monthly* 105 (1998), no. 4, 305–19], where they will find a lengthy bibliography along with a detailed exposition of an explicit solution of the cattle problem similar to the one presented by Lenstra.

—Harold P. Boas

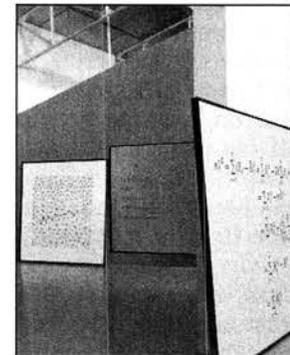
About the Cover

Applied Mathematics

This month’s cover accompanies Karl Hofmann’s review of the art of Bernar Venet (pages 663–668). Laying down mathematical symbols on large canvases is not normally what one means by applying mathematics, certainly. Whereas to a mathematician the symbols have meaning, to Venet they seem to be just surface texture, rather like hieroglyphics to the Greeks. Of course the exposition of mathematics has always involved careful consideration of how it is to be displayed. Venet’s art will be controversial among mathematicians, but it should be valuable to nearly all of them to see its artistic component carried to an extreme. Particularly interesting might be the somewhat aggressive tone of mathematical symbolism writ large. To how much of the population does all mathematics appear so fearsome?

The images on the canvases are taken from (left to right) *Planar graph blocking for external searching* by S. Baswana and S. Sen, *Theory of measurement* by J. Pfanzagl, and *Basic probability theory* by R. Ash. The photograph was taken at Venet’s studio in Le Muy, Var, France. All photographs of Venet’s work used in this issue were supplied by Venet himself.

—Bill Casselman
(covers@ams.org)



Singular Surfaces and Meromorphic Functions

Mario Bonk

In the nineteenth century the theory of analytic functions grew into a major field of mathematical research. Mostly, mathematicians were interested in properties of specific classes of analytic functions such as elliptic functions. It was relatively late that general analytic functions became the focus of investigation. One of the early results in this respect is Picard's famous theorem of 1879, sometimes called "Picard's little theorem": *Every nonconstant meromorphic function in the complex plane \mathbb{C} attains every value with at most two exceptions.*

Two exceptional values can really occur, as the exponential function shows; it omits 0 and ∞ . Picard's theorem can easily be proved by resorting to a holomorphic universal covering map λ from the unit disk \mathbb{D} onto the Riemann sphere $\hat{\mathbb{C}}$ punctured at 0, 1, and ∞ . Namely, if a meromorphic function f omits three distinct values $a, b, c \in \hat{\mathbb{C}}$, then after composing f with a Möbius transformation, we may assume that $\{a, b, c\} = \{0, 1, \infty\}$. Then the map f has a holomorphic lift $\tilde{f}: \mathbb{C} \rightarrow \mathbb{D}$ such that $f = \lambda \circ \tilde{f}$. Now \tilde{f} maps into the unit disk and is thus a bounded analytic function. According to Liouville's theorem the function \tilde{f} , and hence also f , is constant, proving the claim.

Mario Bonk is professor of mathematics at the University of Michigan, Ann Arbor. His e-mail address is mbonk@math.lsa.umich.edu.

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Of course, Picard could not invoke these by now standard facts from the theory of covering spaces that ensure the existence of λ and the lift \tilde{f} . But at the time the function λ was explicitly known from the theory of elliptic modular functions. Picard defined \tilde{f} locally as $\lambda^{-1} \circ f$ and then noted that there are no obstructions to analytic continuation of this analytic element along any path in the plane. Since the plane is simply connected, analytic continuation of \tilde{f} along two paths with the same end points will lead to the same analytic element. In this way, we can define a single-valued holomorphic function \tilde{f} on the entire complex plane.

According to a remark by Littlewood, this theorem and its proof could have been the shortest Ph.D. thesis in mathematics conceivable. Picard's theorem is a striking instance of a result that leaves one unsatisfied, because its short proof does not reveal the deeper reasons behind the statement. Indeed, after its discovery Picard's theorem stood in isolation for almost two decades. It was only in the late 1890s that the result was put into a broader context by work of E. Borel and J. Hadamard. This development culminated in the 1920s with R. Nevanlinna's value distribution theory for meromorphic functions, which provides far-reaching generalizations of Picard's theorem.

An important intermediate step in these investigations was the desire to obtain an *elementary* proof of Picard's theorem. Here "elementary" means avoiding the use of the elliptic modular function λ . After several such proofs had been given, in 1924 A. Bloch based his proof of Picard's theorem on a fundamental covering property of holomorphic

functions that had not been noticed before [3]: *Every holomorphic function f in the unit disk \mathbb{D} normalized by $|f'(0)| = 1$ univalently covers a disk of radius c_0 , where $c_0 > 0$ is a numerical constant independent of f .*

Here we say that a disk (or a more general region) D is univalently covered by f , if there exists a subregion $U \subset \mathbb{D}$ such that the restriction $f|U$ is a one-to-one conformal map of U onto D . In other words, D is univalently covered if we can find a holomorphic branch of the inverse function f^{-1} defined on all of D .

Bloch's theorem says in particular that the image $f(\mathbb{D})$ of every holomorphic function f in \mathbb{D} contains a disk of a fixed size given that $|f'(0)| = 1$. The best constant c_0 in Bloch's theorem (more precisely, the supremum of all constants c_0) is now called Bloch's constant B . Its precise value is still not known, but one has the estimates

$$.433 < B < .472$$

(see [8] for the most recent developments). An immediate corollary of Bloch's theorem is the following theorem of G. Valiron: *A nonconstant entire function univalently covers arbitrarily large disks.* It seems that this result was first stated explicitly by Bloch, who extracted it from work of Valiron.

In order to derive Picard's theorem from Valiron's theorem, let us assume, as we may, that a meromorphic function f in the plane omits the values $-1, 1, \infty$ from its range. Now one can use f to form other functions with an even larger set of omitted values. For example, just as in Picard's proof, the branches of $\arccos(f)$ lead to holomorphic functions in \mathbb{C} . Let $g = \frac{1}{\pi} \arccos(f)$ for one such branch. Then g is holomorphic and omits all the integers, in particular $-1, 1, \infty$. Hence we can repeat this procedure once more and form $h = \arccos(g)$. This will lead to an entire function omitting the values

$$k\pi \pm i \cosh^{-1}(m), \quad k \in \mathbb{Z}, m \in \mathbb{N}.$$

It is easy to see that these values form a set which does not contain arbitrarily large disks in its complement. Hence h is constant by Valiron's theorem, and so are g and f .

The preceding discussion shows that the value distribution theory of meromorphic functions (as exemplified by Picard's theorem) is connected to their covering properties. The main goal of this article is to present some recent developments in this area.

Covering Properties of Meromorphic Functions

The connection between covering properties and value distribution of analytic functions was systematically explored by L. Ahlfors in the 1930s. He was apparently motivated by Bloch's paper [4] and

set out to put some of Bloch's speculations on a firm basis. Ahlfors's most beautiful result in this respect is his "Five-Islands Theorem": *Let f be a nonconstant meromorphic function in the plane, and let $\Omega_1, \dots, \Omega_5$ be five Jordan regions on the Riemann sphere $\hat{\mathbb{C}}$ with pairwise disjoint closures. Then one of the regions is covered univalently by f .* This theorem is a special case of a more general "Scheibensatz" proved in the paper [2] that earned Ahlfors one of the first two Fields Medals in 1936. A very elegant new proof of the Five-Islands Theorem has recently been found by W. Bergweiler.

An immediate consequence of the Five-Islands Theorem is the following Valiron-type covering theorem for meromorphic functions and the spherical metric [1]: *Every nonconstant meromorphic function in the plane univalently covers spherical disks of radii arbitrarily close to $\pi/4 = 45^\circ$.*

Here we metrically identify the Riemann sphere $\hat{\mathbb{C}}$ with the unit sphere in \mathbb{R}^3 and use the intrinsic spherical metric to measure distances. So for example, a hemisphere can be considered as a disk of radius $\pi/2 = 90^\circ$. In the usual model $\hat{\mathbb{C}} = \mathbb{C} \cup \{\infty\}$, the spherical metric is given by the length element

$$\frac{2|dz|}{1+|z|^2}.$$

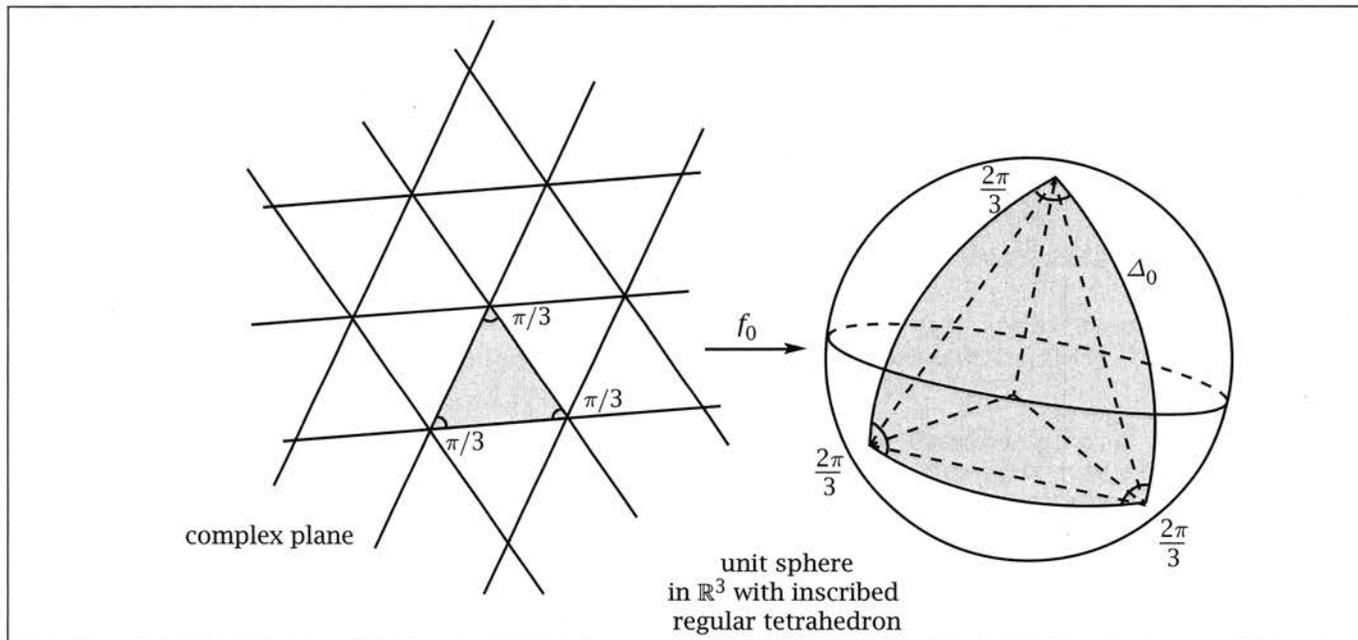
In order to derive the above covering property from the Five-Islands Theorem, choose five spherical disks of equal size as the regions Ω_i . Note that one can find four disjoint open disks of radius 45° with centers on a great circle, say the equator. Then there is space for another open disk with radius 45° disjoint from the others, if we center it at the north pole. Actually, there would even be space for a sixth such disk centered at the south pole, but this extra space cannot be used to increase the radii of the first five disks while keeping them disjoint. The five disks will touch at boundary points. In order to apply the Five-Islands Theorem, where we require *disjoint closures* of the regions, we shrink the radii of the disks by an arbitrarily small amount $\epsilon > 0$, and the result follows.

The covering theorem for meromorphic functions seems to be of a more fundamental nature than Bloch's covering theorem, because a fixed sized spherical disk is covered by every nonconstant meromorphic function independent of any normalization for the derivative of the function.

The precise value of Bloch's constant is not known. In contrast, A. Eremenko and the author recently proved the following sharp constant result [5].

Theorem 1. *Every nonconstant meromorphic function in the complex plane univalently covers spherical disks of radii arbitrarily close to*

$$\arctan(\sqrt{8}) \approx 70^\circ 32'.$$



The map f_0 maps an equilateral Euclidean triangle onto an equilateral spherical triangle with angles $2\pi/3$. The triangle Δ_0 is the projection of a face of a regular tetrahedron inscribed in the unit sphere.

The number $\arctan(\sqrt{8})$ is best possible.

It is a nice exercise to give yet another proof of Picard's theorem by using this statement (take a cube root of a function omitting $\{0, 1, \infty\}$ and use the geometric interpretation of $\arctan(\sqrt{8})$ discussed below). Indeed, one can even derive the Five-Islands Theorem by using some standard machinery of quasiconformal mappings, but we will not go into this. It is an open problem whether the phrase "arbitrarily close" in Theorem 1 is essential, i.e., whether every nonconstant meromorphic function in the complex plane univalently covers a spherical disk of radius $\arctan(\sqrt{8})$.

The following example shows why the number $\arctan(\sqrt{8})$ in Theorem 1 cannot be replaced by any larger number. We consider a conformal map f_0 of an equilateral Euclidean triangle onto an equilateral spherical triangle Δ_0 with angles $2\pi/3$.

The Riemann mapping theorem guarantees that we can choose f_0 so that this map sends vertices to vertices. By repeated application of the Schwarz reflection principle, we can find an analytic continuation of the function f_0 as a meromorphic function in \mathbb{C} . At the vertices of our original Euclidean triangle and at all points corresponding to these vertices under successive reflections, the map f_0 doubles angles. Hence these points are critical points of f_0 , i.e., zeros of the derivative. There are no other critical points. So the critical points of the function f_0 form a regular hexagonal lattice, and its critical values, the images of the critical points, correspond to the four vertices of a regular tetrahedron inscribed in the unit sphere.

If we place one of the vertices of the tetrahedron at the point corresponding to $\infty \in \hat{\mathbb{C}}$ and normalize

the map by $z^2 f_0(z) \rightarrow 1$ as $z \rightarrow 0$, then f_0 becomes a Weierstrass \wp -function with a hexagonal lattice of periods. It satisfies the differential equation

$$(\wp')^2 = 4(\wp - e_1)(\wp - e_2)(\wp - e_3),$$

where the numbers e_j correspond to the three remaining vertices of the tetrahedron.

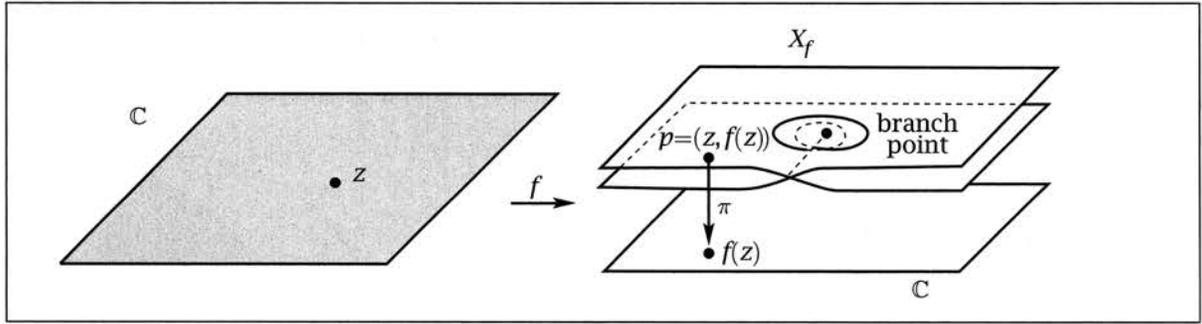
For a spherical disk to be covered univalently by f_0 , it has to avoid the critical values of f_0 , since near these points no branch of the inverse is locally holomorphic. Indeed, these points, the four vertices of our tetrahedron, are the only obstructions. So we obtain a largest spherical disk covered univalently by f_0 if we place its center at the center of Δ_0 and let its radius be equal to the circumscribed radius b_0 of Δ_0 . Computation yields

$$b_0 = \arctan(\sqrt{8}).$$

The remainder of this article will be used to explain some of the ideas that go into the proof of Theorem 1. The main notions here are Riemann surfaces of analytic functions, the classical type problem, and curvature properties of surfaces with singularities. We hope to convey to the reader some of the appeal that the ensuing questions about surface geometry exhibit.

The Problem of Type and Riemann Surfaces of Analytic Functions

The classical uniformization theorem implies that every open simply connected Riemann surface X is biholomorphic either to the unit disk \mathbb{D} or to the complex plane \mathbb{C} . According to these two cases, one says that X has *hyperbolic* or *parabolic conformal*



Schematic drawing of a multisheeted branched covering surface arising from a holomorphic function in the plane.

type. As with all classification theorems, it is important to know criteria for deciding in which class a given object belongs. In the case of the uniformization theorem we are led to the *type problem*: how to decide the type of an open simply connected Riemann surface, if it is given in some explicit geometric way, for example as a branched covering surface over \mathbb{C} or $\hat{\mathbb{C}}$. This question has been extensively studied since the 1930s.

If $f: \Omega \rightarrow \mathbb{C}$ is a holomorphic function defined in some region $\Omega \subset \mathbb{C}$, then we can associate with f the branched covering surface $X_f = \{(z, f(z)) : z \in \Omega\}$ over \mathbb{C} . The way to think of X_f becomes more intuitive if we use the following picture. A point $p = (z, f(z)) \in X_f$ should be thought of as sitting “above” the image point $w = f(z)$ of z . In this way, over each point $w \in \mathbb{C}$ there will be a fiber $f^{-1}(w)$ of several points z corresponding to its preimages under f . These fibers are merged to give the surface X_f which has the same topology as Ω . So if two points z_1 and z_2 are close, then they remain close after they are moved to the location “above” their image points $w_1 = f(z_1)$ and $w_2 = f(z_2)$.

We equip X_f with the metric coming from the pull-back of the Euclidean length element in the w -plane by the projection map $\pi: X_f \rightarrow \mathbb{C}$, $(z, f(z)) \mapsto w = f(z)$. Then π will be a local isometry away from the discrete set of *branch points* of f , i.e., the points corresponding to the critical points of f . As a metric space, X_f is isometric to Ω equipped with the length element

$$|f'(z)| |dz|.$$

The map $z \mapsto (z, f(z))$ is a biholomorphism from Ω onto X_f . If Ω is simply connected, then X_f has the same property and it makes sense to speak of the type of X_f . In this case, the type of X_f is the same as the type of Ω , i.e., it is parabolic if $\Omega = \mathbb{C}$ and hyperbolic otherwise.

In this picture of the Riemann surface X_f as a branched covering surface of \mathbb{C} , it is easy to see when a disk $D \subset \mathbb{C}$ is covered univalently by f . This happens precisely if we can find a *schlicht disk* $U \subset X_f$ on the surface X_f , avoiding the “boundary” and the branch points of X_f , so that the projection

map $\pi|_U$ is a bijection (and hence an isometry) from U onto D .

If $f: \Omega \rightarrow \hat{\mathbb{C}}$ is a meromorphic function, then its Riemann surface Z_f is defined in a similar way. We also equip Z_f with a metric, this time by pulling-back the spherical length element. As a metric space, Z_f is isometric to Ω equipped with the length element

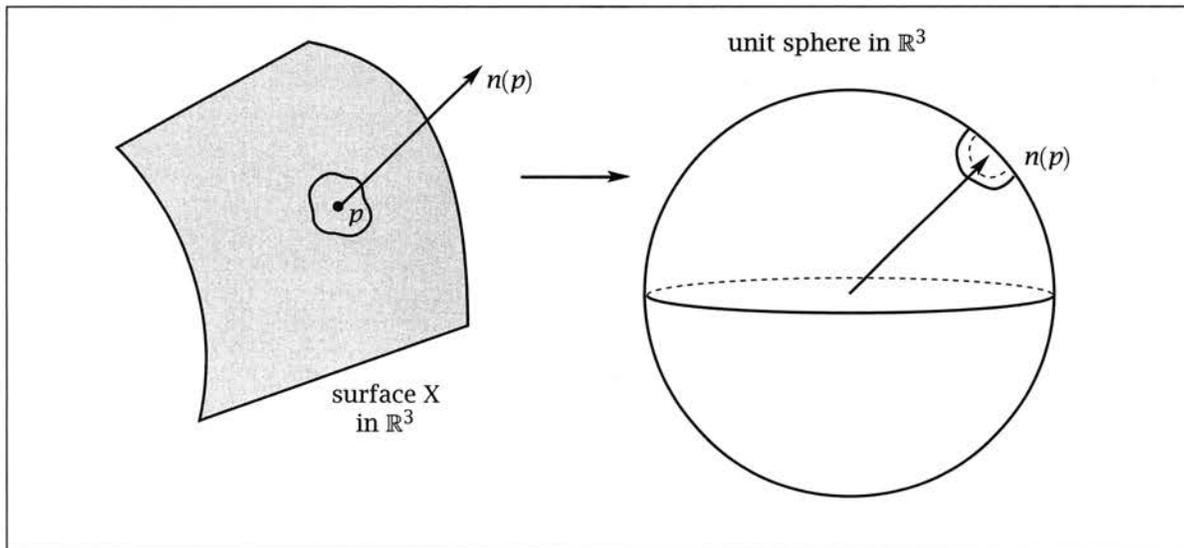
$$\frac{2|f'(z)|}{1 + |f(z)|^2} |dz|.$$

Again the type of Z_f is the same as that of Ω , if Ω is simply connected.

One can derive covering properties of meromorphic functions from type criteria as follows. Suppose we have some geometric condition that forces hyperbolic type of an open simply connected Riemann surface. If f is a meromorphic function in the plane, then its Riemann surface Z_f is of parabolic type and so it cannot satisfy the geometric condition in question. For example, we will see that if the branch points are distributed very “densely” on a surface, then the surface is of hyperbolic type. This implies that the branch points of the Riemann surface of a meromorphic function in the plane cannot be too dense. We will see that ideas like this lead to the proof of Theorem 1.

Polyhedral Surfaces

Let us have a closer look at the geometry of the Riemann surface X_f of a holomorphic function f and at curvature properties of this surface. Away from the set of branch points B_f , the surface is smooth and each point has a neighborhood isometric to a subset of \mathbb{C} . Hence $X_f \setminus B_f$ is “flat”. Suppose z_0 is a critical point of f . Then one can find local biholomorphisms ϕ and ψ mapping z_0 and $w_0 = f(z_0)$ to the origin, respectively, so that the map $g := \psi \circ f \circ \phi^{-1}$ has the form $g(u) = u^k$ near the origin, where $k \in \mathbb{N}$, $k \geq 2$. It follows that f is k -to-1 near z_0 . The number k is called the local degree of f at z_0 . The local geometry of X_f near $p_0 = (z_0, f(z_0))$ can be described as follows: There is a neighborhood of p_0 which is isometric to a truncated Euclidean cone $C_a(\epsilon)$, where $a = k$. For arbitrary $a > 0$ we let $C_a(\epsilon)$ be the



The Gauss map.

disk $D(0, \epsilon)$ in the complex plane equipped with the length element

$$(0.1) \quad |z|^{a-1} |dz|.$$

For $0 < a < 1$ the metric space $C_a(\epsilon)$ really looks like it should, namely like an ice-cream cone. For $a = 1$ we just get a flat Euclidean disk.

In our case, where $a = k$, we can obtain $C_k(\epsilon)$ also as follows. Take k copies of the open Euclidean disk of radius $\epsilon' = \epsilon^k/k$ centered at the origin. Make a slit into each of the disks along the radius $[0, \epsilon']$. These slits produce two “banks” in each disk; call them the upper and lower banks. Now glue the slit disks along the banks in cyclic order, so that the lower bank of a disk is glued to the upper bank of the slit of its successor. In this way, $C_k(\epsilon)$ can be visualized as a spiral staircase (with inevitable self-intersection if we want to realize this space in \mathbb{R}^3 in the way described).

If $a \neq 1$, then the vertex o of $C_a(\epsilon)$ (corresponding to the center of $D(0, \epsilon)$) is a singularity, where the surface ceases to be smooth. Nevertheless, this *conical singularity* is of a benign nature. Surfaces that are flat everywhere except at some isolated conical singularities of the above type are called *Euclidean polyhedral surfaces*. A singularity p of a Euclidean polyhedral surface can be detected from the *total angle* σ at p . This is the total angular variation of the directions issuing from p , if one goes around p once. So for $o \in C_a(\epsilon)$ the total angle σ is equal to $2\pi a$ and equal to 2π at all other points of $C_a(\epsilon)$. In this way the conical singularities of a Euclidean polyhedral surface can be described as the set of points where the total angle differs from 2π .

There is a well-developed theory of surfaces, created by A. D. Aleksandrov and his students in the 1950s, that includes both smooth and polyhedral surfaces and provides us with the usual amenities of

differential geometry such as area, length, and angles. These surfaces are called *surfaces of bounded curvature in the sense of Aleksandrov*, or *Aleksandrov surfaces* for short (see [10] for a survey). For our purposes it suffices to say that an Aleksandrov surface is a surface where the length element can locally be expressed by complex coordinates z in the form

$$(0.2) \quad \rho(z) |dz|,$$

where

$$(0.3) \quad \rho(z) = \exp(u(z))$$

and u is the difference of two subharmonic functions. In addition, we require that the length element (0.2) is locally integrable along analytic curves. Note that, in general, u and ρ are non-smooth functions. Complex coordinates for which the length element on the surface has the local representation (0.2) are called *isothermal coordinates*.

If the length element on a surface can be expressed locally as in (0.1), where $a > 0$, then it is locally integrable along analytic curves, and we have $u(z) = (a - 1) \log |z|$. The function u is subharmonic or superharmonic depending on whether $a \geq 1$ or $a \leq 1$. This shows that Euclidean polyhedral surfaces and, in particular, Riemann surfaces of holomorphic functions are Aleksandrov surfaces.

On each Aleksandrov surface X one can define the *integral curvature*, denoted by μ (the surface is understood), as a measure on Borel sets of the surface.

The integral curvature of a (Borel) subset E of a smooth embedded surface X in \mathbb{R}^3 is the area of the image of E under the Gauss map. The Gauss map on X (for a fixed orientation of the surface) is the map into the unit sphere that associates with every point $p \in X$ the unit normal vector $n(p)$ to

the surface X at p , where $n(p)$ is considered as a point in the unit sphere.

According to Gauss's Theorema Egregium, the integral curvature μ is completely determined by the inner geometry of the surface and does not depend on the particular embedding. Indeed, if we represent the surface locally by isothermal coordinates as in (0.2) and (0.3) which is always possible (and if we disregard the distinction between the set E and its image set under a coordinate map), then μ can be expressed as

$$\mu(E) = - \int_E \Delta \log \rho = - \int_E \Delta u,$$

where integration is with respect to Euclidean area in the z -plane. This formula remains valid on every Aleksandrov surface, if we interpret the Laplacian in a distributional sense.

Let us come back to our case of Euclidean polyhedral surfaces. Since they are Aleksandrov surfaces, it makes sense to attribute an integral curvature $\mu(p) := \mu(\{p\})$ to a conical singularity p . It is equal to $2\pi - \sigma$, where σ is the total angle at p . In the case of a Riemann surface X_f of a holomorphic function we have $\sigma = 2\pi k$, $k \in \mathbb{N}$, and so $\mu(p) = 2\pi(1 - k)$ for $p \in X_f$. Since $k \geq 2$ for every branch point, we see that each branch point carries some definite mass of negative curvature. As X_f is flat everywhere else, the Riemann surface of a holomorphic function is a Euclidean polyhedral surface that is nonpositively curved.

Uniformly Hyperbolic Surfaces

Every Aleksandrov surface carries an essentially unique Riemann surface structure determined by isothermal coordinates. In particular, we can ask for its conformal type if the surface X is open and simply connected.

Suppose E is a continuum in such a surface X . Then X is of parabolic type if and only if for every $\epsilon > 0$ there exists a Borel measurable density $\lambda: X \rightarrow [0, \infty]$ such that

$$\int_X \lambda^2 dA < \epsilon,$$

where integration is with respect to area A on the surface, and

$$\int_\gamma \lambda ds \geq 1$$

for every locally rectifiable path γ connecting E to "infinity", i.e., γ starts at E and eventually leaves every compact subset of the surface. In the last integral, integration is with respect to arc length. If this condition is true for *some* continuum $E \subset X$, then it is actually satisfied for *all* continua $E \subset X$. In plain words, a surface is parabolic if a continuum E can be blocked from infinity at arbitrarily small "cost" and hyperbolic otherwise. The reader

might find it a worthwhile exercise to check the parabolicity of the complex plane by using this criterion.

As we have seen, the Riemann surfaces of holomorphic functions are always nonpositively curved. In view of this, it is natural to start the investigation of the type question for surfaces that resemble these Riemann surfaces, namely nonpositively curved Aleksandrov surfaces. Roughly speaking, a dominant presence of negative curvature tends to make the surface hyperbolic, while the surface is parabolic if the negative curvature is diluted over the surface. So one should expect hyperbolic type if the negative curvature is somehow uniformly distributed, say if every disk of a fixed radius R_0 contains a definite amount of negative curvature. Indeed, the surfaces of this type admit various equivalent characterizations given in Theorem 2 below [6]. It is interesting that this result links several important notions that have found applications in other areas of mathematics. The new concepts in conditions (ii)–(iv) of this theorem will be briefly explained after the statement, but a full understanding of them is not really necessary for the rest of the article.

Theorem 2. *Let X be an open simply connected nonpositively curved Aleksandrov surface. Then the following conditions are equivalent:*

- (i) *There exist $R_0 > 0$ and $\epsilon > 0$ such that every relatively compact open disk $D(a, R_0) \subset X$ has integral curvature less than $-\epsilon$.*
- (ii) *X is hyperbolic in the sense of Gromov.*
- (iii) *X satisfies a linear isoperimetric inequality.*
- (iv) *The (differential) Kobayashi metric on X is uniformly bounded from below.*

Moreover, if X satisfies any of these conditions, then X is necessarily of hyperbolic type.

The Gromov hyperbolicity of a metric space (X, d) means that there exists a constant $\delta \geq 0$ such that for all points $x, y, z, w \in X$

$$(0.4) \quad (x, z)_w \geq \min \{(x, y)_w, (y, z)_w\} - \delta,$$

where $(u, v)_w := (1/2)\{d(u, w) + d(v, w) - d(u, v)\}$. A more intuitive definition can be given for complete surfaces X ; in this case, the metric space X is *geodesic*, which means that every two points $x, y \in X$ can be joined by a *geodesic segment* $[x, y]$, i.e., a curve whose length is equal to the distance of x and y . Then the Gromov hyperbolicity of a geodesic metric space X is equivalent to the existence of a constant $\delta' \geq 0$ such that

$$\text{dist}(u, [x_1, x_3] \cup [x_3, x_2]) \leq \delta',$$

whenever $x_1, x_2, x_3 \in X$ and $u \in [x_1, x_2]$. In other words, geodesic triangles $[x_1, x_2] \cup [x_2, x_3] \cup [x_3, x_1]$ are rather “thin”. The concept of Gromov hyperbolicity encodes one of the basic properties of negatively curved spaces. It was originally utilized in the theory of discrete groups but has recently found applications in other areas (see [9] for general background and [7] for some recent developments).

The surface X satisfies a *linear isoperimetric inequality* if there exists a constant $C > 0$ such that all Jordan regions $\Omega \subset X$ satisfy

$$A(\Omega) \leq C\ell(\partial\Omega),$$

where A stands for area and ℓ for length. Again, a linear isoperimetric inequality is a distinctive feature of negatively curved spaces. Ahlfors [2] was one of the first to recognize the importance of this concept. The equivalence of Gromov hyperbolicity and a linear isoperimetric inequality (if appropriately defined) is true in much greater generality.

Finally, the *Kobayashi metric* is one of several invariant metrics that occur in the theory of complex manifolds. Its uniform boundedness from below means in our case that there exists a constant $C > 0$ such that for all holomorphic maps $f: \mathbb{D} \rightarrow X$ we have $\|f'(z)\| \leq C$ for $z \in \mathbb{D}$, where the norm $\|f'(z)\|$ of the derivative is the ratio at z of the pull-back of the length element on X to the length element

$$\frac{2|dz|}{1-|z|^2}$$

of the Poincaré metric of constant negative curvature -1 on \mathbb{D} .

We call surfaces satisfying the hypotheses and any of the equivalent conditions (i)–(iv) in Theorem 2 *uniformly hyperbolic*. We remark that as a mere type criterion this theorem is a rather weak statement. As one would expect, much better sufficient conditions for hyperbolic type are available.

As an illustration of how to apply Theorem 2, we will derive Valiron’s theorem as an easy corollary. So suppose $f: \mathbb{C} \rightarrow \mathbb{C}$ is a nonconstant holomorphic function. Then the Riemann surface X_f of f is of parabolic type. Suppose that f does not univalently cover arbitrarily large disks. Let us assume that no disk of radius $R_0 > 0$ is covered univalently. So if a disk $D = D(a, R_0)$ is compactly contained in X_f , then D must contain a branch point p_0 of X_f . For otherwise, this disk would be a schlicht disk over the disk $D' = D(\pi(a), R_0) \subset \mathbb{C}$, and so D' would be covered univalently by f . Hence the integral curvature of D is bounded above by the integral curvature at p_0 which is $\leq -2\pi$. Therefore, X_f satisfies condition (i) in Theorem 2, which forces the hyperbolicity of the surface. This is a contradiction.

Two other corollaries of Theorem 2 are worth pointing out. The first one deals with a very explicit

case of polyhedral surfaces which can be obtained as follows: Take a triangulation of the plane by topological triangles, and assign a Euclidean triangle to each triangle of the triangulation. Assume that the lengths of the sides of two Euclidean triangles are the same if the sides correspond to the same edge in the triangulation. Then we can glue the Euclidean triangles together according to the combinatorial pattern of the triangulation and obtain a Euclidean polyhedral surface. We emphasize that the reader should visualize this surface as an abstract metric space not tied to any particular embedding into a Euclidean space. Theorem 2 now gives a sufficient condition for a surface of this type to be uniformly hyperbolic.

Corollary 1. *Let X be a Euclidean polyhedral surface homeomorphic to the plane which is equipped with a triangulation T . Suppose that each triangle $\Delta \in T$ is isometric to a Euclidean triangle and that there exist constants $\epsilon, C > 0$ such that:*

- (i) $\text{diam}(\Delta) \leq C$ for each triangle $\Delta \in T$.
- (ii) *The total angle at each vertex of T is $\geq 2\pi + \epsilon$.*

Then X is uniformly hyperbolic (and hence of hyperbolic type).

A holomorphic function $f: \mathbb{D} \rightarrow \mathbb{C}$ is called a *Bloch function* if there exists a constant $C \geq 0$ such that

$$|f'(z)| \leq \frac{C}{1-|z|^2} \text{ for } z \in \mathbb{D}.$$

In other words, f is Bloch if it is a holomorphic Lipschitz map from the unit disk equipped with the Poincaré metric into the plane equipped with the Euclidean metric. Bloch functions were first considered in connection with Bloch’s constant B defined above. They play an important role in the study of the boundary behavior of conformal maps.

Corollary 2. *Suppose $f: \mathbb{D} \rightarrow \mathbb{C}$ is holomorphic. Then f is a Bloch function if and only if its Riemann surface X_f is Gromov hyperbolic.*

Spherical Polyhedral Surfaces

In the previous section we have seen that Theorem 2 implies Valiron’s theorem. This is an example of how results on surface geometry can be used to obtain results on covering properties of holomorphic functions.

In order to prove Theorem 1, which is about *meromorphic* functions one has to consider surfaces with polyhedral metric, but in this case the surfaces will be piecewise spherical instead of piecewise Euclidean.

A *spherical polyhedral surface* Z is an Aleksandrov surface with intrinsic metric so that each point has a neighborhood isometric to a truncated

spherical cone, i.e., to the (Euclidean) disk $D(0, \epsilon)$ equipped with the length element

$$\frac{2a|z|^{a-1}|dz|}{1+|z|^{2a}}.$$

If $a = 1$, a truncated cone is isometric to a spherical cap; for $a = k \in \mathbb{N}$, one can obtain the space as in the Euclidean case by gluing together k slit spherical caps.

Apart from isolated points on Z we have $a = 1$. Near these regular points the local geometry coincides with the geometry on the unit sphere; in particular, the integral curvature of a set on the surface not containing any singularities is equal to the area of the set. At the singular points where $a \neq 1$, the total angle is $2\pi a$, and so the integral curvature has a Dirac mass $2\pi(1 - a)$.

Now suppose that Z_f is the Riemann surface of a meromorphic function f . Then Z_f is a spherical polyhedral surface. The singular points of this surface are its branch points and correspond to the critical points of f . If the order of the critical point is $k \in \mathbb{N}$, $k \geq 2$, then $a = k$. In particular, each critical point of order k of f gives rise to a singular point carrying negative curvature of mass $2\pi(1 - k) \leq -2\pi$. So the negative curvature of the surface Z_f is sitting in the branch points, and the other parts of the surface contribute to the positive curvature according to their areas.

The following theorem is analogous to Corollary 1.

Theorem 3. *Let Z be a spherical polyhedral surface homeomorphic to the plane which is equipped with a triangulation T . Suppose that each triangle $\Delta \in T$ is isometric to a spherical triangle and that there exists a constant $\epsilon > 0$ such that:*

- (i) *The circumscribed radius of each triangle Δ of T is $\leq \arctan(\sqrt{8}) - \epsilon$.*
- (ii) *The total angle at each vertex of T is $\geq 4\pi$.*

Then Z is of hyperbolic type.

Let us give a heuristic argument that explains the occurrence of the number $\arctan(\sqrt{8})$ in this theorem. Indeed, as we remarked above, this number is the circumscribed radius of an equilateral spherical triangle Δ_0 with all angles equal to $2\pi/3$. It is easy to believe and not hard to see that this triangle has largest area among all spherical triangles with circumscribed radius at most $\arctan(\sqrt{8})$. Since for our surface Z the positive part of the integral curvature of any set is equal to its area, each triangle in the triangulation T carries total positive curvature at most

$$A(\Delta) \leq A(\Delta_0) = \pi.$$

Let α, β, γ be the angles at the vertices of Δ . Then

$$A(\Delta) = \alpha + \beta + \gamma - \pi \leq \pi,$$

and so

$$\alpha + \beta + \gamma \leq 2\pi.$$

Now consider the negative curvature that one should attribute to the triangle Δ . The negative curvature sits in the vertices of the triangulation. We know that at each vertex v we have curvature $\mu(v) = 2\pi - \sigma$, where σ is the total angle at v . In our case $\sigma \geq 4\pi$, and so we have for the negative part of the curvature

$$(0.5) \quad \mu^-(v) = -\mu(v) \geq \sigma/2.$$

Now let us “distribute” this curvature at v to the triangles in T which have v as a vertex. One way to do this is to let each triangle have a share of the curvature at v proportional to the angle of the triangle at this vertex. Then according to (0.5), each triangle will acquire negative curvature μ^- at least half as large as the sum of its angles. So the total curvature balance for Δ is

$$\begin{aligned} \mu(\Delta) &\leq -\frac{1}{2}(\alpha + \beta + \gamma) + A(\Delta) \\ &= \frac{1}{2}(\alpha + \beta + \gamma) - \pi \leq 0. \end{aligned}$$

This means that the negative curvature on Z at least compensates for the positive curvature. The additional ϵ in the theorem forces the area of the triangles to be a definite amount smaller than the area of Δ_0 . This tips the curvature balance in favor of the negative curvature, and we may have reason to expect hyperbolicity of our surface as Theorem 3 claims.

Is there an analog of Theorem 2 for spherical polyhedral surfaces? The answer is no. Indeed, there exist spherical polyhedral surfaces Z such that every disk of some fixed radius R_0 carries some definite negative curvature $\leq -\epsilon$, but the surface is still of parabolic type. As was pointed out by O. Schramm, an example of such a surface can be obtained as follows: Take a square grid in the plane. For each square let there be a corresponding hemisphere with four equally spaced points on its boundary. These points decompose the boundary of the hemisphere into four arcs of equal length corresponding to the sides of the square. Now glue the hemispheres according to the incidence pattern of the squares. We obtain a spherical polyhedral surface Z which happens to be isometric to the Riemann surface of the Weierstrass \wp -function satisfying the differential equation

$$(\wp')^2 = 4\wp(\wp^2 - 1).$$

In particular, the surface is of parabolic type. We leave it as an exercise for the reader to find explicit numbers $R_0 > 0$ and $\epsilon > 0$ with the required properties.

It seems that in order to get a hyperbolicity criterion for a spherical polyhedral surface one has to impose a very tight control of the negative curvature over the positive curvature.

It is a natural question whether Theorem 3 holds for other appropriate values in conditions (i) and (ii): Suppose X is as in Theorem 3 and suppose that the total angle at each vertex is at least $2\pi q$ with $q \in (1, 3]$ and that the supremum of the circumscribed radii of the triangles is at most

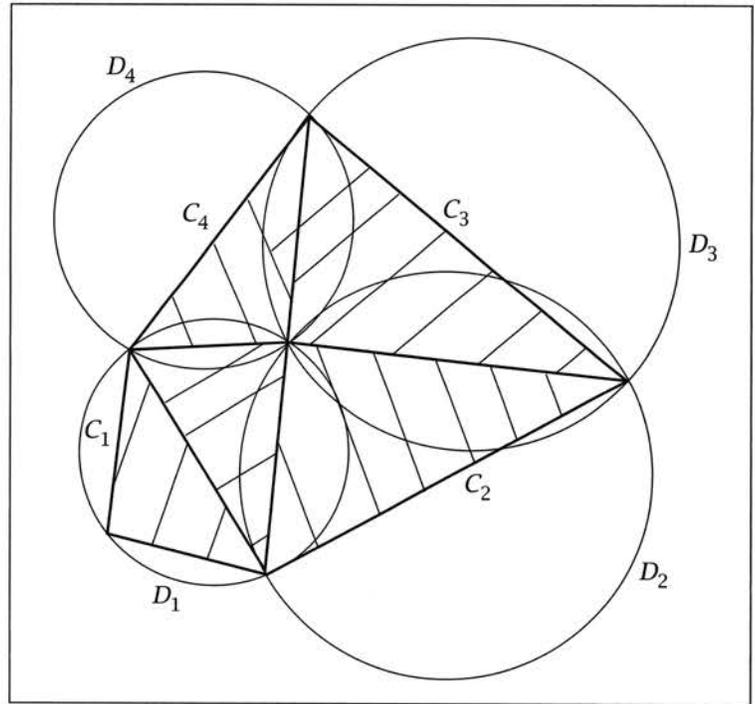
$$(0.6) \quad \arctan \sqrt{\frac{-\cos(\pi q/2)}{\cos^3(\pi q/6)}} - \epsilon.$$

Is X of hyperbolic type?

The number in (0.6) (where $\epsilon = 0$) is the circumscribed radius of the equilateral spherical triangle with angles $\pi q/3$. Theorem 3 corresponds to the case $q = 2$, and Corollary 1 can be considered as a limiting case $q \rightarrow 1$. In the case $q = 3$, the answer to this question is also positive [5].

Before we comment on the proof of Theorem 3, let us briefly indicate how this theorem can be used to prove Theorem 1. Consider the Riemann surface Z_f of a meromorphic function in the plane. Let us assume that the surface Z_f is complete. This will not be true in general, due to possible asymptotic values of f , but the general case can essentially be reduced to this one by invoking some techniques of quasiconformal surgery. We know that spherical disks D' covered univalently by the function correspond to schlicht disks D contained in Z_f . If Z_f is complete, then a disk $D \subset Z_f$ is schlicht if it does not contain any branch points of Z_f . In order to get a contradiction, let us assume that no schlicht disk has a radius exceeding $\arctan(\sqrt{8}) - \epsilon$, where $\epsilon > 0$. In this case one can construct a triangulation of Z_f (to be precise, it is rather a tiling of Z_f by triangles, but let us ignore this subtlety) satisfying the conditions of Theorem 3. The basic idea to obtain this triangulation is very simple: Consider all schlicht spherical disks D in Z_f containing at least three branch points in the boundary ∂D . Consider the (spherical) convex hull $C \subset \bar{D}$ of the branch points in ∂D . Then it can be shown that these convex sets C do not overlap and that they tile Z_f . If we draw diagonals in C , we obtain a triangulation of Z_f by triangles with vertices in the set of branch points. Moreover, each triangle is contained in a disk of radius $\leq \arctan(\sqrt{8}) - \epsilon$, and so its circumscribed radius is bounded by the same number.

So we arrive at the set-up of Theorem 3, and we conclude that our surface should be of hyperbolic type. On the other hand, Z_f is the Riemann surface of a function meromorphic in the plane, and so it is of parabolic type. This is the desired contradiction.



The schlicht disks in the surface containing at least three singular points in their boundaries can be used to construct a tiling of the surface by triangles. By the same construction, we can tile the plane by triangles with vertices in a given discrete set A which has the property that each point in the plane has uniformly bounded distance to A . Part of such a tiling is shown in the figure.

Bi-Lipschitz Maps

The idea of how to prove Theorem 3 is to reduce it to Corollary 1 by an auxiliary bi-Lipschitz map. A bijection f between two metric spaces (X, d_X) and (Y, d_Y) is called *bi-Lipschitz* if there exists a constant $L \geq 1$ (a bi-Lipschitz constant for f) such that

$$\frac{1}{L} d_X(x, y) \leq d_Y(f(x), f(y)) \leq L d_X(x, y)$$

for $x, y \in X$.

If there exists a bi-Lipschitz map between two metric spaces X and Y with bi-Lipschitz constant L , then the spaces are called *L -bi-Lipschitz equivalent*. If the constant L does not matter, we call the spaces *bi-Lipschitz equivalent*.

It is well known that bi-Lipschitz equivalent surfaces are of the same conformal type. Actually, there is an even larger class of type-preserving mappings, namely quasiconformal mappings, but it seems that this fact does not help in the proof of Theorem 3.

Let us now proceed to some more details: Suppose we somehow associate with each spherical triangle Δ of the triangulation T of our surface Z in Theorem 3 a corresponding Euclidean triangle $\tilde{\Delta}$. We want to glue the triangles $\tilde{\Delta}$ together according to the combinatorics of T to obtain a

Euclidean polyhedral surface \tilde{Z} . For the gluing to work, we need that if two triangles in the triangulation are adjacent, then the corresponding sides of the Euclidean triangles $\tilde{\Delta}$ have equal length. A way to guarantee this condition is to specify a function F so that if a, b, c are the side lengths of a spherical triangle $\Delta \in T$, then the side lengths of the corresponding Euclidean triangle are $F(a), F(b), F(c)$. In other words, the length of a side of a Euclidean triangle should depend only on the length of the side of the corresponding spherical triangle. We can choose F quite arbitrarily subject to some obvious conditions, e.g., we need that if a, b, c are the side lengths of a spherical triangle, then there should exist a Euclidean triangle with the side lengths $F(a), F(b), F(c)$. So these numbers have to satisfy the triangle inequalities. Let us denote the Euclidean triangle $\tilde{\Delta}$ associated to Δ by means of the function F by Δ_F .

A map from Z to \tilde{Z} can be obtained by mapping each triangle Δ to the corresponding triangle $\tilde{\Delta} = \Delta_F$ using, say, barycentric coordinates. The length distortion of this map will be controlled by the values of the ratio $F(x)/x$. In general, the condition $F'(0) < \infty$ will be enough to ensure that the map is bi-Lipschitz.

A second condition on F comes from the following consideration. If we want to apply Corollary 1, then we have to make sure that the total angle at each vertex of the surface \tilde{Z} exceeds 2π by a definite amount. Since the total angle at each vertex of Z is at least 4π , this will be true if the transition from Δ to $\tilde{\Delta}$ squeezes each angle by a factor bounded away from $1/2$. Let us state this more formally. Let α, β, γ be the angles of Δ and $\tilde{\alpha}, \tilde{\beta}, \tilde{\gamma}$ be the corresponding angles of $\tilde{\Delta}$. Define the angle distortion of Δ with respect to F by

$$D(\Delta, F) := \min\{\tilde{\alpha}/\alpha, \tilde{\beta}/\beta, \tilde{\gamma}/\gamma\}.$$

Then we need a function F such that

$$(0.7) \quad D(\Delta, F) \geq 1/2 + \delta(\epsilon) > 1/2$$

for every spherical triangle Δ of circumscribed radius $\leq \arctan(\sqrt{8}) - \epsilon$. It is instructive to look at the extremal case of the equilateral spherical triangle Δ_0 with angles $2\pi/3$. Whatever F is, the corresponding Euclidean triangle $\tilde{\Delta}_0$ is equilateral and has angles $\pi/3$. Hence $D(\Delta_0, F) = 1/2$.

It can be shown that the function

$$F(t) = \min\left\{2k \sin(t/2), \sqrt{2 \sin(t/2)}\right\}$$

satisfies $F'(0) < \infty$ and (0.7), where $k = k(\epsilon)$. The proof is elementary but quite cumbersome. Using this function F and the above construction, Theorem 3 can be reduced to Corollary 1.

One can summarize the whole proof of Theorem 3 by saying that the positive part of the curvature of the surface Z is eliminated by a carefully chosen bi-Lipschitz map so that on the target surface \tilde{Z} enough negative curvature remains to ensure that \tilde{Z} is uniformly hyperbolic.

Related techniques also work in other situations. U. Lang and the author have recently proved the following theorem.

Theorem 4. *Suppose X is an Aleksandrov surface which is complete, open, and simply connected. If $\mu^+(X) < 2\pi$ and $\mu^-(X) < \infty$, then X is bi-Lipschitz equivalent to \mathbb{C} .*

A similar statement had previously been established by J. Fu under the assumption $|\mu|(X) < \epsilon_0$, where $0 < \epsilon_0 < 2\pi$ is some numerical constant.

The constant 2π in Theorem 4 is best possible. To see this, let the surface X be a one-sided infinite cylinder, closed off by a hemisphere on its finite end. Then $\mu^+(X) = 2\pi$ and $\mu^-(X) = 0$, but it is an easy exercise to see that X is not bi-Lipschitz equivalent to \mathbb{C} .

The proof of Theorem 4 uses an approximation argument to reduce to the case of a Euclidean polyhedral surface. Then again we apply a ‘‘curvature elimination technique’’: We find appropriate pairwise disjoint flat sectors on the Euclidean polyhedral surface which go from a conical singularity to ‘‘infinity’’. By a bi-Lipschitz map these sectors are opened up or squeezed down according to whether the integral curvature at the singularity is positive or negative. In other words, the sectors are adjusted to compensate for the defect or excess of the total angle at the singularity with respect to 2π . In this way all the curvature on the target surface \tilde{X} of the bi-Lipschitz map can be eliminated, and one obtains a flat, complete, open, and simply connected surface. Hence \tilde{X} is isometric to \mathbb{C} , and X is bi-Lipschitz equivalent to \mathbb{C} .

The sectors can be chosen to give control on the bi-Lipschitz constant of the bi-Lipschitz equivalence. One obtains the stronger statement that each surface as in Theorem 4 is L -bi-Lipschitz equivalent to \mathbb{C} where L depends only on $2\pi - \mu^+(X)$ and $\mu^-(X)$.

Concluding Remarks

It should have become clear from the preceding discussion that it is useful to know when two surfaces are bi-Lipschitz equivalent. At present, there are few techniques to decide this question and many basic problems remain open. For example, the fundamental question behind Theorem 4 is: *How to characterize \mathbb{R}^2 up to bi-Lipschitz equivalence?* This problem has additional interest, since it is equivalent to the problem of characterizing Jacobians of planar quasiconformal mappings up to multiplicative constants.

Of course, the characterization of other standard surfaces or even higher dimensional spaces up to bi-Lipschitz equivalence also merits attention; see [11] for information on this and related topics.

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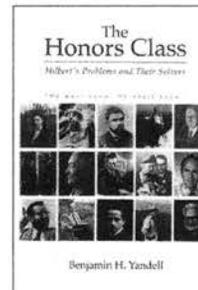
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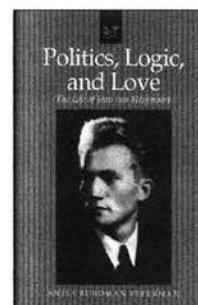
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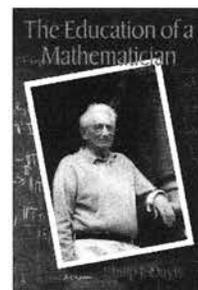
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Reflections on the Future of Mathematics

Felix Browder

Felix Browder served as president of the AMS during 1999–2000. On January 6, 2002, at the Joint Mathematics Meetings in San Diego, he delivered his Retiring Presidential Address. What follows is an abridged version of his address.

One of the mandated duties of the president of the AMS is to deliver a Retiring Presidential Address. The fact that this duty has not been met by a few presidents does not mean that one should not take it seriously. The content of this address is not mandated by the bylaws of the Society; one can presumably deliver a mathematical lecture or talk about policy issues.

The title of this lecture is intended to be as general as possible. One can reflect on the future; one cannot predict the future with precision. For example, I cannot predict with any measure of authority whether the Riemann Hypothesis will be proved or disproved. But I can predict that people will work on the Riemann Hypothesis until the question is settled. That is a prediction with a high degree of probability. The same applies for the Poincaré Conjecture and other celebrated problems.

This is one kind of reflection that is possible: to consider where some of our topics of concern are probably going to come from. Another way to reflect is to consider the internal workings of mathematics on the one hand and, on the other, the way in which mathematics fits into institutional structures, such as universities, government, private foundations, etc. This is the area where policy comes in.

I shall take seriously some recent articles and speeches on these and related themes. One article is based on the address Michael Atiyah gave at

a meeting at the Fields Institute in Toronto. The article has just been published [1]. There is an interesting programmatic article by Mikhael Gromov, which appeared originally in a report of the National Science Foundation—a very influential report, as a matter of fact, on the problems of American mathematics in the future [2]. There was also a lecture in the same direction given by Robert MacPherson of the Institute for Advanced Study in Princeton. This was the one and only official lecture I heard about mathematical policy given at the Institute; it was entitled “Can One Predict the Future of Mathematics?” MacPherson remarked on a cyclical process in the twentieth century in which, after a mid-century emphasis on general abstract theories, we have returned to an emphasis on concrete problems and scientific applications reminiscent of 1900.

Of Hilbert and Poincaré

One of the most famous attempts to set the course for the future of mathematics was made in the early twentieth century, in a paper by David Hilbert. Hilbert delivered the paper, or rather part of it, at the International Congress of Mathematicians in Paris in 1900. He was not specifically invited to give such a paper, but he did it anyway. The speech was instigated by his friend Hermann Minkowski, to whom he was very close personally and mathematically at Göttingen. The speech was an attempt to answer an earlier paper presented by Henri Poincaré at the first International Congress of Mathematicians, held in 1897 in Zurich. Poincaré’s paper did not specifically describe the future of

Felix Browder is professor of mathematics at Rutgers University. His e-mail address is browder@math.rutgers.edu.

mathematics, but it was centered on the theme of how mathematical problems arising in physics would probably be very influential in mathematics. The thesis that Hilbert wanted to develop is that mathematical problems arising in other directions would also be influential, in particular in number theory. The Hilbert Problems that have been influential fall into three sections: the problems on logic and foundations, the problems on number theory, and the problems on partial differential equations. (For those who are interested in the genesis and influence of the Hilbert Problems, I strongly recommend two publications: the recent book by Jeremy Gray called *The Hilbert Challenge* [3] and an article by the historian David Rowe [4].)

There are some ironies that people have remarked on in the Hilbert Problems and the attempts to predict what would be done in mathematics after the year 1900. First of all, the Hilbert Problems did not predict what Hilbert would do. For example, there is not a word in the Hilbert Problems about functional analysis or integral equations, which are the subjects that Hilbert worked on in the succeeding two decades. Second, the problems ignored many of the major trends that were going on in mathematics at the time that he spoke. There is very little on topology, which Poincaré had founded and which a few years after Hilbert's speech was revolutionized by L. E. J. Brouwer. Third, the section on logic is very interesting from a psychological point of view and is probably the most influential part of the Hilbert Problems. It gave rise to Kurt Gödel's incompleteness theorem and the work of Gödel and Paul Cohen on the continuum hypothesis. These results constituted a negation of Hilbert's most powerful presupposition: that every problem could be solved. But the whole modern thrust of foundations was to prove the contrary.

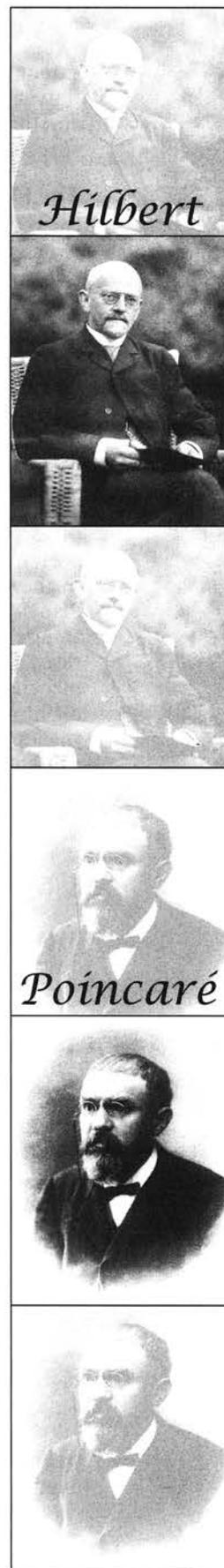
Nevertheless, I think anybody who really dares to try such a thing as Hilbert tried should be commended, because after all it stimulates research. Whatever the ultimate influence of the Hilbert Problems has been, they certainly were a major stimulus in research and in diversifying mathematics.

At the 1908 Rome International Congress, Poincaré gave a response to Hilbert's speech in a speech entitled "The Future of Mathematics". Poincaré's approach is much broader and much more tolerant than Hilbert's, emphasizing, among other things, the connection of mathematics with theoretical physics, of which Poincaré was the foremost practitioner. One of Hilbert's problems, for example, was to axiomatize physics. This was a misguided endeavor at that time, which was just before relativity theory and quantum theory began. Even if one could have axiomatized physics, one could just as well ignore the axioms, because physics changed so drastically shortly thereafter. Poincaré was much closer to the physicists than was

Hilbert (although Hilbert had a good deal of interaction with his local physicists). I have been told that physicists considered Poincaré to be one of the great physicists of his time, particularly because of his work on thermodynamics and relativity theory, where in effect he competed with Einstein for the origins of that subject. This is not to speak of areas like celestial mechanics, where Poincaré was the chief contributor for many years. His work earned him more nominations for the Nobel Prize in Physics than probably everybody else put together. In fact, in 1908, Gösta Mittag-Leffler went to every major physicist in Western Europe and got all but a very few to sign a petition saying that Poincaré deserved the Nobel Prize in Physics. Hundreds signed, but he still did not get it. Much of this is described in Jeremy Gray's book.

A number of years ago, at a symposium at the National Academy of Sciences, the mathematical physicist Elliott Montroll said, "The first half of the twentieth century in physics was the era of Hilbert, and the second half was the era of Poincaré." What did he mean? He meant that Hilbert's influence in setting up the research program that other people practiced in spectral theory had a very crucial influence on the development of quantum mechanics in the 1920s and 1930s. From Montroll's point of view, Poincaré's creative work in founding what we now call chaos theory is probably the decisive influence on physics in the latter half of the twentieth century.

In the 1940s, that habitually courageous mathematician, André Weil, wrote an essay entitled "The Future of Mathematics" [5]. I personally find this essay very sympathetic. It is also entirely free of the ideology that we call today Bourbaki-ism—Weil does not refer to Bourbaki; he does not praise formalization and the abstract movement in mathematics. He ignores it completely, even though he was one of the founders and principal figures of Bourbaki. Weil begins the essay by quoting Poincaré—even though Bourbaki, until the late 1970s, rarely said a good word about Poincaré. Weil also discusses, not in a very sanguine spirit, the institutional influences on mathematics. He had just finished a stint teaching at American universities, and he was not very optimistic about their intellectual future, because they did not have much intellectual structure at the time. This essay actually does to a large



extent predict Weil's own intellectual tendencies in the years that followed. It is a very penetrating essay, and the spirit is so vigorous and free of prejudice—surprisingly so—that it is well worth reading.

The Mathematics of Bisociation

During my AMS presidency I organized a symposium called “Mathematical Challenges of the 21st Century”, which took place at the University of California, Los Angeles, in August 2000. There are many axes on which one could organize such a meeting—or on which one can organize one's thinking about the future of mathematics. I chose an unorthodox axis, the precursor for which was an essay by Dieudonné published almost twenty-five years ago [6]. This essay provides a framework for discussing two aspects of developments in mathematics: its internal structure and its interdisciplinary nature. Many of these developments can be seen as examples of “bisociation”, a word coined by the political and scientific writer Arthur Koestler. Bisociation occurs when two seemingly unrelated things are shown to have unanticipated connections. Arthur Koestler argues that all creativity is bisociation. In his book on humor, he argues that all humor is bisociation. One can accept these theses or not. But I believe that “bisociation” is a good description of many significant developments in mathematics in recent decades. This is put elegantly by Poincaré as follows:

In proportion as science develops, its total comprehension becomes more difficult; then we seek to cut it in pieces and to be satisfied with one of these pieces: in a word, to specialize. If we went on in this way, it would be a grievous obstacle to the progress of science. As we have said, it is by unexpected union between its diverse parts that it progresses.

Mathematics is now extremely diverse. First of all, the size of the mathematical community since I started fifty-odd years ago has multiplied by a factor of more than ten. The first meetings of the AMS I attended were minuscule compared to today's meetings. At that time the AMS had about 4,000 members. And now we have 30,000 members all over the world. The number of mathematical specialties has increased greatly. There are many people working on a lot of subjects, and some people know nothing but their own narrow subject. This is a very unusual situation, in historical terms. To some extent it influences what the mathematical community thinks is of high significance. For example, the solution to historically famous problems is considered significant. Nobody in the mathematical world could doubt that Fermat's Last Theorem and the Riemann Hypothesis are of

high significance. The same can be said for the “Millennium Prize Problems” identified by the Clay Mathematics Institute [7], although some of those problems may be less famous. Nevertheless, those problems at least are plausible candidates for being considered significant.

What else is significant, besides such problems? That is where the term “bisociation” comes in. Developments that have been regarded by the tastemakers of the mathematical community as being highly significant are almost always developments in which ideas and techniques from one set of mathematical sources impinge fruitfully on the same thing from another set of mathematical sources. In modern history, a major example of that in my experience was the Atiyah-Singer Index theorem, where K -theory and differential geometry on the one hand and elliptic partial differential equations on the other hand were identified in a very crucial way. Another example, which is perhaps of even greater importance in terms of its influence on contemporary mathematical research, was the thesis of Simon Donaldson, where he attained revolutionary new results on the topology of four-dimensional differentiable manifolds by using techniques of quantum field theory, particularly the study of Yang-Mills fields. An even more significant example is the interaction between quantum field theory and topology in the work of Edward Witten in the last two decades.

Many examples arose in lectures at the UCLA symposium. One was the Langlands Program. Andrew Wiles' solution of the Fermat problem consists of verifying one important special case of the Langlands Program. And what is the Langlands Program? It is essentially to establish systematically an interrelation between number theory and certain problems in group representations and automorphic forms. The program continues to develop, and every new case that is verified will be regarded as a very significant development. In his essay, Atiyah emphasizes quantum algebra, arguing that the mathematics of the future will consist of algebraic developments related to the fact that quantum field theory is both nonlinear and infinite-dimensional and therefore falls outside of the frame of reference of most of the classical mathematics that people try to apply to it.

Another interesting example is stochastic processes, which is a fairly classical field by now. The so-called Malliavin Program consists of putting stochastic processes in the framework of Sobolev spaces. Sobolev spaces were designed explicitly for studying partial differential equations, and Paul Malliavin has revolutionized this field by putting stochastic processes into this framework. There are other interesting variants of bisociation that can be mentioned. For example, there are developments in the topology of Sobolev manifolds. This is

another case of the intrusion of Sobolev spaces where ordinarily one would not see them. I asked one of the practitioners of this field whether the topologists take his work seriously, and he said they do and he has great interactions with them.

I believe that a great deal of the internal development of mathematical ideas will consist of examples of this kind, where ideas from one area suddenly impinge on another area. Sometimes this causes displeasure, but I think that displeasure has to be quelled. It appears that, at least in the major mathematical centers, the students have learned to adapt to such changes. In fact, sometimes they flock from one fad to another. It is sometimes comical to see a group of people decide to change their minds about what they are interested in.

The most important area of bisociation lies in the interaction between mathematics and the sciences.

One major external influence on mathematics is, of course, the computer. Everything that relates to this sphere will be of central importance to mathematics in the coming century or as long as our civilization continues on its present trajectory—which means as long as it lasts! The influence of quantum computation is hard to predict, because nobody actually knows how to carry it out. It is still in the realm of mathematical modeling. But many other things—such as complexity of computation or number theory applied to codes—provide very striking examples of bisociation that certainly nobody would have predicted thirty years ago.

In molecular biology, mathematics has a much greater role to play than people realize, even though mathematics has had, for example, a significant effect on the course of the genome project. There will be an even larger effect when it comes to analyzing how the genome actually creates living cells. This development has caused a great upsurge of interest in mathematics on the part of biologists.

In his brief paper, Gromov mentions the essential developments in data analysis, which have an impact on such areas as genomics. David Donoho, an eminent practitioner of data analysis, gave a talk about this at the UCLA symposium. He showed how sophisticated mathematical tools such as wavelets are being used in data analysis. The rituals of classical statistics no longer suffice to deal with many problems that people face, especially when they have large masses of data—and large masses of data are the basic ingredient of the modern world.

Relations of Mathematics to Societal Structures

The interactions between mathematics and the sciences are important for mathematics not just for its internal development, but also for the future of mathematics within societal structures such as the federal government. There is now an initiative of

the National Science Foundation (NSF) to try to boost the NSF mathematics budget—an initiative coming directly from the director of the NSF, Rita Colwell, a distinguished biologist, who is firmly convinced that a good deal of the future of biology rests on its interactions with mathematics. She has taken a proactive attitude of favor towards mathematics and plans to increase funding for it. Some may dislike the initiative's emphasis on interdisciplinary research. The emphasis reflects the fact that mathematicians, especially young mathematicians, ought to be interested in how mathematics is applied to other things.

The importance of the relations of mathematics to the institutions of society can be seen in the following example. American mathematicians often think of France as a country where mathematics is much encouraged. However, the relations of mathematics and mathematicians to the French government have been extremely problematic. In fact, there was a major crisis in 2000, when Claude Allègre was the French minister of science, research, and education. He is a reasonably distinguished geophysicist and has written several books, one called *The Defeat of Plato*—Plato being a representative of mathematics. In this book he clearly reveals that he does not know about the mathematics pervading fundamental physics after the year 1900. And he is firmly convinced that with the computer one does not need to know much mathematics of any kind to do science. While he was minister, Allègre decided that mathematics was overemphasized in French education. He advocated the elimination of mathematics classes in the schools. Because he was a very close friend of the prime minister, this looked like a very dangerous situation. Mathematicians were saved from the consequences of Allègre's dogmas, but not through their own influence. Allègre got very much under the skin of the major teachers' unions in France, who were very angry about his proposed reforms. In France, which has a socialist regime, you do not irritate the teachers' unions! So no matter how close Allègre was to the prime minister, he had to go. And he went. I do not think his successors have taken up his ideas. This episode illustrates that mathematicians have to be aware and alert in responding when these kinds of problems arise in the institutions that determine our destiny.

Fortunately, the AMS has taken a very proactive attitude toward dealing with many of the problems to which I just referred, and as long as it continues in this role, the Society will be a vital influence on the future of American mathematics. The AMS is playing an extremely important role, which most of its members do not realize, in organizing and focusing attention on policy matters. I urge the membership to find out what is going on in this sphere. One can go to meetings of the committees

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that deal with these matters. The meetings are held in Washington, D.C., and are open to the mathematical public.

The report in which Gromov's essay appeared noted that mathematics in the United States is flourishing, but it is not guaranteed that it will continue to flourish, for two reasons. One is the scarcity of resources. But even more important is the scarcity of recruitment, especially of talented American students, to mathematical vocations. Both of these are very crucial questions, and questions that we must continue to address.

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Commutative Diagrams in the Fine Arts

Karl Heinrich Hofmann

Almost imperceptibly, mathematics has emerged into public view in works of fiction, theater, and cinematography, and people at large suddenly find mathematicians to be interesting characters. Like a number of my colleagues, I have been to see the Broadway play *Proof* [1], in which all of the characters are attached to mathematics in one way or another. Its author, David Auburn, received a Pulitzer Prize and a Best Play Tony Award [7]. His play was amply reviewed in mathematics journals, indeed twice in the *Notices* [2], [11] (see also [3], [18]). Remarkable popular acclaim keeps it running on Broadway, and it is now appearing on stages abroad [3]. It is undoubtedly good for mathematics to appear as a normal human endeavour, but in my mind I see the question of *authenticity* arise instantly whenever I encounter cross-cultural links between the humanities and mathematics. In *Proof*, we listen in on the following dialogue between Hal, a young mathematics Ph.D., and the protagonist Catherine (Act I, Scene 3, [1], p. 34):

Hal: [...] Mathematicians are insane. I went to this conference [...] last fall. I'm young, right? I'm in shape. I thought I could hang out with the big boys. Wrong. I've never been so exhausted in my life. Forty-eight straight hours of partying, drinking, drugs, papers, lectures...

Catherine: Drugs?

Karl Heinrich Hofmann is professor of mathematics at the Fachbereich Mathematik, Technische Universität Darmstadt, Darmstadt, Germany, where his e-mail address is hofmann@mathematik.tu-darmstadt.de, and at Tulane University, where his e-mail address is khh@math.tulane.edu.

Hal: Yeah. Amphetamines mostly.[...] Some of the older guys are really hooked. [...] They think math's a young man's game. Speed keeps them racing, makes them feel sharp. There's this fear that your creativity peaks around twenty-three and it's all downhill from there. Once you hit fifty it's over, you might as well teach high school.

I guess I needed to be told that for me, at least, it's been all "over" for the last twenty years. I suppose also that in all probability, in all these and the preceding years, I have attended the wrong meetings. Little consolation that younger mathematicians expressed surprise about this kind of "proof" as well [18]!

If a cultural relationship between mathematics and the stage has its tenuous points even under the best of circumstances, then perhaps relief is in sight when we discover mathematics as a core topic in the fine arts.

Not long ago, *New York Arts Magazine* published a feature essay [9] in which was discussed a segment of the remarkable work of the French-American artist Bernar Venet, in which he recycles the typography of mathematical formulae into a novel genre of conceptual paintings of monumental proportions. The essay concludes as follows:

"The Greek 'mathemat' means lesson or learning, but Venet's use of color as the ground for his mathematical "figures" undermines their didactic look. [...] We are no longer afraid to be ignorant, for the color allows us to embrace our ignorance as the way to the emotional truth. [...] the alienness of the mathematics becomes an entry into the emotional depths. What emotional truth, what

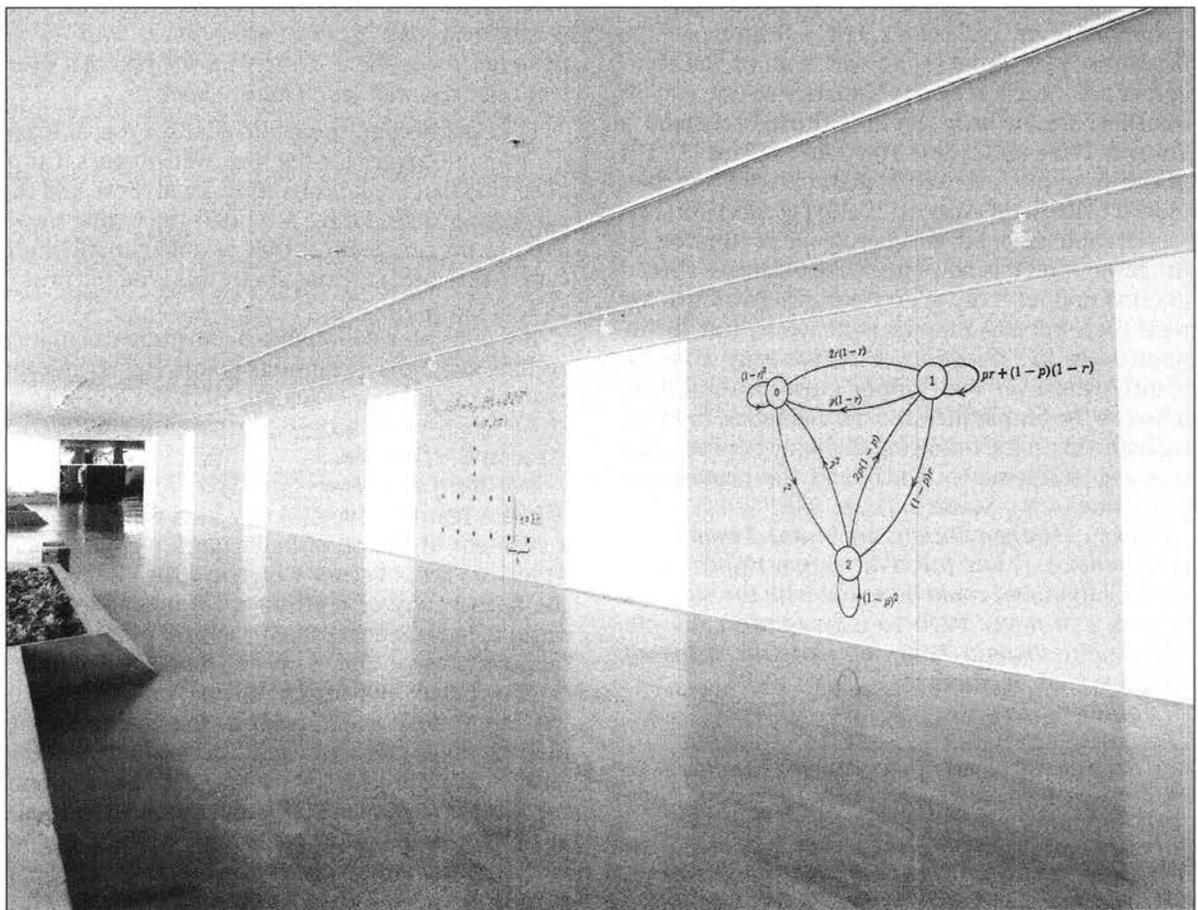
emotional truth? I suggest it is a sexual truth and depth [...], which at its deepest establishes an erotic relationship with the spectator. And which in itself re-enacts the sexual union of opposites. I suggest that Venet's wall paintings do so, without showing its consummation. They are profoundly sexual in import, on a grand scale that masks their poignancy" [9].

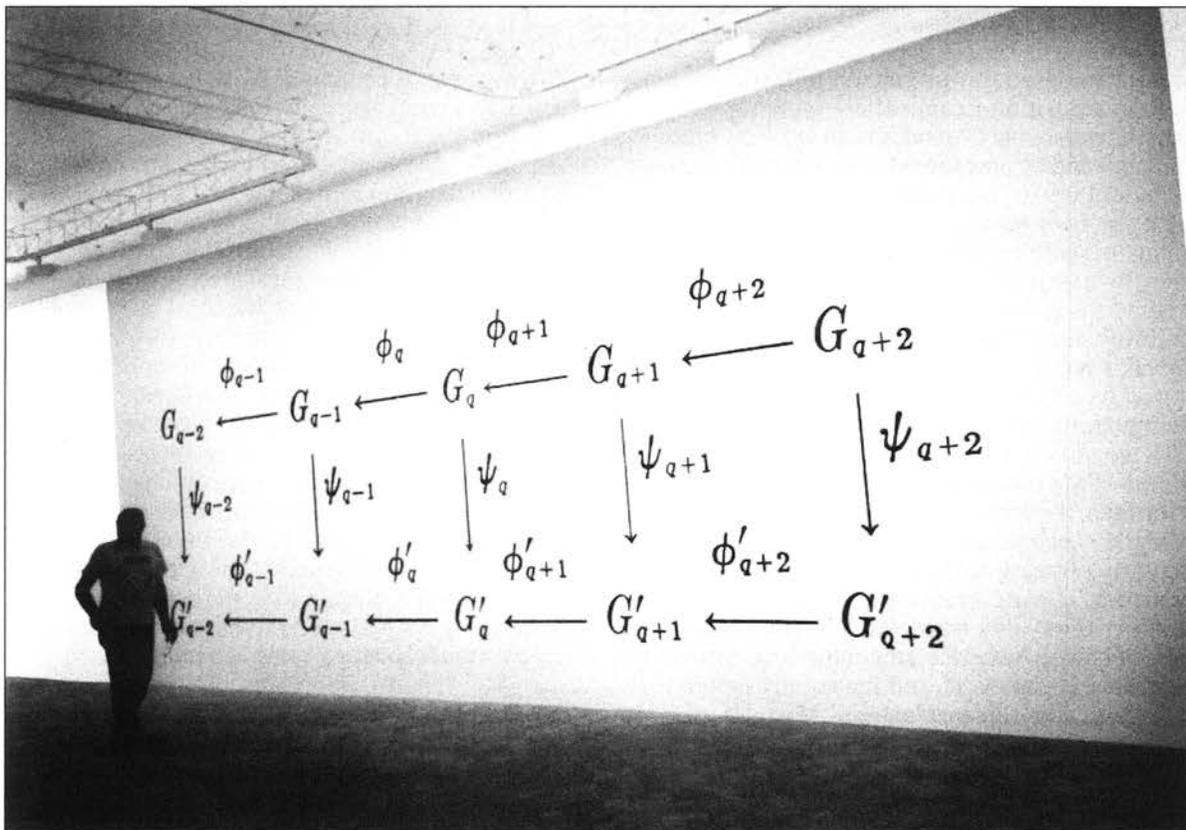
Having done mathematics more than anything else during these past fifty years while staying close to the fine arts by inclination, I am again asking myself: Could it be possible that I have missed out on something?

When I visit the Mathematisches Forschungsinstitut in Oberwolfach for a conference, barely a few hours pass before some mathematician occupies the music room, playing the piano or orchestrating some chamber music with like-minded colleagues. "Scratch a mathematician; find a musician," as the saying goes. Musical and mathematical talents appear to cohabitate comfortably. The concert goes and opera buffs among us appear to be legion. But our cohort of museum visitors, gallery hoppers, and artists is much smaller; yet it was distinctly present at various events during the International Congress of Mathematicians in Berlin in 1998. Perhaps the aesthetics of computer-generated

art has helped us to recruit art lovers among mathematicians. Remarkably, one of the featured speakers at the Berlin Congress was a writer and poet well known on the literary scene—certainly in Germany. Hans Magnus Enzensberger addressed the Congress in a speech entitled "Drawbridge Up", metaphorically referring to mathematics as a castle separated from the humanities and arts by deep moats and dysfunctional bridges. The bilingual publication of this address in German and English brilliantly pleads for the central place of mathematics within the panoply of cultures [4] and is a pleasure to read for all mathematicians; after C. P. Snow's "Two Cultures" this is surely one of the grand essays on the integration of mathematics in the universe of creative intellectual activity. Regarding the relations, more specifically, between *mathematics and the fine arts*, until we have a grand essay by some articulate member of the writing guild, we have to content ourselves in the meantime with finding and commenting on artists that allow us to study this relationship in concrete cases. Such an artist is Bernar Venet whose versatile oeuvre is impressive in its wide horizon, encompassing sculpture [10], painting [9], poetry [15]. His sculptures are publicly placed; one of the steel constructs from his series entitled *Indeterminate*

Photographs of paintings courtesy of Bernar Venet.





Lines [10] is positioned on the MIT campus in Cambridge (Massachusetts) in front of Dewey Library: *Two Indeterminate Lines* [17]. The very compact excerpt of Venet's curriculum vitae, which is appended, gives only a very incomplete picture of this artist's creative horizon.

Naturally, as mathematicians we are particularly interested in that very recent portion of his work which appears to link very closely with mathematics and which generates such orgiastic sentiments in the souls of trained art critics. But professional mathematicians should not be led astray by the professional arts commentators. We as mathematicians are in an excellent position to appreciate and experience straightforwardly the outside aesthetics of Venet's mathematical conceptual art as well as its intrinsic quality.

What, concretely, is Venet doing? He creates wall paintings of imposing scale with radiant coloration under graphical structures that are taken from mathematical formula language. The artist lifts from mathematical texts and monographs items like formulae or illustrations and transfers enlarged copies of these in black, that is, in the color of the original printing ink, onto luminously monochromatic surfaces, generating, in the process, paintings of a monumental format, filling entire wall segments in an exhibition hall. Well centered as they were in a rectangular space allotted to them in the book, the formulae now fill the rectangle bounded by the frame of the picture. The deliberate positioning of a formula in a book originally served the

purpose of transmitting scientific information for which the typesetter aspires to optimal clarity and legibility. Prominent examples used by Venet are homological diagrams (for him, the bigger the better), vector fields in the plane, matrix calculations, level-line diagrams. The sources tapped by Venet are (surely in addition to others) [19], [20], [22], [23], [24], [25]. Among the space filling formulae, the ones most striking to the mathematician are probably the homological commutative diagrams from Eilenberg-Steenrod's classic [20]. Even though other illustrations from mathematical texts are taken as well, the preponderance of designs used appear to be of a typographical nature.

Mathematicians are likely to react and respond immediately; outsiders are probably surprised if not stunned by the artist's proposition that tokens of a highly specialized technical language are to be used as building blocks of a new artistic expression. The element of surprise is calculated [15]: "Il n'y a qu'un moyen de faire avancer l'art. C'est de donner tort à l'art déjà constitué" (Bernar Venet 1999). ["There is only one way to make art advance: to put existing art into the wrong."] In Venet's work, mathematical typography is recognized as its own graphical and architectural structure, utilized and elevated artistically in a twofold fashion: First, by the brilliant monochromatic backgrounds, and second, by the monumental format. The ostentatiously colorful character of these works notwithstanding, they are largely graphical; it appears appropriate to describe them as "wall graphics".

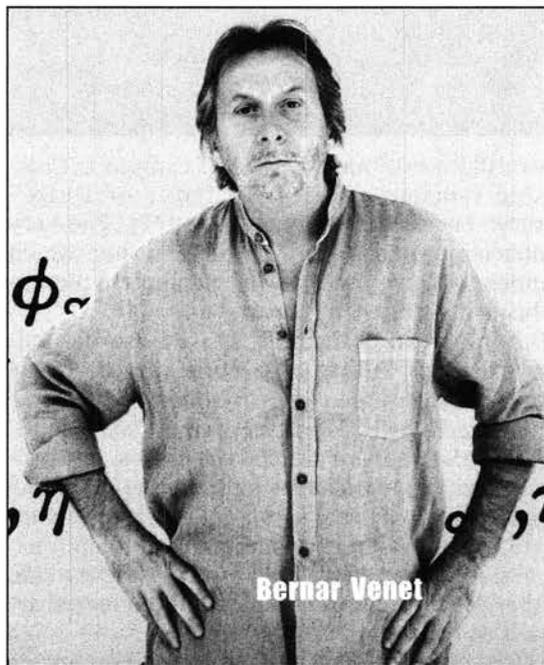
For two decades, working mathematicians have been in a position to appreciate typography as an artistic endeavor. Donald Knuth [8] first empowered us—and by now forced us—to typeset our own texts and create the typography of our formulae *with our own hands*. While it is true that we are doing this with our fingers on the keyboards rather than by assembling lead cast letters, Knuth has shaped his programming language \TeX so that it faithfully emulates the original craft. The title of Spivak's handbook on the use of $\mathcal{A}_{MS}\text{-}\text{\TeX}$ is *The Joy of \TeX* . Most of us have realized the challenges of typography and experienced the satisfaction arising out of the accomplishment of having found—for problems involving the typesetting of a formula, the arrangement of a diagram, or the organization of a printed page—a solution that is particularly pleasing to the eye as well as clear in exposition. Having created a fine typographical product thus adds extra satisfaction to the pleasure of having found a mathematically aesthetic result, having proved it, and having presented it in a stylistically elegant fashion. Mathematicians, therefore, know of the experience brought about by an activity recognized by the world at large as artistic. The artist and art theoretician Joseph Beuys vigorously proposed the theme that each person, by virtue of one's own creativity, is an artist (see [5]), and I suggest that mathematicians, quite apart from graphics and typography, are excellently qualified to understand this point. Hans Magnus Enzensberger, referring to Godfrey Harold Hardy's *A Mathematician's Apology*, expresses this sentiment:

"The autonomy Hardy requires for his basic research finds its counterpart in the arts, and it is no coincidence that most mathematicians are thoroughly comfortable with aesthetic criteria—a proof needs not just to be conclusive; the mathematician aspires to 'elegance'. The word expresses a quite particular aesthetic sensibility that has characterized the mathematical enterprise since its earliest beginnings" [4, p. 25].

Venet elevates the tokens of the mathematicians' language to a form of art in a very explicit fashion. To a mathematician it appears that he is partly motivated by an artist's desire to make the mathematicians' infatuation with "elegance"—certainly an aesthetic category—manifest for the layman.

If this all sounds a bit aloof, perhaps a chat about commutative diagrams makes the point, because some of us have struggled with them in our publications and because Venet chose to feature them prominently in his wall graphics. Mac Lane's *Fundamental Theorem* says: *Every diagram is commutative*. To anyone who doubted that, Mac Lane proved it in the form of his coherence theorems [21]. They are complicated enough. Experience teaches us that, heuristically, a "natural" diagram is likely to be commutative. The suggestion that emerges from

the diagrams "formulated" by Venet seems to confirm this—contrary to our having often experienced how difficult it can be to actually verify a seemingly obvious commutativity. The commutativity of a diagram represents one or several equations—well known to the aficionados. Suppose we step back for a moment and take stock: Is it not remarkable that homological algebra and category theory have created, during the third quarter of the last century, a graphical and therefore visible expression for certain equations? The words "graph" and "diagram" still exhibit the Greek word for "writing". On many occasions I have experienced the effort of organizing and drawing a supposedly commutative diagram on a piece of paper as stressful, and I have found that a good visualisation is often the essential step in the final proof of the equation in the background. The actual drawing of a commutative diagram by the working mathematician is an artistic activity even if not consciously performed as such.



Photograph courtesy of NY Arts Magazine.

Venet, the professional artist, may not be aware of the technicalities of the mathematics underlying the diagrams he uses, but he certainly senses that artistic element in their creation. He comments on his own work in a more rigorously purist mode: "I did not present Mathematics as Art: but Mathematics as such, merely for its own importance, for its own function. The Art existed only on a propositional and conceptual level" [14]. Whatever his artistic message to the general public may be—mathematicians at any rate are reminded at this juncture of one of the many points of contact between the mathematical and the artistic aspects of

their own work, mathematicians as artists, as Beuys had postulated. Venet claims to present “mathematics as such.” We concede, as mathematicians, that he attains an uncontested degree of authenticity by copying material from its scholarly environment without modifying or adulterating it, and thus maintains what we call “truth”.

Suppose that, in Venet’s monumentally presented painting *Related to the Homology Simplicial Complexes*, in the place of $H_{q-1}(|L^{q-1}|)$ the artist had copied $H^{q-1}(|L^{q-1}|)$. The extraneous aesthetic quality of the wall graphic would not in the least be impaired. Most observers other than algebraic topologists would not even notice what would be in fact a mathematical absurdity; the substitute is a perfectly sensible expression for a perfectly meaningful cohomology group—but it has no place in a diagram of homology groups. Such a minute transformation in the graphical design does not affect the design nor its monumentality nor its coloration, and from a purely graphical point of view, it could still be enjoyed no less than a page of Chinese calligraphy might be enjoyed by a person who is unable to read it. The modification does, however, invalidate the mathematics. The art critic without mathematical training would still be enraptured by coloration and depth. But what about “truth”? The aesthetics of Venet’s mathematical wall graphics therefore inhabits two levels. I suggest that Venet’s use of mathematical material serves—quite apart from the external aesthetic charm—as a semiotic reference, as a signal pointing to creativity in an other than the purely artistic domain in which beauty expresses itself through the truth, coherence, and logical elegance of propositions and through nothing else. How should the artist otherwise make evident the parallels between logical and pictorial creativity than by amalgamating the expressive material of both? In a recent play [13], during a discourse on the relative virtues of scholarship and poetry, the author, Tom Stoppard, has one of his characters say (Act I, p. 37): “Taste is not knowledge. A scholar’s business is to add to what is known. That is all. But it is capable of giving the very greatest satisfaction, because knowledge is good. It does not have to look good or sound good or even do good. It is good just by being knowledge. And the only thing that makes it knowledge is that it is true.” Venet’s recent paintings present us with a marvellous synthesis of scholarship and art along just this line.

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Appendix: Excerpts from Venet’s Biography

1941. BERNAR VENET is born on April 20 at Château-Arnoux-Saint-Auban in the Alpes de Haute-Provence. At age eleven, he is invited to exhibit in the Salon de Peinture Pêchiney in Paris.

- 1963–64. VENET establishes a studio in the old quarter of Nice. His first sculpture, *Coal Pile*, has no specific dimensions. The work is characterized by extremely restrained means. He participates in the Salon Comparaisons at the Museum of Modern Art, Paris. He exhibits alongside the New Realist and Pop Artists, despite the intentionally divergent nature of his cardboard reliefs.
1966. VENET takes his first trip to New York in April and May. He returns to Nice. In the course of his work he becomes aware of the objective aspect of blueprints and their semantic characteristics. He works intently on diagrams, creating his first monosemiotic works. In December, he decides to permanently settle in New York. Initially he lives in Arman's studio, 84 Walker Street, formerly Tinguely's studio.
- 1967–68. His conceptual work develops along logical lines. VENET frequents the mathematics and physics departments at Columbia University and befriends two researchers, JACK ULLMAN and MARTIN KRIEGER. He collaborates with the scientists from Columbia University to stage a performance at the Judson Church Theater in SoHo, New York. Two conceptual exhibitions take place at the Wide White Space Gallery and, along with Beuys and Broodthaers, at the Düsseldorf Kunsthalle. Works are bought by the Krefeld Museum, which offers to stage his first museum exhibition. The Museum of Modern Art, New York, acquires a VENET piece.
- 1969–71. Retrospectives are organized at the Krefeld Museum, Germany, and at the New York Cultural Center, New York.
- 1972–74. VENET returns to Paris. Teaches "Art and Art Theory" at the Sorbonne, Paris. Frequent lectures in France, England, Italy, Poland, and Belgium. His conceptual work is exhibited at the Institute of Contemporary Art, London. He represents France at the XIII São Paulo Biennale, Brazil, with Gottfried Honegger and François Morellet.
1976. VENET returns to New York in January and produces his first canvases from the series *Angles and Arcs*, a group of extremely restrained paintings of elementary geometrical figures. A retrospective of his conceptual works is shown at La Jolla Museum of Contemporary Art, La Jolla, California.
- 1977–78. VENET exhibits at Documenta VI, Kassel, Germany, and participates in the exhibit *From Nature to Art. From Art to Nature*, at the Venice Biennale, Italy.
1979. He begins the series of wood reliefs *Arcs, Angles, Diagonals*, creates the first *Indeterminate Line*, and starts work on steel sculptures composed of two arcs. VENET receives a grant from the National Endowment of the Arts. He develops the series of wood reliefs *Indeterminate Lines*.
1987. For the 750th anniversary of Berlin, the French Ministry of Foreign Affairs and Air France present the city with *Arc of 124.5°*. This sculpture measures 70 x 140 feet.
- 1988–89. VENET receives the Design Award for his sculpture in Norfolk, Virginia. He is commissioned to create the monumental *Two Indeterminate Lines* for the new La Défense business center on the edge of Paris and is awarded the Grand Prix des Arts de la Ville de Paris, by JACQUES CHIRAC, mayor of Paris.
1990. The monumental sculpture *Indeterminate Line* is inaugurated at Place de Bordeaux, Strasbourg, France.
1992. VENET travels to Japan for the inauguration of the sculpture at Adachi-ku, Tokyo.
1993. Retrospective exhibition at the Musée d'Art Moderne et d'Art Contemporain in Nice, France, which travels to the Wilhelm-Hack Museum in Ludwigshafen, Germany.
1994. From May through July, JACQUES CHIRAC, then the mayor of Paris, invites VENET to present twelve sculptures from his *Indeterminate Lines* series on the Champ de Mars.
1995. In the spring he travels to San Francisco for the inauguration of his monumental sculpture *Indeterminate Line*, at the Runnymede Sculpture Farm. In May, he inaugurates in Kowloon, Hong Kong, at the Museum of Modern Art, the first exhibition of the world tour of the works presented in 1994 at Champ de Mars. In June, he is the first artist to inaugurate the new Museum of Art in Shanghai. He starts to execute new reliefs in steel with an acetylene torch: *Indeterminate Area*.
- 1996, 1997. VENET is awarded the honor of Commandeur dans l'ordre des Arts et Lettres by the Minister of Culture in France and becomes a Member of the European Academy of Sciences and Arts in Salzburg, Austria.
1998. VENET travels to China and is invited by the mayor of Shanghai to participate in the Shanghai International Sculpture Symposium.
1999. Installation of a public sculpture in the City of Cologne, Germany, in honor of the G-8 Summit. Publication of his poetry *Apoétiques 1967–1998*, by the Musée d'Art Moderne et Contemporain, Geneva. Public commissions for the new university in Geneva.
- 2000, 2001. VENET develops a new series of wall paintings called *Major Equations*, which are exhibited at the Museu de Arte Moderna in Rio de Janeiro; at the Museu Brasileiro da Escultura in São Paulo; in the Teatro Nacional Brasília; at Centre d'Art Contemporain Georges Pompidou in Cajarç; and at MAMCO in Geneva. He exhibits the new paintings on canvas at the gallery Jérôme de Noirmont in Paris.

Acknowledgement. Without the encouragement and the contributions of the cover editor of the *Notices*, Bill Casselman, this article could not have materialized. Nor would the illustrations be what they are. Thanks. —K. H. H.

Added in Proof, March 26, 2002. The remarks in the first paragraph of my article are now strengthened by the public success of the movie *A Beautiful Mind* (see *Notices* 4 (2002), 455–9) and by the acclaim heaped on it by the movie industry through the awarding of several Oscars, among them the top award for best film. —K. H. H.

The Mathematical Explorer: An Interactive Mathematics Book

Reviewed by David Austin

The Mathematical Explorer

Stan Wagon

Wolfram Research, Inc., 2001

\$89.95 CD-ROM

Though electronic mathematical publishing is still in its infancy, the technology offers tantalizing possibilities. Certainly, \TeX has democratized the way mathematical texts are produced, while PostScript and Adobe Acrobat, combined with the Internet, have given mathematicians more control over the distribution of their printed works. In spite of these revolutions, the format and content of what is delivered to the audience has changed little.

However, it is easy to imagine an electronic text containing hypertext links, the ability to search for keywords, and a more sophisticated use of color. Animations to illustrate dynamic concepts seem to be another reasonable expectation. While this kind of format is currently available on the World Wide Web, we have yet to see a text combining these features with the first-rate mathematical typesetting and ease of use that we are accustomed to in traditional books and are rightly hesitant to sacrifice.

We might also consider our last visit to our favorite online bookseller. The first page likely greeted us by name and contained personalized recommendations based upon previous visits. Essentially, the page has been constructed using our input, unwitting though it may be. Whether this is helpful or intrusive is for each of us to decide.

David Austin is professor of mathematics at Grand Valley State University. His e-mail address is david@merganser.math.gvsu.edu.

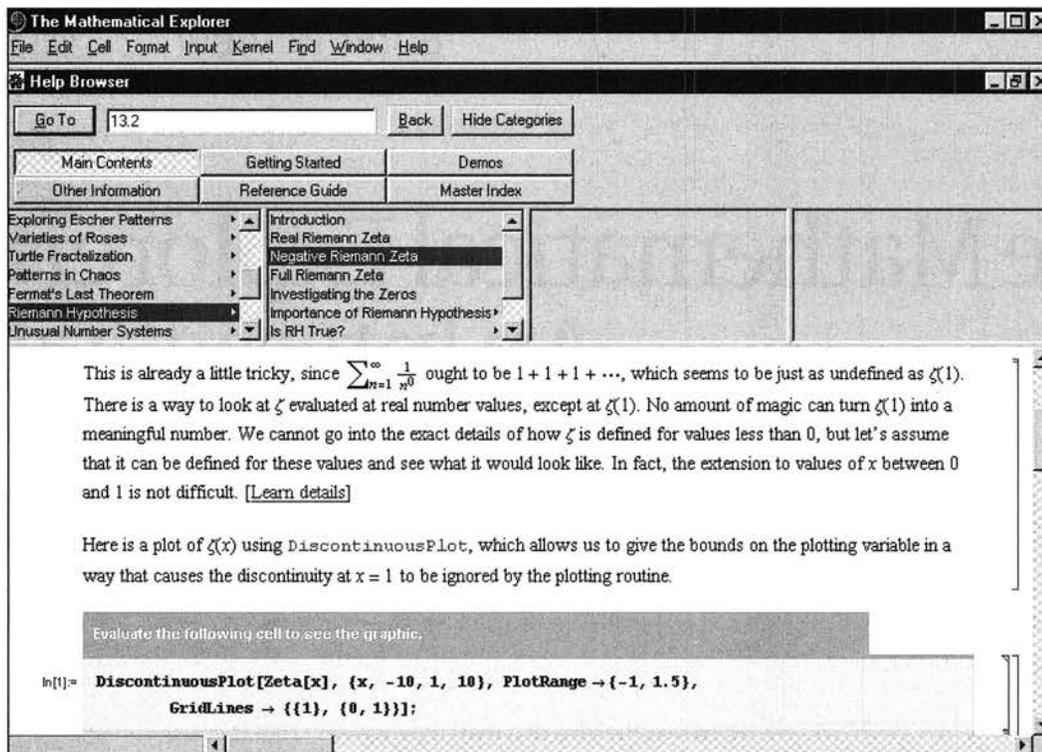
However, the idea of a mathematical text that is constructed in part by us, that allows us to generate examples, make conjectures, and discover results for ourselves is very appealing.

The ability to deliver such content challenges an author to think in new ways. Perhaps it is similar to taking a high school geology class on a field trip. Probably one would want to take the students to a place where they were certain to find something of interest with a little effort and something of great interest with more work. The students should have tools necessary for the job, say, a shovel and pick, but not so sophisticated that learning to use them detracts from their investigations. There should be a definite amount of time allowed for discovery at the end of which the students are called back together so their discoveries are studied and put into context.

The Mathematical Explorer

Since the ideas we understand best are those we discover ourselves, it is tempting to imagine using new technology to give mathematical readers an experience something like this field trip. Such is the promise of Stan Wagon's *The Mathematical Explorer*, an electronic "book" that includes a customized version of the *Mathematica* kernel together with a collection of *Mathematica* notebooks grouped into sections and chapters. While this is not a new means for delivering mathematical content—indeed, it is standard at some universities to distribute laboratory exercises to undergraduates in this way—the scope and intended audience of this book make it a novel and ambitious project.

Priced at \$89.95, *The Mathematical Explorer* package includes a CD-ROM from which the book



This is already a little tricky, since $\sum_{n=1}^{\infty} \frac{1}{n^0}$ ought to be $1 + 1 + 1 + \dots$, which seems to be just as undefined as $\zeta(1)$. There is a way to look at ζ evaluated at real number values, except at $\zeta(1)$. No amount of magic can turn $\zeta(1)$ into a meaningful number. We cannot go into the exact details of how ζ is defined for values less than 0, but let's assume that it can be defined for these values and see what it would look like. In fact, the extension to values of x between 0 and 1 is not difficult. [\[Learn details\]](#)

Here is a plot of $\zeta(x)$ using `DiscontinuousPlot`, which allows us to give the bounds on the plotting variable in a way that causes the discontinuity at $x = 1$ to be ignored by the plotting routine.

Evaluate the following cell to see the graphic.

```
In[1]:= DiscontinuousPlot[Zeta[x], {x, -10, 1, 10}, PlotRange -> {-1, 1.5},
GridLines -> {{1}, {0, 1}};
```

may be installed on most Windows and Macintosh operating systems and a small booklet featuring installation and operating instructions. Upon opening the license agreement, one enters a new, not entirely friendly, age of reading—the owner is allowed to install *The Mathematical Explorer* on only one machine. As a result of the electronic format and the license agreement, the ability to read a book in the bathtub and then lend it to a friend is lost. After installing and opening the book, the reader is presented with an interface like that shown above.

With an advertised audience ranging from anyone with just “a little basic algebra and a sense of fun” to professional mathematicians, *The Mathematical Explorer* surveys a range of topics divided into fifteen roughly independent chapters: prime numbers, calculus, computations of π , properties of the catenary, code checking, encryption, recreational mathematics, Escher tilings, aesthetic qualities of parametric plots, fractals, chaos, Fermat's Last Theorem, the Riemann Hypothesis, unusual number systems, and the Four-Color Theorem. Clearly, some chapters aim to convey an impression of rather deep mathematics while others are

more elementary and intend mainly to entertain. In between, we find applications of subjects likely familiar to an undergraduate mathematics major.

In no way is the treatment within a chapter meant to be exhaustive; the emphasis generally is on describing phenomena rather than explaining them. Instead, the goal is to convey some of the excitement of these mathematical ideas while allowing the reader to explore them using *Mathematica* commands embedded in the text. *The Mathematical Explorer* describes itself as “part text, part guide, part museum and completely fun.” Indeed, it is most enjoyable when ap-

proached as a museum in which exhibits are chosen to present curious or even beautiful phenomena while others aim to familiarize the reader with important mathematics.

A Visit to the Museum

Let's take a quick tour through the first and perhaps strongest chapter, a pleasant excursion through prime numbers and their properties. The first section demonstrates one of the best uses of *Mathematica*. Here, the definition of a prime number is given and a *Mathematica* command, `PrimeQ`, that reports the primality of a given integer, is introduced. By editing the *Mathematica* command line, the reader is allowed to modify the integer and test the primality of other integers (see bottom left).

I modified this to ask whether 12 is prime, and after taking a few seconds to load the kernel, *Mathematica* told me that it was, in fact, not. This is a simple example, but the ability is useful. When presented with a new mathematical definition or construction, most readers likely think of other candidates that may fit the given definition. *Mathematica* gives us a chance to query the book with no intervening computation.

Not all *Mathematica* commands are meant to be edited, though: The use of *Mathematica* for displaying mathematical formulas appears next as we encounter Euclid's proof of the infinitude of prime numbers, one of the few proofs Wagon gives

A **prime number** is a whole number whose only divisors are 1 and the number itself. For example, 11 is prime.

`PrimeQ[n]` yields True if n is a prime number. It yields False otherwise. **warning!**

Evaluate the following input by placing the cursor anywhere in the cell and then pressing Shift-Enter.

You can try other values by editing the input.

```
PrimeQ[11]
```

```
True
```

To compute the n th Euclid number, take the product of the first n prime numbers and then add 1.

```
Euclid[n_] := 1 + Product[Prime[i], {i, 1, n}];
```

This computes the 3rd Euclid number $2 \cdot 3 \cdot 5 + 1$.

in the book. This leads naturally to the introduction of Euclid numbers, conventionally defined by

$$e_{n+1} = 1 + \prod_{i=1}^n p_i$$

where p_i is the i th prime number. Wagon's definition appears as shown above.

Here the definition is given, not in standard mathematical notation, but rather as a piece of *Mathematica* code. This is a general tendency: Displayed mathematical formulas are given in *Mathematica* command lines. Though it is not usually confusing, keeping track of two sets of notation can take some concentration, especially as new and highly specialized *Mathematica* commands begin to proliferate. For instance, algebraic manipulations are performed using commands such as `FullSimplify` and `FunctionExpand` whose meanings are not entirely clear without some investigation. (There is a reference for all of the commands included as an appendix together with hypertext links to places within the text where they are used.)

Following this, we see an intriguing result of electronic publishing. The largest prime Euclid number known at the time of publication was e_{2673} , and *Mathematica* shows us all 10,386 digits of this number. It is one thing to be told by an author that this number has 10,386 digits, but the sensation produced as the digits scroll by for five seconds is much more immediate. Of course, printing this number in a traditional book is not practical (it is about half the length of this review), but in its electronic format, *The Mathematical Explorer* can display it for no added cost. Many of the numbers Wagon presents to us are huge, and *The Mathematical Explorer* gives a good appreciation for the intellectual accomplishment of learning anything about them. Another illustration of this principle occurs in the chapter on Fermat's Last Theorem, primarily a discussion of Diophantine equations. Here, we are explicitly shown a lengthy polynomial in twenty-six variables for which the set of positive outputs resulting from nonnegative integral inputs is exactly the set of prime numbers. Even better, we are given some code to evaluate the polynomial, and we quickly see how difficult it is to generate prime numbers in this way.

Wagon makes the point that though the Euclid numbers will give new primes, few of the numbers are themselves prime, which he illustrates with a table of the first twenty Euclid numbers

showing which ones are prime. He then suggests we explore by editing the *Mathematica* command line to change twenty to a larger number and see whether we find any other prime Euclid numbers. This is a typical kind of experiment that readers are encouraged to make. I edited this line to look at the first 100 Euclid numbers and saw that it is indeed rare to find a prime this way. However, this was not a particularly satisfying discovery; there was no thought required on my part and my understanding and appreciation of this fact was not increased by the experiment.

Another example of this kind of exploration occurs later in the chapter where we are given a command to build tables of prime numbers and asked to make conjectures about the behavior of primes (see below). These tables are a little difficult to

`PrimeTable[a, n]` creates a table of n primes starting at the first prime greater than or equal to a . The number of columns is set by the `Columns` option.

```
PrimeTable[2, 100, Columns -> 10]
```

2	3	5	7	11	13	17	19	23	29
31	37	41	43	47	53	59	61	67	71
73	79	83	89	97	101	103	107	109	113
127	131	137	139	149	151	157	163	167	173
179	181	191	193	197	199	211	223	227	229
233	239	241	251	257	263	269	271	277	281
283	293	307	311	313	317	331	337	347	349
353	359	367	373	379	383	389	397	401	409
419	421	431	433	439	443	449	457	461	463
467	479	487	491	499	503	509	521	523	541

digest and *Mathematica* could have helped by representing the information graphically, say, with the prime numbers indicated on a number line. In addition, most lay readers likely would benefit from a bit more guidance from Wagon; there is no indication of what kinds of things to look for. For instance, it would be helpful to be told to consider how the gaps between primes change as the primes grow larger. Wagon does not physically separate the region of the text in which the exploration occurs from the rest of the text, and it is consequently unclear how much effort we are encouraged to spend here. Finally, there is no summary given of the things we might have found. In fact, the next link takes us to a discussion of Gauss' discovery that the number of primes less than or equal to x is approximated by

$$\int_2^x \frac{1}{\ln(t)} dt.$$

numbers, we would then have a very fast test for primality. But alas, this is not the case. The following computation gives the remainder when 2^{341-1} is divided by 341.

```
n = 341;
Mod[2^n-1, n]
1
```

But 341 is the product of 11 and 31.

```
11*31
341
```

Certainly, we are not expected to discover this approximation, though its qualitative content could be revealed by the exploration, and there is risk that the reader feels the time spent building tables has been wasted.

Most sections contain a few explorations, and the reader could spend considerable time with them. Generally, more creativity is needed in their design to make them more meaningful, and more discussion of the results of the explorations should be provided.

Later, a presentation of Mersenne primes and the question of their infinitude introduces us to some tests for primality and one “almost” test. In particular, we learn that if n is an odd prime, then $2^{n-1} \equiv 1 \pmod{n}$. Examples lead us to suspect that if n is composite, then $2^{n-1} \not\equiv 1 \pmod{n}$. However, $n = 341$ is a counterexample, as shown above.

This illustrates how *Mathematica* code is at times used as an authority that the reader is asked to trust. Typically, an author and reader have an implicit agreement that the author accurately presents the material and takes care of little details to unburden the reader. In several places, *The Mathematical Explorer* asks *Mathematica* to

perform some lengthy computations that are only of interest for their output. We are told several times, in fact, that *The Mathematical Explorer* can prove a result for us, and a line of *Mathematica* code is given with the desired output. Whether this is more convincing than a simple statement by the author is arguable. Seen in this light, however, Wagon’s discus-

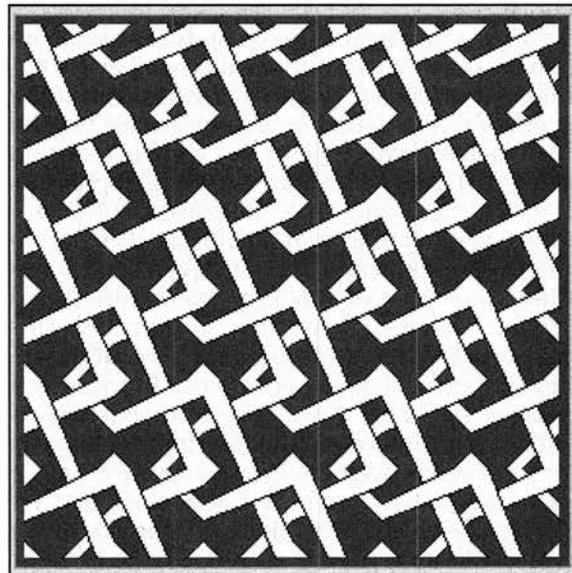
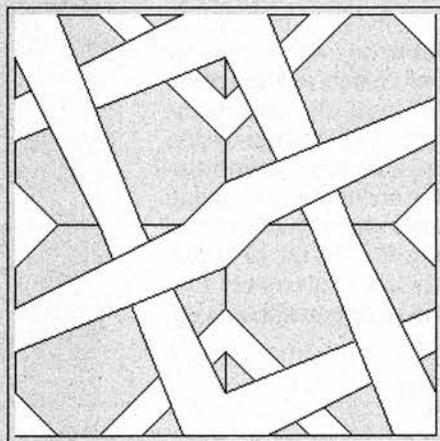
sion of the proof of the Four-Color Theorem and its implications for the nature of proof appears somewhat ironic.

The chapter on prime numbers is well organized and has a strong focus, and *Mathematica* makes a real contribution by showing us just what kind of numbers we are working with. Another interesting chapter concerns Escher’s lesser known work on Euclidean tessellations. Escher began with a simple figure called a “motif”, applied symmetries of the square to four copies of the motif, and then used these to build a 2×2 square (see bottom left). With this as a fundamental region, he tiled the plane to produce interesting, and sometimes beautiful, patterns (see bottom right). In this chapter, the graphics, built with the help of Rick Mabry, are quite good. By editing the *Mathematica* command line, we are able to modify the fundamental region and see what new effects are produced.

The chapter on Escher tilings seems like a good place for a mathematical discussion of symmetry. However, Wagon takes us in a more combinatorial direction, studying the problem of coloring the strands so that the colors appear continuous in the tessellation. Generally, the book tends to emphasize combinatorial mathematics, here at the expense of

Evaluate the following cell to see the graphic.

```
EscherTiling[{{1 2}, {4 3}}, TilingGridLines -> MotifGrid, Colors -> Yellow];
```



a more appealing, geometrical study nicely set up by the graphics.

The chapter titled “Unusual Number Systems” also benefits from *Mathematica*’s abilities. Beginning with a straightforward discussion of representations of numbers in bases other than 10, it proceeds to describe continued fraction expansions. The reader is presented with opportunities to input a number and watch its continued fraction expansion come out. The ability to produce examples effortlessly is a good use of the technology, and we see clearly the property that the partial quotients of a continued fraction provide the best rational approximations for irrational numbers.

We also meet the so-called “harmonic” number system, in which a real number x is represented in the form

$$x = a + \frac{1}{2} \left(b + \frac{1}{3} \left(c + \frac{1}{4} (d + \dots) \right) \right)$$

using integers where $0 \leq b < 2$, $0 \leq c < 3$, and so on. By looking at the representation of different numbers in this system, the reader quickly gains a working understanding. This theme reaches a crescendo with the introduction of the “spigot algorithm”, a surprising algorithm that utilizes a number system similar to the harmonic system to compute the digits of π using only integer arithmetic.

Finally, the chapter on Fermat’s Last Theorem is notable. Here we learn some of the history of the problem and the progress on a solution before Wiles’ work. Wagon wisely chooses not to attempt a sketch of Wiles’ proof and instead diverts us toward a historical discussion of Diophantine equations and various places in which they arise. This chapter has the effect of giving us the feeling that we have rubbed shoulders with a hard problem while still presenting some accessible mathematics.

Regrettably, the quality of the chapters varies considerably. For instance, the chapter on calculus is particularly poor. It is rather short and contains little that would lead one unfamiliar with the subject to much understanding. The writing is sloppy in this section, as it is in a few others, and ranges from merely careless—“We have already pointed out that the reciprocals of the integers diverge to infinity”—to confusing. Consider Wagon’s definition of tangent, the first time this word is used outside of the title of a reference: “Here the slope of the **tangent** [emphasis original] to the curve means that for a small enough interval, the tangent line is indistinguishable from the curve.”

Furthermore, this chapter fails to demonstrate that calculus is a useful subject. The only application of the derivative is to solving the problem of where best to stand when viewing a painting in an

art gallery. Of course, *The Mathematical Explorer* draws the graph of the function we want to maximize. Why do we need derivatives to make life more complicated?

The chapter on code checking introduces us to roughly nine different methods, such as the UPC bar code, by which various kinds of identification numbers are verified. The sections describing these methods vary little and it seems as if so many different methods are included simply because it was easy to modify the *Mathematica* code to produce them. The reader who gives in to the temptation to skip the last sections will miss a surprising method that arises from an application of non-abelian groups and that was used to check the serial numbers of German currency.

Most chapters contain at least a small amount of history or historical anecdotes. Also an appendix contains short biographies of many mathematicians from Archimedes to Wiles. Some of the anecdotes provide amusing counterpoint to the mathematical discussion.

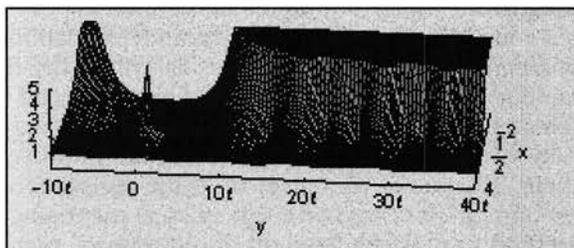
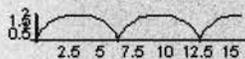
As noted above, some of the writing is careless, frequently containing typographical errors, inaccurate statements, and repetitions. At times, the prose has a breathless quality that may not be appealing to all: “If the space-filling curve is not mind-blowing enough, here is something that is totally outrageous.” Many sections would be better if they informed us as to where we are headed and summarized important ideas once we have seen them. Hypertext links are used inconsistently, sometimes leading to the next section and sometimes not.

Publishing with *Mathematica*

Though *Mathematica* adds useful computational features, its use as a publication tool appears to be somewhat limited. *The Mathematical Explorer* has fonts to produce mathematical notation, such as integral signs, square root symbols, and the Greek alphabet, with a quality only a little inferior to, say, Microsoft Word’s Equation Editor. However, it is cumbersome to navigate the text; the interface looks something like a web browser, and it is disappointing to realize how limited its functionality is compared to a typical browser. Moving about a page is performed by scrolling, with no page up or page down shortcuts. There is a “Back” button for returning the reader to the last page viewed, but no accompanying “Forward” button. Furthermore, the “Back” button always returns you to the top of the previous page rather than to the spot where you were reading. Finally, any modifications made to *Mathematica* commands are lost upon leaving that page. Imagine reading a book and wanting to look up a result in a previous section. By doing so, you lose any trace of the current section and how to return to it; when you do return, it is to the

Evaluate the following cell to see the graphic.

```
ParametricPlot[{t - Sin[t], 1 - Cos[t]}, {t, 0, 5π}, AspectRatio -> Automatic];
```



beginning of the section and any marginal comments you have written have been erased.

Adding to this frustration (see figures above) is the fact that most figures are produced by *Mathematica* commands that the reader must evaluate by pressing “Return” while holding the “Shift” key down before seeing the figure. Of course, you have the flexibility to edit these figures, but there is a price to be paid: When you leave a page, your figures disappear. Furthermore, some of the figures depend on *Mathematica* commands that are given earlier on the page and that must be evaluated by the reader. This means that if you leave a page and return expecting to see a figure, you must reload a string of earlier *Mathematica* commands, and it is often not clear which commands are required.

Generally, the figures produced by *Mathematica* are inferior to illustrations in a traditional book. Of course, *Mathematica* is designed to handle a wide range of graphical requests. This means that the figures have not been customized in any meaningful way as they would be in a printed book.

Animations are especially bad. Usually the number of frames is too small and the time interval between them too large to create the illusion of motion. Worse, however, are the occasional animations created by taking a series of figures and laying them out vertically while the browser scrolls down at just the right speed so that one figure appears to replace its predecessor. Here the viewer has no control over the speed of the animation, and there is a distracting flicker as each new image is displayed. This particular style of animation is largely unusable, and the final chapter on the Four-Color Theorem especially suffers. In the most technical chapter of *The Mathematical Explorer*, Wagon explains Kempe’s erroneous 1879 proof, demonstrating Kempe’s algorithm for coloring a map with such an animation. Since an important part of the discussion in this chapter depends upon understanding this algorithm, the animation is a real hindrance to the reader’s understanding.

Some good opportunities for animations are passed by. There is a section on the Brachistochrone

Problem in which we can compare the time it takes for a ball to roll down the brachistochrone to the time it takes to roll down various other tracks. *Mathematica* here is used only to compute the amount of

time it takes to reach the bottom of the different tracks. The idea could have been illustrated more effectively with an animation showing the two balls rolling down the tracks side by side. In addition, this would have given some insight into why the brachistochrone works.

The Economics of Electronic Publishing

The electronic format of *The Mathematical Explorer* raises some important issues concerning the cost required to produce a book. One appreciates immediately the frequent use of color, reflecting the fact that the marginal cost to include color electronically is almost nothing. Also, *The Mathematical Explorer* can afford to devote large chunks of space to figures and lists without worrying about filling up costly pages. However, the ability to add bulk to a book easily without necessarily increasing its content, as in the chapter on code checking, could be an undesirable byproduct.

There are other electronic books (see Devlin [D], for example) that provide high quality graphics, animations, and even movies, but generally these lack *The Mathematical Explorer*’s ability to respond to substantial requests made by the reader. In fact, the cost of adding interactivity to text is currently high, especially when the human effort of the author and reader is added to the financial cost. Clearly, a significant amount of work has gone into planning and creating the customized *Mathematica* commands used in *The Mathematical Explorer*. However, most of what the reader actually sees has suffered as a result: The writing appears hastily done and the figures are overly reliant on *Mathematica* for their creation.

Also, the reader can find editing the command line repeatedly in *The Mathematical Explorer* to be tedious and error prone. Consider Wagon’s discussion of the derivative of a function by viewing its graph on an increasingly fine scale: To see each refinement, the reader needs to type in a new range. Experience with other software justifies the belief that there are easier ways to operate this demonstration by, say, clicking a button to see the next refinement.

Indeed, demonstrations like this exist on the Web written in the programming language Java, with notable efforts including Bogomolny’s large collection of mathematical applets [B] and Joyce’s edition of *Euclid’s Elements* [J] illustrated in Java. This kind of work represents, in some sense, another end of a spectrum. Since Java offers only low-level mathematical and graphical capabilities

compared to *Mathematica*, the cost to the author in creating Java applets is typically high. However, the rewards can be great: The illustrations and demonstrations that result can be tailored to very specific ends and delivered cheaply over the Web. Well-designed applets have a simpler, easier to use interface than *The Mathematical Explorer*, and the reader's explorations can be more carefully controlled and hence more productive. Furthermore, projects like WebMathematica [WM] and JavaMath [JM] offer the possibility of accessing a computational engine, like *Mathematica*, from within Java, while the New Typesetting System project [N] aims to rewrite \TeX in Java. There is hope for an easily distributed, easy to use format that can support interactive content, high-level computation, and superb typesetting.

Summary

The Mathematical Explorer makes a valuable contribution to a discussion of electronic mathematical publishing. Indeed, it seems almost certain that some kind of high-powered computational engine will eventually be included in electronic texts. Ultimately though, one wishes for a more judicious use of *Mathematica*, or at least for it to be less visible. After all, we are reading a collection of *Mathematica* notebooks, and *The Mathematical Explorer* reveals *Mathematica*'s limited capabilities for displaying mathematics, producing illustrations, and easy navigation. Most users will be frustrated by the interface, expecting that some tasks could more easily be performed. Indeed, *The Mathematical Explorer* reflects the fact that no completely satisfactory means for delivering mathematics with interactive content currently exists.

Furthermore, the problem of how best to use *Mathematica* effectively within the text has not been completely solved. Many of the explorations either require too little thought, which leads to too little payoff, or lack clear objectives and summaries to give readers the pleasure of discovering mathematics. As it stands, this book would most likely appeal to proficient users of *Mathematica* or those who aspire to be. For others wishing to concentrate on the mathematical content, the embedded *Mathematica* can at times be distracting.

Finally, *The Mathematical Explorer* reminds us that books exist so that authors might communicate to their audience; any new tool requires fresh thought to serve that aim effectively. What is most valuable in an electronic book likely will not be much different than that in a traditional book: ease of use, familiar notation and conventions, high-quality typesetting and illustrations, clear exposition, and a style and format that help the reader take possession of new mathematical ideas.

References

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- [JM] JavaMath, <http://javamath.sourceforge.net>.
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Book Review

The Book of Nothing: Vacuums, Voids, and the Latest Ideas About the Origins of the Universe

Reviewed by Jean-Pierre Luminet

The Book of Nothing: Vacuums, Voids, and the Latest Ideas About the Origins of the Universe

John D. Barrow

Pantheon Books, 2001

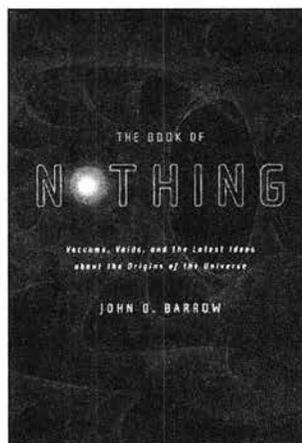
ISBN 0-375-42099-1, 361 pages, \$27.50

According to the Greek poet Hesiod (eighth century B.C.), the world was created *ex vacuo*, i.e., out of the void that existed before it, rather than *ex nihilo*, out of nothing. The distinction is fundamental and has led to centuries of commentaries and controversies in the fields of philosophy and religion as well as science.

Indeed, a *Book of Nothing* was already published in 1510 in Amiens, France (with the Latin title *Liber de Nichilo*). Its author, the illuminist philosopher Charles de Bouelles, invoked the metaphysical and mystical doctrines of Nicolas of Cusa and the Neo-Platonists to show God in the act of creating a finite and temporal universe out of the void.

The 2001 *Book of Nothing* is due to the prolific John Barrow, a research professor of mathematical sciences at the University of Cambridge, an internationally known cosmologist, and an enlightening science writer. He also directs the Millennium Mathematics Project, which aims to raise public understanding of mathematics (see <http://mmp.maths.org/>). Although Barrow does not refer to his rather unknown predecessor, his book draws on a rich cultural background in history, literature, philosophy, religion, ... and, of course, science.

Jean-Pierre Luminet is an astrophysicist working at the Paris Observatory (France). As a science writer, he has written several books, including Black Holes, Celestial Treasury, and Glorious Eclipses, all published by Cambridge University Press. His e-mail address is jean-pierre.luminet@obspm.fr.



Through 280 pages of text, twenty pages of quotes, 100 or so diagrams, followed by fifty pages of notes, Barrow takes the reader on a journey through history and science to explain every aspect of nothingness. From the zeros of mathematicians to the void of philosophers, from Shakespeare to the null set, from the

ether to the quantum vacuum, his book tells how discoveries in science have revealed that Nothing has hidden depths.

The book starts out with historical perceptions of nothing and zero, noting that the very concept was taboo in many places; the Greeks and the Romans did not have a zero in their number systems, and hence Europe for many centuries could not represent it. The zero of the current numeral system originated in India and was put into practice by the merchants of the flourishing medieval Arab civilization, whence it entered Europe in the late Middle Ages. From then, the mathematical zero triumphed because of its usefulness. The notion of a physical zero, however, did not enter the mindset until the physicists Torricelli and von Guericke, in the seventeenth century, removed all the air out of chambers, thereby producing the first laboratory demonstrations of vacuums.

For over three centuries the idea of “empty space” was a staple of human thought until shattered with the arrival of quantum theory in the twentieth

century, with all its bizarre but entirely verifiable implications. Most especially, the uncertainty principle in energy and time tells us that there is a longest time interval available for the energy determination of a system in a given state. Such a law thus expressly forbids a system from assuming any definite energy, which a total vacuum (with zero matter and zero energy) would patently violate. Thus, in contrast to the traditional concept of the primeval void, the quantum vacuum is like a virtual ocean whose surface is continuously agitated by ripples of energy. These ripples can spontaneously generate pairs of particles and antiparticles, which disappear almost as soon as they appear, leaving behind a sort of bubbling brew of energy, in constant flux, the "space-time foam". Occasionally the ripples create particles and antiparticles that are far enough apart not to cancel each other out. This is how matter emerges from the vacuum.

These phenomena have genuine effects on the observable world and on the results of experiments. There is the Casimir effect, for example, a small attractive force that acts between two close parallel uncharged conducting plates, due to quantum vacuum fluctuations of the electromagnetic field. Barrow shows well the many ways now recognized in which something can indeed arise from nothing. For instance the idea of the null set generating numbers, with a neat ironic analogy to how universes are perhaps created out of the vacuum, makes worthwhile reading.

For the remainder of the book, Barrow concentrates on cosmology. Today, many astronomers suspect that vacuum effects may have triggered the Big Bang itself, filling our universe with matter. Indeed, the very latest observations suggest that vacuum effects will dictate the ultimate fate of the universe. Quantum cosmology, based on the general theory of relativity and quantum physics, is an attempt to explain in mathematical terms how the universe suddenly emerged from the quantum vacuum. Some physicists have suggested that in its initial state the quantum vacuum was not at all homogeneous. According to this hypothesis, many different universes were created by different types of fluctuations, each with its own physical properties, each in parallel with or embedded within the others so that no communication between them was possible, except through hypothetical "wormholes".

Barrow does a good job of presenting the mind-boggling idea that our universe may be but one of an infinite number of universes all popping probabilistically out of the vacuum. But problems arise when Barrow ponders the implications this idea holds for the overall structure of the universe. The so-called cosmological constant, which seems to be opposing gravity and pushing the galactic superclusters apart, is of unknown nature and ori-

gin. Barrow makes a very good historical point on page 185 when he recalls the insight of Lemaitre, who as early as 1931 interpreted the cosmological constant as originating in the behavior of matter at very high energies. The cosmological constant may or may not be related to the energy field of the vacuum, but Barrow mixes the term with other concepts such as vacuum energy, dark energy, and quintessence and seems to say many different things about it. As a consequence, his presentation is rather confusing.

For instance, Barrow tries to figure out how the apparent repulsive force is affecting the cosmic expansion and discusses the implications for the future tendencies of the universe. All of the scientific journals show that this is a hotly debated topic full of question marks about the factors we already know, let alone the myriad considerations that we are still unsure about or have not yet thought of. Barrow basically ignores these issues and provides an oversimplified picture.

The most disputable part of the book concerns the notion, supposedly derived from the quantum-mechanical concept of wavefunction collapse of alternate possibilities, that, given sufficient time, every possibility will manifest itself. In reference to the possible eternal expansion of our particular universe, Barrow notes on page 300 that "[w]hen there is an infinite time to wait then anything that can happen, eventually will happen." Applying this deduction to that possible infinity of universes, one finds a companion to the "many worlds" interpretation of quantum mechanics in which a new universe is created with every quantum event. This companion interpretation asserts that in an infinite universe every possible event will take place, and every thought unthought will eventually be thought, that indeed there are unicorns somewhere and politicians who do not lie, and a place where bread always lands butter side up.

This idea is not new and, as already pointed out by many researchers, is basically a misinterpretation of the probabilistic nature of quantum mechanics: Even though the set of possible occurrences that become actual does become larger and larger with time, the pool of possibilities increases even more rapidly. Moreover, the extrapolation breaks down when one considers different arrangements of the actualizations; it is basically a confusion about applying set theory to physics. Such applications should be more modestly utilized.

If Barrow had simply been more careful to acknowledge the speculative nature of the cosmological topics or just allowed for a few more well-placed "we do not know the answers", the later sections of the book would have been of higher quality.

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Hail, Saudi Arabia**



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To summarize, Barrow's book is an outstanding work that seems rushed in its most speculative parts. His thesis is that nature really does abhor the vacuum in the most concrete physical sense: The old notion of a complete void, of empty space, is colossally wrong. The cosmos as revealed by modern astronomy, astrophysics, relativity, quantum mechanics, and the ideas from string theory is a story of breathtaking and mind-boggling sweep and grandeur, often totally unintuitive and beyond the lay reader's wildest imaginings. As picturesque, inventive, and psychologically satisfying as the ancients' tales of the cosmos are, they pale beside the conception of the universe as seen by modern science. Perhaps the main merit of Barrow's *Book of Nothing* is to exemplify the contrast between the ancient lore about the creation of the universe and the modern scientific view.

QED

Reviewed by Allyn Jackson

QED

Peter Parnell

Performed by Alan Alda and Kellie Overbey
Vivian Beaumont Theatre, Lincoln Center

The Nobel Prize-winning physicist Richard Feynman was one of the great iconoclasts. Hard-headed and straight-talking, he insisted on the primacy of understanding things for one's self. When he dropped an O-ring seal into a glass of ice water during a 1986 press conference about the investigation into the explosion of the space shuttle *Challenger*—vividly demonstrating how the cold affected the seals and led to the disaster—Feynman exhibited a world view that sets no store by pronouncements of so-called experts but values instead a direct encounter with the facts, merciless as those facts might be. This relentless rationality did not lead him to cynicism; on the contrary, Feynman had an impish, buoyant personality that was fueled by childlike awe over the beauty of nature and the mysteries of life.

The play *QED*, which opened in Los Angeles in the spring of 2001 and is running in New York at least until early June 2002, attempts to give a sense of who Feynman was, in all his many dimensions. *QED* differs from other plays with scientific and mathematical themes, such as *Arcadia*, *Copenhagen*, *Breaking the Code*, and *Proof*. The first two come under the genre of the theater of ideas, and the other two under the genre of drama; *QED*, by contrast, is a character sketch. The double entendre of the play's title—it could refer to quantum electrodynamics, of which Feynman was a founder, or to *Quod erat demonstrandum*, which traditionally ends a mathematical proof—is apropos: Feyn-

man was a physicist with a mathematician's uncompromising sense of rigor, which comes through strongly in the play.

Essentially a monologue, *QED* was written by Peter Parnell and draws on Feynman's many biographical writings. Ralph Leighton, a friend of Feynman's and author of *Tuva or Bust!: Richard Feynman's Last Journey*, served as a creative consultant for the play, and Tom Rutishauser, Feynman's old drumming buddy, coached actor Alan Alda in the part. Those familiar with such Feynman classics as *Surely You're Joking, Mr. Feynman!* or *What Do You Care What Other People Think?* will find that nearly every bit of *QED* follows closely such works. This approach has the advantage of presenting many of Feynman's best stories largely the way he told them and the disadvantage that many audience members will have heard them before.

The action takes place in Feynman's office at Caltech during a day in 1986. On the blackboard is the Feynman motto: "What I cannot create I do not understand." Feynman was not so self-centered as to assert that anything created by someone else is meaningless to him. What he meant is that understanding comes not from passive acceptance of information but instead arises from a creative struggle with ideas. In the play he talks about how, when he would learn some piece of physics, he would always have to recreate it for himself in some way. "I don't trust the experts," he declares.

Through the course of the play, Feynman flits from one era of his life to another. He talks about his work on the Manhattan Project, which resulted in the world's first atomic bomb, and how his time at the project site in Los Alamos, New Mexico, was punctuated by weekend visits to his wife as she slowly died of tuberculosis. At one moment his office phone rings and it's the chairman of the committee investigating the *Challenger* disaster; at the

Allyn Jackson is senior writer and deputy editor of the Notices. Her e-mail address is axj@ams.org.

next ring it's his friend Ralph Leighton, who is at the airport picking up a bunch of drunken Russians flown in as part of a scheme he and Feynman have hatched to get to the long-gone land of Tuva.

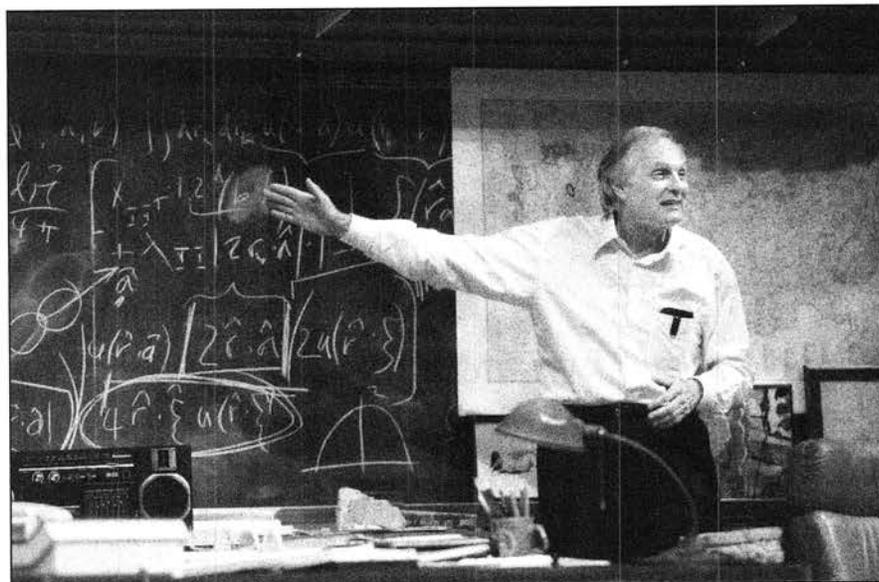
Feynman's well known love of women arises as a running theme. At one point he relates the story about the threatened closure of a topless dance club he frequented; he was the only patron willing to testify publicly on the club's behalf. "The newspapers had a field day!" he recalls, as they related the story of the Nobel Prize winner defending a topless club.

As the play proceeds, jumping from one topic to the next, the bits of science—how light bounces off a mirror, why probability is at the heart of modern physics—arise naturally, as if Feynman saw physics as one more facet of an infinitely interesting world. Along the way he explains the basic ideas behind Feynman diagrams and path integrals (although these names are not used).

At the time of the play Feynman has had a relapse of the cancer that would kill him a year and a half later. He has read a research paper, written by one of his doctors, that discusses a little-understood, experimental method for killing off tumors. On the phone with the doctor, Feynman suggests an explanation for why the method should work. The doctor asks whether Feynman is trying to reinvent all of medical science. "You bet I am!" Feynman retorts with his characteristic hubris. On the phone later with another doctor, Feynman says he wants to be awake if death should come to him on the operating table; he wants to "be there" for his own death. "Wouldn't that be a great experiment?" he asks.

Feynman's infectious curiosity and sense of wonder, mixed with his irreverence and flair for showmanship, make him a natural subject for a one-man show, and Alan Alda plays the part with relish. As the monologue jumps around, Alda's expert sense of timing helps but cannot quite overcome the incoherence of the script. Also, the herky-jerky changes of topic tend to drain the pathos from Feynman's ruminations on death, both his own and that of his first wife.

Apart from Feynman, there is one other character who appears on stage, a fictional student named Miriam Field (played by Kellie Overbey). Infatuated



Alan Alda plays world-renowned Nobel Prize-winning physicist Richard Feynman in Peter Parnell's play *QED*, at the Lincoln Center's Vivian Beaumont Theater in New York City. Photo credit: Craig Schwartz.

by her charismatic and famous teacher, she now and again in the course of the play knocks on his door and asks to see him. At the beginning of the second act Feynman, who was a proficient amateur drummer, returns to his office after performing in a student production of *South Pacific*. Miriam again turns up at his office, this time slightly tipsy after the postperformance party. With Feynman clad in his costume of a long red robe and headdress with enormous orange feathers, the two cut loose and dance wildly around the stage before collapsing in laughter. The dramatic purpose of this bit of physical action is to draw Feynman out of the depression to which he had begun to succumb after brooding about his cancer and the death of his first wife; after this episode he calls his doctor to say that yes, he will go through with another operation after all. But his turnaround seems too pat and is at odds with Feynman's unsentimental view of life. As a result, the catharsis the playwright seems to be reaching for does not occur.

Still, *QED* makes for a thoroughly enjoyable evening in the company of one of the great physicists and one of the extraordinary personalities of our time. This positive portrayal of a scientist in love with his work and with life may help dispel negative perceptions about scientists and mathematicians. The play shows that, far from being deadening and cold, a life of the mind can be full of wonder and adventure. *QED* manages to be a paean both to rational thought and to the sheer joy of life.

Mathematical Sciences in the FY 2003 Budget

Samuel M. Rankin III

Highlights

- Federal support for the mathematical sciences is slated to grow from an estimated \$282.9 million in FY 2002 to an estimated \$326.204 million in FY 2003, an increase of 15.3 percent.
- The National Science Foundation's (NSF) Division of Mathematical Sciences (DMS) would receive a 20.1 percent increase for a total of \$181.87 million in FY 2003 compared to \$151.48 million in FY 2002.
- The mathematics program at the Defense Advanced Research Projects Agency (DARPA), a Department of Defense (DOD) agency, would grow by 33.2 percent. Other major DOD mathematics programs would decline after factoring in inflation.
- The Department of Energy's (DOE) applied mathematics program FY 2003 budget would increase by 13.2 percent over FY 2002.

Introduction

The National Science Foundation (NSF), the Department of Defense (DOD), and the Department of Energy (DOE) together supply the majority of federal support for mathematical sciences research. The NSF accounts for approximately 70 percent of the academic research support for the mathematical sciences and is the only agency that supports mathematics research broadly across all fields. The DOD and DOE support research in the mathematical sciences that contributes to the research and development missions of these agencies. Research supported through these programs is primarily carried out in academic institutions.

Samuel M. Rankin III is director of the AMS Washington office. His e-mail address is smr@ams.org. This article is an adapted version of a chapter that appeared in AAAS Report XXVII: Research and Development FY 2003, an analysis of the fiscal year 2003 federal budget for support of research and development. The report, issued by the American Association for the Advancement of Science, may be found on the Web at <http://www.aaas.org/spp/dspp/rd/fy03.htm>.

The DOD has five programs supporting mathematical sciences research and related activities: the Directorate of Mathematics and Space Sciences within the Air Force Office of Scientific Research (AFOSR); the Mathematical and Computer Sciences Division within the Army Research Office (ARO); the Mathematical, Computer, and Information Sciences Division within the Office of Naval Research (ONR); the Applied and Computational Mathematics Program within the Defense Advanced Research Projects Agency (DARPA); and the Mathematical Sciences Program within the National Security Agency (NSA). The DOE funds mathematics through its Applied Mathematics program within the DOE Mathematical, Computational, and Computer Sciences Research program.

Several other agencies have small amounts of funding for mathematics research as it relates to agency missions. These agencies include National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the Environmental Protection Agency (EPA), and the National Institutes of Standards and Technology (NIST).

Trends in Federal Support for the Mathematical Sciences

The FY 2003 estimated aggregate spending for mathematical research and related activities is \$326.2 million, a potential increase of 15.3 percent over FY 2002 estimated spending. Most of this increase is a result of the 20.1 percent increase proposed for the Division of Mathematical Sciences at the NSF. The DOD agencies have had very little increase in funding levels the last several years, and after adjusting for inflation most DOD programs have decreased in real terms. The increase at DOE for FY 2003 is a healthy 13.2 percent increase over the FY 2002 level.

The NSF is shouldering a significant portion of federally supported academic research in the mathematical sciences, approximately 70 percent. Just a few years ago the NSF portion was in the 50 percent range. This change has come about because of significant increases in the NSF budget while the

budgets of the other agencies have decreased or stayed constant. Recently the contributions that the mathematical sciences make to advances in science and technology have gained more recognition. Hopefully this will result in adequate funding for mathematical sciences research in the future.

National Science Foundation

For FY 2003 NSF has proposed the mathematical sciences as a Foundation-wide priority area and has requested \$60.09 million to carry out the priority area activities. The NSF first requested that the mathematical sciences be designated as a priority area in FY 2002 and added \$30 million for the priority area to the Division of Mathematical Sciences (DMS) budget. The FY 2003 budget request adds another \$30.09 million across the Foundation for a total of \$60.09 million for this priority area. The amount of money requested within DMS for the mathematical sciences priority area is \$47.39 million, while the remaining \$12.7 million of the \$60.09 million total is spread throughout the rest of the NSF.

According to the FY 2003 budget request, the DMS would receive an increase of \$30.39 million for a total of \$181.87 million compared to the FY 2002 level of \$151.48 million. Of the \$30.39 million increase, \$17.39 million is for activities supporting the goals of the NSF-wide mathematical sciences priority area. The remaining \$13 million of the increase is for DMS investments beyond the priority area.

Three goals emerge from the designation of the mathematical sciences as a priority area: fundamental research in the mathematical and statistical sciences, integration of mathematics and statistics research across the full range of science and engineering, and mathematical sciences education. Scientific areas of special interest addressing the second goal are management of large data sets, modeling of uncertainty, and modeling and prediction of complex nonlinear systems.

Mathematics is central to advances in science and technology, so the agency plans to place emphasis on building partnerships with other disciplines. This would be done by establishing collaborations through other NSF divisions and directorates and through other federal agencies. Collaborative projects receive support through the mathematical sciences and from the participating NSF divisions or agencies. Several collaborative efforts began in FY 2002 and include partnerships with the NSF Directorates of Computer and Information Sciences and Engineering (CISE) and Geosciences (GEO), with the National Institute of General Medical Sciences (NIGMS) of the NIH, and with DARPA.

The DMS has several established programs that will facilitate the implementation of the goals of the mathematical sciences priority area. Targeted educational activities can be carried out through the

Vertical Integration of Research and Education (VIGRE) program, the Research Experiences for Undergraduates (REU) program, and by supplements to existing grants. The Focused Research Group (FRG) program would be used to facilitate interdisciplinary interactions as well as to continue to enhance mathematical research through the support of groups of mathematicians working on a problem or on a set of problems.

In FY 2003 the DMS would fund up to seven mathematical sciences institutes. Currently three institutes are supported. Up to four additional institutes will be awarded seed money in FY 2002 with full funding slated to begin in FY 2003. There are no plans to have an institute solicitation in FY 2003; the three current institutes will be reviewed when their current five-year awards expire and can receive, upon satisfactory review, a second five-year award.

The DMS would use some of the additional funds to increase size and duration of grants. The average size of DMS grants is among the smallest in the NSF, and the National Science Board has supported increased grant size and duration in order to support research adequately based on the needs of the science and engineering enterprise.

Air Force Office of Scientific Research (AFOSR)

The Directorate of Mathematics and Space Sciences of AFOSR provides funds for research and related activities in the mathematical sciences in support of the Air Force mission. Current program emphases include cooperative control, quantum computing, and Maxwell's equations. The AFOSR program includes dynamics and control, physical mathematics and applied analysis, computational mathematics, optimization and discrete mathematics, electromagnetics, and signals communication and surveillance. The AFOSR budget shows a decrease under the Administration's budget proposal.

Army Research Office (ARO)

The Mathematical and Computer Sciences Division of ARO continues to be application driven. Specific areas of interest are modeling and simulation of the environment, discrete mathematics, computational mathematics, stochastic analysis, and mathematics related to materials science. Mathematics, which contributes to the advancement of the cognitive sciences and to the biological sciences, is a new interest. The ARO mathematical sciences budget has not increased in two years.

Defense Advanced Research Projects Agency (DARPA)

For FY 2003 the Applied and Computational Mathematics Program at DARPA plans to emphasize the areas of computational geometry and topology, particularly as applied to representation and analysis of geospatial data; modeling and control of quantum systems; applied and computational

harmonic analysis, especially in connection with waveform design for active sensing and with representation of gravitational data; optimization of integrated sensing and processing systems; and numerical analysis, particularly applied to electromagnetic scattering problems. The FY 2003 budget for the mathematical sciences would increase by 33.2 percent over FY 2002.

National Security Agency (NSA)

The NSA has a small grants program that supports fundamental research in the mathematical areas of algebra, number theory, discrete mathematics, and probability and statistics. Other funds are available to support Historically Black Colleges and Universities, Research Experiences for Undergraduates, and a sabbatical leave program for university faculty. The NSA is the world's largest employer of mathematicians. Because it is constrained to hire only U.S. citizens, the NSA has a special interest in encouraging more U.S. citizens to study mathematics.

Office of Naval Research (ONR)

The scientific objective of ONR's Mathematical, Computer, and Information Sciences Division is to establish rigorous mathematical foundations and analytical and computational methods that enhance understanding of complex phenomena and enable prediction and control for naval applications in the future. Basic research in the mathematical sciences is focused on analysis and computation for multiphase, multimaterial, multiphysics

problems; predictability of models for nonlinear dynamics; electromagnetic and acoustic wave propagation; signal and imaging processing; modeling pathological behaviors of large, dynamic complex networks and exploiting hybrid control to achieve reliability and security; optimization; sequencing and scheduling; and construction of complex system software. The division's budget has experienced very little growth in recent years.

Department of Energy

Mathematics is funded through the Applied Mathematics program of the Mathematical, Information, and Computational Sciences Division of DOE. Research is conducted on the underlying mathematical understanding and numerical algorithms to enable effective description and prediction of physical systems. The president's proposed FY 2003 budget includes an increased level of funding for the Computational Sciences Graduate Fellowship program and funding for developing the mathematical understanding and techniques needed for a partnership with the DOE Biological and Environmental Research Program. This research would offer ways to solve environmental challenges related to DOE's missions, including toxic waste cleanup, new clean energy sources, and global climate stabilization through carbon sequestration. The FY 2003 budget for the Applied Mathematics program would grow by 13.2 percent over FY 2002.

Note: Information gathered from agency documents and from agency program officers.

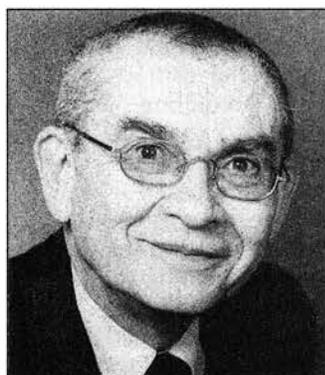
Federal Funding for the Mathematical Sciences (millions of dollars) *

	FY 2001 Actual	FY 2002 Estimate	FY 2003 Request	Change 2002-2003 Amount	Change 2002-2003 Percent
National Science Foundation					
DMS	\$121.441	\$151.48	\$181.87	\$30.39	20.1%
Department of Defense**					
AFOSR	32.7	32.6	32.5	-0.1	-0.3%
ARO	26.4	26.4	26.4	0.0	0.0%
DARPA	16.3	25.0	33.3	8.3	33.2%
NSA	1.7	2.25	2.5	0.25	11.0%
ONR	12.5	13.2	13.4	0.2	1.5%
Total DOD	89.6	99.45	108.1	8.65	8.7%
Department of Energy					
Applied Mathematics	27.11	32.0	36.234	4.234	13.2%
Total All Agencies	238.151	282.93	326.204	43.274	15.3%

*Budget information comes from agency documents and conversations with program managers.

**Budgets are estimates for FY 2002 and FY 2003; DARPA amount assumes approval of Geosciences initiative.

Manin and Shor Receive 2002 Faisal Prize



Yuri I. Manin



Peter W. Shor

On November 27, 2001, in Riyadh, Saudi Arabia, Prince Khaled Al-Faisal, director general of the King Faisal Foundation, announced the winners of the 2002 King Faisal International Prize. Mathematics was the topic for the 2002 Faisal Prize in Science, which was presented to YURI I. MANIN and to PETER W. SHOR.

Manin is widely regarded as one of the outstanding mathematicians of the twentieth century. His work spans such diverse branches of mathematics as algebraic geometry, number theory, and mathematical physics. His many fundamental contributions include the solution of major problems and the development of new techniques that enabled further research. In particular, he is known for his 1963 proof of the Mordell conjecture for function fields. He drew intuition from geometry to make strides in number theory, particularly in Diophantine geometry (Brauer-Manin obstruction), p -adic analysis, and the theory of modular forms. He has also made many contributions to mathematical physics, including work on Yang-Mills instantons, quantum groups, and quantum cohomology. Manin is a director of the Max-Planck-Institut für Mathematik in Bonn, Germany and a leading researcher at the Steklov Mathematical Institute in Moscow (since 1993 in absentia). He has received many awards, including the Lenin Prize for Science (1967), the Brouwer Gold Medal (1987), the Nemmers Prize in Mathematics (1994), the Rolf

Schock Prize in Mathematics (1999), and the Georg Cantor Medal (2002).

In 1994, Peter Shor received worldwide recognition for demonstrating that the uncertainty inherent in quantum systems could be used to factor integers much more quickly than any known algorithm based on the logic of conventional computers. This was the first clear demonstration that quantum systems could increase computing power far beyond today's computers. Shor's breakthrough sparked an explosion of research into the development of quantum computers, which at present remain in the realm of theory. In addition, his result generated great concern about the security of cryptographic systems based on the difficulty of factoring large numbers. Shor has also done work on quantum error-correcting codes and fault-tolerant quantum computation that addresses some of the main obstacles to making quantum computers a reality. Shor is a member of the research staff at AT&T Laboratories. His honors and awards include the Nevanlinna Prize (1998) and a MacArthur Fellowship (1999). He also received the Gödel Prize for his paper "Polynomial-Time Algorithms for Prime Factorization and Discrete Logarithms on a Quantum Computer" (*SIAM Journal of Computing* 26 (1997), no. 5, pages 1484-1509).

The King Faisal Foundation (<http://www.kfff.com/>) each year awards International Prizes for Service to Islam, for Islamic Studies, for Arabic Literature, for Medicine, and for Science. The prize for science rotates among the fields of biology, physics, mathematics, and chemistry. Each prize carries a cash award of SR750,000 (US\$200,000). Each winner also receives a 200-gram, 22-carat gold medallion and a certificate outlining the work for which the prize is awarded.

Institutions and organizations around the world nominate candidates for the prizes. The formal awards ceremony takes place in Riyadh in March each year.

— Allyn Jackson

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Mathematics People



Albert C. Fannjiang



Wee Teck Gan



Ravi Ramakrishna

Institute, and the California Institute of Technology.

Wee Teck Gan

Wee Teck Gan received his Ph.D. from Harvard University in 1998 under the supervision of Benedict H. Gross, as well as Gordan Savin of the

University of Utah. Since graduation, he has been at Princeton University and the Institute for Advanced Study, first as a Veblen Instructor and then as assistant professor at Princeton. He plans to use the Centennial Fellowship to visit Harvard University and Stanford University.

Gan's research interests lie in the intersection of number theory, representation theory, and the theory of automorphic forms. His current research efforts focus on the arithmetic of Fourier coefficients of automorphic forms and the construction of cusp forms and Arthur packets by theta correspondences.

Ravi Kumar Ramakrishna

Ravi Ramakrishna received his Ph.D. from Princeton University in 1992, under the direction of Andrew Wiles. He was an L. E. Dickson Instructor at the University of Chicago (1992-94) and a J. W. Gibbs Assistant Professor at Yale University (1994-98). He is currently an assistant professor at Cornell University.

Ramakrishna's main interest is algebraic number theory. The bulk of his work has involved the study of two-dimensional representations of the absolute Galois group of the rational numbers. In particular, he has studied when $\text{mod } p$ representations can be lifted to characteristic zero deformations. The existence of such liftings provides evidence for an important conjecture of Serre. He plans to use the Centennial Fellowship to visit the University of California at Berkeley.

Please note: Information about the competition for the 2003-04 AMS Centennial Fellowships will be published in the "Mathematics Opportunities" section of an upcoming issue of the *Notices*.

—Allyn Jackson

2002-2003 AMS Centennial Fellowships Awarded

The AMS has awarded three Centennial Fellowships for 2002-03. The recipients are ALBERT C. FANNJIANG of the University of California, Davis; WEE TECK GAN of Princeton University; and RAVI KUMAR RAMAKRISHNA of Cornell University. The amount of the fellowship is \$55,000, with an additional expense allowance of \$1,650.

Albert C. Fannjiang

Albert Fannjiang received his Ph.D in 1992 from the Courant Institute of Mathematical Sciences, New York University, under the supervision of George Papanicolaou. He was a Computational and Applied Mathematics Assistant Professor at the University of California, Los Angeles (1992-95). In 1995, he moved to the University of California, Davis, where he is currently an associate professor and Chancellor's Fellow.

Fannjiang's research concerns differential equations and dynamical systems arising in chaotic or random environments. In particular, he has worked on the problems of turbulent transport of particles, radiative transfer of Schrödinger and acoustic waves, cracks in strain-gradient elasticity, and dynamical systems with noises. His current interests include motion in irregular velocity fields, homogenization of fluid equations, reaction-diffusion problems in fluid flows, wave propagation in multi-scaled media, and noise-induced phenomena in classical and quantum systems.

He plans to use part of the Centennial Fellowship to visit Stanford University, the Mathematical Sciences Research

Sunyer i Balaguer Prize Awarded

The Institut d'Estudis Catalans has awarded the 2002 Ferran Sunyer i Balaguer Prize to ALEXANDER LUBOTZKY, Hebrew University of Jerusalem, and DAN SEGAL, Oxford University, for their joint monograph *Subgroup Growth* and to ANDRÉ UNTERBERGER, University of Reims, for his monograph *Automorphic Pseudodifferential Analysis and Higher-Level Weyl Calculi*. The prize consists of 10,000 euros (about US\$9,000). According to the terms of the prize, the monographs will be published in the Birkhäuser series Progress in Mathematics.

The Ferran Sunyer i Balaguer Prize is awarded each year for a mathematical monograph of an expository nature presenting the latest developments in an active area of mathematics research in which the author has made important contributions.

—From an Institut d'Estudis Catalans announcement

Green and Schwarz Awarded 2002 Heineman Prize

MICHAEL B. GREEN of Cambridge University and JOHN H. SCHWARZ of the California Institute of Technology have been awarded the 2002 Dannie Heineman Prize for Mathematical Physics for their work in the development of superstring theory. The prize carries a cash award of \$7,500 and is presented in recognition of outstanding publications in the field of mathematical physics. The prize was established in 1959 by the Heineman Foundation for Research, Educational, Charitable, and Scientific Purposes, Inc., and is administered jointly by the American Physical Society (APS) and the American Institute of Physics (AIP). The prize is presented annually.

—From an APS announcement

Brillinger Wins Parzen Prize

The Emanuel and Carol Parzen Prize for Statistical Innovation for 2002 has been awarded to DAVID R. BRILLINGER of the University of California, Berkeley, for "outstanding distinction and eminence in research on the theory of statistical time series analysis and data analysis, in applications of statistical methods in diverse fields, and in providing international leadership and continuing impact through his vision and effectiveness as an applied statistician."

The Parzen Prize is awarded in even-numbered years by the Department of Statistics at Texas A&M University to North American statisticians who have made outstanding and influential contributions to the development of applicable and innovative statistical methods. The 2002 Parzen Prize Committee members were Randall Eubank, James Matis, Bradley Efron, Grace Wahba, and Marvin Zelen. The

prize consists of a \$1,000 honorarium and travel to College Station, Texas, to present a lecture at the prize ceremony.

—Department of Statistics, Texas A&M University

Smirnov and Prabhakar Awarded Rollo Davidson Prizes

The trustees of the Rollo Davidson Trust have awarded the 2002 Rollo Davidson Prizes to STANISLAV SMIRNOV of the Royal Institute of Technology, Stockholm, and BALAJI PRABHAKAR of Stanford University. Smirnov was honored for his achievements in critical percolation and conformality in stochastic processes. Prabhakar was chosen for his achievements in queueing theory applied to communication networks.

The prize was established to commemorate the life and work of Rollo Davidson and is awarded to young scientists of outstanding promise and achievements for work in probability, statistics, and related areas.

—From a Rollo Davidson Trust announcement

Stewart and Falconer Win AAAS Awards

The 2002 Award for Public Understanding of Science and Technology of the American Association for the Advancement of Science (AAAS) has been awarded to IAN STEWART of the University of Warwick, England. The award acknowledges talented scientists and engineers who popularize their work and promote their research in a responsible manner. Stewart is known for his popular science writing on mathematical themes and for furthering the public understanding of science.

The AAAS Mentor Award for Lifetime Achievement was given to ETTA Z. FALCONER of Spelman College "for her passionate dedication and long-standing commitment, as a mentor, role model, administrator, and educator, to increase the number of African-American women entering mathematics-related careers."

Both awards carry a cash value of \$5,000.

—From an AAAS announcement

National Science Board Gives Public Service Award

The 2002 National Science Board (NSB) Public Service Award for increasing public understanding of science and engineering has been awarded to the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), an organization that promotes diversity in science careers,

especially for underrepresented Latinos and Native Americans. The annual award recognizes outstanding contributions to communicating, promoting, or helping to develop broad public policy in science and engineering. The NSB honored SACNAS for its work in mentoring and giving information, support, and guidance to young Latino and Native American scientists and engineers. SACNAS was founded in 1972 by Richard Tapia, a mathematician at Rice University.

—From a National Science Foundation announcement

Guggenheim Fellowships Awarded

The John Simon Guggenheim Memorial Foundation has announced the names of 184 artists, scholars, and scientists who were selected as Guggenheim Fellows from more than 2,800 applicants in the 2002 competition. The awards totaled \$6,750,000. Guggenheim Fellows are appointed on the basis of distinguished achievement in the past and exceptional promise for future accomplishment.

Following are the names of the awardees who work in the mathematical sciences, together with their affiliations and areas of research interest. DANIEL S. FREED, University of Texas, Austin: Applications of K -theory to geometry and physics; PAUL H. HALPERN, University of the Sciences in Philadelphia: The concept of dimensionality in science; ALEXANDER KECHRIS, California Institute of Technology: Classification problems in mathematics, group actions, and equivalence relations; KEFENG LIU, University of California, Los Angeles: Mathematical and physical aspects of the mirror principle; MIKHAIL LYUBICH, State University of New York, Stony Brook: Geometric structures in holomorphic dynamics; and RICHARD TAYLOR, Harvard University: Galois representations and modular forms.

—From a Guggenheim Foundation news release

Fulbright Awards Announced

The J. William Fulbright Foundation and the United States Information Agency have announced the names of the recipients of the Fulbright Foreign Scholarships for 2001–02. Following are the U.S. scholars in the mathematical sciences who have been awarded Fulbright scholarships to lecture or conduct research, together with their home institutions and the countries in which they plan to use the awards.

JONATHAN D. FARLEY, Vanderbilt University: United Kingdom; ABDUL J. JERRI, Clarkson University: Jordan; MARTIN L. JONES, College of Charleston: Venezuela; ANATOLY S. LIBGOBER, University of Illinois, Chicago: Israel; JAMES H. MATIS, Texas A&M University: India; ROMAN A. POLYAK, George Mason University: Israel; ALEXANDER M. SAMAROV, University of Massachusetts, Lowell: Israel; and KENNETH J. WILDER, University of Chicago: Colombia.

—From a Fulbright Foundation announcement

2002 Sloan Fellows Announced

The Alfred P. Sloan Foundation has announced the names of 104 outstanding young scientists and economists who have been selected to receive Sloan Research Fellowships. Grants of \$40,000 for a two-year period are administered by each fellow's institution. Once chosen, fellows are free to pursue whatever lines of inquiry most interest them, and they are permitted to employ fellowship funds in a wide variety of ways to further their research aims. More than four hundred nominations for the 2002 awards were reviewed by a committee of distinguished scientists. The mathematicians on the committee were George C. Papanicolaou, Stanford University; Peter Sarnak, Princeton University; and Ronald J. Stern, University of California, Irvine.

The 2002 Sloan Fellows in mathematics are: VINAYAK VATSAL, University of British Columbia; THOMAS SCANLON, University of California, Berkeley; ALEXANDER SOSHNIKOV, University of California, Davis; HONGKAI ZHAO, University of California, Irvine; VAN H. VU, University of California, San Diego; STEPHEN BIGELOW, University of California, Santa Barbara; LEONID V. RYZHIK, University of Chicago; DANIEL BERNSTEIN, University of Illinois, Chicago; ANDRAS VASY, Massachusetts Institute of Technology; PETER D. MILLER, University of Michigan; MARKUS KEEL, University of Minnesota; ERIC VANDEN-EIJNDEN, New York University; BURKHARD WILKING, University of Pennsylvania; BROOKE E. SHIPLEY, Purdue University; KO HONDA, University of Southern California; SERGEY LOTOTSKY, University of Southern California; RAVI DAMODAR VAKIL, Stanford University; SÁNDOR KOVÁCS, University of Washington; YU YUAN, University of Washington; and JAMES F. GEELEN, University of Waterloo.

—Alfred P. Sloan Foundation announcement

NSF Graduate Research Fellowships Announced

The National Science Foundation (NSF) has awarded its Graduate Research Fellowships for fiscal year 2002. This program supports students pursuing doctoral study in all areas of science and engineering and provides a stipend of \$18,000 per year for three years of full-time graduate study.

Listed below are the names of the awardees in the mathematical sciences for 2002, followed by their undergraduate institutions (in parentheses) and the institutions at which they plan to pursue graduate work.

JAMES J. BRINK (Indiana University, Bloomington), University of California, Berkeley; ANDREW G. CANTRELL (Macalester College), University of Wisconsin, Madison; HANS P. CHRISTIANSON (University of Minnesota, Twin Cities), Stanford University; SCOTT M. CORRY (Reed College), University of California, Berkeley; ETHAN G. COTTERILL (Massachusetts Institute of Technology), Harvard University; MATTHEW B. DAY

(University of Texas, Austin), University of Chicago; SARAH E. DEAN (Duke University), Harvard University; MARVIN G. DECKER (University of Kansas), Texas A&M University; EDWARD M. FAN (University of California, Los Angeles), Massachusetts Institute of Technology; DAVID S. FREEMAN (Harvard University), University of California, Berkeley; TEENA M. GERHARDT (Stanford University), Harvard University; JOSH E. GREENE (Harvey Mudd College), University of Chicago; BERTRAND J. GUILLOU (University of Michigan), Massachusetts Institute of Technology; KAY L. KIRKPATRICK (Montana State University), University of California, Berkeley; LIONEL T. LEVINE (Harvard University), Massachusetts Institute of Technology; ROBERT LIPSHITZ (Princeton University), Stanford University; GRACE LYO (Harvard University), University of California, Berkeley; KARL E. MAHLBURG (Harvey Mudd College), University of Wisconsin, Madison; FREDERICK A. MATSEN (Stanford University), Harvard University; DAVESH MAULIK (Harvard University), University of California, Berkeley; CHRISTINA J. OBERLIN (Florida State University), Massachusetts Institute of Technology; LILLIAN B. PIERCE (Princeton University), University of California, Berkeley; DANIEL A. RAMRAS (Cornell University), Massachusetts Institute of Technology; LUCAS A. SABALKA (University of Nebraska, Lincoln), Princeton University; TRAVIS J. SCHEDLER (Harvard University), Massachusetts Institute of Technology; CAMILLIA SMITH (Michigan State University), California Institute of Technology; NOAH J. SNYDER (Harvard University), University of California, Berkeley; BRIDGET E. TENNER (Harvard University), Massachusetts Institute of Technology; ELLEN R. VEOMETT (University of Nebraska, Lincoln), University of Michigan; ERIC D. WEINHANDL (Saint Olaf College), University of Minnesota, Twin Cities; JARED S. WEINSTEIN (Harvard University), University of California, Berkeley; PAUL A. WRIGHT (University of California, Berkeley), New York University; DANIEL L. K. YAMINS (Harvard University), University of California, Berkeley; and JAKUB M. ZIELINSKI (Washington University), University of California, Berkeley.

Editor's note: The institutions of graduate study listed here are from the students' original applications. In some cases students will have switched institutions by the time the fellowship tenure begins.

—From an NSF announcement

2002 Intel Science Talent Search Winners Announced

Three high school students working in mathematics have been awarded Intel Science Talent Search Scholarships for 2002. JACOB LICHT, a seventeen-year-old student at West Hartford High School in West Hartford, Connecticut, won second prize and a \$75,000 scholarship for his project "Rainbow Ramsey Theory: Rainbow Arithmetic Progressions and Anti-Ramsey Results". EMILY RIEHL, a seventeen-year-old student at University High School in Bloomington, Illinois, won third place and a \$50,000 scholarship for her project expanding on geometric objects named for the French mathematician Jacques Tits. The project is titled

"On the Properties of Tits Graphs". Sixth place and a \$25,000 scholarship was awarded to NIKITA ROZENBLYUM, seventeen years old, of Stuyvesant High School in New York, New York. His project is titled "Nullhomotopic Knots in Real Projective Space".

—From an Intel Corporation announcement

National Academy of Engineering Elections

The National Academy of Engineering has announced the election of seventy-four new members and seven foreign associates, including three who work in the mathematical sciences. FRED W. GLOVER of the University of Colorado, Boulder, was elected for contributions to optimization modeling and algorithmic development and for solving problems in distribution, planning, and design. A. STEPHEN MORSE of Yale University was elected for contributions to geometric control theory, adaptive control, and the stability of hybrid systems. ELAINE J. WEYUKER of AT&T Laboratories, Florham Park, New Jersey, was elected for contributions to software testing, reliability, and measurement, and for the development of mathematical foundations for software testing.

—From a National Academy of Engineering announcement

Correction

In the May 2002 issue of the *Notices*, an announcement about the National Academy of Sciences Prize in Applied Mathematics and Numerical Analysis gave an incorrect affiliation for the prizewinner, Heinz-Otto Kreiss. He is a professor emeritus at the University of California, Los Angeles.

Mathematics Opportunities

Call for Nominations for National Medal of Science

The President's Committee on the National Medal of Science is calling for nominations for the 2003 medal. The National Medal of Science is awarded to individuals in recognition of outstanding contributions to knowledge in the fields of mathematical, physical, biological, engineering, and social and behavioral sciences.

The deadline for nominations for the 2003 award is **June 30, 2002**. Further information, guidelines, and instructions for submitting nominations electronically can be found on the website of the National Science Foundation (NSF) at <http://www.nsf.gov/nsb/awards/nms/start.htm>.

—From an NSF announcement

Call for Nominations for Sloan Fellowships

Nominations for candidates for Sloan Research Fellowships, sponsored by the Alfred P. Sloan Foundation, are due by **September 15, 2002**. A candidate must be a member of the regular faculty at a college or university in the United States or Canada and must be at an early stage in his or her research career. For information, write to: Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, NY 10111, or consult the foundation's webpage: <http://www.sloan.org/>.

—From a Sloan Foundation announcement

NSF CAREER Program Guidelines Available

The guidelines for the Faculty Early Career Development (CAREER) Program of the National Science Foundation (NSF) are now available on the World Wide Web. The program solicitation number is NSF 02-111. Information is available at <http://www.nsf.gov/cgi-bin/getpub?nsf02111>. Proposals must be submitted electronically. The deadline for proposals in the mathematical and physical sciences is **July 25, 2002**.

—From an NSF announcement

Call for Nominations for AWM Hay and Schafer Awards

The Executive Committee of the Association for Women in Mathematics (AWM) is calling for nominations for the Louise Hay Award for Contributions to Mathematics Education and the Alice T. Schafer Mathematics Prize. The Louise Hay Award is intended to recognize outstanding achievements in any area of mathematics education, interpreted in the broadest possible sense. The award is presented annually to highlight the importance of mathematics education and to evoke the memory of all that Hay exemplified as a teacher, scholar, administrator, and human being.

The nomination document(s) should include: (1) a one- to three-page letter of nomination highlighting the exceptional contributions of the candidate, (2) a curriculum vitae of the candidate, not exceeding three pages, and (3) three letters supporting the nomination. It is strongly recommended that the letters represent a range of constituents affected by the nominee's work.

The Alice T. Schafer Prize is awarded to an undergraduate woman for excellence in mathematics. The nominee

may be at any level in her undergraduate career but must either be a U.S. citizen or have a U.S. school address. A letter of nomination for the Schafer Prize should include, but not be limited to, an evaluation of the nominee on the following criteria: (1) quality of performance in advanced mathematics courses and special programs, (2) demonstration of real interest in mathematics, (3) ability to do independent work in mathematics, and (4) performance in mathematical competitions at the local or national level, if any. A copy of transcripts and an indication of the candidate's undergraduate level should be included with a letter of nomination. Supporting materials (e.g., reports from summer work using mathematics, copies of talks given in student chapters, recommendations, etc.), if applicable, should be enclosed with the nomination.

Five complete copies of nomination material for these awards should be sent to either: The Hay Award Selection Committee or The Alice T. Schafer Award Selection Committee, Association for Women in Mathematics, 4114 Computer & Space Sciences Building, University of Maryland, College Park, MD 20742-2461. For further information call the AWM at 301-405-7892 or send e-mail to awm@math.umd.edu. Please note that nominations via e-mail or fax are not acceptable. The deadline for nominations for both awards to be received at the AWM office is **October 1, 2002**.

—AWM announcement

MATHEMATICS OPPORTUNITIES

For Your Information

Photos from Fine Hall

"Fine Hall in the Early 60s" is a website containing a collection of photos taken at Fine Hall, home of the mathematics department of Princeton University. Over seventy mathematicians are depicted in the candid photos, which were taken by Jay Goldman of the University of Minnesota. The URL is <http://www.math.sunysb.edu/~tony/album/finehall10.html>.

—Allyn Jackson

IMU Launches Math-Net

In April 2002 the International Mathematical Union (IMU) released Math-Net, a worldwide electronic information and communication system for mathematics (see <http://www.math-net.org/>).

Why is Math-Net needed? Today almost every mathematics department or research institute offers information online. But the content, structure, and presentation of these pages vary widely, making it difficult for users to navigate and find information. Math-Net has been developed as an alternative, effective way for academic departments and research institutes to present structured basic information about themselves and their programs consistently. Math-Net has been designed to facilitate access to high quality mathematical information worldwide, both by human users and search engines.

A special feature of Math-Net is the Math-Net Page, a web gate for mathematics departments and institutes that presents information in a standardized, well-structured, and easy-to-use format.

The Math-Net Page is an additional entry point to institutional information, immediately accessible from the department's homepage, and not meant to replace it. Using this secondary homepage, mathematicians, scientists, students, and the news media can easily find relevant

data, such as staff, student programs, colloquia, seminars, and publications.

The Math-Net Page is an enhanced version of a webpage that originated in a project in Germany that was targeted at establishing a nationwide information and communication system for mathematics departments. A tool for creating Math-Net pages as well as assistance are available at no charge at http://www.math-net.org/Math-Net_Page_Help.html. Mathematics departments around the world are currently beginning to set up Math-Net Pages.

The Math-Net Pages are collected by the Math-Net service NAVIGATOR (<http://www.math-net.org/navigator/>), which gathers the local information and makes it globally available. Other services of this type are MPRESS (<http://mathnet.preprints.org/>), which collects information about mathematical preprints, and PERSONA MATHEMATICA (http://www.mi.uni-koe1n.de/Math-Net/persona_mathematica/), a search engine for mathematical researchers.

Math-Net aims at paving the way towards open and free exchange of information within and for the international mathematics community. In May 2000 the IMU adopted the Math-Net Charter (see <http://www.math-net.org/Charter/>). The IMU's Committee on Electronic Information and Communication (CEIC) has issued a recommendation that universities and institutes worldwide install the Math-Net Page.

—IMU News Release

New Zealand Institute Launched

On March 6, 2002, the formation of five Centers of Research Excellence was announced by the New Zealand government. The New Zealand Institute of Mathematics and its Applications (NZIMA) was one of the five successful centers. In addition, one of the other centers, the Allan Wilson

Center for Molecular Ecology and Evolution, has a major biomathematics component.

The NZIMA is based at the University of Auckland and headed by Vaughan Jones of the University of California, Berkeley, and Marston Conder of the University of Auckland. It will be modeled on similar mathematical research institutes, notably the Fields Institute in Toronto, Canada; the Instituto de Matemática Pura e Aplicada in Rio de Janeiro, Brazil; the Mathematical Sciences Research Institute in Berkeley; and the Isaac Newton Institute in Cambridge, UK. The NZIMA will emphasize world-class research and the use of high-level mathematical techniques in modern application areas such as bioengineering, bioinformatics, medical statistics, operations research, and risk assessment.

The objectives of the NZIMA are to (1) create and sustain a critical mass of researchers in concentrations of excellence in mathematics and statistics and their applications, (2) provide New Zealand with a source of high-level quantitative expertise across a range of areas, (3) act as a facilitator of access to new developments internationally in the mathematical sciences, and (4) raise the level of knowledge and skills in the mathematical sciences in New Zealand.

The NZIMA is expected to open for business later in 2002. Its key activities will include: the organization of two six-month programs each year on themes drawn from a range of fields; an associated workshop held at various locations around New Zealand; scholarships and postdoctoral fellowships in the theme areas; and annual Maclaurin Fellowships to enable mathematical scientists from New Zealand or worldwide to take time out from their usual occupations and undertake full-time research in New Zealand (or partly overseas if based in New Zealand).

The Maclaurin Fellowships are named in honor of Richard Cockburn Maclaurin, who was a graduate of Auckland University College. He went on to study at Cambridge, where he won the Smith Prize in Mathematics and Yorke Prize in Law, and was appointed as Foundation Professor of Mathematics at Victoria University College in 1899 and later dean of law and professor of astronomy. In 1908 he was invited to become president of the Massachusetts Institute of Technology, where he helped transform that institution into the world-class research-based technological university it is today.

The Allan Wilson Center for Molecular Ecology and Evolution will be hosted by Massey University and directed by professors David Penny (biology) and Michael Hendy (mathematics). The center's vision is to utilize the network of outstanding New Zealand biologists and mathematicians who have made significant contributions to developing new analytical methods and techniques in this area, to address some of the fundamental questions about New Zealand's plant and animal life. A significant degree of collaboration with the NZIMA in areas of biomathematics and bioinformatics is anticipated.

—From an announcement by Rod Downey, president,
New Zealand Mathematical Society

Correction

My review of the movie *A Beautiful Mind* (*Notices*, April 2002, pages 455-7) reads: "I wonder at Crowe's visually informed intelligence. What inspired him in the fall of 2000 as he watched a Rademacher lecture alone at the back of the hall?..." In fact, it was Nash, not Crowe, who attended the Rademacher lecture. Crowe was in Australia on September 18, 2000.

—Lynne M. Butler

Correction

Listed in the category of "Gifts in Honor of" in the "American Mathematical Society—Contributions" (May 2002, page 587) was an incorrectly spelled name. The name listed should have been H. F. Bohnenblust.

Inside the AMS

AMS-AAAS 2002 Mass Media Fellow Chosen

The 2002 AMS-AAAS Mass Media Fellowship has been awarded to KATHERINE PAUR, a mathematics graduate student at Harvard University. Paur has been placed at the *Chicago Tribune* for her summer fellowship, beginning in June 2002, after an orientation in Washington, DC.

Paur did her undergraduate work at the Massachusetts Institute of Technology, graduating in 1999. She expects to receive her Ph.D. from Harvard in 2005.

—AMS Washington Office

AMS Capitol Hill Briefing

Ingrid Daubechies of Princeton University spoke on “Mathematics, Patterns, and Homeland Security” at this year’s Congressional lunch briefing on Capitol Hill for members of Congress and their staffs, held February 28, 2002. The Mathematical Sciences Research Institute (MSRI), in Berkeley, California, joined the AMS to sponsor the event, one in a series intended to bring mathematicians to Washington to discuss federally-funded research that affects sensitive issues currently before Congress.

Daubechies described how mathematicians use wavelet analysis in several of these areas; for example, the FBI uses wavelets to compress its vast library of fingerprint data. Wavelets are also a key ingredient in the analysis of sonar data.



At the congressional lunch briefing in Washington, DC, left to right: speaker Ingrid Daubechies, Congressman Vernon J. Ehlers, and MSRI director David Eisenbud.

David Eisenbud, MSRI director and AMS president-elect, welcomed guests on behalf of AMS and MSRI. James Schatz of the National Security Agency introduced the speaker and gave a short overview of the types of security issues encountered by NSA.

Congressman Rush Holt and Congressman Vernon J. Ehlers, long-time champions of science, were our Congressional hosts, and both attended the briefing.

—Monica Foulkes, AMS Washington Office

A Summer at Discovery.com

Each summer, the American Association for the Advancement of Science (AAAS) runs a fellowship program that places science graduate students in ten-week internships at media outlets. In sponsoring the AMS-AAAS Mass Media Fellowship, the AMS provides funds for one or two mathematics graduate students to participate each year. What follows are reflections by Rafe Jones, a mathematics graduate student at Brown University, about his fellowship at Discovery.com during the summer of 2001.

The deadline to apply for the AMS-AAAS Mass Media Fellowship is traditionally January 15 each year. Information about applying will appear in the “Stipends” section of the September issue of the Notices.

Words and writing have held my interest nearly as long and well as mathematics. Someday I hope to explore ways of combining these interests, perhaps by writing about math for the general public. In order to explore the world of writing for a general audience and to get a glimpse of how the media work, I decided to spend the summer as a AAAS-AMS Mass Media Fellow. I discovered that writing for the general public is a strange hybrid of information and amusement, and the tension between the two came into sharp focus during my ten week stint writing for Discovery.com, located in Bethesda, Maryland.

When I started the fellowship, Discovery.com had recently undergone dramatic cutbacks and changes. Only a year before, the website had been almost entirely independent from the Discovery TV channels, and the staff had been nearly three times as large. I arrived to find a relatively understaffed group that produced a website where nearly everything promoted or enhanced the content of Discovery’s TV programs. One exception stands out: a series of news pages, edited by Lori Cuthbert, the lone survivor of what was once a busy ten-person staff. Lori was responsible for bringing me to Discovery, and she served as

my mentor and director, finding me a series of interesting projects in various corners of the labyrinthine website. She spent a solid week showing me the protocols for creating pages, farming out work on the news sites to me, and introducing me to the startlingly good \$5 sushi lunch at the nearby Bethesda Food Court.

Lori also got me connected to Greg Henderson, executive producer of a package tied to the show “When Dinosaurs Roamed America,” and a former Supreme Court correspondent and long-distance bicyclist. Greg gave me my first meaty, independent assignment, one that I might not have gotten had the staff been less shorthanded. The dinosaur package featured a dinosaur ZIP code finder: type in your ZIP code, and up pops a list of the dinosaurs that used to roam your neighborhood. Clicking on one of the names in the list produced a small window containing a description of the dinosaur. These descriptions were my job. My mom tells me I was a dinosaur-obsessed child, and that enthusiasm bubbled up again as I researched the 25 different dinosaur species. I described the *Thescelosaurus* as a “swift, two-legged plant-muncher [who] liked to loiter in Cretaceous forests,” while the *Syntarsus* “cavorted through Early Jurassic arid lands, chasing down lizards and big insects for meals.” Though subsequent drastic cutting of my descriptions frustrated me a bit—I’d been told the final versions could be 100 words each when in fact only around 50 words survived—I was happy with them. The basic purpose of the pieces was to educate, but I felt I’d made them somewhat entertaining as well.

If the dinosaur pieces were meant to entertain as well as inform, my next project focused almost exclusively on information. A package tied to Shark Week included a page containing a compendium of shark-related news stories from the past year. Lori and I had to scrape to get enough stories, and ended up including a couple that probably were not entertaining enough. We dug up stories from Discovery’s archives and various places on the Web. Where the stories were incomplete, I fleshed them out, and wrote from scratch one story on shark feeding—where paid dive leaders attract sharks with dead fish so that divers can see them up close. The different voices I heard while doing interviews for that story have stuck with me. A dive-shop owner whose business depended in part on shark feeding defended it in colloquial but passionate terms; a scientist I reached on his cell phone at a music shop attacked the feedings with a rambling indignation chock full of statistics. This gave me valuable experience with actual journalism, and I learned a great deal as well from the extensive editing the piece received.

After that the pendulum swung dramatically to entertainment. I went to work on a package tied to a three-part TV series called “The Human Face.” I undertook the writing and building of a page devoted to the first part of the series, about an ex-plastic surgeon who’d developed a mask that he deemed the shape of the perfect face. Although the doctor’s work didn’t seem to be devoid of science—he claimed to have done extensive studies showing a broad preference for faces that fit his mask—he went well beyond claiming his mask simply fit beautiful faces. He

asserted that in each human mind is a genetically determined “ideal” face that he had discovered. This claim is the one that draws viewers, and I believe is the reason Discovery decided to devote an entire show to the mask. However, I learned that not many scholars accept the notion of “ideal” bodies or parts of bodies, and in fact such ideas hark back to the dark days of eugenics. I soon discovered, though, that I wasn’t allowed to call the doctor’s theories into question. The purpose of the package was to get people to watch the show, and casting doubt on the claims of the mask’s perfection didn’t further that purpose. I wrote a piece that focused mainly on the math the doctor used to make the mask, but I had to include his theories in a relatively prominent place, essentially without an opposing viewpoint.

During this project, another Mass Media Fellow passed me a press release that proved to be my most memorable learning experience on the difficulty of writing for a general audience on a topic one knows well. The press release detailed recent progress towards showing that the digits of π are normal—that is, that any string of n digits is as likely to occur as any other such string. Up until this point, my math background had served me well: It gave me some general analytical skills, but meant I knew little more than the average person about most science that appears in the news. Having just understood the basics of a subject makes it much easier to write for a general audience. With the π story, though, my knowledge was a liability. I think the story held genuine interest for the public, and Lori was curious, but my first attempt at putting the story into comprehensible terms resulted in an article without a clear main point and too full of intricate details. A second rewriting led to a much more understandable story whose main point wasn’t stated in a way that made it compelling enough. A third rewriting made the point compelling, I thought, but by then the story’s window of opportunity had passed, and I don’t think it got any further consideration.

I have not reached any ironclad conclusions about the relationship between news and entertainment. During my experience with the beauty mask, I saw that excessive emphasis on entertainment compromises the value of an article. From my experience with the π piece, I learned that excessive emphasis on complicated information also diminishes an article’s impact. Good writing manages to balance concerns of education and entertainment, even though the two aren’t always compatible. I feel fortunate to have worked on projects where education took precedence over entertainment—most of the work at Discovery has more in common with the beauty mask story than with the shark news archive. Though Discovery may lean a bit too far to the side of entertainment for my tastes, this leaning helped me better understand the role of entertainment in effective public communication.

I take away from the summer a sense that communicating science to the general public is difficult, but that there is in the public a real hunger for scientific stories, as evidenced by the impressively large number of hits on the various news pages on Discovery’s site. Although I don’t plan to pursue a career in journalism, the skills I gained

this summer will make me a better communicator of science from within the scientific community. As math is a particularly difficult subject to communicate well to the public, we are in need of articulate mathematicians who have some rapport with the media. I hope to be able to provide help on that front, as math depends on public exposure for funding, public trust, and the making of future mathematicians.

—*Rafe Jones, Brown University*

STIX Fonts Given Unicode Codes

STIX (Scientific and Technical Information eXchange) is a project that aims to produce a free font set to meet the needs of scientific and technical publishing both online and in print. A major milestone of STIX was reached recently, with the release of a set of unique, universally standardized computer codes for a large collection of mathematical and technical symbols.

The wide variety of symbols used in scientific and technical writing mean that authors and publishers often patch together font sets by mixing proprietary and freely available fonts. Font licensing considerations can restrict the exchange of these fonts sets and sometimes of the documents created with them. The aim of STIX is to address these problems in both print and electronic media. STIX is a project of a group of six publishers (including the AMS) and is overseen by a team of about ten electronic publishing professionals drawn from the publishers' staffs.

The first goal of STIX has now been largely realized: to ensure that all the symbols to be included in the STIX font set have Unicode codes. Like the familiar ASCII system, Unicode is a system for encoding written material into a form that can be processed by computer. But where ASCII represents only the (unaccented) Latin alphabet, Unicode has the capacity to provide 16-bit codes for 64,000 characters and symbols. The goal of Unicode is to provide such codes for all symbols in all languages, so that speakers of any language can communicate directly in their own language, without artificial mechanisms for adding accents or transliterating into a different alphabet. All Web browser suppliers are now basing their products on Unicode, which will eventually replace ASCII. In the spring of 2002, Unicode Version 3.2 was released, and it includes all of the symbols the STIX project had identified as needing codes. (See http://www.unicode.org/press/press_release-3.2.html for further information on the Unicode release.)

The second goal of STIX is the actual creation of the STIX fonts. After a round of bids was received, a well respected font vendor was chosen to develop the fonts. The vendor has been delivering the symbols on an ongoing basis, and at the time of this writing had finished development of about half of the symbols, the total number of which runs into the thousands. The STIX team is currently carrying out refinements and testing. The fonts, which will be available under license but free of charge, should be complete in late 2003.

Free availability of a universal font set will facilitate the flow of scientific and technical communication by simplifying exchange of documents among authors and publishers. It will also improve the on-screen appearance of technical symbols in Web documents. The STIX team has had close cooperation with the developers of the MATHML markup language for presenting mathematics in Web documents. In this way, the STIX project will contribute to the realization of mathematics publishing on the World Wide Web.

STIX is a project of STIPUB (Scientific and Technical Information Publishers), which consists of the AMS, the American Chemical Society, the American Institute of Physics, the American Physical Society, the Institute of Electrical and Electronics Engineers, and Elsevier, Inc. The cost of the development of the STIX fonts is being shared among the STIPUB members.

—*Allyn Jackson*

Deaths of AMS Members

HARALD BERGSTROM, Goteborg, Sweden, died on April 23, 2001. He was a member of the Society for 47 years.

RICHARD L. W. BROWN, York University, Canada, died on March 9, 2002. He was a member of the Society for 37 years.

JULIUS S. DWORK, of Essex Junction, VT, died on February 20, 2002. He was a member of the Society for 56 years.

FRIITZ HERZOG, Michigan State University, died on November 21, 2001. Born on December 6, 1902, he was a member of the Society for 66 years.

SOLOMON HURWITZ, professor emeritus of City College, City University of New York (Manhattan), died on December 22, 2001. Born on April 11, 1907, he was a member of the Society for 58 years.

LEONCE LESIEUR, of Sceaux, France, died on March 26, 2002. He was a member of the Society for 52 years.

ROBERT C. MEACHAM, of St. Petersburg, FL, died on February 19, 2002. He was a member of the Society for 53 years.

MENACHEM MAX SCHIFFER, professor emeritus of mathematics, Stanford University, died on November 11, 1997. Born in 1911, he was a member of the Society for 50 years.

LOWELL I. SCHOENFELD, of Grand Island, NY, died on February 6, 2002. He was a member of the Society for 58 years.

BINYAMIN SCHWARZ, professor emeritus, Technion-Israel Institute of Technology, Haifa, died on August 10, 2001. Born on December 7, 1919, he was a member of the Society for 46 years.

CHARLES STEELE, of Lowell, MA, died on December 25, 2001. He was a member of the Society for 31 years.

NAZA TANOVIC-MILLER, of Sarajevo, Bosnia-Herzegovina, died on November 15, 2001. She was a member of the Society for 8 years.

ALAN T. THOMAS, of Louisville, KY, died on September 16, 2001. He was a member of the Society for 44 years.

KAZUSHIGE UENO, of Tokyo, Japan, died on April 9, 2002. He was a member of the Society for 16 years.

TILLA WEINSTEIN, Rutgers University, died on January 22, 2002. She was a member of the Society for 24 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.

Information for *Notices* Authors

The *Notices* welcomes unsolicited articles for consideration for publication, as well as proposals for such articles. The following provides general guidelines for writing *Notices* articles and preparing them for submission.

Notices readership. The *Notices* goes to about 30,000 subscribers worldwide, of whom about 20,000 are in North America. Approximately 8,000 of the 20,000 in North America

are graduate students who have completed at least one year of graduate school. All readers may be assumed to be interested in mathematics research, but they are not all active researchers.

Notices feature articles. Feature articles may address mathematics, mathematical news and developments, mathematics history, issues affecting the profession, mathematics education at any level, the AMS and

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 E-mail Addresses—November 2001, p. 1195

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 2001, p. 1032

Backlog of Mathematics Research Journals—December 2001, p. 1355, January 2002, p. 46

Conference Board of the Mathematical Sciences—September 2001, p. 843

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

Mathematics Research Institutes Contact Information—August 2001, p. 731

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 2001, p. 1009 (DoD, DoE); November 2001, p. 1198 (NSF)

its activities, and other such topics of interest to *Notices* readers. Each article is expected to have a large target audience of readers, perhaps 5,000 of the 30,000 subscribers. Authors must therefore write their articles for nonexperts rather than for experts or would-be experts. In particular, the mathematics articles in the *Notices* are expository. The language of the *Notices* is English.

Most feature articles, including those on mathematics, are expected to be of long-term value and should be written as such. Ideally each article should put its topic in a context, providing some history and other orientation for the reader and, as necessary, relating the subject matter to things that readers are likely to understand. In most cases, articles should progress to dealing with contemporary matters, not giving only historical material. The articles that are received the best by readers tend to relate different areas of mathematics to each other.

By design the *Notices* is partly magazine and partly journal, and authors' expository styles should take this into account. For example, many readers want to understand the mathematics articles without undue effort and without consulting other sources.

Mathematics feature articles in the *Notices* are normally six to nine pages, sometimes a little longer. Shorter articles are more likely to be read fully than are longer articles. The first page is 400 or 500 words, and subsequent pages are about 800 words. From this one should subtract an allowance for figures, photos, and other illustrations, and an appropriate allowance for any displayed equations and any bibliography.

Form of articles. Except with very short articles, authors are encouraged to use section headings and subsection headings to help orient readers. Normally there is no section heading at the beginning of an article. Despite the encouraged use of internal headings, the assigning of numbers to sections and subsections is not permitted in any article.

The bibliography should be kept short. In the case of mathematics articles, bibliographies are normally lim-

ited to about ten items and should consist primarily of entries like books in which one may do further reading. To help readers who might want lists of recent literature, an author might include a small number of recent publications with good bibliographies.

Editing process. Most articles that are destined to be accepted undergo an intensive editing process. The purposes of this process are to ensure that the target audience is as large as practicable, that the content of the article is clear and unambiguous, and that the article is relatively easy to read. Usually it is the members of the editorial board who are involved in this process. Sometimes outside referees are consulted.

Preparation of articles for submission. The preferred form for submitted articles is as electronic files. Authors who cannot send articles electronically may send the articles by fax or by postal mail.

Articles with a significant number of mathematical symbols are best prepared in $\text{T}_\text{E}\text{X}$, $\text{L}^{\text{A}}\text{T}_\text{E}\text{X}$, or $\mathcal{A}\mathcal{M}\mathcal{S}\text{-T}_\text{E}\text{X}$. There are no special style files for the *Notices* because $\text{T}_\text{E}\text{X}$ code gets converted to something else during the production process. Since the *Notices* is set in narrow columns, keeping displayed formulas relatively short helps to minimize adjustments during the production process; avoiding non-standard supplementary files and complex sequences of $\text{T}_\text{E}\text{X}$ definitions also helps. For the handling of figures and other illustrations, please consult the editor.

Articles without a significant number of mathematical symbols may be prepared as text files or in Microsoft Word. In the case of files prepared in Microsoft Word, it is advisable to send both the file and a fax of a printout.

Upcoming Deadlines

June 30, 2002: Nominations for the National Medal of Science. See "Mathematics Opportunities" in this issue.

July 15, 2002: Applications for the AAAS Women's International Science Collaboration Program (WISC). See <http://www.aaas.org/international/wiscnew.shtml>, or contact WISC Travel Grant, American Association for the Advancement of

Science, Directorate for International Programs, 1200 New York Avenue, NW, Washington, D.C., 20005.

July 25, 2002: Proposals for NSF CAREER Program. See "Mathematics Opportunities" in this issue.

August 1, 2002: Applications for Fulbright Lecturing and Research Grants. See "Mathematics Opportunities" in this issue.

August 15, 2002: Applications for National Research Council Research Associateship Program. See <http://www4.nationalacademies.org/pga/rap.nsf/> or contact the National Research Council, Associateship Programs (TJ 2114), 2101 Constitution Avenue, NW, Washington, DC 20418; telephone 202-334-2760; fax 202-334-2759; e-mail: rap@nas.edu.

September 15, 2002: Nominations for Sloan Research Fellowships. See "Mathematics Opportunities" in this issue.

October 1, 2002: Nominations for AWM Hay and Schafer Awards. See "Mathematics Opportunities" in this issue.

October 1, 2002: Applications for NSF/AWM Travel Grants for Women. See <http://www.awm-math.org/travelgrants.html>; telephone 301-405-7892; e-mail: awm@math.umd.edu.

October 15, 2002: Applications for spring semester of Math in Moscow and for AMS scholarships. See <http://www.mccme.ru/mathin-moscow> or contact Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax +7095-291-65-01; e-mail: 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; e-mail: prof-serv@ams.org.

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

New Journals for 2001

Below is a list of mathematical journals appearing for the first time in

2001, as compiled by *Mathematical Reviews*. This list, as well as the listings for new journals for other years, can be found on the Web at <http://www.ams.org/mathweb/mi-newjs.html>.

Advances in Geometry, 1615-715X, de Gruyter.

Advanced Nonlinear Studies, 1536-1365, Adv. Nonlinear Stud., San Antonio.

Algebraic & Geometric Topology, Geometry & Topology Publications.

Applied Mathematics E-Notes, Tsing Hua Univ., Taiwan.

Discrete and Continuous Dynamical Systems, Series B, 1531-3492, Southwest Missouri State University.

Forum Geometricorum, Florida Atlantic University.

Foundations of Computational Mathematics, 1615-3375, Springer.

Journal of Applied Mathematics, 1110-757X, Hindawi.

Journal of Evolution Equations, 1424-3199, Birkhäuser.

Journal of Mathematical Logic, 0219-0613, World Scientific.

Moscow Mathematical Journal, 1609-3321, Independent University of Moscow.

Stochastics and Dynamics, World Scientific.

Theory and Practice of Logic Programming, Cambridge University Press.

Book List

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

* *Algebraic Number Theory and Fermat's Last Theorem*, by Ian Stewart

and David Tall. A K Peters, revised third edition, December 2001. ISBN 1-56881119-5.

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

The Bit and the Pendulum: How the New Physics of Information Is Revolutionizing Science, by Tom Siegfried. John Wiley & Sons, February 2000. ISBN 0-47132-174-5.

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 in this issue.)

Calculated Bets: Computers, Gambling, and Mathematical Modeling to Win, by Steven S. Skiena. Cambridge University Press, September 2001. ISBN 0-521-00962-6.

* *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.

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

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 Difference Engine: Charles Babbage and the Quest to Build the First Computer, by Doron Swade. Viking Press, September 2001. ISBN 0-670-91020-1.

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.

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.)

Exploring Randomness, by Gregory J. Chaitin. Springer, December 2000. ISBN 1-852-33-417-7. (Reviewed October 2001.)

Flatterland: Like Flatland, Only More So, by Ian Stewart. Perseus Publishing, May 2001. ISBN 0-7382-0442-0. (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.

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

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, to appear March 2002. ISBN 3-540-41949-7.

Gödel: A Life of Logic, by John L. Casti and Werner DePauli. Perseus Publishing, August 2000. ISBN 0-7382-0274-6. (Reviewed September 2001.)

* *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.

Reference and Book List

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.

The Hole in the Universe: How Scientists Peered over the Edge of Emptiness and Found Everything, by K. C. Cole. Harcourt Brace, January 2001. ISBN 0-151-00398-X.

How the Other Half Thinks: Adventures in Mathematical Reasoning, by Sherman Stein. McGraw-Hill, July 2001. ISBN 0-071-37339-X.

In Code: A Mathematical Journey, by Sarah Flannery and David Flannery. Workman Publishing, May 2001. ISBN 0-761-12384-9.

* *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.

Logical Dilemmas: The Life and Work of Kurt Gödel, by John Dawson. A K Peters, December 1997. ISBN 1-56881-025-3. (Reviewed September 2001.)

The Mathematical Explorer, by Stan Wagon. Electronic book, Wolfram Research, Inc., 2001. (Reviewed in this issue.)

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

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 0-198-50769-0 (hardcover), 0-198-50770-4 (paperback).

* *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.

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

Newton's Tyranny: The Suppressed Scientific Discoveries of John Flamsteed and Stephen Gray, by David H. Clark and Stephen P. H. Clark. W. H. Freeman & Co., October 2000. ISBN 0-716-74215-2.

Number: From Ahmes to Cantor, by Midhat Gazalé. Princeton University Press, March 2000. ISBN 0-691-00515-X. (Reviewed August 2001.)

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

Proofs from THE BOOK, by M. Aigner and G. M. Ziegler. Revised and expanded second edition, Springer, January 2001. ISBN 3-540-67865-4. (First edition reviewed August 1999.)

Puzzlers' Tribute: A Feast for the Mind, Tom Rodgers, 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 0-807-03126-7. (Reviewed March 2002.)

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

Sacred Geometry, by Miranda Lundy. Walker & Company, April 2001. ISBN 0-802-71382-3.

* *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 Permeates Biology, by Richard Solé and Brian Goodwin. Basic Books, January 2001. ISBN 0-465-01927-7.

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 0-8218-2614-X. (Reviewed March 2002.)

Turing and the Universal Machine: The Making of the Modern Computer, by Jon Agar. June 2001, Totem Books. 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, assisted by 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

Reference and Book List

in two parts, January 2002 and February 2002.)

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

The Unknowable, by Gregory J. Chaitin. Springer, August 1999. ISBN 9-814-02172-5. (Reviewed October 2001.)

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.

Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being, by George Lakoff and Rafael Núñez. Basic Books, October 2000. ISBN 0-465-03770-4. (Reviewed November 2001.)

Women Becoming Mathematicians: Creating a Professional Identity in Post-World War II America, by Margaret A. M. Murray. MIT Press, September 2000. ISBN 0-262-13369-5. (Reviewed August 2001.)

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.



KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

College of Sciences Department of Mathematical Sciences

The Department of Mathematical Sciences at King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia, invites applicants for faculty positions at the levels of Lecturer, Assistant Professor and above. Candidates with the following specialization are sought: Real and Complex Analysis, Applied Mathematics and Statistics with emphasis on Time Series and Computational Statistics.

Applicants should hold a Ph.D. degree, should be able to teach undergraduate and graduate courses, and should be committed to research.

The Department of Mathematical Sciences currently has over 60 faculty members in a wide range of areas of specialization. The department has BS, MS and Ph.D. programs in Mathematics.

Salary/Benefits: Two-year renewable contract. Competitive salaries based on qualifications and experience. Free furnished air-conditioned on-campus housing unit with free essential utilities and maintenance. The appointment includes the following benefits according to the University's policy: air ticket to Dammam on appointment; annual repatriation air tickets for up to four persons; assistance with local tuition fees for school-age dependent children; local transportation allowance; two months' paid summer leave; end-of-service gratuity. KFUPM campus has a range of facilities including a medical and dental clinic, an extensive library, computing, research and teaching laboratory facilities and a recreation center.

To apply: Mail, fax or e-mail cover letter and detailed resume to:
Dean, Faculty & Personnel Affairs
KFUPM, DEPT. MATH-2130
Dhahran 31261, Saudi Arabia
Fax: 966-3-860-2429

E-Mail: faculty@kfupm.edu.sa or c-math@kfupm.edu.sa

Please visit our website address: <http://www.kfupm.edu.sa>

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

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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.com), a new electronic resource being offered by the AMS (in partnership with Duke University) for the first time in 2001-02. The system provides a way for applicants to produce printed coversheet forms, apply for jobs, or publicize themselves in the "Job Wanted" list. Employers can post a job listing, and once applications are made, search and sort among their applicants. Note-taking, rating, e-mail, data downloading and customizable EOE functions are available to

employers. Also, reference writers can submit their letters online. A paperless application process is possible with this system, however; employers can choose to use any portion of the service. It is hoped that departments hiring for postdoc positions, especially, will utilize the system this year. There will be no fees for any services this year. This system was developed at the Duke University Department of Mathematics, and was tested by a group of departments in 2000-01.

Please direct all questions and comments to: emp-info@ams.org.

AMS STANDARD COVER SHEET

Last Name _____

First Name _____

Middle Names _____

Address through next June _____ Home Phone _____

_____ e-mail Address _____

Current Institutional Affiliation _____ Work Phone _____

Highest Degree Held or Expected _____

Granting Institution _____ Date (optional) _____

Ph.D. Advisor _____

Ph.D. Thesis Title (optional) _____

*This form is provided
courtesy of the
American
Mathematical Society.*

*This cover sheet
is provided as an aid
to departments
in processing
job applications.
It should be included
with your application
material.*

*Please print or type.
Do not send this form
to the AMS.*

Indicate the mathematical subject area(s) in which you have done research using, if applicable, the Mathematics Subject Classification printed on the back of this form or on e-MATH. If listing more than one number, list first the one number which best describes your current primary interest.

Primary Interest _____

Secondary Interests optional _____

Give a brief synopsis of your current research interests (e.g. finite group actions on four-manifolds). Avoid special mathematical symbols and please do not write outside of the boxed area.

Most recent, if any, position held post Ph.D.

University or Company _____

Position Title _____

Indicate the position for which you are applying and position posting code, if applicable

If 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.



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

From the AMS Secretary

Officers of the Society 2001 and 2002 Updates

Except for the members at large of the Council, the month and year of the first term and the end of the present term are given. For members at large of the Council, the last year of the present term is listed.

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All terms are for three years and expire on January 31 following the year given.

2001

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Tatiana Toro

Nolan R. Wallach

2002

Patricia E. Bauman

William Fulton

Martin Golubitsky

Jonathan M. Rosenberg

Lisa M. Traynor

2003

Walter L. Craig

Keith J. Devlin

Irene Fonseca

Alexander Nagel

Louise A. Raphael

2004

Colin C. Adams

Sylvia T. Bozeman

Irene Gamba

Henri A. Gillet

David R. Morrison

Members of Executive Committee

Members of the Council, as provided for in Article 7, Section 4 (last sentence), of the Bylaws of the Society.

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Hugo Rossi 2/02-1/06

Joel Spencer 2/98-1/02

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Colloquium Editorial Committee

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Journal of the AMSEditorial Committee

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Linda Keen 2/99-1/04

Andy Magid 2/97-1/02

B. A. Taylor (*ex officio*) 2/93-1/03

Carol S. Wood 2/02-1/07

Ethical Guidelines for the Society

In January 1994 the Council received the report of its Special Advisory Committee on Professional Ethics. The committee, which consisted of Murray Gerstenhaber, Frank Gilfeather, Elliott Lieb, and Linda Keen (chair), presented ethical guidelines for adoption by the Council. Those draft guidelines were published twice in the *Notices*, with a request to the membership for responses and suggestions for changes or improvements. These were sent to the committee, which considered all suggestions. The committee then redrafted the guidelines, which were then presented to the January 1995 Council. At that meeting, the Council voted to adopt these guidelines on behalf of the Council (by a vote that was unanimous save for one abstention). Later, in Business by Mail and according to the bylaws, the Council approved the Guidelines in the name of the Society by a vote of twenty-five (25) in favor and three (3) opposed.

Ethical Guidelines of the American Mathematical Society

To assist in its chartered goal, "...the furtherance of the interests of mathematical scholarship and research...", and to help in the preservation of that atmosphere of mutual trust and ethical behavior required for science to prosper, the American Mathematical Society, through its Council, sets forth the following guidelines. While it speaks only for itself, these guidelines reflect its expectations of behavior both for its members and for all members of the wider mathematical community, including institutions engaged in the education or employment of mathematicians or in the publication of mathematics.

It is not intended that something not mentioned here is necessarily outside the scope of AMS interest. These guidelines are not a complete expression of the principles that underlie them but will, it is expected, be modified and amplified by events and experience. These are guidelines, not a collection of rigid rules.

The American Mathematical Society, through its Committee on Professional Ethics (COPE), may provide an avenue of redress for individual members injured in their capacity as mathematicians by violations of its ethical principles. COPE, in accordance with its procedures, will, in each case, determine the appropriate ways in which it can be helpful (including making recommendations to the Council of the Society). However, the AMS cannot enforce these guidelines, and it cannot substitute for individual responsibility or for the responsibility of the mathematical community at large.

I. Mathematical Research and its Presentation

The public reputation for honesty and integrity of the mathematical community and of the Society is its collective treasure, and its publication record is its legacy.

The correct attribution of mathematical results is essential, both as it encourages creativity, by benefiting the creator whose career may depend on the recognition of the

work, and as it informs the community of when, where, and sometimes how original ideas have entered into the chain of mathematical thought. To that end, mathematicians have certain responsibilities, which include the following:

To endeavor to be knowledgeable in their field, especially as regards related work;

To give proper credit (even to unpublished sources, because the knowledge that something is true or false is valuable, however it is obtained);

To use no language that suppresses or improperly detracts from the work of others;

To correct in a timely way or withdraw work that is erroneous or previously published.

A claim of independence may not be based on ignorance of well-disseminated results. Errors and oversights can occur, but it is the responsibility of the person making the error to set the record straight.

On appropriate occasions, it may be desirable to offer or accept joint authorship when independent researchers find that they have produced identical results. However, the authors listed for a paper must all have made a significant contribution to its content, and all who have made such a contribution must be offered the opportunity to be listed as an author. To claim a result in advance of its having been achieved with reasonable certainty injures the community by restraining those working toward the same goal. Publication of results that are announced must not be unreasonably delayed. Because the free exchange of ideas necessary to promote research is possible only when every individual's contribution is properly recognized, the Society will not knowingly publish anything that violates this principle, and it will seek to expose egregious violations anywhere in the mathematical community.

II. Social Responsibility of Mathematicians

The Society promotes mathematical research together with its unrestricted dissemination, and to that end encourages all and will strive to afford equal opportunity to all to engage in this endeavor. Mathematical ability must be respected wherever it is found, without regard to race, gender, ethnicity, age, sexual orientation, religious or political belief, or disability.

The growing importance of mathematics in society at large and of public funding of mathematics may increasingly place members of the mathematical community in conflicts of interest. The appearance of bias in reviewing, refereeing, or in funding decisions must be scrupulously avoided, particularly where decisions may affect one's own research, that of close colleagues, or of one's students; in extreme cases one must withdraw.

A reference or referee's report fully and accurately reflecting the writer's views is often given only on the understanding that it be confidential or that the name of the writer be withheld from certain interested parties; therefore, a request for a reference or report must be assumed, unless there is a statement to the contrary, to carry an implicit promise of confidentiality or anonymity which must be carefully kept unless negated by law. The writer of the reply must respond fairly and keep confidential any

privileged information, personal or mathematical, that the writer receives. If the requesting individual, institution, agency or company becomes aware that confidentiality or anonymity cannot be maintained, that must immediately be communicated, and if known in advance, must be stated in the original request.

Where choices must be made and conflicts are unavoidable, as with editors or those who decide on appointments or promotions, it is essential to keep careful records which, even if held confidential at the time, would, when opened, demonstrate that the process was indeed fair.

Freedom to publish must sometimes yield to security concerns, but mathematicians should resist excessive secrecy demands, whether by government or private institutions.

When mathematical work may affect the public health, safety or general welfare, it is the responsibility of mathematicians to disclose the implications of their work to their employers and to the public, if necessary. Should this bring retaliation, the Society will examine the ways in which it may want to help the "whistle-blower", particularly when the disclosure has been made to the Society.

III. Education and Granting of Degrees

Holding a Ph.D. degree is virtually indispensable to an academic career in mathematics and is becoming increasingly important as a certificate of competence in the wider job market. An institution granting a degree in mathematics is certifying that competence and must take full responsibility for it by insuring the high level and originality of the thesis work and sufficient knowledge by the recipient of important branches of mathematics outside the scope of the thesis. The original results in a thesis should be publishable in a recognized journal. When there is evidence of plagiarism, it must be carefully investigated, even if it comes to light after granting the degree, and, if proven, the degree should be revoked.

Mathematicians and organizations involved in advising graduate students should honestly inform them about the employment prospects they may face upon completion of their degrees. No one should be exploited by the offer of a temporary position at a low salary and/or a heavy work load.

IV. Publications

The Society will not take part in the publishing, printing or promoting of any research journal where there is some acceptance criterion, stated or unstated, that conflicts with the principles of these guidelines. It will promote the quick refereeing and timely publication of articles accepted to its journals.

Editors are responsible for the timely refereeing of articles and must judge articles by the state of knowledge at the time of submission. Editors and referees should accept a paper for publication only if they are reasonably certain the paper is correct.

The contents of an unpublished and uncirculated paper should be regarded by a journal as privileged information. If the contents of a paper become known in advance of publication solely as a result of its submission to or handling by a journal, and if a later paper based on knowledge of

the privileged information is received anywhere (by the same or another journal), then any editor aware of the facts must refuse or delay publication of the later paper until after publication of the first—unless the first author agrees to earlier publication of the later paper.

At the time a manuscript is submitted, editors should notify authors whenever a large backlog of accepted papers may produce inordinate delay in publication. A journal may not delay publication of a paper for reasons of an editor's self interest or of any interest other than the author's. The published article should bear the date on which the manuscript was originally submitted to the journal for publication, together with the dates of any revisions. Editors must be given and accept full scientific responsibility for their journals; when a demand is made by an outside agency for prior review or censorship of so-called "sensitive" articles, that demand must be resisted, and, in any event, knowledge of the demand must be made public.

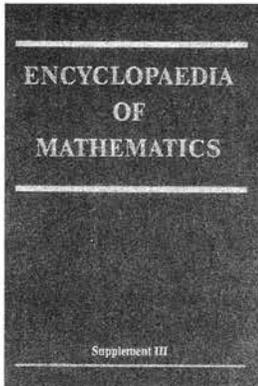
All mathematical publishers, particularly those who draw without charge on the resources of the mathematical community through the use of unpaid editors and referees, must recognize that they have made a compact with the community to disseminate information, and that compact must be weighed in their business decisions.

Both editors and referees must respect the confidentiality of materials submitted to them unless these have previously been made public, and above all may not appropriate to themselves ideas in work submitted to them or do anything that would impair the rights of authors to the fruits of their labors. Editors must preserve the anonymity of referees unless there is a credible allegation of misuse.

These are ethical obligations of all persons or organizations controlling mathematical publications, whatever their designation.

Robert J. Daverman
Secretary
Knoxville, TN

New Titles From Kluwer!!



Encyclopaedia of Mathematics, Supplement III

edited by **Michiel Hazewinkel**, *CWI, Amsterdam, The Netherlands*

This is the third supplementary volume to Kluwer's highly acclaimed twelve-volume *Encyclopaedia of Mathematics*. This additional volume contains nearly 500 new entries written by experts and covers developments and topics not included in the previous volumes. These entries are arranged alphabetically throughout and a detailed index is included. This supplementary volume enhances the existing twelve volumes, and together, these thirteen volumes represent the most authoritative, comprehensive and up-to-date *Encyclopaedia of Mathematics* available.

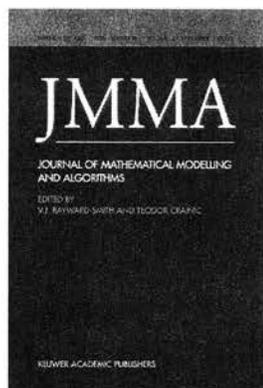
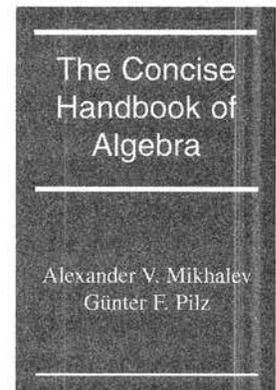
Hardbound, ISBN 1-4020-0198-3 January 2002, 568 pp.
USD 229.00 / EUR 249.00

The Concise Handbook of Algebra

by **Alexander V. Mikhalev**, *Moscow State University, Moscow, Russia* and **Günter F. Pitz**, *Johannes Kepler University Linz, Linz, Austria*

The Concise Handbook of Algebra provides a succinct, but thorough treatment of algebra. The editors have gone to great lengths to capture the core essence of the different ideas, concepts and results that make up algebra as we know it today. In a collection that spans about 150 sections organized in 9 chapters, algebraists are provided with a standard knowledge set for their areas of expertise.

Hardbound, ISBN 0-7923-7072-4 May 2002, 618 pp.
USD 116.00 / EUR 126.00



Journal of Mathematical Modelling and Algorithms

Editor-in-Chief: **Vic Rayward-Smith**, *University of East Anglia, Norwich, UK*

Regional Editor: **Teodor Gabriel Crainic**, *Université du Québec, Montréal, Canada*

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Subscription Information

2002, Volume 1 (4 issues), ISSN 1570-1166
Institutional rate: EUR 295.00 / USD 260.00
Individual rate: EUR 65.00 / USD 57.00

Institutional Rate refers to either the Paper version or the Online version.
To receive the Combined Paper & Online Version please add 20%.
The individual rate, if applicable, is available for the paper version only.

Mathematics Calendar

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

June 2002

1–2 **Conference in Honor of Jan Mycielski**, University of Colorado, Boulder, Colorado. (Feb. 2002, p. 269)

1–4 (REVISED) **2002 ASL Annual Meeting**, Las Vegas, Nevada. (Feb. 2002, p. 269)

1–7 **Minimal Varieties in Geometry and Physics**, SUNY at Stony Brook, Stony Brook, New York. (May 2002, p. 603)

2–6 **7th Valencia International Meeting on Bayesian Statistics**, Tenerife, Canary Islands, Spain. (Apr. 2002, p. 500)

2–7 **Foundations of Probability and Physics-2**, International Center for Mathematical Modelling in Physics, Engineering and Cognitive Sciences, Växjö University, Sweden. (Apr. 2002, p. 500)

2–8 **Combinatorics 2002**, Maratea (Potenza), Italy. (Jan. 2002, p. 56)

3–8 **Abel Bicentennial Conference 2002**, Univ. of Oslo, Oslo, Norway. (Nov. 2001, p. 1228)

3–8 **Algebra Conference–Venezia 2002**, Venice International University, Island of San Servolo, Venice, Italy. (Mar. 2002, p. 355)

3–9 **BIOCOMP2002: Topics in Biomathematics and Related Computational Problems at the Beginning of the Third Millennium**, Vietri sul Mare (Amalfi Coast), Italy. (Feb. 2002, p. 269)

4–13 **3rd Linear Algebra Workshop**, Bled, Slovenia. (Sept. 2001, p. 908)

5–8 **Variational Methods: Open Problems, Recent Progress, and Numerical Algorithms**, Northern Arizona University, Flagstaff, Arizona. (Apr. 2002, p. 501)

5–9 **A Conference in Honour of Hans Wallin**, Umeå, Sweden. (Oct. 2001, p. 1050)

5–9 **Hawaii International Conference on Statistics and Related Fields**, Sheraton Waikiki Hotel, Honolulu, Hawaii. (Feb. 2002, p. 269)

6–8 **Conference on Zero-dimensional Schemes and Related Topics**, Acireale, Italy (Sicily). (Apr. 2002, p. 501)

6–15 **Fourth International Conference on Geometry, Integrability and Quantization**, Sts. Constantine and Elena resort (near Varna), Bulgaria. (Dec. 2001, p. 1366)

*7–August 1 **AMS-IMS-SIAM Joint Summer Research Conferences**, Mount Holyoke College, South Hadley, Massachusetts.
Information: URL: <http://www.ams.org/meetings/src.html>.

10–13 **The Tenth Conference of the International Linear Algebra Society**, Auburn Univ., Auburn, Alabama. (June/July 2001, p. 630)

10–14 **PIMS-MITACS Summer School on Applications of Computational Geometry**, Simon Fraser University, Burnaby, BC, Canada. (May 2002, p. 603)

10–14 **Théories d'Homologie, Représentations et Algèbres de Hopf**, CIRM, Luminy, Marseille, France. (Jan. 2002, p. 56)

10–15 **Algebraic Transformation Groups**, Centre de Recherches Mathématiques (CRM), Université de Montréal, Montréal (Québec), Canada. (Aug. 2001, p. 752)

10–15 **Quantum Probability and Infinite Dimensional Analysis**, Levico Terme, Trento, Italy. (May 2002, p. 603)

10–16 **Aarhus Topology 2002**, Univ. of Aarhus, Aarhus, Denmark. (Jan. 2001, p. 55)

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/>.

10-16 **NS2002 "Nonstandard Methods and Applications in Mathematics"**, Pisa, Italy. (May 2002, p. 603)

12-15 **Bachelier Finance Society: 2nd World Congress**, Crete, Greece. (Nov. 2001, p. 1228)

* 12-16 **First Joint International Meeting between the American Mathematical Society and the Unione Matematica Italiana**, Pisa, Italy.

Information: <http://www.dm.unipi.it/7Emeet2002/>.

13-15 **19th Annual Workshop in Geometric Topology**, Calvin College, Grand Rapids, Michigan. (Nov. 2001, p. 1228)

15-17 **CMS Summer Meeting 2002**, Laval University, Québec City, Québec, Canada. (Mar. 2002, p. 356)

16-18 **PIMS-MITACS Workshop on Facility Location Problems**, Simon Fraser University, Burnaby, British Columbia, Canada. (May 2002, p. 603)

16-20 **Conference on Analysis and Probability on Fractals**, Cornell University, Ithaca, New York. (Feb. 2002, p. 269)

16-21 **Current Trends in Commutative Algebra**, Grand Hotel Bellavista, Levico Terme, Trento, Italy. (May 2002, p. 603)

16-23 **Second Russian-German Geometry Meeting Dedicated to 90th Anniversary of A. D. Alexandrov**, Euler International Mathematical Institute, St Petersburg, Russia. (Feb. 2002, p. 269)

17-19 **24th International Conference on Boundary Element Methods and Meshless Solutions Seminar**, Sintra, Portugal. (Nov. 2001, p. 1228)

* 17-22 (NEW DATE) **CCR/DIMACS Workshop/Tutorial on Mining Massive Data Sets and Streams: Mathematical Methods and Algorithms for Homeland Defense**, Center for Communications Research (CCR), Princeton, New Jersey.

Dates: Tutorial: June 17-19, 2002; Workshop: June 20-22, 2002.

Short Description: The event will bring together researchers from a variety of fields for tutorials and specialized talks about these challenges. The tutorial, which runs from Monday to Wednesday, will present to nonexperts or those wanting a coherent introduction to the field a variety of tools that are relevant to the topics described. The workshop, which runs from Thursday through Saturday, will contain more specialized talks. It is possible to register for the tutorial alone, the workshop alone, or both.

There will be tutorials on text mining, parallel data mining, algorithmic issues in processing data streams, database support for data mining, on-line learning, forensic ring analysis, and data fusion, as well as a number of survey talks.

The workshop will include talks on algorithmic issues in processing streaming data, text mining and classification, anomaly detection, outlier analysis, forensic data analysis, on-line learning, real-time data mining, parallel data mining, visualization and data mining, and mining graphical data.

Sponsors: The Center for Communications Research (CCR) and DIMACS.

Organizers: B. Grossman, chair, Univ. of Illinois and Two Cultures Group; P. Kantor, Rutgers Univ.; M. Muthukrishnan, Rutgers Univ.

Contacts: B. Grossman, chair, Univ. of Illinois and Two Cultures Group; grossman@uic.edu.

Local Arrangements: D. Koch, CCR, DJK@idaccr.org; tel: 609-924-4600.

Information: See <http://dimacs.rutgers.edu/Workshops/Homeland/>.

17-20 **Second Haifa Workshop on Interdisciplinary Applications of Graph Theory, Combinatorics and Algorithms**, University of Haifa, Israel. (May 2002, p. 603)

17-21 **Second MaPhySto and StocLab Summer School on Stereology and Geometric Tomography**, Sandbjerg Manor, Sønderborg, Denmark. (May 2002, p. 603)

17-21 **Seventh International Conference on p-Adic Functional Analysis**, Univ. of Nijmegen, The Netherlands. (June/July 2001, p. 630)

17-21 **Stochastic Inequalities and their Applications: A Euro-Conference**, Centre de Recerca Matemàtica, Bellaterra (Barcelona), Spain. (Mar. 2002, p. 356)

* 17-28 **Fonctorialité de Langlands: Progrès Récents**, CIRM, Luminy, France.

Information: e-mail: goldberg@math.purdue.edu.

17-28 **MSRI Summer Graduate School on "Excursions in Computational Number Theory—Polynomials with Integer Coefficients"**, PIMS-SFU, Burnaby, British Columbia, Canada. (May 2002, p. 603)

18-19 **The Fields Institute 10th Anniversary Celebrations**, The Fields Institute, Toronto, Ontario, Canada. (May 2002, p. 604)

18-22 **The Barcelona Conference on Stochastic Inequalities and Their Applications (A EuroConference)**, Bellaterra (Barcelona). (Jan. 2002, p. 56)

19-21 **The EUROMECH Colloquium 437: Identification and Updating Methods of Mechanical Structures**, Prague, Czech Republic. (Jan. 2002, p. 56)

19-23 **2nd Canadian Conference on Nonlinear Solid Mechanics**, SFU Harbour Centre, Vancouver, British Columbia, Canada. (May 2002, p. 604)

* 20-22 **AMS Western Section and MAA Pacific Northwest Section Joint Meeting**, Portland State University, Portland, Oregon.

Information: URL: <http://www.ams.org/amsmtg/sectional.html>.

21-26 **Symmetries and Integrability of Difference Equations—EuroConference on Discrete Painlevé Equations and the Solvability of Difference Equations**, VVF La Badine, Giens (near Toulon), France. (Apr. 2002, p. 501)

23-28 **Fourteenth U.S. National Congress of Theoretical and Applied Mathematics**, Virginia Polytechnic Inst. and State Univ., Blacksburg, Virginia. (Dec. 2000, p. 1437)

23-28 **Recent Advances and New Directions in Mechanics, Continuum Thermodynamics, and Kinetic Theory: Symposium in Memory of Clifford Ambrose Truesdell III**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (Apr. 2002, p. 501)

24-25 **Higher Dimensional Complex Geometry**, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK. (Mar. 2002, p. 356)

24-27 **International Conference on "Information and Knowledge Engineering" (IKE'02)**, Las Vegas, Nevada. (Apr. 2002, p. 501)

24-27 **International Workshop on Orthogonal Polynomials: Orthogonal Polynomials and Approximation Theory (IWOP'02)**, Leganés, Madrid, Spain. (Apr. 2002, p. 501)

24-27 **Special Session on "Knowledge Representation and Reasoning" in 2002 International Conference on Artificial Intelligence (IC-AI)**, Las Vegas, Nevada. (Apr. 2002, p. 501)

24-28 **Symposium on Partial Differential Equations To Celebrate the Seventy-Fifth Birthday of James Serrin**, Università degli Studi di Perugia, Italy. (May 2002, p. 604)

* 24-28 **Workshop on "Bone Mechanics: Mathematical and Mechanical Models for Analysis and Synthesis"**, IST, Lisbon, Portugal. (Apr. 2002, p. 501)

24-28 **Tenth International Conference on Fibonacci Numbers and Their Applications**, Flagstaff, Arizona. (Oct. 2001, p. 1050)

24-28 **The Third International Conference on High Dimensional Probability**, Sandbjerg Estate, Denmark. (Jan. 2002, p. 56)

- 24-29 **Conference on Geometry and Its Application in Technology**, Aristotle University of Thessaloniki, Greece (May 2002, p. 604)
- 24-29 **Conference on Stochastic Networks**, Stanford University, Palo Alto, California. (Mar. 2002, p. 356)
- 24-29 **Topology, Geometry and Quantum Field Theory**, Oxford, England. (Apr. 2002, p. 501)
- 25-28 **ACA'2002: 8th International Conference on Applications of Computer Algebra**, Volos, Greece. (Mar. 2002, p. 356)
- 25-29 **The Twenty-sixth Summer Symposium in Real Analysis**, Washington and Lee Univ., Lexington, Virginia. (Oct. 2001, p. 1050)
- 27-July 2 **19th International Conference on Operator Theory**, West University, Timisoara, Romania. (Apr. 2002, p. 502)
- 28-30 **MathML 2002: MathML and Math on the Web International Conference**, Hickory Ridge Conference Center, Chicago, Illinois. (Feb. 2002, p. 269)
- *30-July 6 **Real Methods in Complex and CR Geometry**, Martina Franca (Taranto), Italy.
Scientific Direction: D. Zaitsev (zaitsev@math.unipd.it), G. Zampieri (zampieri@math.unipd.it).
Courses: Angular derivatives in several complex variables, M. Abate (Univ. di Pisa (Italia), abate@dm.unipi.it); Real methods in complex dynamics, J. E. Fornæss (Univ. of Michigan, Ann Arbor (USA), fornæss@umich.edu); On the Chern-Moser theory and rigidity problem of holomorphic maps, X. Huang (Rutgers Univ., New Brunswick (USA), huangx@math.rutgers.edu); Theory of analytic functionals, and boundary values in the sense of hyperfunctions, J. P. Rosay (Univ. of Wisconsin, Madison (USA), jrosay@math.wisc.edu); Extremal analytic discs and the geometry of CR manifolds, A. E. Tumanov (Univ. Of Illinois at Urbana-Champaign (USA), tumanov@math.uiuc.edu).
Information: For any further information contact: Fondazione C.I.M.E. c/o Dipartimento di Matematica "U. Dini", Viale Morgagni, 67/A - 50134 Firenze, Italy; Tel. +39-55-434975/ +39-55-4237123; fax +39-55-434975 / +39-55-4222695; <http://www.math.unifi.it/cime/>.
- 30-July 14 **5th Summer School/Conference: Let's Face Chaos through Nonlinear Dynamics**, Maribor, Slovenia. (Aug. 2001, p. 752)
- 30-July 20 **2002 Summer Session: IAS/Park City Mathematics Institute (PCMI)**, Park City, Utah. (Apr. 2002, p. 502)
- July 2002**
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- 1-January 10, 2003 **Representation Theory of Lie Groups**, Institute for Mathematical Sciences, National University of Singapore, Singapore. (Mar. 2002, p. 357)
- 1-5 **28th Conference on Stochastic Processes and Their Applications**, The University of Melbourne, Melbourne, Australia. (Mar. 2002, p. 356)
- 1-5 **Congrès de Mathématiques Appliquées à la Mémoire de Jacques-Louis Lions**, Collège de France, Paris, France. (Mar. 2002, p. 357)
- 1-5 **AISC'2002: Sixth International Conference on Artificial Intelligence and Symbolic Computation Theory, Implementations and Applications (In conjunction with CALCULEMUS'2002)**, Marseille, France. (May 2002, p. 604)
- 1-5 **PIMS Thematic Programme on Asymptotic Geometric Analysis, Conference on Convexity and Asymptotic Theory of Normed Spaces**, PIMS-UBC, Vancouver, British Columbia, Canada. (May 2002, p. 604)
- 1-6 **2nd International Conference on the Teaching of Mathematics**, Crete, Greece. (June/July 2001, p. 631)
- 1-6 **Advanced Course on Mathematical Finance: Further Models**, Bellaterra (Barcelona). (Jan. 2002, p. 56)
- 1-6 **Workshop on Optimal Stopping and Stochastic Games**, Banach Center, Mathematical Research and Conference Center, Bedlewo, Poland. (May 2002, p. 604)
- 1-6 **2002: Workshop on "Wavelets and Applications"**, Barcelona, Spain. (Apr. 2002, p. 502)
- 2-6 **2002 Barcelona Conference on Algebraic Topology (a EuroConference)**, Institut d'Estudis Catalans, Barcelona. (Jan. 2002, p. 56)
- 2-6 **5th Conference of the European Society of Mathematica and Theoretical Biology on Mathematical Modelling and Computing in Biology and Medicine**, Università and Politecnico di Milano, Milano, Italy. (May 2002, p. 604)
- 3-5 **Call for Papers: The Thirteenth Annual Symposium on Combinatorial Pattern Matching (CPM2002)**, Hotel Uminonakamichi, Fukuoka, Japan. (Mar. 2002, p. 357)
- *4-6 **Current Geometry 2002**, Palazzo Serra di Cassano, Naples, Italy.
Program: The 3rd edition of the international conference on problems and trends of contemporary geometry.
Deadlines: June 15, 2002.
Organizers: A. De Paris (Napoli), G. Rotondaro (Napoli), G. Sparano (Salerno), A. Vinogradov (Salerno), R. Vitolo (Lecce).
Scientific Committee: E. Arbarello (Pisa), F. Baldassarri (Padova), U. Bruzzo (Trieste), C. Ciliberto (Roma), A. Collino (Torino), M. Cornalba (Pavia), C. De Concini (Roma), B. Dubrovin (Trieste), L. van Geemen (Pavia), P. Griffiths (Princeton), V. Kac (Boston), K. O' Grady (Roma), C. Procesi (Roma), E. Sernesi (Roma), J. Stasheff (Chapel Hill), A. Vinogradov (Salerno).
Speakers (Preliminary List): E. Arbarello (Pisa), B. Dubrovin (Trieste), L. van Geemen (Pavia), S. Gindikin (Rutgers), V. Kac (Boston), J. Kollar (Princeton, to be confirmed), P. Piazza (Roma), A. Sossinski (Moscow), A. M. Vinogradov (Salerno, to be confirmed), O. Viro (Uppsala).
Information: curgeo@diffiety.org; <http://www.diffiety.org/conf/curgeo02/>; <http://www.diffiety.ac.ru/conf/curgeo02>.
- *5-7 **2002 Korea-Hungary Joint Workshop on Combinatorics**, Postech, Pohang, Korea.
Theme: Combinatorics, graph theory, algorithms, combinatorial matrix theory and related areas of combinatorial or computational mathematics,
Organizing Committee: E. Gyori and M. Simonovits (Renyi Institute, Hungary); J. H. Kwak and S.-G. Lee (Com2MaC, Korea).
Call for Papers: The program will consist of plenary lectures of 45 and 60 minutes, invited lectures of 25 minutes.
Information and Registration form: <http://matrix.skku.ac.kr/sglee/hungary2002/ri.html>; Homepage: <http://matrix.skku.ac.kr/sglee/hungary2002/index.html>.
- *7 **Internet Accessible Mathematical Computation: A Workshop at ISSAC 2002**, Lille, France.
Description: The workshop is part of ISSAC'02 (see <http://www.lifl.fr/issac2002/>) and will involve invited talks, contributed papers, and software demonstrations.
Workshop Registration: The IAMC workshop is part of ISSAC 2002. Participants should register with the ISSAC 2002 conference and select the IAMC workshop. Although we encourage everyone to attend the complete IAMC + ISSAC sessions, a reduced fee is available for those attending IAMC only.
Information: Contact the organizers: N. Kajler (Ecole des Mines de Paris, France), kajler@cc.ensmp.fr; E. Melis (DFKI Saarbrücken, Germany), melis@ags.uni-sb.de; P. S. Wang (ICM/Kent Univ., USA), pwang@mcs.kent.edu. If you are interested, please contact one of the organizers. Other details of this workshop will be forthcoming

and will be available on both the ISSAC'02 official site and on SymbolicNet.

IAMC URLs: Visit <http://www.symbolicnet.org/conferences/iamc2002/>. Also see <http://www.medicis.polytechnique.fr/symbolicnet/conferences/iamc2002/>.

ISSAC URL: <http://www.lifl.fr/issac2002/>.

7-10 ISSAC 2002 International Symposium on Symbolic and Algebraic Computation, University of Lille I, France. (Feb. 2002, p. 269)

7-12 The 5th Americas Conference in Differential Equations and Nonlinear Dynamics, Univ. of Alberta, Edmonton, Canada. (Jan. 2002, p. 56)

7-24 32nd Probability Summer School, Saint-Flour, France. (May 2002, p. 604)

* **8-10 Com2MaC Conference on Graphs and Combinatorics**, Postech, Pohang, Korea.

Purpose: The conference is aimed at bringing together researchers on all aspects of graphs including the algebraic, combinatorial, probabilistic, and topological approach to graph theory and their applications.

You may also be interested in participating in the 2002 Korea-Hungary joint workshop on Combinatorics July 5-7, 2002, Postech, Pohang, Korea. The participants can join both conferences.

Call for papers: The conference will consist of an hour or 45-minute-long plenary talks and 25-minute contributed talks. Abstracts are invited and should include: name(s) of author(s), affiliation(s), address of the contact person, phone and fax number, and e-mail address. Authors are kindly requested to submit their abstracts via e-mail in LaTeX (or AMS TeX) to one of the following conference organizer.

Organizing Committee: S.-R. Kim (Kyung Hee Univ., srkim@khu.ac.kr), J. Lee (Yeungnam Univ., jullee@yu.ac.kr), H. H. Cho (Seoul Nat. Univ., hancho@snu.ac.kr).

Plenary Speakers (Preliminary): G. Katona, Alfred Renyi Inst. of Math. Hungar. Acad. of Sci., ohkatona@renyi.hu; I. Goulden, Dept. of Comb. and Optim., Univ. of Waterloo, igould@math.uwaterloo.ca; D. Archdeacon, Dept. of Math. and Stat., Univ. of Vermont, archdeac@emba.uvm.edu; F. R. McMorris, Dept. of Appl. Math., Illinois Inst. of Tech., mcmorris@iit.edu; J. H. Kim, Theory Group, Microsoft Research, jehkim@microsoft.com; H. M. Mulder, Econometrisch Institut, Erasmus Univ., hmulder@few.eur.nl; F. S. Roberts (tentative), Director of DIMACS, Dept. of Math., Rutgers Univ., froberts@dimacs.rutgers.edu; V. T. Sos, Alfred Renyi Math. Inst., Hungar. Acad. of Sci., sos@renyi.hu.

Information: See <http://com2mac.postech.ac.kr/conference/cgc2002/index.html>.

8-11 The Tenth International Symposium on Dynamic Games and Applications, Saint Petersburg State Univ., Saint Petersburg, Russia. (Jan. 2002, p. 56)

8-12 14th International Conference on Formal Power Series and Algebraic Combinatorics, Univ. of Melbourne, Australia. (Jan. 2002, p. 56)

8-12 An International Conference on Boundary and Interior Layers—Computational & Asymptotic Methods, Univ. of Western Australia, Perth, Australia. (Dec. 2001, p. 1366)

8-12 Harmonic Maps, Minimal Surfaces and Geometric Flows, University of Bretagne Occidentale, Brest, France. (Feb. 2002, p. 270)

* **8-12 Interactions between Representation Theories, Knot Theory, Topology, and Mathematical Physics**, Potsdam College, Potsdam, New York.

Description: This workshop investigates the interactions between representation theories, knot theory, topology, and mathematical physics. This conference will be of great benefit to researchers, recent Ph.Ds, and graduate students.

Financial Support: Some support is available for graduate students, recent Ph.Ds, and others who are qualified.

Speakers: H. Wenzl (San Diego), L. Kauffman (Chicago), G. Benkart (Wisconsin), R. Orellana (Dartmouth), S. Bigelow (Santa Barbara), S. Lambropoulou (Greece), B. LeClerc (France), S. Lomonaco (Maryland), J. Przytycki (Washington), Y. Geun Oh (Wisconsin/Princeton)(invited), K. Murasugi (Toronto), De Witt Sumners (Florida State), D. Radford (Illinois, Chicago).

Organizers: L. Kauffman (Chicago), G. Benkart (Wisconsin), K. Mahdavi (Potsdam).

Poster Session: There will also be a poster presentation session.

Information: Contact: K. Mahdavi, mahdavi@potsdam.edu; or visit <http://www2.potsdam.edu/mahdavi/Conf.htm>.

Funded by: NSF, NSA, SUNY Potsdam, Clarkson University, and St. Lawrence University.

8-12 PIMS Thematic Programme on Asymptotic Geometric Analysis, Concentration Period on Measure Transportation and Geometric Inequalities, PIMS-UBC, Vancouver, British Columbia, Canada. (May 2002, p. 605)

8-12 SIAM 50th Anniversary and 2002 Annual Meeting, Philadelphia Marriott Hotel, Philadelphia, Pennsylvania. (May 2002, p. 605)

8-12 Workshop on Nonself-adjoint Operator Algebras, The Fields Institute, Toronto, Ontario, Canada. (May 2002, p. 605)

8-19 Biomathematics Euro Summer School: Dynamical Systems in Physiology and Medicine, Urbino, Italy. (Feb. 2002, p. 270)

8-19 Dynamic Equations on Time Scales (Measure Chains), Univ. of Wyoming, Laramie, Wyoming. (Jan. 2002, p. 57)

* **8-19 Dynamical Systems in Physiology and Medicine**, Urbino, Italy.

Program: The school will offer five courses centered on the biological background and on the mathematical modelling of relevant biomedical phenomena: the spread of cardiac electrical excitation; the physiology of gas flow in the airways; the system controlling glucose blood levels by means of the hormone insulin; the activity and synchronisation of neurones; the mechanism of production of blood cells with attendant regulations and possible derangements.

Information: <http://www.biomatematica.it/urbino2002/>.

8-19 SMS-NATO ASI: Normal Forms, Bifurcations, and Finiteness Problems in Differential Equations, Université de Montréal, Canada. (Dec. 2001, p. 1366)

8-26 School and Conference on Algebraic K-Theory and its Applications, The Abdus Salam International Centre for Theoretical Physics (ICTP), Strada Costiera 11, I-34014, Trieste, Italy.

* **9-11 2002 International Conference on Related Subjects to Clay Problems**, Chonbuk National University, Chonju City, Chonbuk, Korea.

Program: Our conference will help unravel CMI's (Clay Mathematics Institute) 7 millenium problems, especially centering on the Riemann Hypothesis.

Organizers: S. Oh, G. Seo, J.-H. Yang, Y.K. Kim (representative)

Main Speakers: S. Gonek (Rochester, USA), C. Yildirim (Istanbul, Turkey), D. Prasad (Harish-Chandra Institute, India), K. Vilonen (Northwestern, USA), S. Wang (Henan, China), H. Kim (Seoul National, Korea) J.-H. Yang (Inha, Korea), Y. Kim (Chonbuk National, Korea).

Hosting Institute: The Institute of Pure and Applied Mathematics.

Information: <http://math.chonbuk.ac.kr/>. Inquiring and corresponding addresses: G. S. Seo, Dept. of Math., College of Nat. Sci., Chonju, Chonbuk 561-756, Korea.

9-13 Genetic and Evolutionary Computation Conference GECCO-2002, New York City, New York. (Dec. 2001, p. 1366)

- 10-13 **VISIT-ME 2002: Vienna International Symposium on Integrating Technology into Mathematics Education**, Vienna, Austria. (Apr. 2002, p. 502)
- * 10-19 **Analytic Number Theory**, Cetraro (Cosenza), Italy.
Scientific Direction: C. Viola (Univ. di Pisa, viola@dm.unipi.it), A. Perelli (Univ. di Genova, perelli@dima.unige.it).
Courses: The abstracts of the courses are available at the (CIME) address <http://www.math.unifi.it/cime/>. Producing prime numbers via sieve methods, J. Friedlander (Toronto, Canada); Exponential sums, uniform distribution and cryptographic applications, J. Friedlander (Toronto, Canada); Counting rational points on algebraic varieties, R. Heath-Brown (Oxford Univ., England); Automorphic L-functions, H. Iwaniec (Rutgers Univ., USA); Aximomatic theory of L-functions: the Selberg class, J. Kaczorowski (Poznan, Poland).
Information: For any further information contact: Fondazione C.I.M.E. c/o Dipartimento di Matematica "U. Dini", Viale Morgagni, 67/A - 50134 Firenze, Italy; Tel. +39-55-434975/ +39-55-4237123; fax +39-55-434975 / +39-55-4222695; <http://www.math.unifi.it/cime/>.
- 12-15 **XIth Oporto Meeting on Geometry, Topology and Physics**, Porto, Portugal. (Apr. 2002, p. 502)
- 13-19 **Symbolic Computational Algebra 2002: Fields Inst. Special Meeting on Symbolic and Numeric Computation in Geometry, Algebra and Analysis**, Univ. of Western Ontario, London, Ontario, Canada. (Sept. 2001, p. 909)
- * 14-17 **Intelligent Agents in Design Workshop and AID-02 Conference**, Cambridge University, Cambridge (UK).
Submission: The preferred method of admission is to send a 4 to 6 page position paper. Each position paper will be reviewed by at least 2 reviewers. The format of a submission is to be the AID format, available from Submission Details at the AID-02 Conference website. Contributions should be submitted electronically via e-mail to niek@cs.vu.nl, preferably in PostScript or PDF. Author details do not need to be separated from the paper, as specified for conference submissions.
Important Dates: Submission: Monday, June 3rd; Reviewer comments: Monday, June 17th; Final version: Monday, July 1st; Workshop: afternoon, Sunday July 14th.
Registration: To register for the workshop, participants need to register for the AID-02 conference at the registration page. It will be possible to register for the workshop separately if you have already registered for the conference. In the event that the workshop is overbooked, priority will be given to registrants who have submitted papers and position statements.
Information: Workshop: http://www.iids.org/events/AID2002_IAD/ and Conference: <http://www.arch.usyd.EDU.AU/kcdc/conferences/aid02/index.html>.
- 14-18 **The Fourth International Conference on Matrix Analytic Methods in Stochastic Models**, Univ. of Adelaide, Adelaide, Australia. (June/July 2001, p. 631)
- 14-18 **PIMS Thematic Programme on Selected Topics in Mathematical and Industrial Statistics, Design and Analysis of Experiments I (DAE I)**, Coast Plaza Suite Hotel, Vancouver, British Columbia, Canada. (May 2002, p. 605)
- 14-23 **PIMS Thematic Programme on Asymptotic Geometric Analysis, Conference on Phenomena of Large Dimension**, PIMS-UBC, Vancouver, British Columbia, Canada. (May 2002, p. 605)
- 15-18 **Modular Curves and Abelian Varieties (A EuroConference)**, Bellaterra (Barcelona). (Jan. 2002, p. 57)
- 15-19 **6th International Conference on the Electrical Transport and Optical Properties of Inhomogeneous Media (ETOPIM 6)**, Cliff Lodge, Snowbird, Utah. (Jan. 2002, p. 57)
- * 15-19 **Combinatorics and Integrable Models**, Australian National University, Canberra, Australia.
Scope: The workshop aims to bring together people from the mathematics and physics communities working on closely related problems in combinatorics and statistical mechanics.
Workshop Topics: Random tilings, dimer systems, Hirota equation, determinants, random matrices, alternating sign matrices, enumerations, etc.
Information: <http://wwwmaths.anu.edu.au/conferences/CIM/>.
- 15-19 **International Conference on Nonlinear Partial Differential Equations and Related Topics**, Australian National Univ., Canberra, Australia. (Jan. 2002, p. 57)
- * 15-19 **Tenth Meeting on Real Analysis and Measure Theory**, Hotel Continental Terme, Ischia (Naples), Italy.
Information: The above mentioned conference has a webpage where you can view a list of participants, organizers, and (coming soon) a schedule of events, titles of talks, directions to Ischia, etc.; <http://www.dma.unina.it/~Xcartemi/>.
- 15-20 **IV Brazilian Workshop on Continuous Optimization**, IMPA-Instituto de Matematica Pura e Aplicada, Rio de Janeiro, Brazil. (Nov. 2001, p. 1229)
- 15-August 10 **Conference on Representation Theory of Algebras and Related Topics (ICRA X)**, The Fields Inst. for Research in Math. Sciences, Toronto, Canada. (Dec. 2001, p. 1366)
- 16-22 **7th International Spring School "Nonlinear Analysis, Function Spaces and Applications" (NAFSA 7)**, Prague, Czech Republic. (Jan. 2002, p. 57)
- 18-19 **First Announcement and Call for Papers: MFCST2002, Second Irish Conference on the Mathematical Foundations of Computer Science and Information Technology**, National University of Ireland, Galway, Ireland. (Feb. 2002, p. 270)
- * 19-31 **V Diffiety School in the Geometry of Partial Differential Equations**, Santo Stefano del Sole (Avellino), Italy.
Program: To introduce undergraduate and graduate students in mathematics and physics, as well as postdoctoral researchers, to secondary calculus. Secondary calculus is the result of a natural evolution of the classical geometrical theory of partial differential equations (PDE) originated by Sophus Lie. In particular, it allows the construction of a general theory of PDE, in the same manner as algebraic geometry does with respect to algebraic equations. The strategic goal of the school is to involve interested participants in a series of large scale research programs the Diffiety Institute is launching.
Deadline: June 15, 2002.
Workshop Topics: 1. Differential calculus over commutative algebras and smooth manifolds (suggested to beginners); 2. Infinite jets and diffieties (suggested to more experienced participants).
Organizers: D. Catalano Ferraioli, A. DeParis, C. DiPietro, G. Manno, R. Piscopo, F. Pugliese, G. Rotondaro, F. Strazzullo, R. Vitolo.
Speakers: A. DeParis (Univ. "Federico II" di Napoli), S. Igonin (Independent Univ. of Moscow), F. Pugliese (Univ. di Salerno), A. Verbovetsky (Independent Univ. of Moscow, Diffiety Inst.), A. Vinogradov (Univ. di Salerno, Diffiety Inst.), M. Vinogradov (Diffiety Inst.), R. Vitolo (Univ. di Lecce, Diffiety Inst.)
Information: school@curgeo.org; <http://www.diffiety.org/>; <http://diffiety.ac.ru/>.
- 21-August 3 **Summer School on Applications of Advanced Mathematical and Computational Methods to Atmospheric and Oceanic Problems**, National Center for Atmospheric Research (NCAR), Boulder, Colorado. (Feb. 2002, p. 270)
- 22-25 **Seventeenth Annual IEEE Symposium on Logic in Computer Science**, Copenhagen, Denmark. (Mar. 2002, p. 358)
- * 22-26 **Geometric Aspects of Representation Theory**, University of Sydney, Australia.

Invited speakers: M. Brion, C. De Concini, S. Fomin, D. Gaitsgory, E. Getzler, V. Ginzburg, M. Goresky, I. Grojnowski, H. Kraft, R. MacPherson, V. Ostrik, A. Zelevinsky.

Organizers: G. Lehrer, C. Procesi.

Information: <http://www.maths.usyd.edu.au/u/gart/>; e-mail: gart@maths.usyd.edu.au.

22–26 **Universal Algebra and Lattice Theory**, University of Szeged, Szeged, Hungary. (Feb. 2002, p. 270)

22–August 6 **PIMS-APCTP-PI Frontiers in Mathematical Physics: Brane Worlds and Supersymmetry Workshop**, University of British Columbia, Vancouver, British Columbia, Canada. (May 2002, p. 605)

23–August 2 **EDGE Mid-Term Summer School and Conference**, ICMS, Edinburgh, Scotland, UK. (Nov. 2001, p. 1229)

24–August 5 **PIMS Thematic Programme on Asymptotic Geometric Analysis, Focused Research Groups on Random Methods and High Dimensional Systems**, PIMS-UBC, Vancouver, British Columbia, Canada. (May 2002, p. 605)

25–30 **PIMS Thematic Programme on Selected Topics in Mathematical and Industrial Statistics, Filtering Theory and Applications**, University of Alberta and Jasper, Alberta, Canada. (May 2002, p. 605)

27–29 (REVISED) **The Fifth Annual International Conference of Bridges: Mathematical Connections in Art, Music, and Science**, Towson Univ., Towson, Maryland. (Jan. 2002, p. 57)

28–August 2 **Institute of Mathematical Statistics Annual Meeting**, Banff, Alberta, Canada. (Mar. 2002, p. 358)

28–August 9 **4th PIMS School of Environmental and Industrial Fluid Dynamics**, University of Alberta, Edmonton, Alberta, Canada. (May 2002, p. 605)

29–August 2 **10th International Conference on Finite or Infinite Dimensional Complex Analysis and Applications**, Silla University in Pusane, Korea. (Apr. 2002, p. 502)

29–August 3 **Escuela Latinoamericana de Matemáticas (ELAM)**, Cartagena de Indias, Colombia. (Jan. 2002, p. 57)

29–August 10 **50 Years of the Cauchy Problem in General Relativity–Summer School**, Corsica, France. (Oct. 2001, p. 1050)

*29–August 16 **Mathematical Geophysics Summer School**, Stanford University, Stanford, California.

Description: The Mathematical Geophysics Summer School is an NSF-funded program to be held at Stanford University during the months of August from 1998–2002. Its overall purpose is to attract the attention and interest of theoreticians (applied mathematicians in particular) to the many interesting and important problems in geophysics, as well as to define mathematically, address, and solve some of these problems. The topic for 2002 is imaging.

Speakers for 2002: B. Biondi and J. Claerbout (Stanford), “Basic Concepts in the Seismic Imaging Industry”; B. Symes (Rice) and A. P. E. Ten Kroode (Shell International Exploration and Production Research), “Seismic Imaging”; G. Papanicolaou (Stanford), “Imaging, Time Reversal and Communications in Random Media”; J. Sethian (UC Berkeley), “Fast Algorithms for Level-set Computations and Applications”; H. Zebker (Stanford), “Interferometric Radar Remote Sensing”.

Deadline for Applications: May 15, 2002.

Information: For more information see the webpage at <http://cartan.stanford.edu/mgss/>.

30–August 2 **Mysticism, Reason, Art and Literature: East West Perspectives**, The Society of Indian Philosophy & Religion, Calcutta, India. (Apr. 2002, p. 502)

31–August 2 **The Fourth International Symposium on Probability and its Applications**, Banff, Alberta, Canada. (Mar. 2002, p. 358)

August 2002

3–10 **Logic Colloquium 2002 (ASL European Summer Meeting)**, Westfälische Wilhelms-Universität, Münster, Germany. (June/July 2001, p. 631)

4–8 **PIMS Symposium on Aperiodic Order, Dynamical Systems, Operator Algebras, and Toplogy**, University of Victoria, Victoria, British Columbia, Canada. (May 2002, p. 606)

4–9 **International Conference on Mathematics in Finance**, Berg-en-Dal, Kruger National Park, South Africa. (May 2002, p. 606)

4–9 **Modeling and Simulating Biocomplexity for Mathematicians and Physicists**, Santa Fe Institute (SFI), Santa Fe, New Mexico. (Apr. 2002, p. 502)

5–9 **Conference on Ill-Posed and Inverse Problems**, Sobolev Inst. of Mathematics, Novosibirsk, Russia. (Sept. 2001, p. 909)

5–9 **Stark’s Conjectures and Related Topics**, Johns Hopkins University, Baltimore, Maryland. (May 2002, p. 606)

*5–9 **XVII Brazilian Algebra Meeting**, Cabo Frio, Rio de Janeiro, Brazil.

Deadline: For contributed talks: June 15, 2002.

Speakers: I. Bermejo (Tenerife-Spain); L. Caporaso (Roma III-Italy); M. Chardin (Paris VII, Jussieu-France); A. Giambruno (Palermo-Italy); P. Gimenez (Valladolid-Spain); B. Green (Stellenbosh-South Africa); M. Hindry (Paris VII, Jussieu-France); C. T. Ho (Florida-USA); M. Homma (Kanagawa-Japan); E. Jespers (Vrije-Belgium); T. Kato (Japan); S. Kleiman (MIT -USA); A. Noma (Japan); M. Passi (Alberta-Canada); A. Prestel (Konstanz-Germany); H.-G. Rück (Kassel-Germany); R. Schoof (Roma II-Italy); S. Sehgal (Alberta-Canada); E. Ullmo (Paris XI, Orsay-France); D. Ulmer (Arizona-USA); W. Vasconcellos (Rutgers-USA); S. Collier Coutinho (UFRJ); E. Esteves (IMPA); M. Ferrero (UFRGS); H. Godinho (UnB); J. Goncalves (USP); A. Hefez (UFF); D. H. Kochlouva (UNICAMP); D. Levcovtiz (USP-SC); A. Mandel (USP); P. Shumyatsky (UnB); S. Sidki (UnB); A. Simis (UFPE); F. Torres (UNICAMP); I. Vainsencher (UFPE); P. Zaleski (UnB).

Program: There will be two mini-courses: Introduction to Diophantine Geometry, Marc Hindry (U. Paris VII-Jussieu) and Homologic and homotopic invariants of groups, Dessislava Hristova Kochlouva (U. Campinas-Brazil). There will be one conference cycle: The Arithmetic of $X_0(N)$ and elliptic curves E over \mathbb{Q} , Emmanuel Ullmo (U. Paris XI-Orsay).

Information: Home Page: <http://www.impa.br/~algebra/2002/algebra02.html>; e-mail: algebra@impa.br.

5–10 **6th Brazilian School of Probability**, Praia das Toninhas, Ubatuba, São Paulo, Brazil. (Feb. 2002, p. 271)

5–14 **Foundations of Computational Mathematics 2002 (FoCM’02)**, University of Minnesota, Minneapolis Campus, Minneapolis, Minnesota. (Mar. 2002, p. 359)

5–15 **New Directions in Dynamical Systems 2002 (ICM 2002 Satellite Conference)**, Ryukoku Univ. and Kyoto Univ., Kyoto, Japan. (June/July 2001, p. 631)

*5–25 **Microscopic Chaos and Transport in Many-Particle Systems**, Max Planck Institute for Physics of Complex Systems, Dresden, Germany.

Scope: Chaos in the motion of atoms and molecules composing fluids has become an important topic in nonequilibrium physics. Analyzing the fractal properties of nonequilibrium steady states generated by microscopic chaos poses a fundamental problem to statistical physics and dynamical systems theory. One interesting aspect is to find relationships between characteristic quantities of chaos and transport properties and to assess their validity. The purpose of the workshop is to bring together international experts working at the forefront of research in this field.

Invited Workshop Speakers (*to be confirmed): L. Bunimovich (Atlanta), N. I. Chernov (Birmingham), S. Ciliberto* (Lyon), E. G. D. Cohen (New York), N. Davidson (Rehovot), C. P. Dettmann (Bristol),

W. Ebeling (Berlin), G. Gallavotti (Rome), T. Geisel (Goettingen), P. Haenggi (Augsburg), W. G. Hoover (Livermore), H. Kantz (Dresden), R. Livi (Firenze), M. Mareschal (Brussels/Lyon), G. Morriss (Sydney), G. Nicolis (Brussels), H. A. Posch (Vienna), G. Radons (Chemnitz), L. Rondoni (Torino), S. Tasaki (Tokyo), T. Tel (Budapest).

Invited Seminar Speakers: D. Alonso (Tenerife), P. Balint (Budapest), I. Claus (Brussels), D. Daems (Brussels), T. Gilbert (Rehovot), Z. Kaufmann (Budapest), Z. Kovacs (Budapest), L. Matyas (Dresden), T. Prosen (Ljubljana), D. Searles (Queensland), Th. Schreiber (Stuttgart), J. Vollmer (Mainz), A. de Wijn (Utrecht).

Application and Fee: Applications are welcome and should be made by using the application form on the conference webpage; however, the number of attendees is limited. The workshop's registration fee is EUR 100. Cost for accommodations and meals will be covered by the Max Planck Institute. In exceptional cases, limited funding for travel expenses is available.

Deadline: Deadline for applications is April 30, 2002.

Information: For further information please visit the conference webpage at <http://www.mpipks-dresden.mpg.de/~chaotran/>; or contact: Visitors Program, Max-Planck-Institut für Physik Komplexer Systeme, Noethnitzer Str. 38, D-01187 Dresden; tel.: +49-351-871-2105; fax: +49-351-871-2199; chaotran@mpipks-dresden.mpg.de.

6-9 **PIMS Thematic Programme on Asymptotic Geometric Analysis, Conference on Noncommutative Phenomena and Random Matrices**, PIMS-UBC, Vancouver, British Columbia, Canada. (May 2002, p. 606)

7-10 **The Second International Conference on Neural, Parallel, and Scientific Computations**, Morehouse College, Atlanta, Georgia. (Nov. 2001, p. 1229)

7-11 **Workshop on Geometry, Dynamics, and Mechanics in Honour of the 60th Birthday of J. E. Marsden**, The Fields Institute, Toronto, Ontario, Canada. (May 2002, p. 606)

7-12 **Marsden Workshop on Geometry, Mechanics and Dynamics**, The Fields Inst. for Research in Math. Sciences, Toronto, Canada. (Dec. 2001, p. 1367)

8-9 **Beyond the Formula Statistics Conference**, Monroe Community College, Rochester, New York. (May 2002, p. 606)

9-11 **Colloquium Logicum 2002**, Münster, Germany. (Apr. 2002, p. 503)

* 10-12 **Complex Analysis**, Kyoto Institute of Technology, Kyoto, Japan.

Description: The first half of the Japan-China joint satellite conference.

Topics: Riemann surfaces, Kleinian groups, hyperbolic geometry, geometric function theory and related topics.

Organizing Committee: S. Hiroshige (Chairman, Tokyo Inst. of Tech.), K. Yohei (Osaka City Univ.), M. Fumio (Kyoto Inst. of Tech.), M. Katsuhiko (Ochanomizu), N. Toshihiro (Nagoya), S. Toshiyuki (Kyoto), T. Masahiko (Kyoto).

Information: Homepage: <http://kyotost1.cajpn.org/>.

11-14 **SIAM Conference on Discrete Mathematics**, Handlery Hotel and Resort, San Diego, California. (May 2002, p. 606)

11-16 **Geometric and Algebraic Combinatorics 2**, Oisterwijk, The Netherlands. (May 2002, p. 606)

11-17 **The 7th International Conference on Difference Equations and Applications (7th ICDEA)**, Hunan Univ. at Changsha, China. (Jan. 2002, p. 58)

11-19 **International School "Inverse Problems: Theory and Applications"**, Khanty-Mansiysk, Russia. (May 2002, p. 606)

12-15 **PIMS Thematic Programme on Asymptotic Geometric Analysis, Conference on Banach Spaces**, PIMS-UBC, Vancouver, British Columbia, Canada. (May 2002, p. 606)

12-15 **The 2002 Workshop on the Solution of Partial Differential Equations on the Sphere**, The Fields Institute, Toronto, Canada. (May 2002, p. 607)

12-16 **Geometric Topology—A Satellite Conference of ICM 2002, Beijing**, Shaanxi Normal University, Xi'an, China. (Apr. 2002, p. 503)

12-16 **Infinite Dimensional Function Theory**, Pohang Univ. of Science and Technology (POSTECH), Pohang, South Korea. (Nov. 2001, p. 1229)

12-16 **Integrability and Topology**, South Ural State Univ., Chelyabinsk, Russia. (Sept. 2001, p. 910)

12-16 **MTNS 2002, Fifteenth International Symposium on Math. Theory of Networks and Systems**, Univ. of Notre Dame, Notre Dame, Indiana. (Dec. 2001, p. 1437)

13-19 **Discrete, Combinatorial, and Computational Geometry, an ICM Satellite Conference**, Beijing, China. (May 2002, p. 607)

14-17 **International Congress of Mathematicians, Game Theory and Applications Satellite Conference**, Qingdao Univ., China. (Jan. 2002, p. 58)

15-17 (NEW DATE) **Symposium on Stochastics and Applications (SSA)—An ICM-2002 Satellite Conference**, National Univ. of Singapore, Singapore. (June/July 2001, p. 631)

15-17 **The Eighth Annual International Computing and Combinatorics Conference (COCOON'02)**, Singapore. (Jan. 2002, p. 58)

15-18 **The International Conference on Mathematical Biology (a Satellite Meeting of ICM-2002)**, Guangxi Normal Univ., Guilin, Guangxi Province, P. R. China. (Dec. 2001, p. 1367)

17-19 **A Satellite Conference of ICM 2002 (REVISED)**, Beijing, China. (Jan. 2002, p. 58)

19-23 **24th European Meeting of Statisticians, 14th Prague Conference on Information Theory, Statistical Decision Functions and Random Processes**, Prague, The Czech Republic. (Apr. 2002, p. 503)

20-27 **Summer School: From Levy Processes to Semimartingales—Recent Theoretical Developments and Applications to Finance**, University of Aarhus, Denmark. (May 2002, p. 607)

20-28 **ICM-2002**, Beijing, China. (Mar. 2002, p. 380)

20-28 **Satellite Conferences for ICM 2002**, Beijing, China. (Aug. 2001, p. 752)

24-28 **Compstat 2002—Conference for Computational Statistics**, Humboldt-Universität zu Berlin, Berlin, Germany. (Nov. 2001, p. 1229)

* 25-30 **2002 WSEAS International Conference on ElectroMagnetic Compatibility (EMC'02)**, Miedzyzdroje, Poland.

Information: URL: <http://www.wseas.org/conferences/2002/miedzyzdroje/ec/>; e-mail: poland2002@wseas.org.

* 25-30 **2002 WSEAS International Conference on Global Optical and Wireless Network (GOWN '02)**, Miedzyzdroje, Poland.

Information: URL: <http://www.wseas.org/conferences/2002/miedzyzdroje/gown/>; e-mail: poland2002@wseas.org.

* 25-30 **2002 WSEAS International Conference on Nanoelectronics, Nanotechnologies (NN'02)**, Miedzyzdroje, Poland.

Information: URL: <http://www.wseas.org/conferences/2002/miedzyzdroje/nn/>; e-mail: poland2002@wseas.org.

25-September 1 **40th International Symposium on Functional Equations**, Gronów, Poland. (May 2002, p. 607)

26-28 **The Sixth Iranian International Statistics Conference (ISC6)**, Tarbiat Modarres Univ., Tehran, Iran. (Dec. 2001, p. 1367)

*26–30 **DIMACS Summer School Tutorial: Epidemiology for Mathematical Scientists**, DIMACS Center, CoRE Building, Rutgers University, Piscataway, New Jersey.

Sponsor: DIMACS Center, Rutgers University.

Organizers: D. Ozonoff, Boston Univ., School of Public Health, dozonoff@bu.edu; D. Wartenberg, UMDNJ-Robert Wood Johnson Medical School, wartenbe@umdnj.edu; W. Sofer, Rutgers Univ., Waksman Inst., sofer@waksman.rutgers.edu.

Local Arrangements: J. Thiemann, DIMACS Center, jennifer@dimacs.rutgers.edu, 732-445-5928.

Information: Visit: <http://dimacs.rutgers.edu/Workshops/MathScientists/>.

26–September 1 **Symmetry and Cosymmetry Applications in the Theory of Bifurcations and Phase Transitions**, Big Sochi, Russia. (Mar. 2002, p. 359)

27–31 **7th International Symposium on Generalized Convexity/Monotonicity**, Institute of Mathematics, Hanoi, Vietnam. (Feb. 2002, p. 271)

*29–31 **Mathematics and War**, Blekinge Institute of Technology, Karlskrona, Sweden.

Topics: (1) Military traces in the history of mathematics and in present day mathematics. (2) Changes in the character of warfare under the influence of mathematical theory and mathematically supported technology. (3) Ethical and social aspects of the interaction between mathematics and the military. Mathematics and arms control and disarmament.

Format: There will be invited lectures and ample time for discussions opened by invited comments by respondents.

Registration: Send e-mail to Charlyne de Gosson at cdg@ihn.bth.se. The registration deadline is August 1, 2002. The registration fee is SKR 500.

Information: <http://mmf.ruc.dk/~Booss/mathwar/> or send e-mail to Charlyne de Gosson at cdg@ihn.bth.se.

29–September 2 **International Conference on Nonlinear Partial Differential Equations—Theory and Approximation**, City Univ. of Hong Kong, Hong Kong. (Nov. 2001, p. 1229)

29–September 3 **First Sino-German Meeting on Stochastic Analysis (Satellite Conference to the ICM 2002)**, Beijing, China. (May 2002, p. 607)

30–September 2 **33rd Iranian Mathematics Conference**, Ferdowsi University, Mashhad, Iran. (May 2002, p. 607)

September 2002

September–December 2002 **Set Theory and Analysis Program**, The Fields Inst., Toronto, Ontario, Canada. (Oct. 2001, p. 1051)

*1–5 **3rd WSEAS International MultiConference on Applied and Theoretical Mathematics**, Miedzyzdroje, Poland.

Information: URL: <http://www.wseas.org/conferences/2002/poland/>; e-mail: math2002@wseas.org.

1–8 **17th International Workshop on Differential Geometric Methods in Theoretical Mechanics**, Levico Terme, Trento, Italy. (May 2002, p. 607)

1–9 **8th International Congress on Algebraic Hyperstructures and Applications (AHA 2002)**, Democritus University of Thrace, Samothraki Island, Greece. (Mar. 2002, p. 359)

*2–6 **BISCA-2002: Design and Cognition**, Bolzano, Italy.

Description: Most of the world that we know is designed. Furthermore, almost everyone in the Western world has become a designer at their personal computers (e.g., publishing their own webpages). Design has become everyone's domain, and the 21st century communicates via design.

Organizer: Mitteleuropa Foundation.

Speakers: John Gero, Professor of Design Science and Co-Director of the Key Centre of Design Computing and Cognition, Department of Architectural and Design Science, at the University of Sydney; Michael Leyton, Center for Discrete Mathematics and Theoretical Computer Science at Rutgers; Michael Pratt, Professor of Computer Aided Engineering and Head of the Department of Applied Computing and Mathematics at Cranfield University in the UK; Gerhard Schmitt, Professor of Architecture and Computer Aided Architectural Design (CAAD) at the Department of Architecture of the Swiss Federal Institute of Technology (ETH), Zürich; and architect Daniel Libeskind.

Information: Attendance will be limited to about 35 participants. Each speaker will give 4 lectures, with ample time for discussion. All lectures will be in English. For more information write to L. Albertazzi (Mitteleuropa Foundation, 30 Portici Street, 39100 Bolzano, Italy), or send e-mail (liliana.albertazzi@soc.unitn.it). Information about Bolzano is available from the city's tourist office: <http://www.sudtirolo.com/bolzano/>; website: <http://www.mittleuropafoundation.it/events.htm>.

2–7 **VI International Workshop on Complex Structures, Vector Fields and Applications**, St. Constantine, near Varna/Bulgaria. (Mar. 2002, p. 359)

*2–7 **Poisson 2002—Conference on Poisson Geometry**, Instituto Superior Tecnico, Lisbon, Portugal.

Description: The conference will start on Monday, September 2, in the morning, and finish on Saturday, September 7, in the afternoon, with two half-days for sightseeing.

Confirmed Speakers Include: A. Alekseev (Geneva), M. Bertelson (Brussels), A. Cattaneo (Zurich), M. Crainic (Utrecht), J.-P. Dufour (Montpellier), E. Getzler (Northwestern), V. Ginzburg (Santa Cruz), V. Guillemin (MIT), J. Huebschmann (Lille), B. Khesin (Toronto), Y. Karshon (Jerusalem), J.-H. Lu (Arizona), Y. Maeda (Keio), E. Meinrenken (Toronto), J.-P. Ortega (Nice), T. Ratiu (Lausanne), N. Reshetikhin (Berkeley), D. Roytenberg (Penn State), P. Severa (Bratislava), A. Weinstein (Berkeley), C. Woodward (Rutgers), P. Xu (Penn State), N. T. Zung (Montpellier).

Information: <http://www.math.ist.utl.pt/Poisson2002/>.

4–6 **The Fourth International Workshop on Automated Deduction in Geometry**, RISC-Linz, Hagenberg, Austria. (Mar. 2002, p. 359)

4–7 **International Conference on Dynamical Methods for Differential Equations**, Medina del Campo, Valladolid, Spain. (Oct. 2001, p. 1051)

5 **PIMS Numerical Analysis Potlatch 2002**, University of Victoria, Victoria, British Columbia, Canada. (May 2002, p. 607)

9–13 **Axiomatic and Enriched Homotopy Theory**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Apr. 2002, p. 503)

9–27 **School and Conference on Intersection Theory and Moduli**, The Abdus Salam International Centre for Theoretical Physics (ICTP), Strada Costiera 11, I-34014, Trieste, Italy. (Mar. 2002, p. 360)

10–20 **Advanced Course on Geometric 3-Manifolds**, Bellaterra (Barcelona). (Jan. 2002, p. 58)

*11–13 **EACA-2002, VIII Encuentro de Álgebra Computacional y Aplicacione**, Palacio de Avellaneda, Peparanda de Duero, Spain.

Description: The main goal of this series of meetings on computer algebra and applications (EACA) is to provide a forum for researchers on computer algebra as well as for researchers who essentially use these techniques in their investigation. Originally, this was a Spanish forum, but it is not restricted to Spanish people. In the last EACA events, many researchers from all over the world participated. The EACA-2002 is the eighth EACA meeting. As in the previous events of this series, the participation of young researchers is especially encouraged.

Deadlines: April 30: deadline for abstract submission; June 28: deadline for registration.

Organizer: P. Gimenez (pgimenez@agt.uva.es, Univ. of Valladolid).

Plenary Speakers: C. Andradas (Univ. Complutense, Madrid), B. Buchberger (RISC-Linz), J. Elias (Univ. Barcelona), I. Emiris (INRIA, Nice), A. Simis (Univ. F. Pernambuco, Recife), U. Walther (Purdue Univ.).

Information: <http://www.uva.es/eaca2002/>; e-mail: eaca2002@agt.uva.es.

11-18 **NSEC8: Navier-Stokes Equations and Related Topics**, Euler International Mathematical Institute, St. Petersburg, Russia. (Feb. 2002, p. 271)

13-14 (REVISED) **Topics in Linear Algebra**, Iowa State Univ., Ames, Iowa. (Oct. 2001, p. 1051; Jan. 2002, p. 58)

* 15-21 **Theory and Applications of Imaging**, Martina Franca (Taranto), Italy.

Scientific Direction: G. Papanicolau (Stanford Univ., USA, papanico@georgep.stanford.edu); G. Talenti (Univ. di Firenze, Italy, talenti@math.unifi.it).

Courses: Array imaging in noisy environments, G. Papanicolau (Stanford Univ., USA); Tomographic imaging, F. Natterer (Univ. of Munster, Germany); Diffuse imaging for medical diagnoses, S. R. Arridge, (Univ. College, London, UK); Experimental methods and results in laser-tissue imaging, R. R. Alfano (Inst. for Ultrafast Spectroscopy and Lasers, CUNY, New York); Seismic imaging, W. W. Simes (Rice Univ., USA).

Information: For any further information contact: Fondazione C.I.M.E. c/o Dipartimento di Matematica "U. Dini", Viale Morgagni, 67/A - 50134 Firenze, Italy; Tel. +39-55-434975/ +39-55-4237123; fax +39-55-434975 / +39-55-4222695; <http://www.math.unifi.it/cime/>.

* 15-22 **International Summer School on Operator Methods for Evolution Equations and Approximation Problems (OMEEAP 2002)**, Hotel Villaggio Cala Corvino, Monopoli, Bari, Italy.

Topics: Feller semigroups and Markov processes, positive operators and approximation of functions, positive operators and approximation for evolution equations, semigroups of operators and evolution equations, cosine families of operators and evolution equations.

Aim: The School is especially addressed to Ph.D. students and young researchers. A poster session, in which the youngest researchers can outline their research work and interests, will also be arranged.

Invited Speakers of the Courses: J. van Casteren (Univ. of Antwerp), H. H. Gonska (Univ. of Duisburg), J. Prüss (Univ. of Halle-Wittenberg), I. Ra.a (Technical Univ. of Cluj-Napoca), Sen-Yen Shaw (National Central Univ. of Chung-li).

Invited Lecturers: J. A. Adell (Univ. of Zaragoza), D.-H. Mache (Univ. of Dortmund), Giuseppe Mastroianni (Univ. of Basilicata), A. Rhandi (Univ. of Marrakech), V. Vespri (Univ. of Firenze).

Executive organizing committee: F. Altomare (altomare@dm.uniba.it), A. Attalienti (attalienti@matfin.uniba.it), M. Campiti (campiti@dm.uniba.it), L. D. Ambrosio (dambros@dm.uniba.it), S. Diomede (s.diomede@dse.uniba.it), G. Metafune (Giorgio.Metafune@le.infn.it), D. Pallara (Diego.Pallara@le.infn.it).

Grants: In order to foster the participation of young researchers, some scholarships for attendance (as widely as possible) will likely be available. Applications for scholarships must be sent to F. Altomare, Dipartimento di Matematica Dell Univ. e del Politecnico di Bar Campus Univ., Via E. Orabona, 4, 70125 Bari, Italy (altomare@dm.uniba.it, telefax number: +39-080-5963612) no later than May 31; the applicants must also include a short curriculum vitae and a letter of recommendation.

Deadline for Registration: May 31; no registration fee is required.

Information: Contact one of the executive organizers or visit the website <http://www.dm.uniba.it/documenti/formazione/SummerSchool-OMEEAP2002/index.htm>.

16-18 **KES'2002 Sixth International Conference on Knowledge-Based Intelligent Information & Engineering Systems**, Podere d'Ombriano, Crema, Italy. (Apr. 2002, p. 503)

16-20 **Homotopy Theory of Geometric Categories**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Apr. 2002, p. 503)

* 16-20 **LMS/EPSC Short Course on Differential Geometry, Homogeneous Spaces and Integrable Systems**, University of Durham, United Kingdom.

Description: The instructional course is aimed at research students, both beginning and more advanced. It is funded by the London Mathematical Society and the Engineering and Physical Sciences Research Council (UK). The course consists of three lecture series.

Lecture Series: M. Micallef (Warwick), Introduction to Differential Geometry; D. Alekseevsky (Hull), Lie Groups and Homogeneous Spaces; M. Guest (Tokyo), Geometry and Integrable Systems.

Registration Deadline: July 5, 2002.

Organizers: J. Berndt (Hull), J. Bolton (Durham).

Contact: j.berndt@hull.ac.uk, john.bolton@durham.ac.uk.

Information: <http://www.hull.ac.uk/LMS-DG/>.

17-23 **International Algebra Conference Dedicated to the Memory of Zenon Borewicz (1922-1995)**, Saint Petersburg, Russia. (Apr. 2002, p. 503)

20-21 **AD-HOC NetWorks and Wireless (ADHOC-NOW)**, The Fields Institute, Toronto, Ontario, Canada. (May 2002, p. 607)

* 20-22 **Conference on the Hilbert-Smith Conjecture and its Proof**, Istanbul Bilgi University, Istanbul, Turkey.

Description: There will be a limited number of short talks, 20-30 min. Those wishing to speak should send their requests and abstracts to either L. F. McAuley at louis@math.binghamton.edu or louis@bilgi.edu.tr or to A. Ratiu at ratiu@bilgi.edu.tr.

Principal Speakers: A. V. Chernavsky, D. Repovs, S. Illman, L. F. McAuley.

20-22 **Yamabe Memorial Symposium**, University of Minnesota, School of Mathematics, Minneapolis, Minnesota. (Apr. 2002, p. 503)

20-25 **International Conference on Computational and Math. Methods in Science and Engineering (CMMSE 2002)**, Alicante, Spain. (Oct. 2001, p. 1051)

* 23-26 **8th European Conference on Logics in Artificial Intelligence: Jelias'02**, Cosenza, Italy.

Aim and Scope: The aim is to bring together active researchers interested in all aspects concerning the use of logics in artificial intelligence to discuss current research, results, and problems and applications of both a theoretical and practical nature. Moreover, Jelias strives to foster links and facilitate cross-fertilization of ideas among researchers from various disciplines; among researchers from academia, industry and government; and between theoreticians and practitioners.

Invited Speakers: M. Gelfond (Texas Tech Univ., USA), G. Gottlob (Vienna Univ. of Technology, Austria), M. Vardi (Rice Univ., USA), K. Apt (CWI National Res. Inst. for Math. and Comput. Sci. in the Netherlands).

Tutorials: V. S. Subrahmanian (Univ. of Maryland, USA): Logic based agents; Dino Pedreschi and Fosca Giannotti (Univ. of Pisa, Italy): Logics and data mining; G. Pfeifer (Vienna Univ. of Tech., Austria): Answer set programming.

Information: <http://www.unical.it/jelias/>.

23-27 **Ramification in Arithmetic and Geometry**, Institut Galilée, Université Paris 13, France. (Oct. 2001, p. 1051)

23-28 **Workshop on Categorical Structures for Descent and Galois Theory, Hopf Algebras and Semiabelian Categories**, The Fields Inst. for Research in Math. Sciences, Toronto, Canada. (Dec. 2001, p. 1368)

- *23–October 4 **The Calculemus Autumn School**, Pisa, Italy.
Objectives: The main objectives of the Calculemus Autumn School are: to give young researchers a perspective on the state-of-the-art in symbolic computation and symbolic reasoning; to disseminate advanced scientific knowledge on the integration of computer algebra systems and deduction systems; to foster contacts between the research communities of computer algebra, deduction, math education, and industry. The participants will be trained both theoretically as well as experimentally on selected tools.
Courses and Schedule: For the list of courses and the preliminary schedule visit: <http://www.eurice.de/calculumus/autumn-school/courses2.html> and <http://www.eurice.de/calculumus/autumn-school/timetable.pdf/>.
Registration: Registration deadline is July 1, 2002.
Contact: E-mail: calculumus-autumn-school@eurice.de.
Information: Please visit our webpage for further information on the event: <http://www.eurice.de/calculumus-school/>.
- *24–27 **Symposium on Informatics and Telecommunications**, Sevilla, Spain.
Organizer: Organised under the auspices of DINTEL (<http://www.fundacion-dintel.org>).
Description: SIT'02 is the Spanish Symposium on Informatics and Telecommunications. It is not a pure scientific meeting, but a mixed gathering where people from industry and academia are expected to exchange ideas and experiences and foster lively discussions on topics ranging from pervasive computing to real-time distributed systems or security concerns.
Information: <http://tdg.lsi.us.es/~sit02/>.
- 25–28 **International Conference on Computer Geometry: Information Geometry, Foundation of Computer Science, Erdos-Diophantine Graphs**, Plovdiv University–Filial Smolyan, Smolyan, Bulgaria. (Mar. 2002, p. 360)
- *30–October 4 **DIMACS Workshop on Geometric Graph Theory**, DIMACS Center, Rutgers University, Piscataway, New Jersey.
Sponsors: DIMACS Center.
Organizers: J. Pach, NYU, Courant Institute.
Deadline for Submissions: May 15, 2002.
Contacts: J. Pach, pach@cims.nyu.edu.
Local Arrangements: J. Herold, DIMACS Center, jessicah@dimacs.rutgers.edu; tel: 732-445-5928.
Information: Visit <http://dimacs.rutgers.edu/Workshops/GeometricGraph/>.
- 30–October 4 **K-theory and Arithmetic**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Apr. 2002, p. 504)
- ### October 2002
- *4–5 **Ninth Midwest History of Mathematics Conference and 30th Annual Miami University Mathematics and Statistics Conference**, Miami University, Oxford, Ohio.
Theme and Call for Papers: The program will focus on the history of mathematics in America. Authors wishing to contribute a 15-minute paper consistent with this theme should submit an abstract by September 1, 2002.
Invited Speakers: K. H. Parshall (Univ. of Virginia) and D. Zitarelli (Temple Univ.).
Information: The conference director is D. E. Kullman (Miami Univ.), kullmade@muohio.edu. Abstracts of contributed papers and requests for information should be sent to: History of Mathematics Conference, Dept. of Math. and Stat., Miami Univ., Oxford, Ohio 45056; tel: 513-529-5818; fax: 513-529-1493; website: <http://unixgen.muohio.edu/~MathStat/>. Conference programs with information about registration and housing will be available after August 1.
- 4–5 **SIAM Symposium on Computational Models and Simulation for Intra-Cellular Processes**, Hilton Garden Inn, Washington, DC. (May 2002, p. 608)
- *5–6 **AMS Eastern Section Meeting**, Northeastern University, Boston, Massachusetts.
Information: <http://www.ams.org/amsmtgs/sectional.html>.
- *6–11 **Quantum Control: Mathematical and Numerical Challenges**, Centre de recherches mathématiques, Montréal, Canada.
Topic: This conference will concentrate on advanced numerical methods and new mathematical tools for control and optimization in the quantum control of matter at the molecular level using current advanced laser technology.
Organizers: A. Bandrauk (Sherbrooke, Canada), M. Delfour (Montréal, Canada), C. Le Bris (ENPC, Paris, France).
Information: Conference website: <http://omega.crm.umontreal.ca/QuantumC/>.
- 9–11 **The 7th Conference "Shell Structures. Theory and Applications" (SSTA2002)**, Gdansk, Poland. (Jan. 2002, p. 58)
- *12–13 **AMS Central Section Meeting**, University of Wisconsin-Madison, Madison, Wisconsin.
Information: <http://www.ams.org/amsmtgs/sectional.html>.
- *18–19 **The 24th Midwest Probability Colloquium**, Northwestern University, Evanston, Illinois.
Workshops: On Thursday, October 17, there will be a workshop on related topics including talks by Y. Peres (Berkeley) and B. Virag (MIT). Topics include stochastic Lowener evolution with applications, percolation on trees, discrete lattice processes, and scaling limits in higher dimensions.
Main Speaker: O. Schramm (Microsoft), together with A. Dembo (Stanford) and F. Rezhankalou (Berkeley).
Organizing Committee: C. Mueller, E. Kosygina and S. Sethuraman.
Information: Contact M. Pinsky (pinsky@math.nwu.edu).
- *24–25 **DIMACS Workshop on Visualization and Data Mining**, DIMACS Center, Rutgers University, Piscataway, New Jersey.
Sponsors: DIMACS Center.
Organizers: E. Gansner, AT&T; M. Goodrich, Univ. of California-Irvine; C. Silva, AT&T; R. Tamassia, Brown Univ.
Contacts: E. Gansner, erg@research.att.com; M. Goodrich, goodrich@ics.uci.edu; C. Silva, csilva@research.att.com; R. Tamassia, rt@cs.brown.edu.
Local Arrangements: J. Thiemann, DIMACS Center, jennifer@dimacs.rutgers.edu; tel: 732-445-5928.
Information: See <http://dimacs.rutgers.edu/Workshops/VisDataMining/>.
- *25–27 **2002 Conference on Applied Mathematics (CAM 2002)**, University of Central Oklahoma, Edmond, Oklahoma.
Topics: The conference will feature special sessions in error-correcting codes and wavelets and signal processing.
Speakers: Keynote speakers will be N. Sloane (AT&T Shannon Labs) and V. Wickerhauser (Washington Univ.-St. Louis).
Conference Organizers: J. Byrne, 100 N. University Drive, Edmond, OK 73034; jbyrne@ucok.edu; tel: (405) 974-5575; and C. Simmons, 100 N University Drive, Edmond, OK 73034; cksimmons@ucok.edu; tel: (405) 974-5316.
Information and Deadlines: Papers are invited for contributed paper sessions, including a session for undergraduate and graduate student talks. Those interested in presenting may send an abstract and minivita to the organizers by August 2. Grant proposals to provide travel support for a limited number of participants are pending with NSA and NSF. For more information, please visit the conference website at <http://www.math.ucok.edu>.
- *26–27 **AMS Western Section Meeting**, University of Utah, Salt Lake City, Utah.
Information: <http://www.ams.org/amsmtgs/sectional.html>.

27-29 **King Fahd University of Petroleum and Minerals**, Dhahran, Saudi Arabia. (Mar. 2002, p. 360)

November 2002

2-3 **PIMS Cascade Topology Conference**, University of British Columbia, Vancouver, British Columbia, Canada. (May 2002, p. 608)

* 8-10 **Conference to Celebrate the 70th Birthday of Professor Avner Friedman**, University of Minnesota, School of Mathematics, Minneapolis, Minnesota.

Speakers: D. Kinderlehrer (Carnegie Mellon), M. Gurtin (Carnegie Mellon), B. Pulleyblank (IBM), G. Papanicolaou (Stanford), H. Matano (Univ. of Tokyo), B. Peletier (Leiden Univ.), R. Brualdi (Univ. of Wisconsin), D. James (Univ. of Minnesota), M. Steele (Univ. of Pennsylvania), G. McDonald (General Motors), N. Kopell (Boston Univ.), J. Guckenheimer (Cornell), K. H. Hoffman (Center for Advanced European Studies & Research, Bonn), W. Newman (UCLA).
Organizing Committee: N. Krylov, W. Littman (chair), F. Reitich, F. Santosa.

Financial support: Interested younger participants are invited to apply for partial support for travel and local expenses. Please supply a brief research summary or C.V. and a letter of reference.
Information and Contacts: Email: dept@math.umn.edu; tel: (612) 625-5591. The final list of speakers and other conference details will be posted on the department's website at <http://www.math.umn.edu/>.

* 9-10 **AMS Southeastern Section Meeting**, University of Central Florida, Orlando, Florida.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

* 14-15 **DIMACS Workshop on Computational Geometry**, DIMACS Center, Rutgers University, Piscataway, New Jersey.

Sponsors: DIMACS Center.

Deadline for Submissions: October 11, 2002.

Organizers: J. S. B. Mitchell, SUNY at Stony Brook.

Contacts: J. S. B. Mitchell, jsbm@ams.sunysb.edu.

Local Arrangements: J. Herold, DIMACS Center, jessicah@dimacs.rutgers.edu; tel: 732-445-5928.

Information: <http://dimacs.rutgers.edu/Workshops/CompGeom/>

* 18-22 **International Conference on Fuzzy Systems and Knowledge Discovery (FSKD'02); 9th International Conference on Neural Information Processing (ICONIP'02); 4th Asia-Pacific Conference on Simulated Evolution and Learning (SEAL'02)**, Orchid Country Club, Singapore.

Information: <http://www.ntu.edu.sg/home/nef/>. Please visit the conference homepage or contact: L. Wang, ICONIP'02-SEAL'02-FSKD'02 General Chair, School of Electrical and Electronic Engineering, Nanyang Technological Univ., Block S2, 50 Nanyang Avenue, Singapore 639798; e-mail: elpwang@ntu.edu.sg; phone: +65 6790 6372.

18-22 **Twenty Years of Tilting Theory: An Interdisciplinary Symposium**, Fraueninsel, Germany. (Apr. 2002, p. 504)

25-28 **Fifth International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing (MCQMC 2002)**, Singapore, Republic of Singapore. (Apr. 2002, p. 504)

December 2002

* 5-8 **Geometry and Topology of Quotients**, University of Arizona, Tucson, Arizona.

Focus: The conference focuses on various aspects of geometry and topology of quotients naturally arising in algebraic and symplectic geometry. The plenary lectures will survey recent progress and current directions of research in geometric invariant theory and symplectic reductions, explain connections with other disciplines and applications to physics. In addition to principal lectures, there

will be sessions of contributed talks and round-table discussions. Women and minority researchers are encouraged to participate.

Financial Support: Available for graduate students and researchers with no other means of support.

Principal Speakers: I. Dolgachev (Michigan), W. Fulton (Michigan), S. Keel (Texas), J. Li (Stanford), R. Sjamaar (Cornell), S. Tolman (Illinois), A. Weinstein (Berkeley).

Local Organizers: P. Bressler, P. Foth, Y. Hu, J.-H. Lu.

Information: <http://www.math.arizona.edu/~foth/gtq.html>.

* 9-12 **ICDM '02: The 2002 IEEE International Conference on Data Mining Sponsored by the IEEE Computer Society**, Maebashi TERRSA, Maebashi City, Japan.

Information: See <http://kis.maebashi-it.ac.jp/icdm02/> or mirror page: <http://www.wi-lab.com/icdm02/>.

* 9-13 **9th Annual Biopharmaceutical Applied Statistics Symposium**, Savannah, Georgia.

Organizer: MCV/VCU and GASOU Biostatistics Departments.

Information: 12 tutorials, 4 short courses, on topics related to research, development and regulation of pharmaceuticals, with emphasis on biostatistics; e-mail: KEPeace@gasou.edu; <http://views.vcu.edu/bis/bass/>.

9-13 **Elliptic Cohomology and Chromatic Phenomena**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Apr. 2002, p. 504)

9-13 **FICOFEST, A Conference in Low-dimensional Topology to Celebrate the Sixtieth Birthday of Francisco Javier "Fico" Gonzalez Acuna**, Universidad Autonoma de Yucatan, Merida, Yucatan, Mexico. (May 2002, p. 608)

9-13 **Title 27th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing (27ACCMCC)**, The University of Newcastle, Newcastle, NSW, Australia. (Feb. 2002, p. 271)

* 14-16 **International Symposium on Pure and Applied Mathematics: (ISPAM 2002)**, Calcutta, India.

Dedication: The symposium is dedicated to Niels Henrik Abel to mark the 200th anniversary of his birth.

Topics: a) Algebra and its applications, b) Analysis and topology and their applications, c) Geometry and its applications, d) Dynamical systems, chaos and fractals, e) Continuum mechanics, f) Plasma physics, g) Control theory and optimization theory, h) Biomechanics, i) Applications of mathematics to environmental problems, and j) History and philosophy of physical science.

Information: All correspondence in regard to the symposium is to be addressed to: M. R. Adhikari; H. P. Mazumdar, Convenor; Calcutta Math. Soc., Physics and Applied Mathematics Unit, AE-374, Sector-1, Salt Lake City Indian Statistical Institute, Calcutta-700064, India 203 B.T.Road, Calcutta-700035, India; e-mail: cms@cal2.vsnl.net.in or hpm@isical.ac.in.

* 27-30 **ASL Winter Meeting (with APA)**, Philadelphia Marriott, Philadelphia, Pennsylvania.

Program Committee: J. Burgess, B. Ewald, and S. Weinstein (Chair).

Abstracts: Abstracts of contributed talks submitted by ASL members will be published in *The Bulletin of Symbolic Logic* if they satisfy the rules for abstracts (see <http://aslonline.org/Meetings.htm>). Abstracts must be received by the deadline of September 16, 2002, at the ASL business office: ASL, Box 742, Vassar College, 124 Raymond Avenue, Poughkeepsie, NY 12604, USA; fax: 1-845-437-7830; e-mail: asl@vassar.edu.

January 2003

January-August **Thematic Program on Automorphic Forms**, The Fields Inst. for Research in Math. Sciences, Toronto, Canada. (Dec. 2001, p. 1368)

6-11 **International Conference on Dynamical Systems and Geometry, to Celebrate the Sixtieth Anniversary of Alberto Verjovsky**, Cuernavaca, Mexico. (Oct. 2001, p. 1051)

12-14 **ACM-SIAM Symposium on Discrete Algorithms**, Hyatt Regency, Baltimore, Maryland. (May 2002, p. 608)

* 15-18 **Joint Mathematics Meetings**, Baltimore Convention Center, Baltimore, Maryland.

Information: URL: http://www.ams.org/amsmtgs/2074_intro.html.

* 17-18 **2002-2003 ASL Winter Meeting (with Joint Mathematics Meetings)**, Baltimore Convention Center, Baltimore, Maryland.

Description: This meeting will take place in conjunction with the Joint Mathematics Meetings, which will be held January 15-18, 2003.

Program Committee: H. Becker (Chair), M. C. Laskowski, and R. Solomon.

Abstracts: Abstracts of contributed talks submitted by ASL members will be published in *The Bulletin of Symbolic Logic* if they satisfy the rules for abstracts (see <http://aslonline.org/Meetings.htm>). Abstracts must be received by the deadline of September 30, 2002, at the ASL business office: ASL, Box 742, Vassar College, 124 Raymond Avenue, Poughkeepsie, NY, 12604, USA; fax: 1-845-437-7830; e-mail: asl@vassar.edu.

February 2003

9 **Short Course Prior to Conference on Computational Science and Engineering**, Hyatt Regency Islandia Hotel and Marina, San Diego, California. (May 2002, p. 608)

10-14 **Permutation Patterns**, University of Otago, Dunedin, New Zealand. (May 2002, p. 608)

March 2003

* 14-16 **AMS Southeastern Section Meeting**, Louisiana State University, Baton Rouge, Louisiana.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

17-20 **SIAM Conference on Mathematical and Computational Issues in the Geosciences**, Radisson Hotel and Suites Austin, Austin, Texas. (May 2002, p. 608)

April 2003

* 4-6 **AMS Central Section Meeting**, Indiana University, Bloomington, Indiana.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

* 12-13 **AMS Eastern Section Meeting**, Courant Institute, New York, New York.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

* 17-19 **The Sixth Asian Symposium on Computer Mathematics (ASCM 2003)**, Beijing, Japan.

Description: The Asian Symposium on Computer Mathematics (ASCM) is a series of conferences which offers an opportunity for participants to present original research, to learn of research progress and new developments, and to exchange ideas and views on doing mathematics using computers. ASCM 2003 will provide an international forum for active researchers to review the current state of the art and trends on computer mathematics. The symposium will consist of plenary sessions by invited speakers, regular sessions of contributed papers, and software demonstrations.

Information: <http://www.mmrc.iss.ac.cn/~ascm/>.

May 2003

1-3 **SIAM International Conference on Data Mining**, Cathedral Hill Hotel, San Francisco, California. (May 2002, p. 608)

* 3-4 **AMS Western Section Meeting**, San Francisco State University, California.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

3-5 **First International Conference on Smarandache Geometries**, Griffith Univ., Gold Coast Campus, Australia. (Dec. 2001, p. 1368)

* 11-16 **International Conference on General Control Problems and Applications (GCP 2003): Dedicated to the 100th Anniversary of A. N. Kolmogorov**, Tambov State University, Tambov, Russia.

Scope: A. N. Kolmogorov creative legacy; optimization theory and its prospects; approximation methods and stability in control; variation methods for nonlinear systems investigating and their applications; mathematical models of economic systems control; mathematical models of control technical, natural, and humanities. **Organizers:** Moscow M. V. Lomonosov State Univ.; Steklov V. A. Inst. of Math. of the Russ. Acad. of Sci.; Ministry of Education of Russian Federation; Ministry of Industry, Science, and Technologies of Russian Federation; Tambov region Administration; Tambov G. R. Derzhavin State Univ.

Program committee: V. M. Filippov, A. B. Kurzhansky, Yu. S. Osipov, V. A. Sadovnichy, V. M. Tikhomirov (chairmen); A. I. Bulgakov (deputy); A. P. Afanasiev, A. V. Arutyunov, N. A. Bobylev, A. G. Chentsov, V. B. Demidovich, V. V. Dikumar, A. V. Dmitruk, I. V. Evstigneev, V. I. Levin, G. G. Magaril-Il'yaev, S. M. Nikol'sky, Yu. V. Pokorny, E. L. Tonkov, M. I. Zelikin; E. S. Zhukovsky (scientific secretary).

Languages of Conference: Russian, English.

Call for Papers: Authors are kindly invited to submit abstracts before November 1, 2002. Contributions must be prepared in LaTeX.

Information: Contacts: For up-to-date information, please visit our website <http://www.opu2003.narod.ru/> or contact the conference committee via e-mail: aib@tsu.tmb.ru, uaa@hmb.mnn.tstu.ru.

* 11-18 **Conference on Topological Algebras, Their Applications, and Related Topics**, Poznan, Poland.

Description: The Conference will take place at the Mathematical Conference Center in Bedlewo, near Poznan, Poland, to celebrate the 70th birthday of Professor Wieslaw Zelazko.

Topics: General theory of Banach and topological algebras, Spectral theory of Banach and topological algebras, Operator theory, Topological algebras and complex analysis, Harmonic analysis, Homological methods in the theory of Banach algebras, Automatic continuity, Representations, structure and classification of topological algebras, Nonassociative topological algebras,

Information: <http://main.amu.edu.pl/~ta2003/>; e-mail: ta2003@amu.edu.pl, or write to A. Soltysiak, Faculty of Mathematics and Computer Science, Adam Mickiewicz University, 60-769 Poznan, Poland.

20-24 **Fourth Seminar on Stochastic Analysis, Random Fields and Applications Fourth Minisymposium on Stochastic Methods in Financial Models**, Centro Stefano Franscini, Ascona, Switzerland. (May 2002, p. 608)

20-24 **The 31st Annual Canadian Operator Theory and Operator Algebras Symposium**, UNB, Fredericton, New Brunswick, Canada. (Sept. 2001, p. 910)

27-31 **SIAM Conference on Applications of Dynamical Systems**, Snowbird Ski and Summer Resort, Snowbird, Utah. (May 2002, p. 608)

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.

June 2003

* 1-4 **2003 ASL Annual Meeting**, University of Illinois at Chicago, Chicago, Illinois.

Program Committee: A. Blass (Chair).

Organizing Committee: W. Blok, B. Hart (Chair), B. Howard, and D. Marker.

* 1-6 **International Conference on Group Theory: Combinatorial, Geometric, and Dynamical Aspects of Infinite Groups**, Gaeta, Italy.

Program: Geometric group theory; ergodic theory; groups acting on trees and boundaries; random walks; amenability; growth of groups, languages, and automata; groups and fractals; L^2 -cohomology; bounded cohomology; branch groups; groups generated by finite automata; calculus of spectra; problems of Burnside type; combinatorics of words.

Organizers: L. Bartholdi, Univ. of Calif., Berkeley; T. Ceccherini-Silberstein, Univ. del Sannio di Benevento; T. Smirnova-Nagnibeda, Royal Inst. of Tech., Stockholm; A. Zuk, Ecole Normale Supérieure de Lyon.

Plenary Speakers: D. Anosov (Steklov Institute, Moscow); G. Baumslag (City Univ., New York); M. Burger (ETH Zürich); H. Furstenberg (Hebrew Univ., Jerusalem); E. Ghys (ENS Lyon); R. Grigorchuk (Steklov Institute, Moscow); M. Gromov (IHES, Paris); F. Grunewald (Univ. of Düsseldorf); P. de la Harpe (Univ. of Geneva); V. Jones (UC Berkeley); A. Lubotzky (Hebrew Univ., Jerusalem); W. Lück (Univ. of Münster); A. Ol'shanskii (Vanderbilt Univ., Nashville, and Moscow State Univ.); G. Pisier (Texas A&M and Univ. of Paris VI); S. Sidki (Univ. of Brasília); A. Valette (Univ. of Neuchâtel); A. Vershik (Steklov Institute, St. Petersburg); E. Zelmanov (Yale Univ., New Haven).

Information: e-mail: gaeta@mat.uniroma1.it or gaeta@math.kth.se; <http://www.marth.kth.se/~gaeta/>.

* 17-21 **Fourth Geoffrey J. Butler Memorial Conference**, University of Alberta, Edmonton, Alberta, Canada.

Description: A gathering for researchers and students in differential equations and mathematical biology.

Information: <http://conley.math.ualberta.ca/butler.html>.

* 18-21 **First Joint International Meeting between the American Mathematical Society and the Real Sociedad Matematica Espanola**, Seville, Spain.

Information: URL: <http://www.us.es/rsme-ams/>.

July 2003

* 7-11 **ICIAM 2003, 5th International Congress on Industrial and Applied Mathematics**, Sydney, Australia.

Information: Visit the website at <http://www.iciam.org/> for full information about speakers, registration, embedded submeetings, deadlines for minisymposia and abstracts, venue, accommodations, sponsors and the organizers.

* 27-August 9 (NEW DATE) **Banach Algebras and Their Applications: Banach Algebras 2003**, Edmonton, Alberta, Canada.

Description: This conference is the sixteenth in a series of conferences on Banach algebras that started in 1974 in Los Angeles. We expect that most specialists in Banach algebras as well as leading mathematicians from related areas will attend this conference. In the past, these conferences have always led to fruitful interaction between the participants, and we expect this tradition to continue. In addition to the regular conference program consisting of one-hour and half-hour talks by the participants, we also plan to hold five workshops on the following topics, each of which will be chaired by an internationally recognized specialist in the respective area: Banach algebras in harmonic analysis (to be held in the honor of Eberhard Kaniuth on the occasion of his retirement), Chair: A. T.-M. Lau (Edmonton); Banach algebras in operator theory, Chair: M. M. Neumann (Starkville; USA); Banach algebras and operator spaces, Chair: Z.-J. Ruan (Urbana-Champaign; USA); K -theory of Banach algebras, Chair: J. Cuntz (Muenster, Germany); Topological homology, Chair: A. Ya. Helemskii (Moscow, Russia). Each workshop

will occupy two afternoons. The chairs are completely free to decide on the format of their workshops.

Information: For more detailed information, including a list of invited speakers, see the conference website at <http://www.math.ualberta.ca/~ba03/>.

August 2003

* 14-20 **2003 ASL European Summer Meeting (Logic Colloquium '03)**, Helsinki, Finland.

Program Committee: P. Aczel, Z. Adamowicz, J. Baldwin, E. Bouscaren, M. Detlefsen, M. Gitik, L. Hella, T. Jech, R. Parikh, H. Schwichtenberg, T. Slaman, V. Stoltenberg-Hansen (Chair), and J. Vaananen.

Organizing Committee: T. Huuskonen, T. Hyttinen, J. Kennedy, K. Luosto, J. Oikkonen, J. Vaananen (Chair), and P. Vaisanen.

October 2003

* 11-12 **AMS Eastern Section Meeting**, SUNY-Binghamton, Binghamton, New York.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

December 2003

* 17-20 **First Joint International Meeting between the American Mathematical Society and Various Indian Mathematical Societies**, Goa, India.

Information: <http://www.ams.org/amsmtgs/internmtgs.html>.

January 2004

* 7-10 **Joint Mathematics Meetings**, Phoenix Civic Plaza, Phoenix, Arizona.

Information: http://www.ams.org/amsmtgs/2004_phioeintro.html.

March 2004

* 26-27 **AMS Central Section Meeting**, Ohio University, Athens, Ohio.

Information: <http://www.ams.org/amsmtgs/sectional.html>.

January 2005

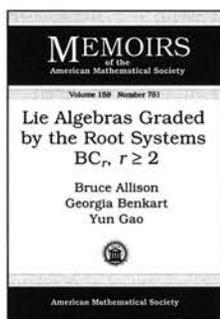
* 5-8 **Joint Mathematics Meetings**, Hyatt Regency Atlanta & Atlanta Marriott Marquis, Atlanta, Georgia.

Information: <http://www.ams.org/amsmtgs/national.html>.

New Publications Offered by the AMS

Algebra and Algebraic Geometry

Independent Study



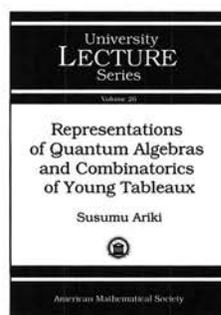
Lie Algebras Graded by the Root Systems BC_r , $r \geq 2$

Bruce Allison, *University of Alberta, Edmonton, AB, Canada*, **Georgia Benkart**, *University of Wisconsin, Madison*, and **Yun Gao**, *York University, Toronto, ON, Canada*

Contents: Introduction; The \mathfrak{g} -module decomposition of a BC_r -graded Lie algebra, $r \geq 3$ (excluding type D_3); Models for BC_r -graded Lie algebras, $r \geq 3$ (excluding type D_3); The \mathfrak{g} -module decomposition of a BC_r -graded Lie algebra with grading subalgebra of type B_2 , C_2 , D_2 , or D_3 ; Central extensions, derivations and invariant forms; Models of BC_r -graded Lie algebras with grading subalgebra of type B_2 , C_2 , D_2 , or D_3 ; Appendix: Peirce decompositions in structurable algebras; References.

Memoirs of the American Mathematical Society, Volume 158, Number 751

July 2002, 158 pages, Softcover, ISBN 0-8218-2811-8, LC 2002018394, 2000 *Mathematics Subject Classification*: 17B20, 17B70, 17B25, 17B65, **Individual member \$32**, List \$53, Institutional member \$42, Order code MEMO/158/751N



Representations of Quantum Algebras and Combinatorics of Young Tableaux

Susumu Ariki, *RIMS, Kyoto University, Japan*

This book contains most of the nonstandard material necessary to get acquainted with this new rapidly developing area. It can be used as a

good entry point into the study of representations of quantum groups.

Among several tools used in studying representations of quantum groups (or quantum algebras) are the notions of Kashiwara's crystal bases and Lusztig's canonical bases. Mixing both approaches allows us to use a combinatorial approach to representations of quantum groups and to apply the theory to representations of Hecke algebras.

The primary goal of this book is to introduce the representation theory of quantum groups using quantum groups of type $A_{r-1}^{(1)}$ as a main example. The corresponding combinatorics, developed by Misra and Miwa, turns out to be the combinatorics of Young tableaux.

The second goal of this book is to explain the proof of the (generalized) Leclerc-Lascoux-Thibon conjecture. This conjecture, which is now a theorem, is an important breakthrough in the modular representation theory of the Hecke algebras of classical type.

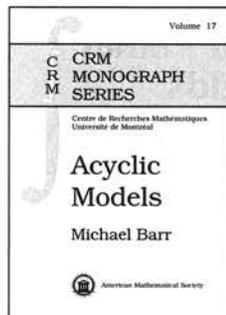
The book is suitable for graduate students and research mathematicians interested in representation theory of algebraic groups and quantum groups, the theory of Hecke algebras, algebraic combinatorics, and related fields.

Contents: Introduction; The Serre relations; Kac-Moody Lie algebras; Crystal bases of U_r -modules; The tensor product of crystals; Crystal bases of U_r^- ; The canonical basis; Existence and uniqueness (part I); Existence and uniqueness (part II); The Hayashi realization; Description of the crystal graph of $V(\Lambda)$; An overview of the application to Hecke algebras; The Hecke

algebra of type $G(m, 1, n)$; The proof of Theorem 12.5; Reference guide; Bibliography; Index.

University Lecture Series, Volume 26

July 2002, 158 pages, Softcover, ISBN 0-8218-3232-8, LC 2002025869, 2000 *Mathematics Subject Classification*: 05E10, 17B37, 17B67, 20C08; 14M15, 16D90, 16G20, 20C33, All AMS members \$25, List \$31, Order code ULECT/26N



Acyclic Models

Michael Barr, *Peter Redpath*
Emeritus Professor of Pure Mathematics, McGill University, Montreal, QC, Canada

Acyclic models is a method heavily used to analyze and compare various homology and cohomology theories appearing in topology and algebra. This book is the first attempt to put together in a concise form this impor-

tant technique and to include all the necessary background.

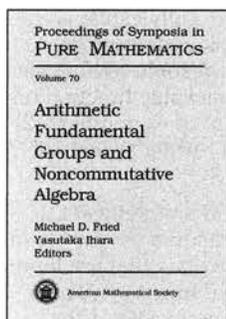
It presents a brief introduction to category theory and homological algebra. The author then gives the background of the theory of differential modules and chain complexes over an abelian category to state the main acyclic models theorem, generalizing and systemizing the earlier material. This is then applied to various cohomology theories in algebra and topology.

The volume could be used as a text for a course that combines homological algebra and algebraic topology. Required background includes a standard course in abstract algebra and some knowledge of topology. The volume contains many exercises. It is also suitable as a reference work for researchers.

Contents: Categories; Abelian categories and homological algebra; Chain complexes and simplicial objects; Triples à la mode de Kan; The main acyclic models theorem; Cartan-Eilenberg Cohomology; Other applications in algebra; Applications in topology; Bibliography; Index.

CRM Monograph Series, Volume 17

July 2002, 179 pages, Hardcover, ISBN 0-8218-2877-0, LC 2002021460, 2000 *Mathematics Subject Classification*: 18G60, All AMS members \$39, List \$49, Order code CRMM/17N



Arithmetic Fundamental Groups and Noncommutative Algebra

Michael D. Fried, *University of California, Irvine*, and
Yasutaka Ihara, *RIMS, Kyoto University, Japan*, Editors

The arithmetic and geometry of moduli spaces and their fundamental groups are a very active research area. This book offers a complete overview of developments made over the last decade.

The papers in this volume examine the geometry of moduli spaces of curves with a function on them. The main players in Part 1 are the absolute Galois group $G_{\mathbb{Q}}$ of the algebraic numbers and its close relatives. By analyzing how $G_{\mathbb{Q}}$ acts on fundamental groups defined by Hurwitz moduli problems, the authors achieve a grand generalization of Serre's program from the 1960s.

Papers in Part 2 apply θ -functions and configuration spaces to the study of fundamental groups over positive characteristic fields. In this section, several authors use Grothendieck's famous lifting results to give extensions to wildly ramified covers. Properties of the fundamental groups have brought collaborations between geometers and group theorists. Several Part 3 papers investigate new versions of the genus 0 problem. In particular, this includes results severely limiting possible monodromy groups of sphere covers. Finally, Part 4 papers treat Deligne's theory of Tannakian categories and arithmetic versions of the Kodaira-Spencer map.

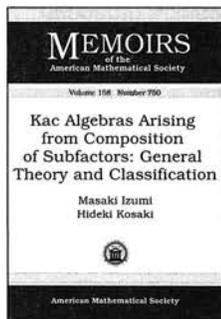
This volume is geared toward graduate students and research mathematicians interested in arithmetic algebraic geometry.

This item will also be of interest to those working in number theory.

Contents: $G_{\mathbb{Q}}$ action on moduli spaces of covers: **P. Dèbes**, Descent theory for algebraic covers; **J. S. Ellenberg**, Galois invariants of dessins d'enfants; **H. Nakamura**, Limits of Galois representations in fundamental groups along maximal degeneration of marked curves, II; **P. Bailey** and **M. D. Fried**, Hurwitz monodromy, spin separation and higher levels of a modular tower; **S. Wewers**, Field of moduli and field of definition of Galois covers; **Y. Ihara**, Some arithmetic aspects of Galois actions on the pro- p fundamental group of $\mathbb{P}^1 - \{0, 1, \infty\}$; **R. T. Sharifi**, Relationships between conjectures on the structure of pro- p Galois groups unramified outside p ; **H. Nakamura** and **Z. Wojtkowiak**, On explicit formulae for l -adic polylogarithms; *Curve covers in positive characteristic:* **A. Tamagawa**, Fundamental groups and geometry of curves in positive characteristic; **M. Raynaud**, Sur le groupe fondamental d'une courbe complète en caractéristique $p > 0$; **M. D. Fried** and **A. Mézard**, Configuration spaces for wildly ramified covers; **M. A. Garuti**, Linear systems attached to cyclic inertia; **R. Guralnick** and **K. F. Stevenson**, Prescribing ramification; *Special groups for covers of the punctured sphere:* **S. S. Abhyankar** and **D. Harbater**, Desingularization and modular Galois theory; **D. Frohardt**, **R. Guralnick**, and **K. Magaard**, Genus 0 actions of groups of Lie rank 1; **H. Völklein**, Galois realizations of profinite projective linear groups; *Fundamental groupoids and Tannakian categories:* **S. Gelaki**, Semisimple triangular Hopf algebras and Tannakian categories; **P. H. Hải**, On a theorem of Deligne on characterization of Tannakian categories; **S. Mochizuki**, A survey of the Hodge-Arakelov theory of elliptic curves I.

Proceedings of Symposia in Pure Mathematics, Volume 70

August 2002, 569 pages, Hardcover, ISBN 0-8218-2036-2, LC 2002021586, 2000 *Mathematics Subject Classification*: 20F34, 14E20, 14F35, 12F12, 20C15, 20D06, 14E20, 14H30, 11R32, 16W30, **Individual member \$74**, List \$124, Institutional member \$99, Order code PSPUM/70N



Kac Algebras Arising from Composition of Subfactors: General Theory and Classification

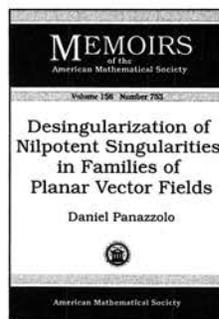
Masaki Izumi, *Kyoto University, Japan*, and Hideki Kosaki, *Kyushu University, Fukuoka, Japan*

Contents: Introduction; Actions of matched pairs; Cocycles attached to the pentagon equation; Multiplicative unitary; Kac algebra structure; Group-like elements; Examples of finite-dimensional Kac algebras; Inclusions with the Coxeter-Dynkin graph $D_6^{(1)}$ and the Kac-Paljutkin algebra; Structure theorems; Classification of certain Kac algebras; Classification of Kac algebras of dimension 16; Group extensions of general Kac algebras; 2-cocycles of Kac algebras; Classification of Kac algebras of dimension 24; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 158, Number 750

July 2002, 198 pages, Softcover, ISBN 0-8218-2935-1, LC 2002018393, 2000 *Mathematics Subject Classification*: 46L37; 46L89, 16W30, **Individual member \$35**, List \$58, Institutional member \$46, Order code MEMO/158/750N

July 2002, approximately 144 pages, Softcover, ISBN 0-8218-2098-2, LC 2002019351, 2000 *Mathematics Subject Classification*: 32Axx, All AMS members \$23, List \$29, Order code MMONO/211N



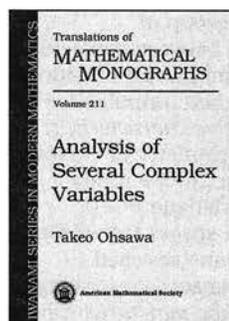
Desingularization of Nilpotent Singularities in Families of Planar Vector Fields

Daniel Panazzolo, *Instituto de Matemática e Estatística, São Paulo, Brazil*

Contents: Introduction; Background material; Nilpotent families and trivialization; Desingularization of Nilpotent singularities; The proof of the desingularization theorem; Applications; Bibliography.

Memoirs of the American Mathematical Society, Volume 158, Number 753

July 2002, 108 pages, Softcover, ISBN 0-8218-2927-0, LC 2002018392, 2000 *Mathematics Subject Classification*: 32S45; 58K60, 14E15, **Individual member \$29**, List \$49, Institutional member \$39, Order code MEMO/158/753N



Analysis of Several Complex Variables

Takeo Ohsawa, *Nagoya University, Japan*

One of the approaches to the study of functions of several complex variables is to use methods originating in real analysis. In this concise book, the author gives a lucid presentation of how these methods produce a variety

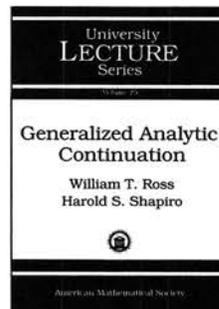
of global existence theorems in the theory of functions (based on the characterization of holomorphic functions as weak solutions of the Cauchy-Riemann equations).

Emphasis is on recent results, including an L^2 extension theorem for holomorphic functions, that have brought a deeper understanding of pseudoconvexity and plurisubharmonic functions. Based on Oka's theorems and his schema for the grouping of problems, the book covers topics at the intersection of the theory of analytic functions of several variables and mathematical analysis.

It is assumed that the reader has a basic knowledge of complex analysis at the undergraduate level. The book would make a fine supplementary text for a graduate-level course on complex analysis.

Contents: Holomorphic functions; Rings of holomorphic functions and $\bar{\partial}$ cohomology; Pseudoconvexity and plurisubharmonic functions; L^2 estimates and existence theorems; Solutions of the extension and division problems; Bergman kernels; Bibliography; Index.

Translations of Mathematical Monographs (Iwanami Series in Modern Mathematics), Volume 211



Generalized Analytic Continuation

William T. Ross, *University of Richmond, VA*, and Harold S. Shapiro, *Royal Institute of Technology, Stockholm, Sweden*

The theory of generalized analytic continuation studies continuations of meromorphic functions in situations where traditional theory says there is a

natural boundary. This broader theory touches on a remarkable array of topics in classical analysis, as described in the book. The authors use the strong analogy with the summability of divergent series to motivate the subject. In this vein, for instance, theorems can be described as being "Abelian" or "Tauberian". The introductory overview carefully explains the history and context of the theory. The book addresses the following questions: (1) When can we say, in some reasonable way, that component functions of a meromorphic function on a disconnected domain, are "continuations" of each other? (2) What role do such "continuations" play in certain aspects of approximation theory and operator theory?

The authors begin with a review of the works of Poincaré, Borel, Wolff, Walsh, and Gončar, on continuation properties of "Borel series" and other meromorphic functions that are limits of rapidly convergent sequences of rational functions. They then move on to the work of Tumarkin, who looked at the continuation properties of functions in the classical Hardy space of the disk in terms of the concept of "pseudocontinuation". Tumarkin's work was seen in a different light by Douglas, Shapiro, and Shields in their discovery of a characterization of the cyclic vectors for the backward shift operator on

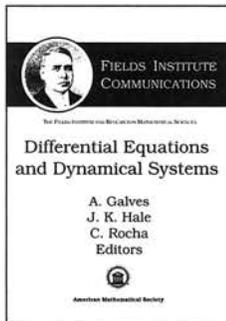
the Hardy space. The authors cover this important concept of "pseudocontinuation" quite thoroughly since it appears in many areas of analysis. They also add a new and previously unpublished method of "continuation" to the list, based on formal multiplication of trigonometric series, which can be used to examine the backward shift operator on many spaces of analytic functions. The book attempts to unify the various types of "continuations" and suggests some interesting open questions.

Contents: Overview; Notation and preliminaries; The Poincaré example; Borel's ideas and their later development; Gončar continuation; Pseudocontinuation; A continuation involving almost periodic functions; Continuation by formal multiplication of series; Generalized analytic continuation; List of symbols; Bibliography; Index.

University Lecture Series, Volume 25

April 2002, 149 pages, Softcover, ISBN 0-8218-3175-5, LC 2002018463, 2000 *Mathematics Subject Classification*: 30B40, 47B38, 30B30, 30E10; 47B38, 47A16, 47A10, All AMS members \$25, List \$31, Order code ULECT/25N

Differential Equations



Differential Equations and Dynamical Systems

A. Galves, *Universidade de São Paulo, Brazil*, J. K. Hale, *Georgia Institute of Technology, Atlanta*, and C. Rocha, *Instituto Superior Técnico, Lisbon, Portugal*, Editors

This volume contains contributed papers authored by participants of a Conference on Differential Equations and Dynamical Systems which was held at the Instituto Superior Técnico (Lisbon, Portugal). The conference brought together a large number of specialists in the area of differential equations and dynamical systems and provided an opportunity to celebrate Professor Waldir Oliva's 70th birthday, honoring his fundamental contributions to the field. The volume constitutes an overview of the current research over a wide range of topics, extending from qualitative theory for (ordinary, partial or functional) differential equations to hyperbolic dynamics and ergodic theory.

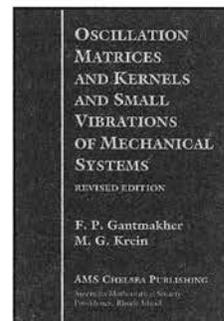
Contents: J. F. Alves and J. Sousa Ramos, Total variations and semiconjugacy; J. M. Arrieta, N. Cónsul, and A. Rodríguez-Bernal, Pattern formation from boundary reaction; B. S. Bardina and S. D. Furta, Asymptotics of periodic travelling waves of an infinite beam on a nonlinear elastic support; L. Barreira and B. Saussol, Variational principles for hyperbolic flows; P. Collet, Extensive quantities for infinite systems; N. Cónsul and S. M. Oliva, Synchronization in herbivorous population models with diffusion and delays; P. D. Cordaro, Approximate solutions in locally integrable structures; E. de Faria, Aspects of rigidity and universality in one-dimensional dynamics; T. Faria and W. Huang, Stability of periodic solutions arising

from Hopf bifurcation for a reaction-diffusion equation with time delay; J. M. Ferreira, On the stability and oscillatory behavior of a retarded functional equation; B. Fiedler, C. Rocha, D. Salazar, and J. Solà-Morales, Dynamics of piecewise-autonomous bistable parabolic equations; G. Gallavotti, Intermittency and time arrow in statistical mechanics and turbulence; J. K. Hale and G. Raugel, Galerkin methods and regularity; A. Jacquemard and M.-A. Teixeira, A note on rigid decompositions of reversible mappings; L. A. C. Ladeira, S. H. J. Nicola, and P. Z. Táboas, Periodic solutions of an impulsive differential system with delay: An L^p approach; B. Lani-Wayda, Representing Poincaré maps by return times; J. Llibre, J. Sotomayor, and M. Zhitomirskii, Impasse bifurcations of constrained systems; L. de Moura, Multipole series and differential equations; N. Martins and J. Sousa Ramos, Cuntz-Krieger algebras arising from linear mod one transformations; F. Mercuri, P. Piccione, and D. V. Tausk, Ordinary differential equations of Morse-Sturm type; W. M. Oliva, Morse-Smale semiflows, openness and A -stability; P. Piccione and D. V. Tausk, Constrained Lagrangians and degenerate Hamiltonians on manifolds: An index theorem; R. Severino and J. Sousa Ramos, Symbolic dynamics in nonlinear boundary value problems; L. Silva and J. Sousa Ramos, A genealogy for kneading sequences of two-piecewise monotonous maps of the interval.

Fields Institute Communications, Volume 31

June 2002, 353 pages, Hardcover, ISBN 0-8218-2860-6, LC 2002018561, 2000 *Mathematics Subject Classification*: 37-XX; 34-XX, 35-XX, Individual member \$59, List \$99, Institutional member \$79, Order code FIC/31N

Independent Study



Oscillation Matrices and Kernels and Small Vibrations of Mechanical Systems

Revised Edition
F. P. Gantmacher and M. G. Krein

From a review of the Russian Edition:

The authors develop in this significant book an extensive theory relating largely to sets of characteristic functions ... The book is characterized throughout by a clear style, by a wealth of results, and by a close union between the mathematical and the dynamical aspects of the investigation.

—*Mathematical Reviews*

Fifty years after the original Russian Edition, this classic Chelsea publication is finally available in English for the general mathematical audience. This book lays the foundation of what later became "Krein's Theory of String". The original ideas stemming from mechanical considerations are developed with exceptional clarity. A unique feature is that it can be read profitably by both research mathematicians and engineers.

The authors study in depth small oscillations of one-dimensional continua with finite or infinite number of degrees of freedom. They single out an algebraic property responsible for the qualitative behavior of eigenvalues and eigenfunctions of one-dimensional continua and introduce a subclass of totally

positive matrices, which they call oscillatory matrices, as well as their infinite-dimensional generalization and oscillatory kernels. Totally positive matrices play an important role in several areas of modern mathematics, but this book is the only source that explains their simple and intuitively appealing relation to mechanics.

There are two supplements contained in the book, "A Method of Approximate Calculation of Eigenvalues and Eigenvectors of an Oscillatory Matrix", and Krein's famous paper which laid the groundwork for the broad research area of the inverse spectral problem: "On a Remarkable Problem for a String with Beads and Continued Fractions of Stieltjes".

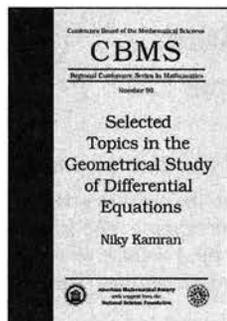
The exposition is self-contained. The first chapter presents all necessary results (with proofs) on the theory of matrices which are not included in a standard linear algebra course. The only prerequisite in addition to standard linear algebra is the theory of linear integral equations used in Chapter 5. The book is suitable for graduate students, research mathematicians and engineers interested in ordinary differential equations, integral equations, and their applications.

This item will also be of interest to those working in applications.

Contents: Introduction; Review of matrices and quadratic forms; Oscillatory matrices; Small oscillations of mechanical systems with n degrees of freedom; Small oscillations of mechanical systems with an infinite number of degrees of freedom; Sign-definite matrices; A method of approximate calculation of eigenvalues and eigenvectors of an oscillatory matrix; On a remarkable problem for a string with beads and continued fractions of Stieltjes; Remarks; References; Index.

AMS Chelsea Publishing

July 2002, 310 pages, Hardcover, ISBN 0-8218-3171-2, LC 2002021449, 2000 *Mathematics Subject Classification:* 34C10, 45A05; 70Jxx, All AMS members \$49, List \$54, Order code CHEL/345.HN



Selected Topics in the Geometrical Study of Differential Equations

Niky Kamran, McGill University, Montreal, QC, Canada

The geometrical study of differential equations has a long and distinguished history, dating back to the classical investigations of Sophus Lie, Gaston Darboux, and Elie Cartan. Currently, these ideas occupy a central position in several areas of pure and applied mathematics, including the theory of completely integrable evolution equations, the calculus of variations, and the study of conservation laws. In this book, the author gives an overview of a number of significant ideas and results developed over the past decade in the geometrical study of differential equations.

Topics covered in the book include symmetries of differential equations and variational problems, the variational bi-complex and conservation laws, geometric integrability for hyperbolic equations, transformations of submanifolds and systems of

conservation laws, and an introduction to the characteristic cohomology of differential systems.

The exposition is sufficiently elementary so that non-experts can understand the main ideas and results by working independently. The book is also suitable for graduate students and researchers interested in the study of differential equations from a geometric perspective. It can serve nicely as a companion volume to *The Geometrical Study of Differential Equations*, Volume 285 in the AMS Contemporary Mathematics series.

Contents: Differential equations and their geometry; External and generalized symmetries; Internal, external and generalized symmetries; Transformations of surfaces; Transformations of submanifolds; Hamiltonian systems of conservation laws; The variational bi-complex; The inverse problem of the calculus of variations; Conservation laws and Darboux integrability; Characteristic cohomology of differential systems; Bibliography.

CBMS Regional Conference Series in Mathematics, Number 96

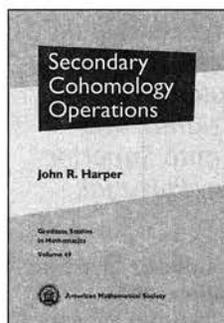
July 2002, 115 pages, Softcover, ISBN 0-8218-2639-5, LC 2002066482, 2000 *Mathematics Subject Classification:* 58A20, 58J70, 58J72, 58J10, 58E30, 58E40, 35L65, 35L60, All AMS members \$20, List \$25, Order code CBMS/96N

Geometry and Topology

Available in Hardcover and Softcover

Recommended Text

Independent Study



Secondary Cohomology Operations

John R. Harper, University of Rochester, NY

Although the theory and applications of secondary cohomology operations are an important part of an advanced graduate-level algebraic topology course, there are few books on the

subject. The AMS now fills that gap with the publication of the present volume.

The author's main purpose in this book is to develop the theory of secondary cohomology operations for singular cohomology theory, which is treated in terms of elementary constructions from general homotopy theory. Among many applications considered are the Hopf invariant one theorem (for all primes p , including $p = 2$), Browder's theorem on higher Bockstein operations, and cohomology theory of Massey-Peterson fibrations.

Numerous examples and exercises help readers to gain a working knowledge of the theory. A summary of more advanced parts of the core material is included in the first chapter. Prerequisite is basic algebraic topology, including the Steenrod operations.

The book is geared toward graduate students and research mathematicians interested in algebraic topology and can be used for self-study or as a textbook for an advanced course on the topic. It is available in both hardcover and softcover editions.

Contents: Review of primary operations; Segue to secondary operations; Fundamental constructions; Secondary cohomology operations; Calculations with secondary operations; The Hopf invariant; The cohomology structure of universal examples; Bibliography; Index.

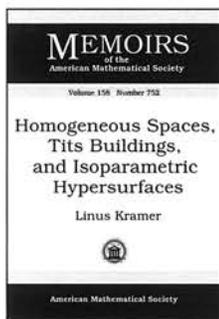
Graduate Studies in Mathematics, Volume 49

Hardcover:

August 2002, 268 pages, ISBN 0-8218-3198-4, LC 2002023236, 2000 *Mathematics Subject Classification:* 55-01, 55S05, 55S10, 55S20, 55S45, 55P99, **All AMS members \$51**, List \$64, Order code GSM/49

Softcover:

August 2002, 268 pages, ISBN 0-8218-3270-0, LC 2002023236, 2000 *Mathematics Subject Classification:* 55-01, 55S05, 55S10, 55S20, 55S45, 55P99, **All AMS members \$39**, List \$49, Order code GSM/49.SN



Homogeneous Spaces, Tits Buildings, and Isoparametric Hypersurfaces

Linus Kramer, *Universität Würzburg, Germany*

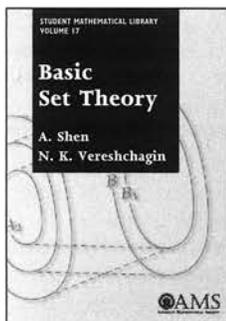
Contents: The Leray-Serre spectral sequence; Ranks of homotopy groups; Some homogeneous spaces; Representations of compact Lie groups; The case when G is simple; The case when G is semisimple; Homogeneous compact quadrangles; Homogeneous focal manifolds; Bibliography.

Memoirs of the American Mathematical Society, Volume 158, Number 752

July 2002, 114 pages, Softcover, ISBN 0-8218-2906-8, LC 2002018395, 2000 *Mathematics Subject Classification:* 51Hxx, 53Cxx; 51E12, 57T15, **Individual member \$30**, List \$50, Institutional member \$40, Order code MEMO/158/752N

Logic and Foundations

Recommended Text



Basic Set Theory

A. Shen, *Institute of Problems of Information Transmission, Moscow Independent University, Moscow, Russia*, and N. K. Vereshchagin, *Institute of Problems of Information Transmission, Moscow State Lomonosov University, Moscow, Russia*

The main notions of set theory (cardinals, ordinals, transfinite induction) are fundamental to all mathematicians, not only to those who specialize in mathematical logic or set-theoretic topology. Basic set theory is generally given a brief overview in

courses on analysis, algebra, or topology, even though it is sufficiently important, interesting, and simple to merit its own leisurely treatment.

This book provides just that: a leisurely exposition for a diversified audience. It is suitable for a broad range of readers, from undergraduate students to professional mathematicians who want to finally find out what transfinite induction is and why it is always replaced by Zorn's Lemma.

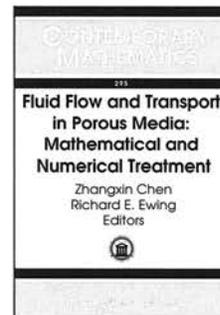
The text introduces all main subjects of "naive" (nonaxiomatic) set theory: functions, cardinalities, ordered and well-ordered sets, transfinite induction and its applications, ordinals, and operations on ordinals. Included are discussions and proofs of the Cantor-Bernstein Theorem, Cantor's diagonal method, Zorn's Lemma, Zermelo's Theorem, and Hamel bases. With over 150 problems, the book is a complete and accessible introduction to the subject.

Contents: Sets and their cardinalities; Ordered sets; Bibliography; Index; Glossary.

Student Mathematical Library, Volume 17

August 2002, approximately 128 pages, Softcover, ISBN 0-8218-2731-6, LC 2002066533, 2000 *Mathematics Subject Classification:* 03-01, 03Exx, **All AMS members \$17**, List \$21, Order code STML/17N

Mathematical Physics



Fluid Flow and Transport in Porous Media: Mathematical and Numerical Treatment

Zhangxin Chen, *Southern Methodist University, Dallas, TX*, and Richard E. Ewing, *Texas A & M University, College Station*, Editors

This volume contains research papers written and edited by prominent researchers working with the mathematical and numerical treatment of fluid flow and transport in porous media.

Papers are based on talks given at a 2001 Joint AMS-IMS-SIAM Summer Research Conference held at Mount Holyoke College (South Hadley, MA). Topics cover a variety of subjects such as network flow modeling, contemporary numerical methods, parallel computation, optimization, multiscale phenomena, upscaling, uncertainty reduction, well treatment, and media characterization.

The material addresses many problems originating from the applied geosciences and focuses on their common state-of-the-art mathematical and numerical treatment. This work is particularly pertinent to those working in oil exploration and other industrial applications.

The book serves as an excellent reference work for all geoscientists, mathematicians, physicists, and engineers working in this research area.

This item will also be of interest to those working in applications.

Contents: J. Aarnes and M. S. Espedal, A new approach to upscaling for two-phase flow in heterogeneous porous media; C. Alboin, J. Jaffré, J. E. Roberts, and C. Serres, Modeling fractures as interfaces for flow and transport in porous media; M. Al-Lawatia and H. Wang, A family of higher-order Eulerian-Lagrangian localized adjoint methods for advection-diffusion equations; C. Almeida, J. Douglas, Jr., F. Pereira, L. C. Roman, and L.-M. Yeh, Algorithmic aspects of a locally conservative Eulerian-Lagrangian method for transport-dominated diffusive systems; I. Berre, H. K. Dahle, K. H. Karlsen, and H. F. Nordhaug, A streamline front tracking method for two- and three-phase flow including capillary forces; S. Bitterlich and P. Knabner, Adaptive and formfree identification of nonlinearities in fluid flow from column experiments; A. Bourgeat, Overall behaviour of fractured porous media versus fractures' size and permeability ratio; M. A. Celia and A. J. Guswa, Hysteresis and upscaling in two-phase flow through porous media; B. M. Chen-Charpentier and H. V. Kojouharov, Simulation of biobarrier-protoczoa interaction in porous media; H. Chen, Z. Chen, G. Huan, and Z. Wang, Mixed discontinuous FE methods and their applications to two-phase flow in porous media; Z. Chen, Y. Cui, and Q. Jiang, Two-phase immiscible flow with the viscous drag in naturally fractured reservoirs; Z. Chen, G. Huan, and B. Li, Mixed finite element methods for multiphase flow in petroleum reservoirs with multiple wells; C. C. Douglas, G. Haase, and M. Iskandarani, An acceleration procedure for the spectral element ocean model formulation of the shallow water equations; J. Douglas, Jr., F. Pereira, and L.-M. Yeh, Relations between phase mobilities and capillary pressures for two-phase flows in fractured media; J. Douglas, Jr. and A. M. Spagnuolo, Parameter estimates for high-level nuclear transport in fractured porous media; D. B. Duncan and Y. Qiu, Overlapping grids for welltest analysis; R. E. Ewing, Upscaling of biological processes and multiphase flow in porous media; R. E. Ewing, J. Wang, S. L. Weekes, and Y. Yang, A numerical simulation of multi-component gas flow in porous media by projection methods; X. Feng, Recent developments on modeling and analysis of flow of miscible fluids in porous media; J. Glimm, Y.-h. Lee, and K. Ye, A simple model for scale up error; J. Glimm, X. L. Li, and Y. Liu, Conservative front tracking in one space dimension; N. Herrmann, BEM with collocation for the heat equation with Neumann and mixed boundary values; G. Huan, Z. Chen, and B. Li, Applications of the control volume function approximation method to reservoir simulations; K. D. Jarman and T. F. Russell, Analysis of 1-D moment equations for immiscible flow; D. L. Kern, J. J. Westman, and F. B. Hanson, Locally optimal pumping and treatment rates in uncertain environments; D. Y. Kwak, A general multigrid framework for a class of perturbed problems; B. Li, Z. Chen, and G. Huan, Modeling horizontal wells using hybrid grids in reservoir simulations; J. Li, A multiblock mixed finite element method for 2D and 3D elliptic problems on mixed unstructured grids and its parallelization; W. B. Lindquist, Network flow model studies and 3D pore structure; Q. Liu, P. Shen, and P. Yang, Pore scale network modelling of gas slippage in tight porous media; Q. Lie, J. Wang, P. Yang, and P. Shen, The calculation of relative permeability by history matching and Beth network model; A. A. Merrikh, J. L. Lage, and A. A. Mohamad, Comparison between pore-level and porous medium models for natural convection in a non-homogeneous enclosure; A. Narasimhan and J. L. Lage, New models for predicting temperature-dependent viscous effects on flow

through porous media; G. Pencheva and I. Yotov, Balancing domain decomposition for porous media flow in multiblock domains; B. Rivière and M. F. Wheeler, Non conforming methods for transport with nonlinear reaction; L. F. Rossi, A high order Lagrangian scheme for flow through unsaturated porous media; M. Sarkis, Partition of unity coarse spaces; S. Subbey, M. Christie, and M. Sambridge, Uncertainty reduction in reservoir modeling; H. Wang, J. Liu, M. S. Espedal, and R. E. Ewing, A Eulerian-Lagrangian substructuring domain decomposition method for multidimensional, unsteady-state advection-diffusion equations; H. Wang, W. Zhao, R. E. Ewing, S. L. Lyons, and G. Qin, An ELLAM simulator for highly compressible flow in porous media with multiple wells; L. Wu and G. F. Pinder, Single-degree freedom collocation method using Hermite polynomials; X. Yu and Y. Wu, A Taylor-Galerkin finite element method for one-dimensional hyperbolic conservation laws; W. Zhang and I. Gladwell, Morphological evolution of a 3D array of particles under surface diffusion.

Contemporary Mathematics, Volume 295

July 2002, 524 pages, Softcover, ISBN 0-8218-2807-X, LC 2002018626, 2000 *Mathematics Subject Classification:* 76S05, 76M25, 65M60, 65M25, 65N55, 35R60, 35K05, 92D25, 49L20, 68W10, **Individual member \$77, List \$129, Institutional member \$103, Order code CONM/295N**



Strings 2001

Atish Dabholkar, Sunil Mukhi, and Spenta R. Wadia, Tata Institute of Fundamental Research, Mumbai, India, Editors

String theory, sometimes called the "Theory of Everything", has the potential to provide answers to key questions involving quantum gravity, black holes, supersymmetry, cosmology, singularities and the symmetries of nature.

This multi-authored book summarizes the latest results across all areas of string theory from the perspective of world-renowned experts, including Michael Green, David Gross, Stephen Hawking, John Schwarz, Edward Witten and others.

The book comes out of the "Strings 2001" conference, organized by the Tata Institute for Fundamental Research (Mumbai, India), the Abdus Salam ICTP (Trieste, Italy), and the Clay Mathematics Institute (Cambridge, MA, USA). Individual articles discuss the study of D-branes, black holes, string dualities, compactifications, Calabi-Yau manifolds, conformal field theory, noncommutative field theory, string field theory, and string phenomenology. Numerous references provide a path to previous findings and results.

Written for physicists and mathematicians interested in string theory, the volume is a useful resource for any graduate student or researcher working in string theory, quantum field theory, or related areas.

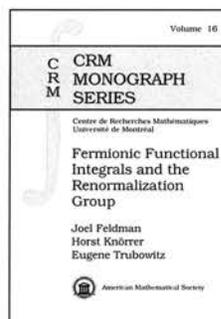
Titles in this series are published by the AMS for the Clay Mathematics Institute (Cambridge, MA).

Contents: R. Gopakumar, M. Headrick, and M. Spradlin, Noncommutative solitons I; J. G. Russo, Free energy and critical temperature in eleven dimensions; P. Hořava, On de Sitter entropy and string theory; C. M. Hull, Strongly coupled gravity

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Clay Mathematics Proceedings, Volume 1

July 2002, approximately 512 pages, Softcover, ISBN 0-8218-2981-5, 2000 *Mathematics Subject Classification*: 81T30, 81T60, 81T40, 83E15, 83E30, 83E50, 83C57, 83C65, 83C45, 83-06, **All AMS members \$59**, List \$74, Order code CMP/1N



Fermionic Functional Integrals and the Renormalization Group

Joel Feldman, *University of British Columbia, Vancouver, BC, Canada*, and
Horst Knörrer and Eugene Trubowitz, *Eidgen Technische Hochschule, Zürich, Switzerland*

This book, written by well-known experts in the field, offers a concise summary of one of the latest and most significant developments in the theoretical analysis of quantum field theory.

The renormalization group is the name given to a technique for analyzing the qualitative behavior of a class of physical systems by iterating a map on the vector space of interactions for the class. In a typical nonrigorous application of this technique, one assumes, based on one's physical intuition, that only a certain finite dimensional subspace (usually of dimension three or less) is important. The material in this book concerns a technique for justifying this approximation in a broad class of fermionic models used in condensed matter and high energy physics.

This volume is based on the Aisenstadt Lectures given by Joel Feldman at the Centre de Recherches Mathématiques (Montréal, Canada). It is suitable for graduate students and research mathematicians interested in mathematical physics. Included are many problems and solutions.

Contents: Fermionic functional integrals; Fermionic expansions; Appendix A. Infinite-dimensional Grassman algebras; Appendix B. Pfaffians; Appendix C. Propagator bounds; Appendix D. Problem solutions; Bibliography.

CRM Monograph Series, Volume 16

July 2002, 115 pages, Hardcover, ISBN 0-8218-2878-9, LC 2002018586, 2000 *Mathematics Subject Classification*: 82B28, **All AMS members \$28**, List \$35, Order code CRMM/16N

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PENNSYLVANIA

THE PENNSYLVANIA
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The Pennsylvania State University enrolls approximately 40,000 students on its University Park campus, including about 8,000 graduate students. The university is located in the center of the state, in a valley surrounded by the Appalachian Mountains and state forest land. The adjoining town of State College is part of a metropolitan area of 100,000 people, with ample health care, indoor and outdoor recreation, and quality of life. The university is within 250 miles of New York City, Philadelphia, Pittsburgh, Baltimore, and Washington, D.C. All the amenities of a metropolitan area—a first rate public transportation system, world class theater and concert events, and advanced technology and research facilities—are available without the attending stress. Scientists, engineers, and professionals from around the world participate in advanced research programs and conferences on a wide range of subjects at the Penn State Conference Center.

Further information about the department can be found at <http://www.math>.

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A candidate is sought who is committed to the mathematical sciences philosophy and who will provide strong leadership for departmental growth in teaching, research, and service activities. Initial screening of applicants will begin September 3, 2002, but applications will be accepted until the position is filled. This position will be available January 1, 2003. Salary will be commensurate with credentials and experience. Vitae (with names, telephone numbers, and e-mail addresses of three references), nominations, and requests for further information should be sent to:

Dr. P.M. Dearing, Interim Chair
Department of Mathematical Sciences
Clemson University, Box 340975
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Duties: Undergraduate and graduate teaching, supervision of graduate students, and research.

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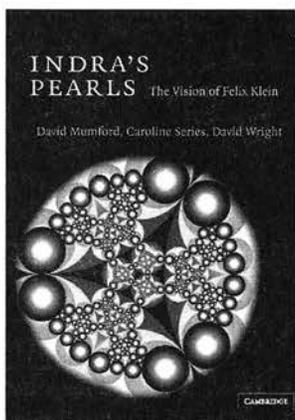
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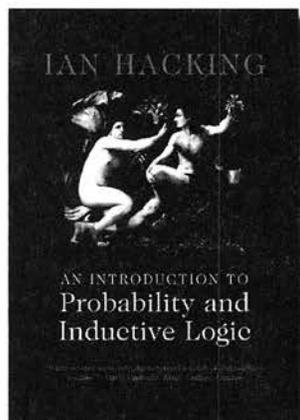
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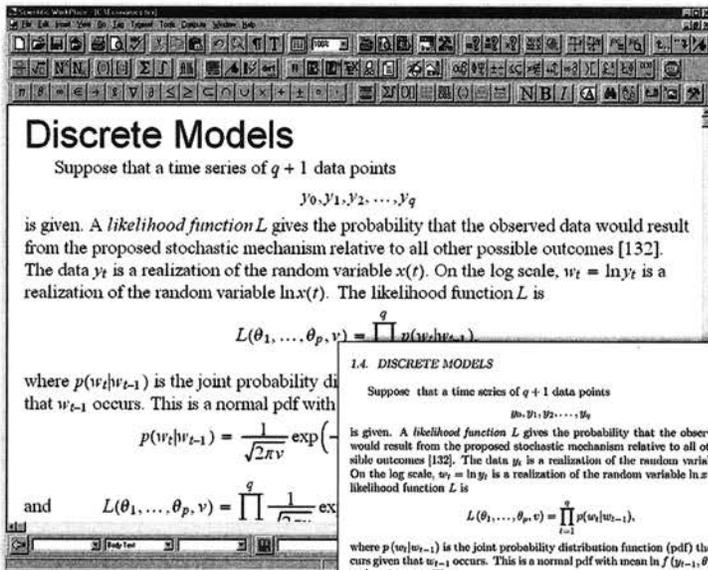
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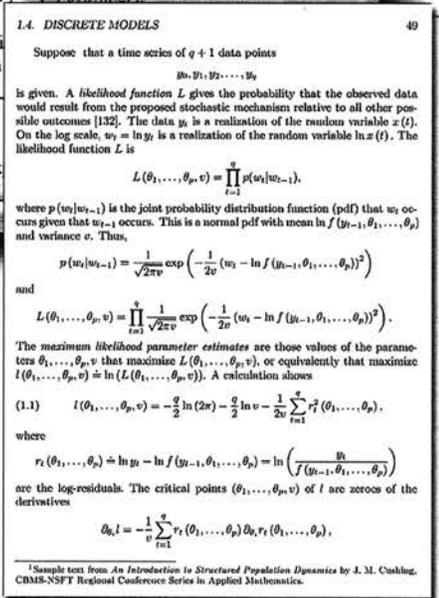
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Volume 1 Just Published

Deformation Quantization

**Proceedings of the Meeting of Theoretical Physicists and Mathematicians,
Strasbourg, May 31 - June 2, 2001**

Edited by: **Gilles Halbout**

2002. viii + 236 pages. ISBN 3-11-017247-X. Paper \$34.95

Contains eleven refereed research papers on deformation quantization by leading experts in the respective fields. Topics covered are: star-products over Poisson manifolds, quantization of Hopf algebras, index theorems, globalization and cohomological problems. Both the mathematical and the physical approach ranging from asymptotic quantum electrodynamics to operads and prop theory will be presented. Historical remarks and surveys set the results presented in perspective.

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Volume 2 Available November 2002

Locally compact quantum groups and groupoids

**Proceedings of the Meeting of Theoretical Physicists and Mathematicians,
Strasbourg, February 21 - 23, 2002**

Edited by: **Leonid Vainerman**

2002. viii + 236 pages. Paper. Approx. \$36.95

Contains seven refereed research papers on locally compact quantum groups and groupoids by leading experts in the respective fields. Topics covered are: various constructions of locally compact quantum groups and their multiplicative unitaries; duality theory for locally compact quantum groups; combinatorial quantization of flat connections associated with $SL(2, \cdot)$; quantum groupoids, especially coming from Depth 2 Extensions of von Neumann algebras, C^* -algebras and Rings. Many mathematical results are motivated by problems in theoretical physics. Historical remarks set the results presented in perspective.

Contents: *E. Buffenoir:* Combinatorial quantization of the moduli spaces of flat connections associated with the group $SL(2, \cdot)$ • *M. Enock:* Quantum groupoids of compact type • *E. Koelink and J. Kustermans:* The normalizer of the quantum $SU(1,1)$ and its duality theory • *M. Muger:* Tannaka-Krein theory for algebraic quantum groups • *K. Szlachanyi:* Quantum groupoids of Depth 2 Extensions of C^* -algebras and Rings • *S. Vaes and L. Vainerman:* On low-dimensional locally compact quantum groups • *A. Van Daele:* Multiplier Hopf $*$ -algebras with positive integral: A laboratory for locally compact quantum groups.

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Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices*. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See <http://www.ams.org/meetings/>. 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.

Pisa, Italy

June 12–16, 2002

Meeting #977

First Joint International Meeting between the AMS and the Unione Matematica Italiana.

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: March 2002

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: Expired

Invited Addresses

Luigi Ambrosio, Scuola Normale Superiore, *Title to be announced.*

Luis A. Caffarelli, University of Texas at Austin, *Title to be announced.*

Claudio Canuto, Politecnico of Torino, *Title to be announced.*

L. Craig Evans, University of California Berkeley, *Title to be announced.*

Giovanni Gallavotti, University of Rome I, *Title to be announced.*

Sergiu Klainerman, Princeton University, *Title to be announced.*

Rahul V. Pandharipande, California Institute of Technology, *Title to be announced.*

Claudio Procesi, University of Roma, *Title to be announced.*

Special Sessions

Advances in Complex, Contact and Symplectic Geometry, **Paolo De Bartolomeis**, University of Firenze, **Yakov Eliashberg**, Stanford University, **Gang Tian**, MIT, and **Giuseppe Tomassini**, Scuola Normale Superiore, Pisa.

Advances in Differential Geometry of PDEs and Applications, **Valentin Lychagin**, New Jersey Institute of Technology, and **Agostino Prastaro**, University of Roma, La Sapienza.

Algebraic Logic and Universal Algebra, **Paolo Agliano**, University of Siena, **Keith A. Kearnes**, University of Colorado, **Franco Montagna**, University of Siena, **Don Pigozzi**, Iowa State University, and **Aldo Ursini**, University of Siena.

Algebraic Vector Bundles, **Vincenzo Ancona**, University of Firenze, **Mohan Kumar**, Washington University, **Giorgio Maria Ottaviani**, University of Firenze, **Christopher Peterson**, Colorado State University, and **Prabhakar Rao**, University of Missouri.

Analytic Aspects of Convex Geometry, **Stefano Campi**, University of Modena, **Richard Gardner**, Western Washington University, **Erwin Lutwak**, Polytechnic University Brooklyn, and **Alijosa Volcic**, University of Trieste.

Classification Theory and Topology of Algebraic Varieties, **Fabrizio Catanese**, University of Gottingen, **Janos Kollar**, Princeton University, and **Shing-Tung Yau**, Harvard University.

Commutative Algebra and the Geometry of Projective Varieties, **Ciro Ciliberto**, University of Roma II, **Anthony Geramita**, University of Genova, **Rick Miranda**, Colorado State University, and **Ferruccio Orecchia**, University of Napoli.

Commutative Algebra: Hilbert Functions, Homological Methods and Combinatorial Aspects, **Aldo Conca**, University of Genova, **Anna Guerrieri**, University of L'Aquila, **Claudia Polini**, University of Oregon, and **Bernd Ulrich**, Michigan State University.

Commutative Rings and Integer-valued Polynomials, **Stefania Gabelli**, University of Roma III, and **Thomas G. Lucas**, University of North Carolina Charlotte.

Complex, Contact and Quaternionic Geometry, **David E. Blair**, Michigan State University, and **Stefano Marchiafava**, University of Roma, La Sapienza.

Contemporary Developments in Partial Differential Equations and in the Calculus of Variations, **Irene Fonseca**, Carnegie Mellon University, and **Paolo Marcellini**, University of Firenze.

Didattica della Dimostrazione, **Ferdinando Arzarello**, University of Torino, **Guershon Harel**, Purdue University, and **Vinicio Villani**, University of Pisa.

Dynamical Systems, **Antonio Giorgilli**, University of Milano-Bicocca, **Stefano Marmi**, Scuola Normale Superiore, Pisa, and **John Norman Mather**, Princeton University.

Elliptic Partial Differential Equations, **Angelo Alvino**, University of Napoli, **Luis Caffarelli**, University of Texas, **Giorgio Talenti**, University of Firenze, and **Vladimir Oliker**, Emory University.

Equazioni di Evoluzione Nonlineari, **Alberto Tesei**, University of Roma, La Sapienza, and **Wei-Ming Ni**, University of Minnesota, Minneapolis.

Free Boundary Problems, **Ricardo Horacio Nochetto**, University of Maryland, College Park, and **Augusto Visintin**, University of Trento.

Geometric Properties of Solutions to PDEs, **Donatella Danielli**, Purdue University, and **Sandro Salsa**, Politecnico di Milano.

Harmonic Analysis, **Fulvio Ricci**, Scuola Normale Superiore, Pisa, and **Elias M. Stein**, Princeton University.

Higher Dimensional Algebra, **John Baez**, University of California, Riverside, and **Giuseppe Rosolini**, University of Genova.

History of Mathematics, **Piers Bursil-Hall**, Cambridge University, **Enrico Giusti**, University of Firenze, and **James J. Tattersall**, Providence College.

Hyperbolic Equations, **Sergiu Klainerman**, Princeton University, and **Sergio Spagnolo**, University of Pisa.

Hyperbolic Systems of Conservation Laws, **Alberto Bressan**, SISSA, Trieste, and **Shi Jin**, University of Wisconsin.

Inverse Boundary Problems and Applications, **Giovanni Alessandrini**, University of Trieste, and **Gunther Uhlmann**, University of Washington.

Jump Processes in Option Pricing Theory, **Claudio Albanese**, University of Toronto, and **Marco Isopi**, University of Bari.

Kolmogorov Equations, **Giuseppe Da Prato**, Scuola Normale Superiore, Pisa, and **Nicolai V. Krylov**, University of Minnesota.

Logarithmic De Rham Cohomology and Dwork Cohomology, **Alan Adolphson**, Oklahoma State University, Stillwater, **Francesco Baldassarri**, University of Padova, **Arthur Ogus**, University of California Berkeley, and **Steven Sperber**, University of Minnesota, Minneapolis.

Mathematical Problems in Soft Matter Modelling, **Eugene C. Gartland**, Kent State University, and **Epifanio Virga**, University of Pavia.

Mathematical Problems in Transport Theory, **Carlo Cercignani**, Politecnico di Milano, and **Irene Gamba**, University of Texas.

Mathematical Schools: Italy and the United States at the Turn of the Twentieth Century, **Umberto Bottazzini**, University of Palermo, and **Karen Hunger Parshall**, University of Virginia.

Mathematics in Polymer Science, **Antonio Fasano**, University of Firenze, and **Kumbakonam R. Rajagopal**, Texas A&M University.

Microlocal Analysis and Applications to PDE, **Daniele Del Santo**, University of Trieste, **M. K. Venkatesha Murthy**, University of Pisa, and **Daniel Tataru**, Northwestern University.

Nonlinear Analysis, **Antonio Ambrosetti**, SISSA, Trieste, **Vieri Benci**, University of Pisa, **Haim Brezis**, Rutgers University, and **Paul Rabinowitz**, University of Wisconsin.

Nonlinear Elliptic and Parabolic Equations and Systems, **Gary Lieberman**, Iowa State University, and **Antonio Maugeri**, University of Catania.

Nonstandard Methods and Applications in Mathematics, **Alessandro Berarducci**, University of Pisa, **Nigel Cutland**, University of Hull, **Mauro Di Nasso**, University of Pisa, and **David Ross**, University of Hawaii.

Operator Algebras, **Sergio Doplicher**, University of Roma, La Sapienza, and **Edward George Effros**, University of California Los Angeles.

Optimization and Control, **Roberto Triggiani**, University of Virginia, and **Tullio Zolezzi**, University of Genova.

Partial Differential Equations of Mixed Elliptic-Hyperbolic Type and Applications, **Daniela Lupo**, Politecnico di Milano, **Cathleen S. Morawetz**, Courant Institute, and **Kevin R. Payne**, University of Milano.

Periodic Solutions of Differential and Difference Equations, **Massimo Furi**, University of Firenze, and **Mario Umberto Martelli**, Claremont McKenna College.

Poisson Geometry and Integrable Systems, **Franco Magri**, University of Milano, and **Ping Xu**, Pennsylvania State University.

Quantum Cohomology and Moduli Spaces, **Angelo Vistoli**, University of Bologna, and **Aaron Bertram**, University of Utah.

Scaling Limits and Homogenization Problems in Physics and Applied Sciences, **Mario Pulvirenti**, University of Roma, and **George Papanicolaou**, Stanford University.

Semigroups of Operators and Applications, **Francesco Altomare**, University of Bari, and **Frank Neubrandner**, Louisiana State University.

Semigroups, Automata and Formal Languages, **Alessandra Cherubini**, Politecnico of Milano, and **John Meakin**, University of Nebraska-Lincoln.

Some Mathematics Around Composites, **Robert V. Kohn**, Courant Institute, and **Vincenzo Nesi**, University of Roma, La Sapienza.

Structured Matrix Analysis with Applications, **Dario Andrea Bini**, University of Pisa, and **Thomas Kailath**, Stanford University.

The Topology of 3-manifolds, **Ricardo Benedetti** and **Carlo Petronio**, University of Pisa, **Dale Rolfsen**, University of British Columbia, Vancouver, and **Jeffrey Weeks**, Canton, New York.

Variational Analysis and Applications, **Franco Giannessi**, University of Pisa, **Boris S. Mordukhovich**, Wayne State University, Detroit, **Biagio Ricceri**, University of Catania, and **R. Tyrrell Rockafellar**, University of Washington.

Viscosity Methods in PDEs and Applications, **Piermarco Cannarsa**, University of Roma II, **Italo Capuzzo Dolcetta**, University of Roma, La Sapienza, and **Panagiotis Souganidis**, University of Texas, Austin.

White Noise Theory and Quantum Probability, **Luigi Accardi**, University of Roma, Tor Vergata, and **Hui-Hsiung Kuo**, Louisiana State University.

Portland, Oregon

Portland State University

June 20–22, 2002

Meeting #978

Meeting held in conjunction with the Pacific Northwest Section of the Mathematical Association of America.

Western Section

Associate secretary: Bernard Russo

Announcement issue of *Notices*: April 2002

Program first available on AMS website: May 9, 2002

Program issue of electronic *Notices*: June 2002

Issue of *Abstracts*: Volume 23, Issue 2

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
Expired

For abstracts: Expired

For summaries of papers to MAA organizers: Various

Joint Invited Addresses

Kenneth A. Ribet, University of California Berkeley, *Title to be announced* (AMS-MAA Invited Address).

AMS Invited Addresses

Richard W. Montgomery, University of California Santa Cruz, *Variational methods for the N-body problem*.

Edriss S. Titi, University of California Irvine, *The Navier-Stokes and Other Related Equations*.

Michael Wolf, Rice University, *Minimal surfaces, flat structures, and moduli spaces*.

MAA Invited Addresses

Edward B. Burger, Williams College, *Innovative Experiments... and How I Survived Them*.

Tina H. Straley, Mathematical Association of America, *The MAA's Role in the Future of Undergraduate Mathematics*.

Jim H. Valerio, Intel Desktop Architecture Labs, *Improving PC Graphics*.

AMS Special Sessions

Algebraic Geometry and Combinatorics, **Eric Babson** and **Rekha Thomas**, University of Washington, and **Sergey Yuzvinsky**, University of Oregon.

Association Schemes and Distance-Regular Graphs, **John S. Caughman**, Portland State University, and **Paul M. Terwilliger**, University of Wisconsin.

Flat Structures, Moduli Spaces, and Minimal Surfaces, **Matthias Weber**, Indiana University, and **Michael Wolf**, Rice University.

Low Dimensional Homotopy and Combinatorial Group Theory, **F. Rudolf Beyl** and **Paul Latiolais**, Portland State University, **William A. Bogley**, Oregon State University, and **Micheal N. Dyer**, University of Oregon.

Mathematical Biology, **Richard S. Gomulkiewicz**, Washington State University, and **Sebastian Schreiber**, Western Washington University.

Matroid Theory, **Jennifer M. McNulty**, University of Montana, and **Nancy Ann Neudauer**, Pacific University.

Qualitative Properties and Applications of Functional Equations, **Theodore A. Burton**, Southern Illinois University.

Quantum Topology, **Douglas G. Bullock**, **Joanna M. Kania-Bartoszynska**, and **Uwe Kaiser**, Boise State University.

The Quintic Equation: Algebra and Geometry, **Jerry Shurman**, Reed College, and **Scott Crass**, California State University, Long Beach.

Boston, Massachusetts

Northeastern University

October 5–6, 2002

Meeting #979

Eastern Section

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: August 2002

Program first available on AMS website: August 22, 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:
June 18, 2002

For abstracts: August 13, 2002

Invited Addresses

Lou P. van den Dries, University of Illinois, Urbana-Champaign, *Title to be announced*.

Hillel Furstenberg, Einstein Institute of Mathematics, *Title to be announced* (Erdős Memorial Lecture).

Diane Henderson, Pennsylvania State University, *Title to be announced*.

Christopher K. King, Northeastern University, *Title to be announced*.

Xiaobo Liu, University of Notre Dame, *Title to be announced*.

Special Sessions

Convex Geometry (Code: AMS SS N1), **Daniel A. Klain**, University of Massachusetts, Lowell, and **Elisabeth Werner**, Case Western Reserve University.

Developments and Applications in Differential Geometry (Code: AMS SS C1), **Chuu-Lian Terng**, Northeastern University, and **Xiaobo Liu**, University of Notre Dame.

Elliptic Operators on Noncompact Manifolds (Code: AMS SS M1), **Maxim Braverman**, Northeastern University, **Victor Nistor**, Pennsylvania State University, and **Mikhail A. Shubin**, Northeastern University.

Ergodic Theory and Dynamical Systems (Code: AMS SS B1), **Stanley J. Eigen**, Northeastern University, and **Vidhu S. Prasad**, University of Massachusetts, Lowell.

Hilbert Schemes (Code: AMS SS G1), **Mark De Cataldo**, SUNY at Stony Brook, and **Anthony A. Iarrobino**, Northeastern University.

Modern Schubert Calculus (Code: AMS SS A1), **Frank Sottile**, University of Massachusetts, Amherst, and **Christopher T. Woodward**, Rutgers University.

Number Theory and Arithmetic Geometry (Code: AMS SS D1), **Matthew A. Papanikolas**, Brown University, and **Siman Wong**, University of Massachusetts, Amherst.

Quantum Information Theory (Code: AMS SS J1), **Christopher K. King**, Northeastern University, and **Mary Beth Ruskai**, University of Massachusetts, Lowell.

Quivers and Their Generalizations (Code: AMS SS E1), **Alex Martsinkovsky**, **Gordana G. Todorov**, **Jerzy M. Weyman**, and **Andrei V. Zelevinsky**, Northeastern University.

Recent Developments in the Orbit Method for Real and p -adic Groups (Code: AMS SS F1), **Donald R. King**, Northeastern University, and **Alfred G. Noel**, University of Massachusetts, Boston.

Singularities in Algebraic and Analytic Geometry (Code: AMS SS H1), **Terence Gaffney** and **David B. Massey**, Northeastern University, and **Caroline Grant Melles**, U. S. Naval Academy.

The Mathematics of Water Waves (Code: AMS SS K1), **Diane Henderson**, Pennsylvania State University, and **Gene Wayne**, Boston University.

The History of Mathematics (Code: AMS SS L1), **Adrian C. Rice**, Randolph-Macon College, and **Amy E. Shell-Gellasch**, U. S. Military Academy.

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:
June 25, 2002

For abstracts: August 20, 2002

Invited Addresses

Lawrence Ein, University of Illinois at Chicago, *Title to be announced*.

Eleny Ionel, University of Wisconsin, *Title to be announced*.

Mikhail Safonov, University of Minnesota, *Title to be announced*.

John Sullivan, University of Illinois, Urbana-Champaign, *Title to be announced*.

Special Sessions

Arithmetic Algebraic Geometry (Code: AMS SS A1), **Ken Ono** and **Tonghai Yang**, University of Wisconsin-Madison.

Arrangements of Hyperplanes (Code: AMS SS E1), **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 (Code: AMS SS S1), **Shun-ichi Amari**, RIKEN, **Amir Assadi**, University of Wisconsin-Madison, and **Tomaso Poggio**, Massachusetts Institute of Technology.

Characters and Representations of Finite Groups (Code: AMS SS U1), **Martin Isaacs**, University of Wisconsin, Madison, and **Mark Lewis**, Kent State University.

Combinatorics and Special Functions (Code: AMS SS T1), **Richard Askey** and **Paul Terwilliger**, University of Wisconsin-Madison.

Dynamical Systems (Code: AMS SS P1), **Sergey Bolotin** and **Paul Rabinowitz**, University of Wisconsin-Madison.

Effectiveness Questions in Model Theory (Code: AMS SS J1), **Charles McCoy**, **Reed Solomon**, and **Patrick Speissegger**, University of Wisconsin-Madison.

Geometric Methods in Differential Equations (Code: AMS SS H1), **Gloria Mari Beffa**, University of Wisconsin-Madison, and **Peter Olver**, University of Minnesota.

Geophysical Waves and Turbulence (Code: AMS SS M1), **Paul Milewski**, **Leslie Smith**, and **Fabian Waleffe**, University of Wisconsin-Madison.

Group Cohomology and Homotopy Theory (Code: AMS SS G1), **Alejandro Adem**, University of Wisconsin-Madison, and **Jesper Grodal**, Institute for Advanced Study.

Harmonic Analysis (Code: AMS SS C1), **Alex Ionescu** and **Andreas Seeger**, University of Wisconsin-Madison.

Hyperbolic Differential Equations and Kinetic Theory (Code: AMS SS K1), **Shi Jin**, **Marshall Slemrod**, and **Athanassios Tzavaras**, University of Wisconsin-Madison.

Lie Algebras and Related Topics (Code: AMS SS N1), **Georgia Benkart** and **Arun Ram**, University of Wisconsin-Madison.

Lie Groups and Their Representations (Code: AMS SS W1), **Michael Howe**, University of Wisconsin, Eau Claire, and **Gail D. L. Ratcliff**, University of Missouri, St. Louis.

Multiresolution Analysis and Data Presentation (Code: AMS SS F1), **Amos Ron**, University of Wisconsin-Madison.

Optimal Geometry of Curves and Surfaces (Code: AMS SS V1), **Jason H. Cantarella**, University of Georgia, and **John M. Sullivan**, University of Illinois, Urbana.

Partial Differential Equations and Geometry (Code: AMS SS D1), **Sigurd Angenent** and **Mikhail Feldman**, University of Wisconsin-Madison.

Probability (Code: AMS SS R1), **David Griffeath** and **Timo Seppalainen**, University of Wisconsin-Madison.

Ring Theory and Related Topics (Code: AMS SS L1), **Don Passman**, University of Wisconsin-Madison.

Several Complex Variables (Code: AMS SS B1), **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:
July 10, 2002

For abstracts: September 4, 2002

Invited Addresses

Yakov Eliashberg, Stanford University, *Title to be announced.*

Hart F. Smith, University of Washington, *Title to be announced.*

Michael Ward, University of British Columbia, *Title to be announced.*

Amie Wilkinson, Northwestern University, *Title to be announced.*

Special Sessions

Analytic Number Theory (Code: AMS SS B1), **Roger Baker**, **Xian-jin Li**, and **Andrew D. Pollington**, Brigham Young University.

Area-Minimization and Minimal Surfaces (Code: AMS SS A1), **Michael Dorff**, **Denise Halverson**, and **Gary R. Lowler**, Brigham Young University.

Geometry and Topology (Code: AMS SS F1), **Mladen Bestvina**, **Michael Kapovich**, and **Grigory Mikhalkin**, University of Utah.

Nonlinear Partial Differential Equations (Code: AMS SS C1), **David A. Hartenstine**, University of Utah, and **Jon T. Jacobsen**, Pennsylvania State University.

Recent Trends in Algebraic Geometry (Code: AMS SS E1), **Aaron J. Bertram**, University of Utah, and **Christopher Derek Hacon**, University of California Riverside.

Representation Theory of Semisimple Lie Groups (Code: AMS SS D1), **Dragan Milicic** and **Peter Trapa**, University of Utah.

Time Series, Heavy Tails, and Applications (Code: AMS SS G1), **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:
July 23, 2002

For abstracts: September 17, 2002

Invited Addresses

Steven J. Cox, Rice University, *Title to be announced.*

James Haglund, University of Pennsylvania, *Title to be announced.*

Marius Mitrea, University of Missouri-Columbia, *Title to be announced.*

Ricardo H. Nochetto, University of Maryland, College Park, *Title to be announced.*

Special Sessions

Algebraic and Enumerative Combinatorics (Code: AMS SS A1), **James Haglund**, University of Pennsylvania, and **Jeff Remmel**, University of California San Diego.

Commutative Algebra (Code: AMS SS B1), **Heath Martin**, University of Central Florida, and **Stephanie Fitchett**, Florida Atlantic University.

Computational Mathematics (Code: AMS SS C1), **Ricardo Nochetto**, University of Maryland, and **Bernardo Cockburn**, University of Minnesota.

Financial Mathematics (Code: AMS SS D1), **Craig Nolder** and **Alec Kercheval**, Florida State University.

Function Spaces, Singular Integrals and Applications to PDE (Code: AMS SS N1), **Marius Mitrea**, University of Missouri.

Functional and Harmonic Analysis of Wavelets, Frames and their Applications (Code: AMS SS E1), **Deguang Han**, University of Central Florida, and **Manos Papadakis**, University of Houston.

Graph Theory (Code: AMS SS F1), **Robert Brigham**, University of Central Florida, **Cun-Quan Zhang**, West Virginia University, and **Yue Zhao**, University of Central Florida.

Homotopy Theory and Geometric Topology (Code: AMS SS J1), **Alexander Dranishnikov**, **James Keesling**, and **Yuli B. Rudyak**, University of Florida.

Invariants of Knots and Low-Dimensional Manifolds (Code: AMS SS H1), **J. Scott Carter**, University of South Alabama, and **Masahico Saito**, University of South Florida.

Mathematical Neuroscience (Code: AMS SS G1), **Steve Cox**, Rice University, and **Richard Bertram**, Florida State University.

Nonlinear Waves (Code: AMS SS L1), **Min Chen**, Purdue University, and **Roy Choudhury** and **David Kaup**, University of Central Florida.

Riemann-Hilbert Problem and Related Topics (Code: AMS SS M1), **Ken McLaughlin**, University of North Carolina at Chapel Hill and University of Arizona, and **Alexander Tovbis**, University of Central Florida.

The Likelihood Inferences in Statistics (Code: AMS SS K1), **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:
August 6, 2002

For abstracts: October 1, 2002

For summaries of papers to MAA organizers: September 10, 2002

Joint AMS-MAA Invited Addresses

Noam D. Elkies, Harvard University, *Title to be announced.*

Edward R. Scheinerman, Johns Hopkins University, *Title to be announced.*

Joint Special Sessions

Interactions Between Logic, Group Theory and Computer Science (Code: AMS SS Q1), **Alexandre Borovik**, UMIST, and **Alexei Myasnikov**, City College of CUNY. (AMS-ASL)

Mathematics and Education Reform (Code: AMS SS N1), **Naomi Fisher**, University of Illinois at Chicago, **William Barker**, Bowdoin College, **Jerry Bona**, University of Illinois

at Chicago, and **Kenneth Millett**, University of California Santa Barbara. (AMS-MAA-MER)

Research in Mathematics by Undergraduates (Code: AMS SS P1), **Darren A. Narayan**, **Carl V. Lutzer**, and **Tamara A. Burton**, Rochester Institute of Technology. (AMS-MAA-SIAM)

The History of Mathematics (Code: AMS SS S1), **Joseph W. Dauben**, Lehman College, and **David E. Zitarelli**, Temple University. (AMS-MAA)

AMS Invited Addresses

Weinan E., Princeton University, *Title to be announced.*

Andrei Okounkov, University of California Berkeley, *Title to be announced.*

Dana Randall, Georgia Institute of Technology, *Title to be announced.*

Peter Sarnak, Princeton University, *Title to be announced* (Colloquium Lectures).

Vladimir Voevodsky, Institute for Advanced Study, *Title to be announced.*

AMS Special Sessions

Advances in Spherical Designs and Codes (Code: AMS SS A1), **Béla Bajnok**, Gettysburg College, and **Neil J. A. Sloane**, AT&T Shannon Labs.

Algebraic Topology Based on Knots (Code: AMS SS F1), **Mark Kidwell**, U.S. Naval Academy, and **Jozef H. Przytycki** and **Yongwu Rong**, The George Washington University.

Banach Space Theory and Convex Geometry (Code: AMS SS L1), **Teck-Cheong Lim**, Mason University, and **Mikhail Ostrovskii**, The Catholic University of America.

C-Algebras, Quantization, and Noncommutative Geometry: A Tribute to the Memory of Irving Segal* (Code: AMS SS U1), **Robert S. Doran**, Texas Christian University.

C-Extensions and Classifications of C*-algebras* (Code: AMS SS C1), **Shuang Zhang**, University of Cincinnati, and **Huaxin Lin**, University of Oregon.

Computability and Models (Code: AMS SS T1), **Douglas Cenzer**, University of Florida, and **Valentina S. Harizanov**, The George Washington University.

Computational Algebraic and Analytic Geometry for Low-Dimensional Varieties (Code: AMS SS G1), **Mike Seppälä**, Florida State University, and **Emil Volcheck**, Baltimore, Maryland.

Discrete Dynamics and Difference Equations (Code: AMS SS D1), **Saber Elaydi**, Trinity University, and **Gerasimos Ladas**, University of Rhode Island.

Discrete Models (Code: AMS SS K1), **Cris Moore**, University of New Mexico and Santa Fe Institute, and **Dana Randall**, Georgia Institute of Technology.

Dynamical Systems and Oceanography (Code: AMS SS H1), **Reza Malek-Madani** and **Peter A. McCoy**, U.S. Naval Academy.

Dynamics, Physics, and Probability: The Work of the 2002 Nemmers Prize Winner, Yakov Sinai (Code: AMS SS W1), **John M. Franks**, Northwestern University, and **Jeff Xia**, Northwestern University.

Homotopy Theory (Code: AMS SS E1), **Kristine Baxter Bauer**, **J. Michael Boardman**, **Nitu Kitchloo**, **Jean-Pierre Meyer**, **Jack Morava**, and **W. Stephen Wilson**, Johns Hopkins University.

Interactions Between Logic, Group Theory and Computer Science (Code: AMS SS Q1), **Alexandre V. Borovik**, UMIST, and **Alexei Myasnikov**, City College of CUNY.

Modular Forms, Elliptic Curves, and Related Topics (Code: AMS SS J1), **Cristina Ballantine** and **Sharon Frechette**, College of the Holy Cross, and **Holly Rosson**, St. Mary's College of Maryland.

Nonstandard Models of Arithmetic and Set Theory (Code: AMS SS X1), **Ali Enayat**, American University, and **Roman Kossak**, CUNY Graduate Center.

Operator Algebras, Quantization, and Noncommutative Geometry: A Centennial Celebration in Honor of J. v. Neumann and M. H. Stone (Code: AMS SS U1), **Robert S. Doran**, Texas Christian University, and **R. V. Kadison**, University of Pennsylvania.

Recent Advances in Riemannian and Lorentzian Geometries (Code: AMS SS M1), **Krishan L. Duggal**, University of Windsor, and **Ramesh Sharma**, University of New Haven.

Wavelets, Frames and Operator Theory (Code: AMS SS B1), **Christopher Heil**, Georgia Tech, **Palle Jorgensen**, University of Iowa, and **David Larson**, Texas A&M University.

Preliminary Announcement of MAA Contributed Paper Sessions

The organizers listed below solicit contributed papers pertinent to their sessions. Sessions generally limit presentations to ten minutes, but selected participants may extend their contributions up to twenty minutes. Each session room contains an overhead projector and screen; blackboards will not be available. Persons needing additional equipment should contact, as soon as possible, but prior to September 10, 2002, the session organizer whose name is followed by an asterisk (*). Please note that the dates and times scheduled for these sessions remain tentative.

Submission Procedures for MAA Contributed Papers

Submit your abstract directly to the AMS. Concurrently, send a more detailed one-page summary of your paper directly to the organizer indicated with an (*). In order to enable the organizer(s) to evaluate the appropriateness of your paper, include as much detailed information as possible within the one-page limitation. The summary need not duplicate the information in the abstract. **Your summary must reach the AMS and the organizer by Tuesday, September 10, 2002.**

The AMS will publish abstracts for the talks in the MAA sessions. Abstracts must be submitted on the appropriate

AMS form. Electronic submission is available via the Internet or e-mail. No knowledge of \LaTeX is necessary, however, \LaTeX and \AMS-LaTeX can be accommodated. These are the only typesetting systems that can be used if mathematics is included. To see descriptions and to view the electronic templates available, visit the abstracts submission page on the Internet at <http://www.ams.org/abstracts/instructions.html>, or send e-mail to: abs-submit@ams.org, typing HELP as the subject line. Completed e-mail templates must be sent to abs-submit@ams.org with SUBMISSION as the subject line. Abstracts submitted electronically are quickly either acknowledged, with a unique abstract number assigned to the presentation, or rejected, with a short message on what information is missing or inappropriate. All questions concerning the submission of abstracts should be addressed to: abs-coord@ams.org.

Here are the codes you will need: Meeting Number: 983; Event Code: is the seven characters appearing before the title of the sessions shown below, e.g., (MAA CP A1); Subject Code: is the last two-character letter/number combination from the event code list, i.e., A1, B1.

Innovative Uses of the World Wide Web in Teaching Mathematics (MAA CP A1), Wednesday morning and Thursday afternoon. **Brian E. Smith***, Faculty of Management, McGill University, 1001 Sherbrooke St. W., Montreal, QC H3A 1G5, Canada; 514-398-4038; fax: 514-398-3876; smithb@management.mcgill.ca; **Marcelle Bessman**, Jacksonville University; **Marcia P. Birken**, Rochester Institute of Technology; **Thomas E. Leathrum**, Jacksonville State University; **David M. Strong**, Pepperdine University; and **Joe Yanik**, Emporia State University. This session seeks to highlight innovative teaching strategies in mathematics that emphasize the use of the World Wide Web as a learning tool. These strategies could include the construction of teaching materials or creative use of existing or standardly available materials. This session will include Java Applets and other Mathlets used in teaching mathematics.

Classroom Demonstrations and Course Projects That Make a Difference (MAA CP B1) Wednesday morning and Thursday afternoon. **David R. Hill***, Mathematics Department, Temple University, Philadelphia, PA 19122; 215-204-1654; fax: 215-204-6433; hill@math.temple.edu; **Sarah L. Mabrouk**, Framingham State College; and **Lila F. Roberts**, Georgia Southern University. The use of course projects and classroom demonstrations enables instructors to show students that mathematics is meaningful and applicable in a variety of real-life situations. Demos, important tools for instruction in any class format, enable instructors to engage the students on a level beyond that created by lectures. Projects are useful in helping students to apply the course material and to make connections between mathematics and the real world. This session invites papers about favorite instructional demos and course projects appropriate for any level in the undergraduate curriculum designed to engage students and to enable them to gain insight into mathematics. Presenters of demos are encouraged to give the demonstration, if time and equipment allow, and to discuss how to use it in a classroom setting. Presenters of projects are

encouraged to discuss the specifics of how the project was conducted and how it was evaluated. Proposals should describe how the demo/project fits into a course, the use of technology or technology requirements, if any, and the effect of the demo/project on student attitudes toward mathematics.

The History of Mathematics in the Americas (MAA CP C1), Wednesday afternoon. **Amy E. Shell***, Department of Mathematical Sciences, United States Military Academy, West Point, NY 10996-1905; 845-938-2413; aa7423@usma.edu; and **Daniel E. Otero**, Xavier University. This session invites papers on the history of mathematics, mathematicians, or ethno-mathematics of both North and South America. Special consideration will be given to mathematics in countries other than the United States.

Getting Students to Discuss and to Write about Mathematics (MAA CP D1), Wednesday afternoon. **Sarah L. Mabrouk***, Mathematics Department, Framingham State College, 100 State Street, P.O. Box 9101, Framingham, MA 01701-9101; 508-626-4785; fax: 508-626-4003; smabrouk@frc.mass.edu. Many students, especially in lower level courses, tend to view mathematics as incomprehensible equations and calculations rather than as meaningful and applicable in a variety of disciplines. This view of mathematics as meaningless affects the student's ability to verbally communicate mathematics just as it affects the student's understanding of and ability to apply mathematics. When students are required to use the language of mathematics and to explain the meaning of the mathematics that they are applying or analyzing, they learn to understand and to communicate mathematics. This session invites papers about assignments and projects that require students to communicate mathematics through in-class oral presentations that they make, or in-class discussions that they must lead and motivate, and through written assignments and papers. These assignments can include analysis and applications of mathematics, presentations of and analysis of proofs, presentations about famous mathematicians and the mathematics that they studied, and assignments/projects that utilize creative writing. Each presenter is encouraged to discuss how the use of the assignment/project helped students to improve their understanding of mathematics and their ability to communicate mathematics. Of particular interest is the effect of such projects/assignments/presentations throughout the course on the students' understanding of mathematics, their communication of mathematics, and their attitude toward mathematics.

Quantitative Literacy in Practice: What Is It and What Works? (MAA CP E1), Wednesday afternoon. **Richard A. Gillman***, Department of Mathematics and Computer Science, 219 Gellersen Hall, Valparaiso University, Valparaiso IN, 46383; 219-464-5067; fax: 219-464-5065; rick.gillman@valpo.edu. Quantitative literacy can be defined as the ability to use elementary mathematics in authentic contexts from an individual's personal, economic, and social life. Colleges and universities across the country are reasonably expected to deepen and expand the quantitative literacy of all of the students that arrive on their campuses. This session seeks papers that will illustrate how

the presenters and their institutions have operationalized the definition given above. These papers may include discussions of requirements in particular courses or at a general curriculum level, lists of student learning competencies established by the institution, and assessment methods and results at both the student and institutional levels. Of particular interest are discussions of the placement process, articulation agreements with other institutions, and credit transfer issues.

Environmental Mathematics in the Classroom (MAA CP F1), Wednesday afternoon. **Karen D. Bolinger***, Department of Mathematics, Clarion University, Clarion PA 16214; 814-393-2360; fax 814-393-2735; kbolinge@clarion.edu; and **Ben Fusaro**, Florida State University. We invite papers that deal with all aspects of applying mathematics to solve problems of the environment and that are suitable for classroom use at grade levels 12-15. Also invited are papers that address the issue of infusing environmental awareness into the teaching community. Papers dealing with exposition, pedagogy or modeling are as welcome as those about successful experiences with getting this intrinsically interdisciplinary subject into the curriculum. This session is sponsored by the MAA Committee for Mathematics and the Environment.

Incorporating History of Mathematics in the Mathematics Classroom (MAA CP G1), Thursday morning. **Victor J. Katz***, Mathematics Department, University of the District of Columbia, 4200 Connecticut Ave. N.W., Washington, DC 20008; 202-274-5374; fax: 301-592-0061; vkatz@udc.edu; **Edith Prentice Mendez**, Sonoma State University; and **Eisso J. Atzema**, University of Maine. One of the purposes of the History of Mathematics Special Interest Group of the MAA (HOM SIGMAA) is to support the use of the history of mathematics in the teaching of mathematics. Therefore, we are soliciting contributed papers on innovative ways to incorporate the history of secondary and undergraduate mathematics into the mathematics classroom. Presentations describing student projects or classroom activities are especially encouraged, as are those dealing with curriculum development which promotes the use of history by prospective secondary teachers.

Helping Students Give Effective Mathematics Presentations (MAA CP H1), Thursday morning. **Suzanne Dorée***, Augsburg College, Campus Box #61, 2211 Riverside Avenue, Minneapolis, MN 55454; 612-330-1059; fax: 612-330-1649; doree@augsborg.edu; and **Thomas Linton**, Central College. Do you have courses that include student speaking assignments? Is your undergraduate research student presenting a paper at an upcoming conference? Are your future K-12 teachers giving practice teaching demonstrations? Is your advisee preparing for a job interview? Whatever the reason, many of us are faced with the challenge of helping our students be prepared to speak about mathematics. Proposals are sought that describe characteristics of high-quality student presentations, processes used to help students prepare to speak, methods of evaluating student presentations, or innovative uses of student presentations in mathematics programs.

Mathematics Experiences in Business, Industry and Government (MAA CP I1), Thursday morning. **Philip E.**

Gustafson*, Department of Computer Science, Mathematics and Statistics, Mesa State College, 1100 North Avenue, Grand Junction, CO 81501-3122; 970-248-1176; fax: 970-248-1324; pgustafs@mesastate.edu. This contributed paper session will provide a forum for mathematicians with experience in Business, Industry and Government (BIG) to present papers or discuss projects involving the application of mathematics to BIG problems. BIG mathematicians as well as faculty and students in academia who are interested in learning more about BIG practitioners, projects, and issues, will find this session of interest. This session is sponsored by the MAA Business, Industry and Government Special Interest Group (BIG SIGMAA).

Applications of Abstract Algebra (MAA CP J1), Thursday morning. **Robert E. Lewand***, Department of Mathematics and Computer Science, Goucher College, 1021 Dulany Valley Road, Baltimore, MD 21204; 410-337-6239; fax: 410-337-6408; rlewand@goucher.edu; and **George Mackiw**, Loyola College, Maryland. The methods and tools of abstract algebra have been used successfully in many areas of endeavor and study. Cryptography, coding theory, and digital signal processing are examples of areas where algebraic methods are currently prominent. Abstract algebra has also interacted fruitfully with geometry, combinatorics, number theory, logic and other fields of study. Applications can certainly enhance and enliven presentations of the subject, since they provide motivation and can stimulate student interest. This session seeks contributions that present applications of the theory of groups, rings, and fields that would be suitable for use in an undergraduate course. Of particular interest are topics that might not ordinarily be encountered in the standard curriculum and ones that are not readily available in popular texts.

The Special Interest Group of the MAA on Research in Undergraduate Mathematics Education (MAA CP K1), Friday and Saturday mornings. **James F. Cottrill***, Illinois State University, Campus Box 4520, Normal, IL 61790-4520; 309-438-7830; fax: 309-438-5866; jfcottr@math.ilstu.edu; and **Anne E. Brown**, Indiana University South Bend. The Special Interest Group of the MAA on Research in Undergraduate Mathematics Education (SIGMAA on RUME) aims to foster a professional atmosphere for quality research in the teaching and learning of undergraduate mathematics through contributed paper sessions for mathematics educators and mathematicians interested in research on undergraduate mathematics education. Research papers that address issues concerning the teaching and learning of undergraduate mathematics are invited. Theoretical and empirical investigations using qualitative and quantitative methodologies are appropriate. These should be set within established theoretical frameworks and should further existing work. Reports on completed studies are especially welcome.

Best Statistics Projects/Activities (MAA CP L1), Friday and Saturday mornings. **Carolyn K. Cuff***, Westminster College, New Wilmington, PA 16172-0001; 724-946-7291; fax: 724-946-7158; ccuff@westminster.edu; and **Mary M. Sullivan**, Rhode Island College. Successful statistical

education requires that the student not only be exposed to real data but also actively participate in the analysis of the data and effectively communicate the results. Faculty who teach statistics and include activities and projects in their courses are invited to contribute papers that describe creative projects or activities that they have used in their classes. Activities will be demonstrated during the session. These projects and activities can be from introductory to advanced courses in statistics or from courses that are only partially devoted to statistics.

Rethinking the Courses below Calculus (MAA CP M1), Friday and Saturday mornings. **Mary Robinson***, University of New Mexico, Valencia Campus, 280 La Entrada, Los Lunas, NM 87031; 505-925-8622; fax: 505-925-8697; maryrobn@unm.edu; **Sheldon P. Gordon**; SUNY at Farmingdale; **Florence S. Gordon**; New York Institute of Technology; and **Arlene H. Kleinstein**; SUNY at Farmingdale. The MAA and several groups of mathematicians have recently launched a number of related major curriculum initiatives all of which are addressing the changing needs of the students who take courses below calculus. These initiatives include efforts to rethink college algebra and precalculus courses, to increase quantitative reasoning among all students, and to provide better mathematical support to the partner disciplines. Enrollment in these courses is on the order of about 2,000,000 students a year and represents about 2/3 of all mathematics enrollments. Yet, the available evidence indicates that the traditional courses at this level do not work, in terms of preparing students for subsequent math courses, of preparing them for quantitative courses in the other disciplines, or of motivating them to continue on in mathematics. In this session, we specifically seek to address all of the courses below calculus outside of QL programs, with particular emphasis on offerings in College Algebra and Precalculus. In particular, we seek presentations that: present new visions for such courses, describe implementations of such courses, discuss the results of analysis of data on student performance and student tracking information coming out of these courses, discuss the issues involved in smoothing the transitions between mathematics in high school and in college and between different collegiate institutions, discuss the needs of other disciplines from courses at this level. This session is cosponsored by the MAA Task Force on the First College Level Mathematics Course, the Committee on Curriculum Renewal Across the First Two Years (CRAFTY), the Committee on Two Year Colleges, and the Committee on Articulation and Placement.

Assessment of Student Learning: Models and Methodology (MAA CP N1), Friday and Saturday mornings. **Jay A. Malmstrom***, Oklahoma City Community College, 7777 S. May Ave, Oklahoma City, OK 73159; 405-682-1611 x7365; fax: 405-682-7805; malmstrm@qns.com; **Linda Martin**, Albuquerque-TVI; and **Mercedes A. McGowen**, William Rainey Harper College. Accrediting agencies, boards of regents, and government agencies are placing an increased emphasis on the assessment of student outcomes. As a result of this, mathematics departments need to look at their offerings from a variety of viewpoints in order to assess the effectiveness of their courses. These include (but

are not limited to): student readiness for college level work, student readiness for upper division work, student readiness for work in their major, and quantitative literacy. Papers in this session will emphasize: methodology used in the evaluation, lessons learned from the evaluation (which tools worked and which did not), and the impact of the evaluation on the department (how did the department change as a result of the evaluation).

Encouraging Underrepresented Groups of Students in Math Contests (MAA CP P1), Friday afternoon. **Harold B. Reiter***, Department of Mathematics, UNC Charlotte, Charlotte, NC 28223; 704-687-4561; fax: 704-687-6415; hbreiter@email.uncc.edu. **Ruth G. Favro**, Lawrence Technological University; **David M. Wells**, Pennsylvania State University; **Susan Schwartz Wildstrom**, Walt Whitman High School; and **Jeff J. Dodd**, Jacksonville State University. Mathematics competitions at the high school and university levels in the United States have traditionally been dominated by white and Asian males. Females compete successfully in contests for younger students, but do not do very well in middle school years and later. Black and Hispanic Americans also do less well than others, in general, in local, regional, and national math contests. Recruiting these underrepresented groups to math competitions is a vexing problem whose solutions we would like to explore in the session. The Committee on Local and Regional Competitions (CLARC) solicits papers discussing how some have tackled this representation problem. Some possibilities to consider may include: coaching students for competitions, preparing teachers to be coaches for competitions, writing problems for competitions, encouraging participation in competitions, communicating effectively with coaches and participants, competition formats and styles, and social aspects, follow-up of participants or mentoring, interesting uses of technology in conducting competitions (for example, conducting competitions on the Web).

Strategies for Increasing the Diversity of Students in Mathematics (MAA CP Q1), Friday morning. **Marjorie Enneking***, Department of Mathematical Sciences, Portland State University, Portland, OR 97207-0751; 503-725-3643; fax: 503-725-3661; marj@math.pdx.edu; **Wade Ellis**, West Valley College; **William Hawkins**, SUMMA; **Robert E. Megginson**, University of Michigan; **Kenneth C. Millett**, University of California, Santa Barbara; and **William Y. Velez**, University of Arizona. This session will present strategies for recruiting students from diverse backgrounds into mathematics; programs to support high success rates and level of achievement by these students; and faculty development initiatives which help faculty and departments initiate such programs. Presenters will present methods for evaluating such programs and evidence of the success of their programs.

Mathematical Modeling in and out of the Classroom (MAA CP R1), Friday afternoon. **Brian J. Winkel***, United States Military Academy, West Point NY 10996; 845-938-3200; fax: 845-938-2409; Brian-Winkel@usma.edu; **Tanya L. Leise**, Rose-Hulman Institute of Technology; and **Amy E. Radunskaya**, Pomona College. Modeling is still a buzzword in mathematics education circles. For some it

is just that, a buzzword, without comprehension, certainly without concrete examples. We propose a contributed paper session that will help attendees understand the process of mathematical modeling as well as the process of teaching mathematical modeling. Specifically, we ask each presenter to offer the attendees (1) details of a modeling activity (or several)—how, why, what, where, and when, with attention to both mathematics and content area of application; and (2) a discussion on how to implement the activity. We require from each presenter something specific that can be done in a mathematical modeling course or a general course, be it high school mathematics or graduate level course work. Additionally, we shall ask the presenters to prepare an annotated bibliography on five modeling sources/activities materials they have used or found appropriate. This set of annotated bibliographies will be combined into an electronic file for Web access as well as a hard copy for meeting distribution to session attendees. Certainly activities including data collection, modeling lessons/classes, modeling studios/activities, and class consulting are but a few of the appropriate areas discussed.

Philosophy of Mathematics (MAA CP S1), Friday afternoon. **Bonnie Gold***, Mathematics Department, Monmouth University, 400 Cedar Avenue, West Long Branch, NJ 07764-1898, 732-571-4451; fax: 732-263-5378; bgold@monmouth.edu. This session invites papers on any topic in the philosophy of mathematics except logic and set theory. Possible topics include the nature of mathematics, the nature of mathematical objects, the nature of mathematical knowledge, the relation between mathematics and the physical world, the role of esthetics in the development of mathematics; philosophical implications of logic and set theory are also acceptable. Talks should be addressed to a mathematical audience, not an audience of philosophers (in terms of background), but should attempt to meet the same level of precision used in mathematical presentations.

Integrating Undergraduate Research with the Mathematics Curriculum (MAA CP T1), Friday afternoon. **David Brown***, Ithaca College, Department of Mathematics and Computer Science, 1212 Williams Hall, Ithaca NY 14850-7284; 607-274-7375; fax: 607-274-1588; dabrown@ithaca.edu; and **Osman Yurekli**, Ithaca College. In this session, we focus on efforts to incorporate the mathematics research experience within the curriculum. We encourage the submission of papers that demonstrate creative ways of involving undergraduates in mathematical exploration. Ideas ranging from projects within established courses to courses specifically designed to conduct research are welcomed. We also look for discussion of how the models used for sustaining undergraduate research have affected the rest of the curriculum and how valuable such experiences have been. Some questions that we would like to see addressed include: In what way have departments been able to incorporate undergraduate research projects within the curriculum? Have these efforts been successful? What types of research have students completed? What students have had these opportunities (i.e., is the experience only for the most talented)? Has there been any follow-up

for students? What has been the reaction of colleagues? Have such experiences affected the department's curriculum? How have these research experiences been assessed?

Courses and Projects Addressing the Shortage of K-12 Teachers (MAA CP U1), Saturday afternoon. **Harel Barzilai***, Department of Mathematics, Salisbury University, Salisbury MD 21801; 410-543-6472; fax: 410-548-5559; hxbarzilai@salisbury.edu; **Maria G. Fung**, Western Oregon University; and **Jay M. Jahangiri**, Kent State University. As highlighted by the Glenn Commission report "Before It's Too Late", the shortage of well-prepared K-12 mathematics teachers is a serious and growing national concern. Resources such as the NCTM Principles and Standards for School Mathematics and the CBMS Report on the Mathematical Education of Teachers provide valuable insights on where we want to be in teacher education. Nevertheless, creatively implementing change which helps us "get there" is a formidable challenge and will remain so for the foreseeable future. Contributed presentations are invited which address this national shortage of qualified mathematics school teachers through innovative courses, programs, or projects effecting better recruitment, preparation, retention, and professional development for mathematics teachers. Of particular interest are creative efforts which help strengthen the mathematical preparation of preservice and inservice middle school teachers, those teaching on a temporary certification or out of their certification, teachers teaching out of field, and teachers who otherwise lack sufficient background. Additional important elements can include: community outreach; professional networking, mentoring and development of and by teachers; strengthening diversity; collaborations among faculty in mathematics and education departments and between faculty and school system personnel; efforts to help teachers meet the increasing demands of assessment standards from multiple sources; and innovative ways of institutionalizing support systems for teachers and for professional standards in mathematics teaching.

Creative Visualization Labs (MAA CP V1), Saturday afternoon. **Sarah J. Greenwald***, Department of Mathematics, Appalachian State University, Boone, NC 28608; 828-262-2363; fax: 828-265-8617; sjg@math.appstate.edu; **Catherine A. Gorini**, Maharishi University of Management; and **Mary L. Platt**, Salem State College. Effective projects that help students develop visualization skills are important for success in many courses. There are many resources for incorporating such activities into the K-12 geometry classroom, but few are aimed at college level courses. This session invites papers describing a complete lab or series of labs using computers, technology, dynamic software and/or manipulatives aimed at increasing visualization skills. Activities designed for use in college level geometry, topology, or visualization courses are especially encouraged. Presentations detailing student reactions, educational benefits and difficulties encountered, and the effect of the lab on teaching and learning are desired. The organizers are developing a website of college labs, and contributions to this session will be considered for inclusion.

Linking Mathematics with Other Disciplines (MAA CP W1), Saturday afternoon. **Stephanie A. Fitchett***, Honors College, Florida Atlantic University, 5353 Parkside Drive, Jupiter, FL 33458; 561-799-8613; fax: 561-799-8602; sfitchet@fau.edu; **Blake Mellor**, Honors College, Florida Atlantic University; and **Gavin P. LaRose**, University of Michigan. This session will explore the linking and integration of mathematics with other disciplines by inviting contributions, from both mathematicians and instructors in other disciplines, on the following themes: strategies or environments that encourage instructors, as well as students, to take an integrated and interdisciplinary approach to teaching and learning mathematics; the incorporation of realistic applications in mathematics courses in a way that enhances mathematical understanding; examples of how mathematics is used or taught in courses offered by other disciplines (natural science, social science, humanities, business, etc.); and exemplary courses, projects, or collections of activities.

Mathematical Connections in Art, Music, and Science (MAA CP X1), Saturday afternoon. **John M. Sullivan***, Department of Mathematics, University of Illinois at Urbana-Champaign, 1409 W Green St., Urbana IL 61801; 217-244-5930; fax: 217-333-9576; jms@math.uiuc.edu; **Douglas E. Norton**, Villanova University; and **Reza Sarhangi**, Towson University. Mathematics can be defined as the study of patterns. Patterns have always been used in artistic creation: in music, the visual arts, and architecture. This was particularly evident, for example, in antiquity, during the flourishing of Islamic art and in the Renaissance in Europe. Patterns lending themselves to mathematical interpretation arise across the disciplinary spectrum: in the chain of evolution, in the histories of cultures and civilizations, in the extreme complexities encountered in high-speed computations. These patterns are the topics of ever deepening mathematics created to help understand them. Numerous mathematicians are developing curricular materials linking mathematics to the arts and other cultural branches of our civilization. By using attractive and accessible examples to show the presence of and benefit from mathematics in art, music, humanities, and sciences, these materials can help reduce the aversion to mathematics too often found in the general public, fostering new linkages and new appreciation of things mathematical. Objectives of the session include: present new findings relating mathematics to its artistic and aesthetic presentations; demonstrate the use of new technology to illustrate connections between mathematics and the arts; and introduce innovative techniques promoting interdisciplinary work in the fields of mathematics, science, art, and music.

Computation Mathematics in Linear Algebra and Differential Equations (MAA CP Y1), Saturday afternoon. **Richard J. Marchand***, Department of Mathematics and Computer Science, SUNY Fredonia, Fredonia, NY 14063; 716-673-3871; fax: 716-673-3804; marchand@cs.fredonia.edu; **Elias Deeba**, University of Houston-Downtown; and **Timothy J. McDevitt**, Millersville University. Computer algebra systems, spreadsheets and graphing calculators have become popular tools for facilitating

numerical investigations of many meaningful problems in linear algebra and differential equations. Such investigations lead to better students' understanding of mathematical concepts while empowering them with the capabilities to analyze more realistic problems. This session invites papers describing novel projects from these disciplines in which technology is required. Outstanding papers may be considered for publication as part of an MAA collection.

General Contributed Paper Session (MAA CP Z1), Wednesday, Thursday, Friday, and Saturday mornings. **Michael A. Jones**, Montclair State University, 1 Normal Avenue, Upper Montclair, NJ 07043; 973-655-5448; fax 973-655-7686; jonesma@pegasus.montclair.edu; **Jill Dietz**, St. Olaf College; **Steven M. Hetzler**, Salisbury University; and **Shawnee L. McMurrin**, California State University at San Bernardino. This session is designed for papers that do not fit into one of the other sessions. Papers may be presented on any mathematical topic. Papers that fit into one of the other sessions should be sent to that organizer, not to this session. Papers should not be sent to more than one organizer. E-mail submissions are preferred.

Baton Rouge, Louisiana

Louisiana State University

March 14–16, 2003

Meeting #984

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 14, 2002

For consideration of contributed papers in Special Sessions:

To be announced

For abstracts: To be announced

Bloomington, Indiana

Indiana University

April 4–6, 2003

Meeting #985

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: September 4, 2002
 For consideration of contributed papers in Special Sessions:
 To be announced
 For abstracts: To be announced

New York, New York

*Courant Institute***April 12–13, 2003****Meeting #986**

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 12, 2002
 For consideration of contributed papers in Special Sessions:
 To be announced
 For abstracts: To be announced

Invited Addresses

Matthias Aschenbrenner, University of California at 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.*

San Francisco, California

*San Francisco State University***May 3–4, 2003****Meeting #987**

Western Section
 Associate secretary: Michel L. Lapidus
 Announcement issue of *Notices*: To be announced
 Program first available on AMS website: To be announced
 Program issue of electronic *Notices*: To be announced
 Issue of *Abstracts*: To be announced

Deadlines

For organizers: August 3, 2002
 For consideration of contributed papers in Special Sessions:
 To be announced

For abstracts: To be announced

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 Politécnic 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, 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

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 Autonoma 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**, University 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 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.

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.

Interpolation Theory, Function Spaces and Applications, **Fernando Cobos**, University Complutense de Madrid, and **Pencho Petrushev**, University of South Carolina.

Mathematical Fluid Dynamics, **Diego Cordoba**, CSIC, Madrid, and Princeton University, and **Susan Friedlander**, University of Illinois, Chicago.

Nonlinear Dispersive Equations, **Gustavo Ponce**, University of California Santa Barbara, and **Luis Vega**, Universidad del País Vasco.

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 Politecnica de Valencia, **Pedro Paul**, Universidad de Sevilla, and **Cora S. Sadosky**, Howard 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 Biotecnología-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, Boulder

October 2–4, 2003

Meeting #989

Joint Central/Western Section

Associate secretaries: Susan J. Friedlander and Michel L. Lapidus

Announcement issue of *Notices*: To be announced

Program first available on AMS website: To be announced

Program issue of electronic *Notices*: To be announced

Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

Binghamton, New York

SUNY-Binghamton

October 11–12, 2003

Meeting #990

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: March 10, 2003

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

Invited Addresses

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.

Goa, India

December 17–20, 2003

First Joint International Meeting with Various Indian Mathematical Societies

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

Phoenix, Arizona

Phoenix Civic Plaza

January 7–10, 2004

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

Athens, Ohio

Ohio University

March 26–27, 2004

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

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

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 (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).

Associate secretary: John L. Bryant

Announcement issue of *Notices*: October 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

SMARANDACHE MANIFOLDS

by Howard Iseri,
American Research Press, Rehoboth, 2002.

A **Smarandache geometry** (1969) is a geometric space (i.e., one with points, lines) such that some "axiom" is false in at least two different ways, or is false and also sometimes true. Such an axiom is said to be **Smarandachely denied** (or **S-denied** for short). In Smarandache geometry, the intent is to study non-uniformity, so we require it in a very general way.

A manifold that supports a such geometry is called **Smarandache manifold** (or **s-manifold**). As a special case, in this book Dr. Howard Iseri studies the s-manifold formed by any collection of (equilateral) triangular disks joined together such that each edge is the identification of one edge each from two distinct disks and each vertex is the identification of one vertex from each of five, six, or seven distinct disks.

Thus, as a particular case, Euclidean, Lobachevsky-Bolyai-Gauss, and Riemannian geometries may be united altogether, in the same space, by certain Smarandache geometries.

Other mathematical books can be downloaded at www.gallup.unm.edu/~smarandache/eBooks-otherformats.htm.



MATHFEST 2002

BURLINGTON, VERMONT AUGUST 1-3, 2002

THE ANNUAL SUMMER MEETING OF
THE MATHEMATICAL ASSOCIATION OF AMERICA

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6849836774383928371098365748347362738271
3835628918730731200238192716237839125604
38766827**THE 3 TWO-DAY 9 SHORT 7 COURSE 73020027**
456167**THE 3 MATHEMATICS 5 OF 2 CRYPTOLOGY 731734**
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2736957576834437263845857329384756372837

For millennia cryptology and mathematics followed separate paths. Now they are intimately entwined, with cryptology influencing the development of mathematics and vice versa. In this short course we shall visit some of the mathematics that has been stimulated by cryptology, some of the cryptology that has arisen out of mathematical problems, and some of the real-world issues that arise when cryptosystems are actually implemented. Most talks will supplement what is usually found in an undergraduate text on cryptology. The listed talks will be given at the short course. They are listed in alphabetical order by speaker. The actual order will be different. To sign up for this course, go to www.maa.org and download the MathFest registration form.

ORGANIZED BY

Carl Pomerance, *Lucent Technologies, Bell Labs*

PART I: TUESDAY, JULY 30, 9:00 AM – 5:00 PM

PART II: WEDNESDAY, JULY 31, 9:00 AM – 5:00 PM

IMPLEMENTING PUBLIC KEY CRYPTOLOGY: THE DEVIL IS IN THE DETAILS

Daniel Bleichenbacher, *Lucent Technologies, Bell Labs*

HOW HARD IS FACTORING?

Carl Pomerance, *Lucent Technologies, Bell Labs*

HOW HARD ARE DISCRETE LOGARITHMS?

Carl Pomerance, *Lucent Technologies, Bell Labs*

ELLIPTIC CURVES AND CRYPTOLOGY

Joe Silverman, *Brown University and NTRU Cryptosystems, Inc.*

LATTICES AND CRYPTOLOGY

Joe Silverman, *Brown University and NTRU Cryptosystems, Inc.*

THE GIVE AND TAKE OF MAKING AND BREAKING CRYPTOSYSTEMS

Mike Szydlo, *RSA Security, Inc.*

TEXTBOOK CRYPTOGRAPHY AND THE REAL WORLD

Mike Szydlo, *RSA Security, Inc.*

COMBINATORIAL CRYPTOGRAPHY AND THE 'TWO SHERIFFS PROBLEM'

Peter Winkler, *Lucent Technologies, Bell Labs*

COMPARISON WITHOUT DISCLOSURE

(OR AVOIDING CRYPTOGRAPHY FOR FUN AND PROFIT)

Peter Winkler, *Lucent Technologies, Bell Labs*

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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:

2002

June 12-16	Pisa, Italy	p. 735
June 20-22	Portland, Oregon	p. 737
October 5-6	Boston, Massachusetts	p. 738
October 12-13	Madison, Wisconsin	p. 738
October 26-27	Salt Lake City, Utah	p. 739
November 9-10	Orlando, Florida	p. 740

2003

January 15-18	Baltimore, Maryland Annual Meeting	p. 740
March 14-16	Baton Rouge, Louisiana	p. 746
April 4-6	Bloomington, Indiana	p. 746
April 12-13	New York, New York	p. 747
May 3-4	San Francisco, California	p. 747
June 18-21	Seville, Spain	p. 747
October 2-4	Boulder, Colorado	p. 748
October 10-12	Binghamton, New York	p. 748
December 17-20	Goa, India	p. 749

2004

January 7-10	Phoenix, Arizona Annual Meeting	p. 749
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March 26-27 2005	Athens, Ohio	p. 749
January 5-8 2006	Atlanta, Georgia Annual Meeting	p. 749
January 12-15 2007	San Antonio, Texas Annual Meeting	p. 749
January 4-7	New Orleans, Louisiana Annual Meeting	p. 750

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. 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.

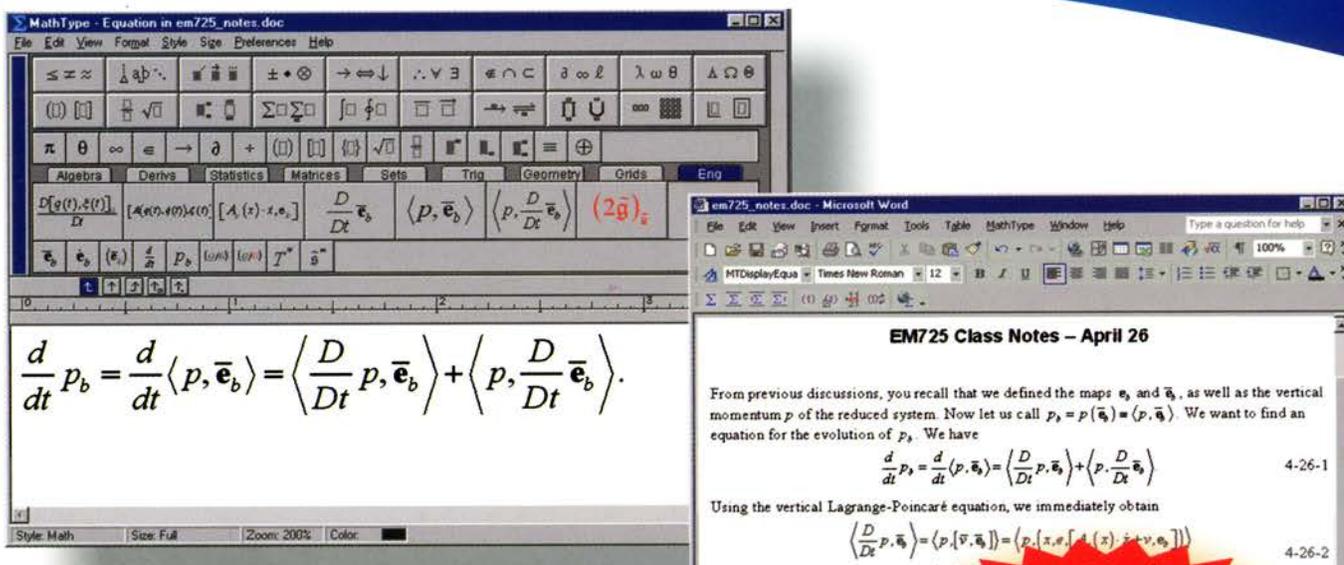
Paper abstract forms may be sent to Meetings & Conferences Department, AMS, P.O. Box 6887, Providence, RI 02940. There is a \$20 processing fee for each paper abstract. There is no charge for electronic abstracts. Note that all abstract deadlines are strictly enforced. Close attention should be paid 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.)

June 7-August 1, 2002: Joint Summer Research Conferences in the Mathematical Sciences, Mount Holyoke College, South Hadley, MA. See pages 1289-1291, November 2001 issue, for details.

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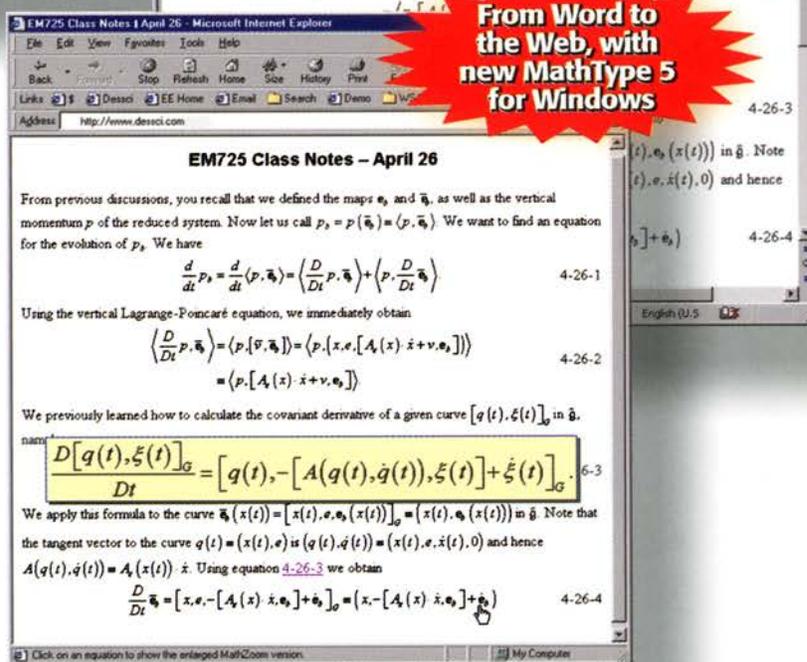
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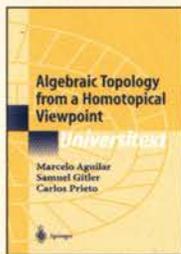


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MARCELO ALBERTO AGUILERA and **CARLOS PRIETO**, both, Universidad Nacional Autónoma de México, DF, México; and **SAMUEL GITLER**, University of Rochester, Rochester, NY

The purpose of this book is to introduce algebraic topology using the novel approach of homotopy theory, an approach with clear applications in

algebraic geometry as understood by Lawson and Voevodsky. The basic concepts of homotopy theory, such as fibrations and cofibrations, are used to construct singular homology and cohomology, as well as K-theory. Throughout the text many other fundamental concepts are introduced, including the construction of the characteristic classes of vector bundles. This book is intended for advanced undergraduates and graduate students with a basic knowledge of point set topology as well as group theory and can be used in a two semester course.

2002/512 PP./HARDCOVER/\$69.95
ISBN 0-387-95450-3
UNIVERSITEXT

THE MATHEMATICAL THEORY OF FINITE ELEMENT METHODS

SECOND EDITION

SUSANNE C. BRENNER, University of South Carolina, Columbia, SC; and **SCOTT L. RIDGWAY**, University of Chicago, Chicago, IL

This book develops the basic mathematical theory of the finite element method, the most widely used technique for engineering design and analysis. This expanded second edition contains new chapters on additive Schwarz preconditioners and adaptive meshes. New exercises have also been added throughout. The book will be useful to mathematicians as well as engineers and physical scientists.

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TEXTS IN APPLIED MATHEMATICS, VOL. 15

ELEMENTS OF MATHEMATICS

Lie Groups and Lie Algebras, Chapters 4-6
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—G.B. SELIGMAN IN MATH REVIEWS

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COMBINATORIAL OPTIMIZATION

Theory and Algorithms

Second Edition

BERNHARD KORTE and **JENS VYGEN**, both, University of Bonn, Germany

Combinatorial optimization is one of the youngest and most active areas of discrete mathematics, and is probably its driving force today. This book describes the most important ideas, theoretical results, and algorithms of this field. It is an up-to-date reference work for current research. The book includes the essential fundamentals of graph theory, linear and integer programming, and complexity theory. It covers classical topics in combinatorial optimization as well as very recent ones. The emphasis is on theoretical results and algorithms with provably good performance. Some applications and heuristics are also mentioned.

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ALGORITHMS AND COMBINATORICS

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Engineering Use of Group-theoretic Bifurcation Theory

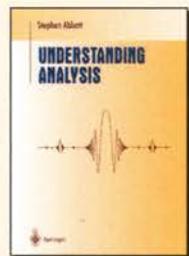
KIYOHIRO IKEDA, Tohoku University, Sendai, Japan; and **KAZUO MURATA**, Kyoto University, Kyoto, Japan

This book provides a modern investigation into the bifurcation phenomena of physical and engineering problems. Systematic methods – based on asymptotic, probabilistic, and group-theoretic standpoints – are used to examine experimental and computational data from numerous examples (e.g., soil, sand, kaolin, concrete, domes, etc.).

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APPLIED MATHEMATICAL SCIENCES, VOL. 149

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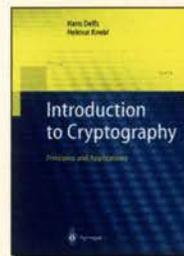
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INTRODUCTION TO CRYPTOGRAPHY

Principles and Applications



HANS DELFS and **HELMUT KNEBL**, both, Georg-Simon-Ohm University of Applied Sciences, Nürnberg, Germany

Modern cryptography provides essential techniques for securing information and protecting data. This book presents the key concepts of cryptography on an undergraduate level, from encryption and digital signatures to cryptographic protocols such as electronic elections and digital cash. In the second part, probability theory is applied to make basic notions precise, such as the security of cryptographic schemes. More advanced topics are also addressed, such as the bit security of one-way functions and computationally perfect pseudo-random bit generators.

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INFORMATION SECURITY AND CRYPTOGRAPHY

UNCERTAIN VOLATILITY MODELS

Theory and Application

ROBERT BUFF, Goldman Sachs & Co., New York, NY

This book introduces Uncertain Volatility Models in mathematical finance and their computer implementation for portfolios of vanilla, barrier and American options in equity and FX markets. Uncertain Volatility Models place subjective constraints such as upper and lower bounds on volatility and evaluate option portfolios under worst- and best-case scenarios. The accompanying CD contains the source code of a C++ implementation of the algorithms presented in the book.

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ISBN 3-540-42657-4
SPRINGER FINANCE

CONTEMPORARY COMBINATORICS

BELA BOLLOBAS, The University of Memphis, Memphis, TN (ed.)

As of April 2001, the Bolyai Mathematical Society in Budapest and Springer-Verlag jointly publish the Bolyai Society Mathematical Studies. This volume is a collection of survey papers in combinatorics that have grown out of the lectures given in the workshop on Probabilistic Combinatorics held at the Paul Erdős Summer Research Center in Mathematics in 1998.

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