

Notices

of the American Mathematical Society

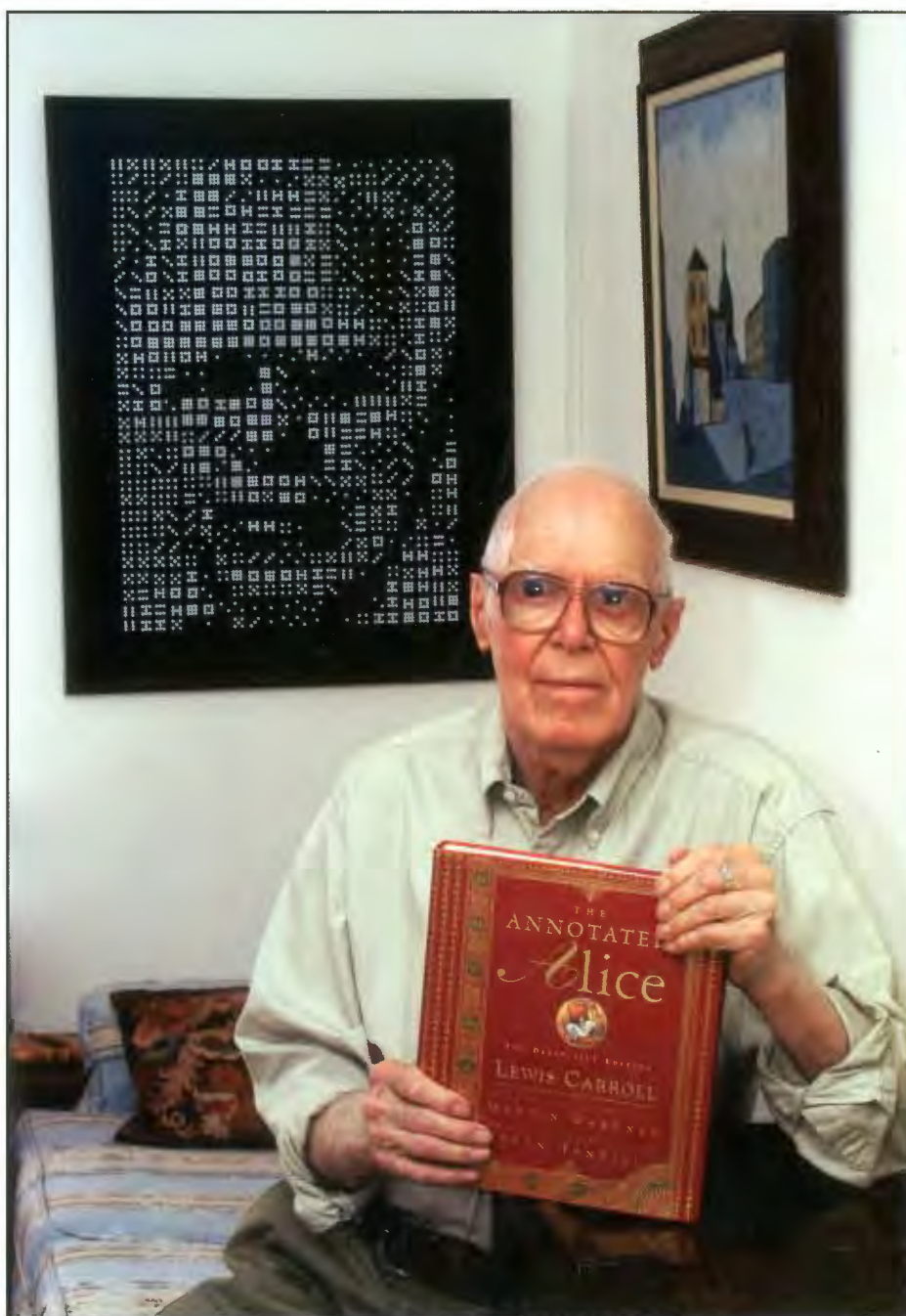
June/July 2005

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Serious Mathematics in a Lively, Reader-Friendly Style



A Mathematical Gift, I, II, III

The interplay between topology,
functions, geometry, and algebra



Shigeyuki Morita, *Tokyo Institute of Technology, Japan*, Koji Shiga, *Yokohama, Japan*, Toshikazu Sunada, *Tohoku University, Sendai, Japan* and Kenji Ueno, *Kyoto University, Japan*

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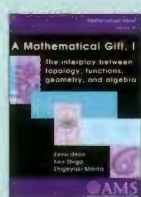
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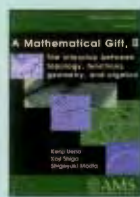
A Mathematical Gift, I

The interplay
between topology,
functions, geometry,
and algebra

Kenji Ueno, *Kyoto University, Japan*, Koji Shiga, *Yokohama, Japan*, and Shigeyuki Morita, *Tokyo Institute of Technology, Japan*

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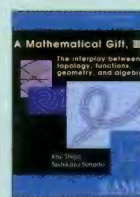
A Mathematical Gift, II

The interplay
between topology,
functions, geometry,
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A Mathematical Gift, III

The interplay
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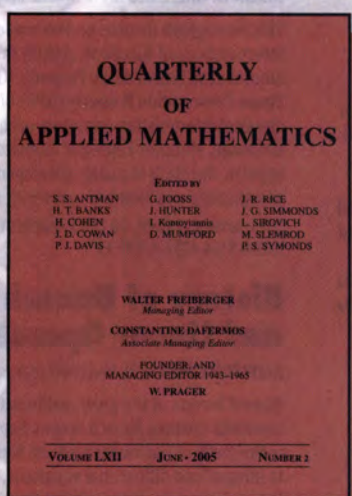
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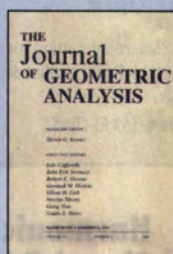
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June/July 2005

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NSF—A Wake-up Call

NSF The NSF (National Science Foundation) is a key component of the nation's investment in basic research and in developing scientific talent. The NSF, the  **2005** National Institutes of Health, and the Department of Energy's Office of Science are the nation's three main sources of basic research investments. For the mathematical sciences, the NSF currently provides 77 percent of federal research investments, and I focus here for simplicity's sake on the NSF's role in the nation's investment in the future. My readings, observations, and travels over the years since leaving the directorship of the NSF's Division of Mathematical Sciences (DMS) have convinced me that we are not even remotely doing enough to live up to our current leadership role in science and technology. We were thrust into this post-WWII leadership role by visionaries advancing the public investment in our future with boldness, and, with the scientific community's sense of common purpose, this advocacy was very successful. The results have been truly magnificent. The investments have massively contributed to our prosperity, health, and security. It is generally accepted by the economic community that more than half of our economic growth is the result of these investments. Basic research is the driver of innovation. Knowledge creation translates into economic growth. Much of this innovation has spurred the current worldwide dynamics in science, engineering, and technology. But this global spread has turned into an economic race in which we are not running at our capacity—in any case, we are not running sufficiently fast to live up to our leadership responsibility.

There is no lack of evidence that U.S. leadership in science and technology is at risk, threatening our scientific capabilities and future economic competitiveness. Even our trade balance for high-tech products is now running a yearly deficit exceeding \$30 billion. Yet our superior innovative capabilities are still seen as the basis of our economic strength. Another long-term indicator is the U.S. share of worldwide undergraduate science and technology degrees awarded, which drops year by year (in the year 2000, about 500,000 such degrees in North America, versus 850,000 in Europe, including Russia, and 1,200,000 in Asian universities). We are not investing enough in basic research, and we are not investing enough in people. The poor state of mathematics and science education in our schools is strongly related. This puts our nation in jeopardy.

The country needs to resolve to act more purposefully and more boldly on its science and technology agenda. A structural impediment is the fact that expenditures and investments in the federal household are lumped together into the same cash budget, with outlays exceeding income by a vast amount. No business could operate on a pure yearly cash basis, neglecting investments which affect business year after year, let alone generation after

generation. There is no way to balance the federal budget by squeezing investments in our scientific future.

Our investments in basic research, as well as mathematics and science education, need to increase at a high rate. This is not news to Congress and the president, as exemplified in Public Law 107-368 (December 2002), aka the "NSF doubling bill", authorizing a doubling of NSF appropriations over the five-year period from 2003 to 2007. But the appropriation process systematically crowds out investments in our future by paying attention to more immediate needs. The NSF budget request for FY 2006 is close to \$3 billion below this authorized target.

What about the mathematical sciences? Funding research in the mathematical sciences has fared relatively well at the NSF over the last few years, but not so at other federal agencies supporting science. But even the NSF's support of the mathematical sciences as a priority area is faltering in the budget request for FY 2006. It contains language about the mathematical sciences being a priority area, but not a single additional dollar is requested for the DMS above the FY 2005 level. This is a good intervention opportunity for the mathematical sciences community to raise its voice. Ask the NSF leadership and your congressional representatives to support an increase in funding for the DMS, currently budgeted at \$200 million (the exact figure is \$200.38 million). Ask your provost, chancellor, or president for help with this specific request. If your letter is addressed to Congress, ask first and foremost for a FY 2006 budget for the NSF of \$6.1 billion. What about the longer term? While the mathematical sciences are generally understood to be critical for progress in science and technology, funding for the mathematical sciences will keep pace with expanding needs only if the trend in federal funding of basic research takes a dramatic turn for the better.

What is needed? The federal research budget is the most important investment in continued American scientific and economic leadership. A threefold investment in the NSF's portfolio is a target to aim at. The current success rate for NSF proposals is drifting toward a low 20 percent, and an incredible amount of first-class research is left unfunded. Many mathematics and science education innovations are not tested in pilot programs for future widespread implementation in our faltering public schools. This ultimately means an underinvestment in the development of our scientific work force at the very time when a soon-to-retire scientific work force is going to have to be replaced. At the same time, it is a fantastic opportunity to involve the increasingly diverse population in this national effort and requires a massive national effort in mathematics and science education.

—Philippe Tondeur
Professor Emeritus of Mathematics
University of Illinois, Urbana-Champaign
Director, Division of Mathematical Sciences
National Science Foundation, 1999–2002

A Connected Department

The interesting article by Jerrold Grossman ("Patterns of research in mathematics") prompted me to discover that I work in a connected department (<http://www.mth.uea.ac.uk/~h720/connected.pdf>). What makes this a little surprising is that we cover research areas from model theory to oceanography, and we remain connected without the Erdős vertex.

—Tom Ward
University of East Anglia
T.Ward@uea.ac.uk
(Received January 31, 2005)

Consequences of Excluding Religious Comments in Obituaries

In reference to the letter of P. Neval, *Notices* AMS, February 2005, if you want to exclude politics, then please also exclude this type of letter. If a writer of obituaries cannot say "God gave her an easy death," then you had better exclude any sympathy or fellow feeling and resign yourself to the ice age of Neval's kind of childish, ill-tempered political correctness. That would be a pity.

—Henry McKean
Courant Institute of Mathematical
Sciences, New York University
mckean@cims.nyu.edu
(Received February 7, 2005)

Review of The Golden Ratio

It is unfortunate that the editors of the *Notices* chose to allocate four full pages to a biased and self-serving "review" of a book intended for a lay audience. Rather than presenting an overview of Mario Livio's 304-page book *The Golden Ratio* (*Notices*, March 2005), together with thoughtful commentary, George Markowsky seemed more intent on promoting his own 1992 College Mathematics Journal article "Misconceptions about the Golden Ratio". Much of the review focuses on repeated claims that Livio did not sufficiently acknowledge that article: [Livio] "closely parallels my paper but does not cite the paper either in the text or in the notes to the text", "does not reference my paper", "does not quote my conclusion", "follows my paper closely without giving any attribution", "no citations are given to my work", etc. Markowsky finally admits, in the penultimate paragraph, that "Livio is aware of my paper and quotes it in

various places, [but] it is not even mentioned in the notes for" Chapter 3. Apparently, one of Markowsky's main complaints is that his CMJ paper was simply not cited often enough—of course, his review compensated for that with more than a dozen references to his own paper.

The fault is not with Dr. Markowsky, who is certainly entitled to his opinion. Rather, the blame for publishing such an unfair review lies squarely with the editors. They should have questioned the objectivity of such an obviously malicious review that accuses the book's author of doing "a disservice to mathematics" and of "sloppy scholarship", and says that the author "seems interested in spawning some new myths", makes "dubious claims", cites a "ridiculous formula", and "repeats a lot of nonsense". *The Golden Ratio* won Livio the 2003 Italian "Peano Prize" (<http://www.dm.unito.it/mathesis/ppeano2003.html>), and the 2004 "International Pythagoras Prize" (<http://143.225.237.3/News/Premio%20internazionale%20Pytagora.htm>) for the best book on mathematics (the same year Andrew Wiles won the IPP for mathematical achievement), and the *Notices'* readers should know that Livio's book has been extremely successful in bringing some of the beauty of mathematics to the masses. Even the 2003 paperback edition carried praise of "wonderful" by Roger Penrose, "eloquent" by *Newsweek*, and "Mysterious, beautiful...a truly splendid text" by the *Los Angeles Times*. Markowsky's biased analysis is certainly not up to the standards expected by readers of the *Notices*. The editors should publish an apology to Livio, and to AMS members, for presenting such an unbalanced review.

—Theodore P. Hill
Georgia Institute of Technology
hill@math.gatech.edu
(Received March 18, 2005)

Reply to Hill

It is a serious disservice to mathematics to continue to peddle discredited stories about the golden ratio. Certainly, we can find material to interest lay audiences in mathematics that is based on fact. If authors wish to use fiction to interest people in mathematics, e.g., *Flatland*, they should label it as such. Interestingly enough, Hill does not directly address the points raised in my

review, but directs a lot of sound and fury at the *Notices* for publishing such a review. The references to my paper provide the reader an opportunity to investigate the claims made in the review. If there are many references, it is because there were many errors that needed to be addressed. Readers should check the references provided and review the points and decide for themselves whether the review is biased. All mathematics books, even ones intended for lay audiences, should be accurate and conform to accepted standards of scholarship. It is time for the mathematics community to retire the golden ratio mumbo-jumbo from mathematical writing.

—George Markowsky
University of Maine
markov@maine.edu
(Received April 1, 2005)

Foreign-Born Presidents

In the Allyn Jackson interview with James Arthur (*Notices*, March 2005), the fifty-eighth president of the AMS mentioned two other Canadians who also served as president: Cathleen Morawetz and Irving Kaplansky. I might point out that Simon Newcomb, the fourth president of the Society, was born in Nova Scotia. Arthur is correct in his belief that he is the first AMS president to live outside the U.S. at the time of his election. His conviction applies not only to the other three Canadians but to presidents born in Russia (F. Browder, S. Lefschetz, and O. Zariski), England (E. W. Brown and F. Morley), Hungary (J. von Neumann and P. Lax), Germany (M. Artin and R. Brauer), Latvia (L. Bers), Poland (N. Jacobson), and Sweden (E. Hille). This list illustrates the fact that the AMS has been an international enterprise for most of its existence.

—David E. Zitarelli
Temple University
zit@temple.edu
(Received March 27, 2005)

Weil's Letter to His Sister

Although the *Notices* does not normally reprint material that has been published elsewhere in English, I was glad to see that an exception was made for Martin Krieger's translation of André Weil's March 1940 letter to his sister, Simone (*Notices*, March 2005). Three matters

about this letter strike me as deserving comment.

The first is that although the body of the letter is mathematical and may not seem to be of great interest to people far removed from algebra, the postscript, occupying page 341, is of immediate general interest. It makes at least four points. The first point is that Weil's letter is a reply to a specific question from his sister: How does a mathematician develop a research program? One must remember that the sister was a famous philosopher and that her interest in this question was likely professional as well as personal. Thus Weil's answer has to be regarded as a really serious attempt to answer the question well. A second point is an acknowledgement by Weil that E. Artin and H. Hasse understood well the analogy discussed at length in the letter. A third point is his view of the purpose of the writing by Bourbaki: that its intention was to "mass the troops," so as to keep them from "paying insufficient attention to each other and so waste their time." In other words, Bourbaki was presenting a body of mathematics that it regarded as the base for the most important and potentially most fruitful directions for future research; there was no claim that Bourbaki books were to be used as textbooks or were to be taken as models of good exposition. A fourth point is a statement that funding agencies in governments around the world would be wise to note: "[I]t is not possible to have someone who can master enough of both mathematics and physics at the same time to control their development alternatively or simultaneously; all attempts at 'planning' become grotesque and it is necessary to leave it to chance and to the specialists."

Krieger does not mention in his short *Notices* article but does say in his book *Doing Mathematics* that in 1960 Weil published a shorter but more pointed version of the discussion of the analogy that was central to the March 1940 letter. The 1960 paper, entitled "De la métaphysique aux mathématiques", appeared in a now defunct journal, *Sciences*, and it can be found in Volume II of Weil's *Collected Papers*. It was this paper that explicitly referred to the hunt for a Rosetta Stone.

To my mind an even clearer discussion of the analogy and the hunt for a Rosetta Stone appears in a preprint, "André Weil", I received from Armand

Borel on October 23, 2000. Almost half of this preprint is devoted to interpreting Weil's "De la métaphysique". I have misplaced the correspondence that indicates where Borel's paper was to be published, but the place is not in anything currently listed in MathSciNet with him as author. So that anyone can view it, I have placed the preprint on my Web page at <http://www.math.sunysb.edu/~aknapp/BorelOnWeil.pdf>.

—Anthony W. Knapp
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(Received April 14, 2005)

High-Stakes Testing

If you wish to be really depressed about the state of American school mathematics education, then Frank Quinn's "Opinion" piece in the April *Notices* should be just the thing for you. He describes "high-stakes K-12 tests" as an "abomination" and gives some of the reasons for hating them. (Missing from these, however, is that their encouragement of direct instruction and discouragement of teacher initiative is sure to exacerbate even further the problem of recruiting highly competent teachers to teach elementary and high school mathematics.)

The depressing thing about Quinn's editorial is that he also calls such high-stakes tests "necessary" and says that such things as falling high school skills and embarrassing international rankings will not "change without high-stakes tests to provide discipline and accountability." Well, no one, I suppose, is against "discipline" or "accountability", but the discipline supplied by these tests is of just the wrong, least-common-denominator kind. And to expect useful accountability from high-stakes tests is to discard all the experience of pre-21st century schooling, when teachers provided accountability where it is really needed—directly to the parents of pupils.

Probably Quinn calls such tests necessary because they are mandated by the No Child Left Behind (NCLB) Act of 2002. Sadly, it will be a considerable number of years before it becomes clear that NCLB is the most destructive education act ever passed by the U.S. Congress. If research mathematicians accept that NCLB is here to stay rather than fighting tooth and nail to repeal it, they will, once again, have shown that they

understand little about precollege mathematics.

—Anthony Ralston
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(Received April 15, 2005)

Reply to Ralston

In my article I tried to present both sides of the argument forcefully enough to suggest that neither is completely wrong and that both sides still have roles to play as we go forward. Personally I dislike test-driven education: I wasn't taught that way, wouldn't want to learn that way, and don't want to teach that way. On the other hand, the status quo really is unacceptable, and the anti-test community has been unable to find a realistic way to fix it. My personal ideal, for instance, would include a tax increase for higher teacher salaries, but pigs will fly before this happens. In any case, this battle is over, and tests have been chosen as the way to address the problem.

I believe Ralston is correct that the NCLB Act will be a disaster if implemented using current tests. It seems remotely possible that better tests might actually work. Ironically, it seems that improving the tests will be up to the people who would rather not have tests at all: advocates tend to think "a test is a test" and are not sensitive to the damage potential of bad tests. So I earnestly entreat those inclined to "fight tooth and nail" against tests to consider instead fighting tooth and nail in a battle not yet lost: against *bad* tests. This is harder of course—grey rather than black-and-white, subtle, and hard work. Those unwilling to help might at least be tolerant of people who agree philosophically but feel obligated to do *something* to try to mitigate the disaster.

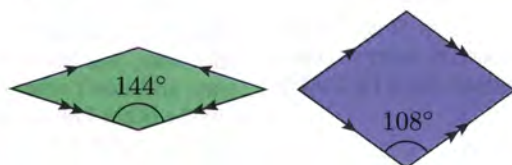
Finally, this is a task that needs research mathematicians. "Good" and "bad" tests differ in content, not format. Implementing this requires sophisticated understanding of mathematical structure and how it builds over the curriculum, and the nature and roles of abstract and symbolic thinking. The same systemic failure that brought us testing also suggests that the professional educational community is not up to this task.

—Frank Quinn
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Up and Down the Tiles

David Austin

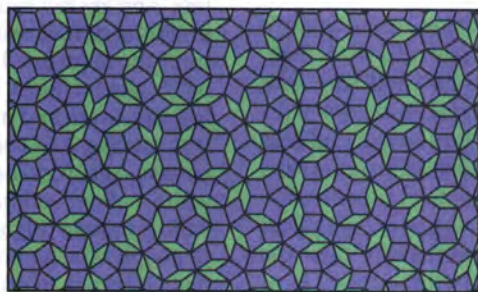
United States Patent 4,133,152, filed in 1975 by Roger Penrose, describes a game played with two rhombs



and asserts that with them

...one can play a form of solitaire. A large supply of pieces is presented.... One may simply play with the pieces and cover as large an area as possible [matching the arrows on the edges of adjacent rhombs], producing many intriguing and ever-varying patterns in the process. [8]

That is, the object of the game is to construct an arbitrarily large—ideally, indefinitely extensible—tiling of the playing area.



Playing this game (see [9], for example) requires some thought. For example, we may begin with the colored tiles shown below, but unless we next lay down the gray tiles, our configuration cannot be extended indefinitely. Using only local techniques,



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such as matching the arrows, will often lead to patterns with no extension (see [6]).

De Bruijn [1] described an ingenious method for constructing Penrose tilings by working with half-rhomb.



Write $A \uparrow B'$ to indicate that A and B' are joined across an edge with a single arrow. Across an arrowed edge on a half-rhomb, only two possible half-rhomb may be joined.

Begin laying down half-rhomb like this:



Start with B' .



Add a $B' \uparrow B$ connection.



Next comes $B \uparrow A$, since may not be extended.



Add $A \uparrow B'$, since may not be extended.



Complete the half-rhomb B' by adding B .

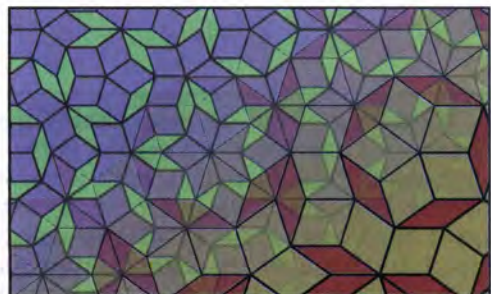


Add A' to form a thick rhomb whose linear dimensions are scaled by the golden ratio $\tau = (1 + \sqrt{5})/2$.

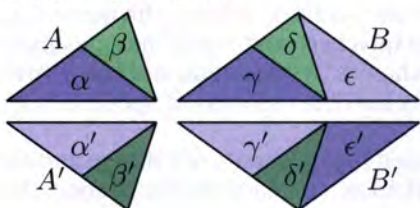
Beginning instead with $B' \uparrow A$ leads to a thin rhomb scaled by τ .



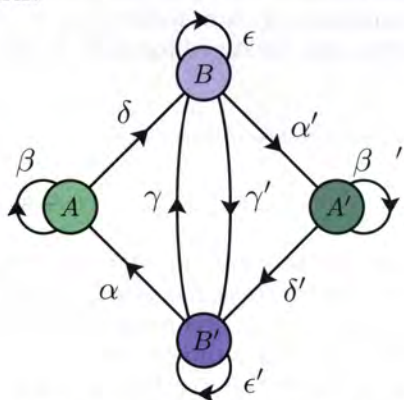
In fact, every half-rhomb in a tiling fits uniquely into one of these two chains, and so the half-rhombs may be grouped in exactly one way to form a second tiling, called the *inflated* tiling, constructed with rhombs scaled by τ .



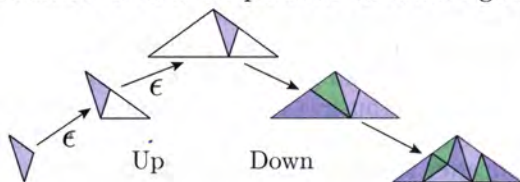
The inflated half-rhombs are uniquely composed of the original half-rhombs.



A directed graph, whose nodes correspond to half-rhombs, results. A directed edge records the containment of one half-rhomb in the inflated version of another.



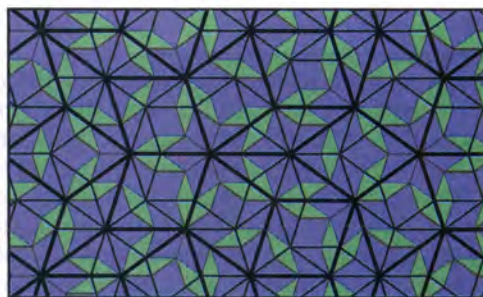
Through the process de Bruijn calls *updown generation*, an infinite path in the directed graph produces, with a few exceptions, a tiling. To illustrate, the figure below, which appears in [7], shows how the finite path $\epsilon \cdot \epsilon$ extends the half-rhomb at the lower left into the patch at the lower right.



Each new edge added to the path gives a way to continue playing Penrose's game.

Also, two paths define the same tiling precisely when they agree beyond some point, so the number of different Penrose tilings is uncountable.

Inflation, first described in Gardner's remarkable article [2], is crucial for understanding Penrose tilings. There is an infinite hierarchy of tilings, in which each tiling is the inflated tiling of its predecessor.



A translational symmetry of a tiling would also be a symmetry of the inflated tiling and hence of every tiling in the hierarchy. As the size of the tiles grows exponentially, however, this is not possible, and so Penrose tilings admit no translational symmetries. The inflation hierarchy, however, does create a sense of order that explains the diffraction patterns of so-called quasicrystals first created in laboratories a few years after Penrose's discovery (see [7]). Penrose tilings have also been used to make thicker, softer toilet paper [4].

References

Penrose's discovery is described in Gardner [2] and Penrose [5], and Grünbaum and Shephard [3] present the original work of Penrose, Conway, and Ammann. Much of what is known about rhomb tilings is due to de Bruijn.

- [1] N. G. DE BRUIJN, Updown generation of Penrose tilings, *Indag. Math. (N. S.)* **1** (2) (1990), 201–219.
- [2] M. GARDNER, Extraordinary nonperiodic tiling that enriches the theory of tiles, *Sci. Amer.* (January 1977), 110–121.
- [3] B. GRÜNBAUM and G. C. SHEPHARD, *Tilings and Patterns*, W. H. Freeman, New York, 1987.
- [4] S. MIRSKY, The emperor's new toilet paper, *Sci. Amer.* (July 1997), 24.
- [5] R. PENROSE, Pentaplexity, *Eureka* **39** (1978), 16–22.
- [6] —, Tilings and quasicrystals: a nonlocal growth problem?, in *Introduction to the Mathematics of Quasicrystals* (Marko Jarić, ed.), Academic Press, 1989, pp. 53–80.
- [7] M. SENECHAL, *Quasicrystals and Geometry*, Cambridge University Press, Cambridge, UK, 1995.
- [8] U. S. Patent and Trademark Office, <http://patft.uspto.gov/netahtml/srchnum.htm>, search for patent 4,133,152.
- [9] <http://merganser.math.gvsu.edu/david/penrose>.

Interview with Martin Gardner

Martin Gardner occupies a unique position in the mathematical world. The author of the "Mathematical Games" column that ran for twenty-five years in *Scientific American* magazine, he opened the eyes of the general public to the beauty and fascination of mathematics and inspired many to go on to make the subject their life's work. His column was the place where several important mathematical notions, such as Conway's Game of Life and Penrose tiles, first became widely known. It was also a place where the sheer fun of mathematical games and puzzles was celebrated and savored. His crystalline prose, always enlightening, never pedantic, set a new standard for high quality mathematical popularization. In 1987 he received the AMS Steele Prize for Mathematical Exposition "for his many books and articles on mathematics and particularly for his column 'Mathematical Games' in *Scientific American*."

In addition to writing about mathematics, Gardner has also been a prominent debunker of pseudoscience, starting with his very first book, originally published in 1952, *Fads and Fallacies in the Name of Science*. His many magazine articles and book collections have performed a public service by exposing quackery and fraud that masquerade as science. His lifelong interest in magic—he was once among the top "card mechanics" in the nation and has written technical manuals for professional magicians—has brought him special insights into the methods of spoon-benders and other hucksters who claim their feats have a psychic basis.

Martin Gardner was born October 21, 1914, in Tulsa, Oklahoma. He attended the University of Chicago and earned a bachelor's degree in philosophy in 1936. After four years in the Navy, he worked as a freelance writer of short stories in Chicago. In the mid-1940s he moved to New York City, and for eight years he wrote for *Humpty Dumpty*, a children's magazine. He began his *Scientific American* column in 1957. In the early 1990s he retired to Hendersonville, North Carolina, from where he continued his prolific writing career. A man of wide interests, Gardner is the author of over fifty books, including a novel, *The Flight of Peter Fromm*, and works on philosophy and literature. In 2002 he moved to Norman, Oklahoma, the home base of the University of Oklahoma, where his son, James Gardner, is a professor of education.

What follows is the edited text of an interview with Martin Gardner conducted in November 2004 by *Notices* senior writer and deputy editor Allyn Jackson. Also present were James Gardner and *Notices* editor Andy Magid. Their help with the interview is gratefully acknowledged.

—A.J.

Notices: Was there someone in your early life who inspired you in math and science?

Gardner: Yes, I had a physics teacher named M. E. Hurst, and he was my most inspiring high school teacher. I got to know him fairly well. I dedicated one of my books to him. He got me interested in physics. Actually, I hoped to become a physicist, and I wanted to go to Caltech, where Millikan was chief physicist. Caltech wouldn't take you until you had at least two years at a liberal arts college. So I went to the University of Chicago and got hooked on philosophy of science. I abandoned my plans to become a physicist. I didn't get any degree higher than bachelor's.

Notices: You also had an interest in magic from an early age. How did that develop?

Gardner: My father was not a magician, but he knew a few magic tricks that he showed me as a

small boy, and that got me interested. Then I got acquainted with a Tulsa magician, and I discovered the magic periodicals and magic shops. I'm not a performer. The only time I came close to performing was when I was in college in Chicago. I used to work Christmas season at Marshall Field's department store, demonstrating magic sets. That's the closest I ever came to getting paid for doing any magic. It's been a lifelong hobby. I particularly like magic tricks that are based on violating topological laws. I've done a number of books for the magic trade. They sell in magic stores.

Notices: Your father was a petroleum geologist.

Gardner: My dad got a Ph.D. in geology, and at that time the oil business was just getting started. So we moved to Tulsa, and he became what they called a wildcatter. He had a small oil production company

that consisted of himself, an accountant, and a secretary. He would go out and look for what they call domes—oil accumulates under limestone domes. He would hire some drillers to drill for oil, and occasionally he would hit and most of the time wouldn't. That's what he did for a living. He contributed occasionally to geological journals.

Notices: *And what about your mother?*

Gardner: She was a kindergarten teacher in Lexington. They met at the University of Kentucky. But she was mainly a housewife.

Heroes of Philosophy

Notices: *Rudolph Carnap was one of your teachers at Chicago.*

Gardner: Yes, he is one of my heroes. I took a seminar from him under the GI bill after I got out of the Navy. It was not when I was an undergraduate. That was the only graduate course I ever took. It was on the philosophy of science, and it had a big influence on me. Later, when Carnap was giving the course in California, I persuaded him to have his wife tape record it. She typed it up and sent me the typed version. I edited it into a book called *Introduction to the Philosophy of Science*. That was the only popular book that Carnap ever did. All I did was edit it into language an average person could understand without knowing any math.

Notices: *What was it about his approach to philosophy that attracted you?*

Gardner: He was in the logical positivist school. The essence of logical positivism is that a philosophical statement is totally meaningless unless you can prove it logically or find some empirical evidence for it. From his point of view, all metaphysical statements are totally meaningless in the cognitive sense. They can have an emotional meaning, but that doesn't prove that they are true. It just means that you want to believe them.

Once Bertrand Russell came to the University of Chicago to give a series of seminars, and Carnap attended them. I attended one in which they got into a big discussion about whether their wives existed or not. Carnap is inclined not to call himself a realist. The only reason he recommends the realistic language is that he thinks that's the most efficient language for science. Of course, Russell is a dyed-in-the-wool realist who thinks the universe exists whether anybody observes it or not. So Russell kept turning the argument into a question of whether they had a right to say their wives really existed outside of their own experience. The next day I was in the University of Chicago post office building to pick up some mail, and I saw Professor Hartshorne, from whom I was taking some courses. He asked, "Were you at Russell's seminar yesterday? How did it go?" I said, "Well, Russell tried to convince Carnap that his wife existed, but Carnap wouldn't admit it." And who should walk in



Figure 1. This original of Escher's *Circle Limit* hangs in Martin Gardner's home.

except Carnap! To my great embarrassment Hartshorne said, "Mr. Gardner here attended your seminar last night, and he said you wouldn't admit that your wife existed." Carnap didn't smile at all, he just glowered down at me—he was a very tall fellow—and he said, "Well, that was not the point at all." What exactly the point was, I am not quite sure! This ends on a very tragic note. It was some time later that Carnap's wife committed suicide. She hanged herself. I have no idea why. I know about it only because there was a piece in California newspapers about it. I never asked Carnap about it.

Bertrand Russell is another one of my heroes.

Notices: *Did you meet Russell at that seminar?*

Gardner: No, I never met him personally.

I was at Chicago during the famous Hutchins-Adler period. Mortimer Adler came from an orthodox Jewish background and became fascinated by Catholicism, and he almost joined the Catholic church. Half a dozen or more students of Adler's at Chicago became Catholics as a result of taking courses from him. I never liked Adler. I took one course, a Great Books course he taught with Hutchins. I wrote a letter to the *New Republic*—it was published—saying that readers should all pray for Adler's conversion to the Catholic church, because that would clear the air, and we would know exactly what he believed. I have a very rare document, a speech that Adler gave at Northwestern University, and incredible as it may seem, he argued that, if the Catholic church is a true church, it had



Figure 2. These hexaflexagons, some of them handmade, were collected by Martin Gardner after his column on the subject appeared in *Scientific American*. They are kept, together with all of his files from his writing career, in the Martin Gardner archive at Stanford University.

a right to execute heretics. Can you imagine somebody in this day and age saying that the church had a right to execute heretics? That's in this lecture. Adler of course is very much ashamed of it. But the punch line is that, shortly before he died, Adler joined the Catholic church. So it took about half a century for the prayers of the *New Republic* readers to be answered.

Notices: You wrote that letter at the time you were at Chicago?

Gardner: Yes, I was an undergraduate. Adler was a character. He had a tremendous ego. He edited the *Encyclopedia Britannica*. If you look through the first volume, which has general articles, you will find very short articles on Bertrand Russell, no article on Carnap, a very short article on Quine—and when you turn to Adler, a big, long article of several columns! But the

university was an exciting place partly because Adler aroused so much animosity among the faculty and among the students. This led somebody to propose the “Madman Theory of Education”, which says that every university should have a madman on the faculty who gets the students all riled up in opposing his views. There was also a joke going around at the time that the University of Chicago was a Baptist school where Jewish professors were teaching Catholic theology.

Notices: You didn't take any math or science when you were there?

Gardner: The university had what they called the “New Plan”, and everybody had to take survey courses. There were four survey courses, and one of them was called Physical Science, and you had to take that. That was the closest I came to taking a science course, aside from a geology class that I audited. But I didn't take any math. My knowledge of math is at a very low level. I go up to calculus, and beyond that I don't understand any of the papers that are being written. I consider that that was an advantage for the type of column I was doing for *Scientific American*, because I had to understand what I was writing about, and that enabled me to write in such a way that an average reader could understand what I was saying. If you are writing

popularly about math, I think it's good not to know too much math.

Launching a Writing Career

Notices: When did you decide you wanted to become a writer?

Gardner: While I was a student at the University of Chicago. I was doing occasional pieces for little magazines that didn't pay anything. Before World War II, I was working in the public relations office of the University of Chicago, mainly writing science releases. When I got out of the service, I could have gotten that job back. At that time I made my first sale. It was a short story for *Esquire* magazine, and I actually got paid for it. That was when I decided I was going to try to freelance. I followed that story with a science fiction story about topology called “The No-Sided Professor”. It's about a mathematician who was a student of the properties of the Möbius strip. You take a strip of paper and twist it and glue the ends together. It loses one of its sides and becomes a one-sided surface. So I imagined that the professor had found a way to fold a piece of paper so that it lost both sides and became a no-sided surface and just vanished with a little “pop”. So that was the beginning of my “No-Sided Professor”. For about a year I lived on sales to *Esquire* magazine—all fiction.

Notices: Then you moved to New York. When was that?

Gardner: It was 1944 or 1945.

Notices: You went to make your living as a writer in New York.

Gardner: That's right, New York's where all the action is. I married a New York girl. I couldn't make a living freelancing. *Esquire* had moved from Chicago to New York and had a new editor, and the new editor didn't care for the type of story that I was selling. So my market with *Esquire* dropped off. I got a job with *Humpty Dumpty* magazine, a children's magazine. That was how I managed to exist. I worked at home and wrote activity features, a short story for every issue about the adventures of Humpty Dumpty Jr., and a poem of moral advice from Humpty to his son. I did that for eight years. I stopped doing it after I began selling to *Scientific American*.

Notices: How did it come about that you started writing for *Scientific American*?

Gardner: I was interested in the topic of mechanical devices that solve logic problems. I sold *Scientific American* an article on the history of logic machines. These are mechanical devices that solve problems in elementary logic. This was before the days of computers, of course, which now can do it much more efficiently. With the article they included a pasteboard sheet that was bound into the magazine, and the sheet contained pictures of cards that had windows in them. You could cut the

cards out and cut open the windows. Then you could pick out cards for the two premises of a syllogism and put them on another card. Through the windows you could see the conclusion of the syllogism. They asked me if I had any more articles similar to that one. The second article I sold them was on hexaflexagons. They had been invented by a group of graduate students at Princeton, including, of all people, Richard Feynman.

Notices: *How did you find out about hexaflexagons?*

Gardner: From my magic contacts, believe it or not. There was a stockbroker in New York City named Royal Heath, who was a magic buff. I was in his apartment one day, and he showed me a large hexaflexagon made of cloth. I had never seen one before. He told me that the group at Princeton had invented it. So I saw the possibility of an article, and I made a trip to Princeton. I interviewed John Tukey, one of the coinventors. He became a very famous mathematician much later. That article ran in *Scientific American* in December 1956. Gerry Piel, who was the publisher, called me in to his office and said, "Is there enough similar material to this to make a regular feature?" And I said I thought so. The next issue was the first of the columns, the January 1957 issue. I resigned from *Humpty Dumpty* and rushed around the old book sections of New York to pick up all the math books I could find that had recreational material.

Notices: *There was a big response to the hexaflexagon article, wasn't there?*

Gardner: Yes, it caught on. All over New York, and especially in advertising, people were folding hexaflexagons! During the first year after the article, a lot of advertising premiums came on the market that were paper hexaflexagons with space for an advertisement.

Notices: *This group of magicians you knew in New York—can you tell us about them?*

Gardner: I got acquainted with a lot of famous magicians. I was doing pamphlets for the profession with material that they provided. I lived in Chicago for fifteen years, and I first got acquainted with professional magicians there. They would meet every week at a roundtable. It included a lot of famous performers—the names would mean nothing now, though. Magic has become a TV spectacular, with David Copperfield and his rivals spending millions of dollars on equipment for their shows. But in those days the magicians worked night clubs. My interest is in what they call close-up magic, which you do close-up, rather than on the stage.

Notices: *In New York you met Persi Diaconis in this circle of magicians. How old was he when you met him?*

Gardner: I think he was a late teenager. He was a professional card shark, or a card mechanic, as

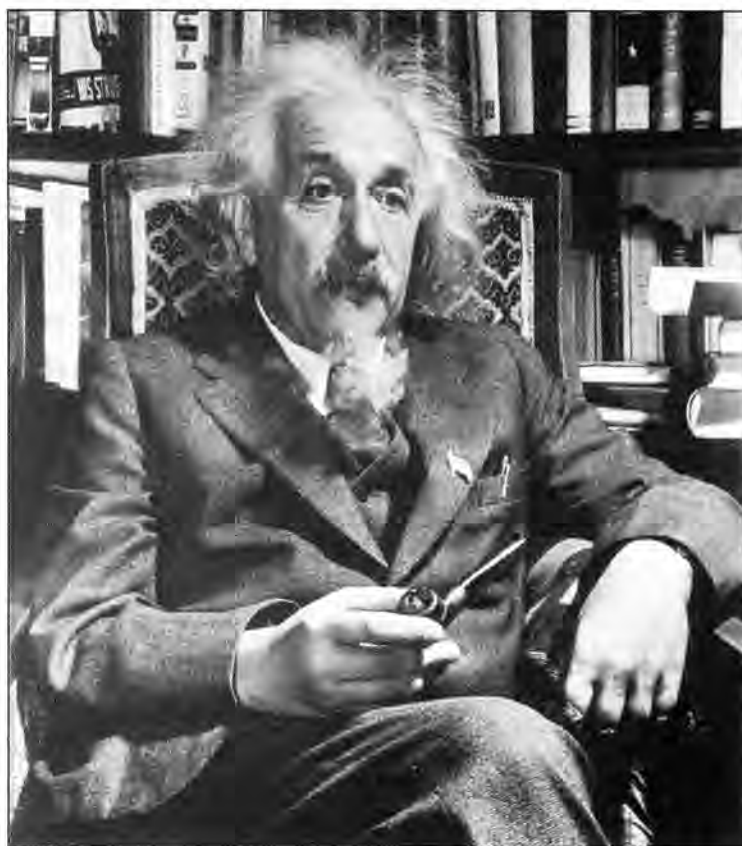


Figure 3. This large-as-life portrait of Albert Einstein was taken by a friend of Martin Gardner's and hangs in Gardner's home.

they call it in the trade. He worked ships between New York and South America. Of course, nobody suspected him of being skillful with cards because he was just a teenager. He was a student at City University of New York, and he paid his way through the university with the money that he got from poker games on ships. At that time Persi was very anxious to get into Harvard. The head of the statistics department at Harvard was Frederick Mosteller, who is a magic buff. He was very active in magic, and his picture has been on the cover of magic magazines. I knew Mosteller slightly, so I wrote him a letter and said, "This young student is one of the best card mechanics in the country. He does a fantastic second deal and bottom deal." (Those are terms for fake deals. When you are dealing from a deck, there is a way to deal the second card instead of the top card, and there is a way to deal the bottom card instead of the top card.) I got back a letter right away from Mosteller, which said, "If he's willing to major in statistics, I can get him into Harvard." So I asked Persi if he was willing to major in statistics, and he said, "Of course!" So he got in, got his Ph.D. in statistics, and is now at Stanford.

By the way, I gave all my math books and math files to Stanford, at the request of Donald Knuth. His *Art of Computer Programming* is filled with

recreational material. One time he wanted to get access to my files and asked if he could visit me when I was living in Hendersonville. He came and stayed a week. I had rented an apartment just to contain my books and files. Knuth stayed in the apartment. It had a kitchen, so he cooked his own meals, and on Sunday he walked to a nearby Lutheran church. He pulled out from my files a stack of papers about this high, which I photocopied for him. Now my files are being indexed by someone at Stanford.

For every column I did there may be four or five folders containing research and notes that I took. I subscribed to seven or eight math journals that had recreational material, and I would clip articles and file them in appropriate folders.

When the column started, the math was on a pretty low level. It slowly got a little more technical, partly because I was learning math myself while I was writing the column, and partly because I was getting material from top mathematicians who were interested in recreational math. So the column became much more interesting a few years after it

started, because I was publishing material that hadn't been published before. It was coming from Sol Golomb, John Conway, Ron Graham, and Frank Harary, among others.

One of the frequent contributors was Sol Golomb. In a paper that he had written when he was quite young, he introduced the idea of polyominoes. When I did the column on polyominoes, it was the first introduction to the general public and to mathematicians. That was one of my very successful columns. A lot of mathematicians began experimenting with polyominoes, and especially the pentominoes.

The Game of Life

Notices: *How did you get in contact with Golomb?*

Gardner: I think I had a copy of the paper in which he first named the polyominoes. I think I just wrote to him and got into correspondence with him, and then we became pretty good friends.

One of my most popular columns was based on Conway's Game of Life. During a visit with me, Conway rapidly went over maybe twenty different things that he was working on at the time, and one of them happened to be the Game of Life. He didn't think there was anything special about it. Of the things he told me, I thought that was the most interesting. When I wrote that up, it really caught on. Computer people all over the U.S. were trying to write algorithms for their computers to play the game. There was one fellow I heard about who had a button under his desk at work, so that he would be working on Life configurations on his computer, but if someone in management walked in, he would press the button, and the computer would go back to something related to his job.

Notices: *How was it that out of this list of twenty different things you picked the Game of Life?*

Gardner: Well, I got columns out of some of the other ideas too.

Notices: *But you knew the Game of Life was something special.*

Gardner: That's right. If I had known more about mathematics, I might not have thought that. But I approached it as a sort of a half-layman. I later did a second column on Life, because Conway had offered \$50 to anybody who could create what he called a Glider Gun. That is a configuration that, when you applied the transition rules of Life, would shoot off gliders. It was discovered by Bill Gosper, who at the time was working for Marvin Minsky at MIT in the artificial intelligence program there. The Glider Gun opened up all kinds of possibilities. So I did a second column based on the Glider Gun. It turned out that by using gliders and shooting them down with another gun, you could actually use the Game of Life to do anything you could do on a general purpose computer, which was a surprising

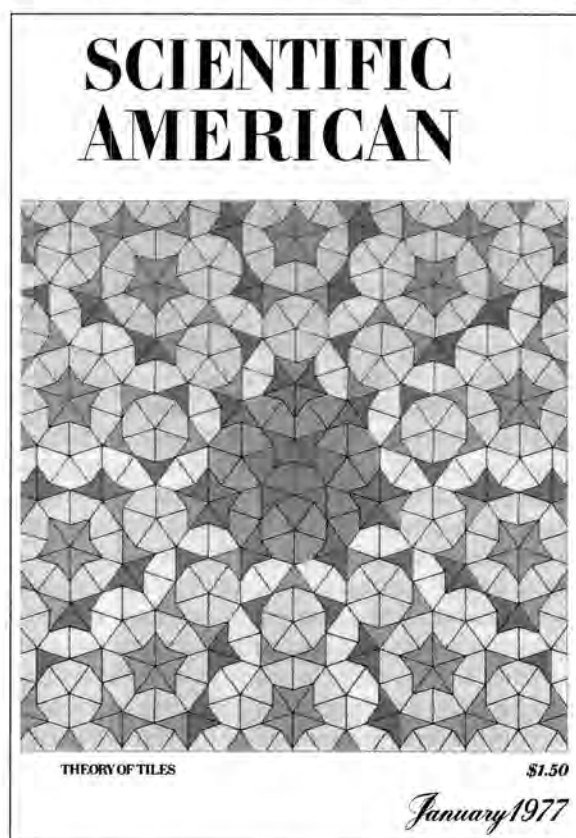


Figure 4. Cover of the January 1977 issue of *Scientific American* that carried a column by Gardner about Penrose tiles. The set of Penrose tiles shown was originally drawn for Martin Gardner by John H. Conway. (Courtesy of *Scientific American*.)

discovery, made by Conway. So the game turned out to be far from trivial.

Notices: *Did Conway tell you how he came up with the specific transition rules in the Game of Life?*

Gardner: All Conway would say is that he experimented with a wide variety of rules and that the rules he finally settled on were the most productive and the most interesting. I got to know Conway fairly well, and he is an authentic genius. His name appears quite often in the column. He sent me marvelous material. I had the great privilege of introducing him to Benoit Mandelbrot. This was when I was still living in New York. Mandelbrot was living in Westchester, not too far away. Conway visited me and stayed maybe several days. I was slightly acquainted with Mandelbrot, so I called him, and he rushed over to meet Conway, because Conway was working on the Penrose tiles. The Penrose tiles have a fractal quality—you can keep magnifying portions of them and you always get the same tiling. So Mandelbrot was quite fascinated by the tiles.

Ciphers, Quantum Mechanics, and the Nature of Reality

Notices: *How did you first find out about the Penrose tiles?*

Gardner: I think Penrose sent me a copy of the piece that he had done on them for a magazine, and I got into correspondence with him and found out more about them. Then Conway got intrigued by them. Actually, most of the pioneer discoveries about the Penrose tiles were made by Conway.

Another column I did was on trapdoor ciphers, and that aroused a lot of controversy. One of the discoverers of the trapdoor cipher, Ron Rivest, came to see me to tell me about it and also to give me materials for a column. The cipher introduced a whole new era in cryptography, because it was an unbreakable code. I had said in the column that if you want to know more about Rivest's trapdoor cipher, he has an unpublished technical paper on it, and he has offered to mail it to anyone who sends him a stamped, self-addressed envelope. Rivest got flooded with thousands of letters. Then the government stepped in and forbade him from mailing out his paper. It was a year or two before the government allowed him to release information on the code. For about a year I got angry letters from people who said, "I followed your advice and I wrote to Rivest and I asked for the paper, and I never heard from him!"

Rivest gave me a short sample written in the code, and he offered a prize to anyone who could crack it. It was many years before somebody cracked this particular message that I had published. It was cracked by a lot of computers working in tandem, running for many, many hours. As a result, Rivest had to revise his code a little bit,

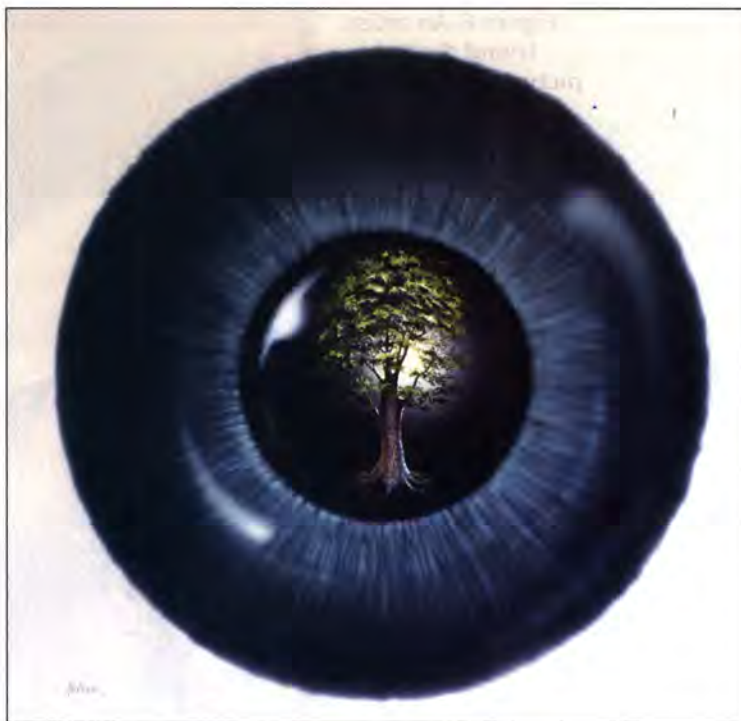


Figure 5. This illustration appeared on the cover of the issue of *Discover* magazine that carried Martin Gardner's article on quantum mechanics, "Quantum Weirdness". A framed version hangs on Gardner's wall.

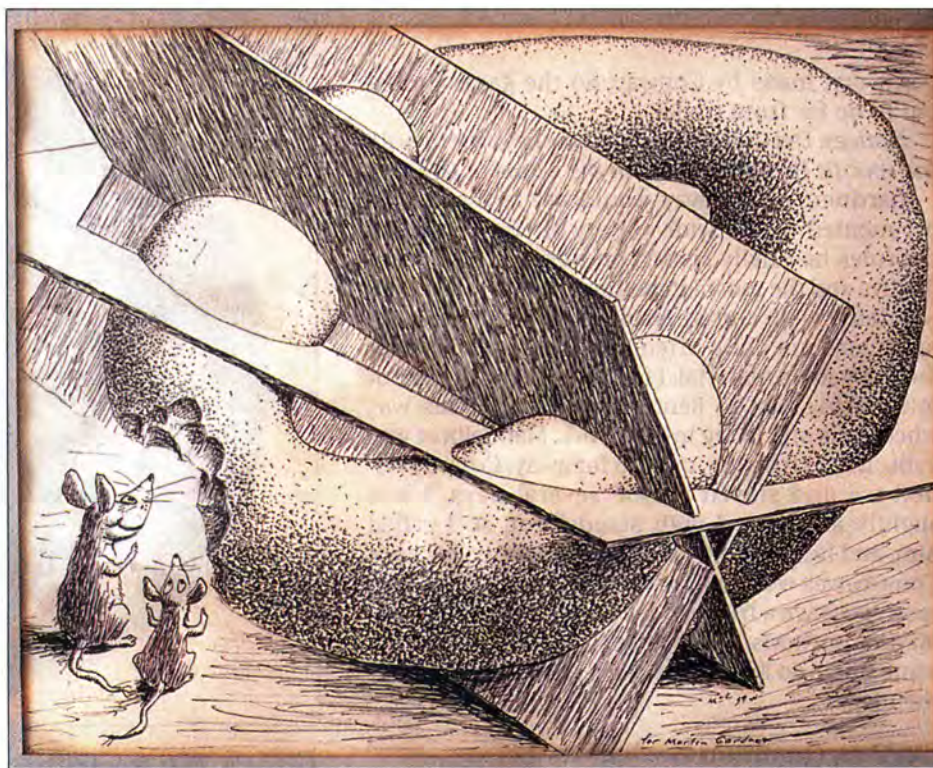
so he used larger primes. The code is based on multiplying two primes together. I think he had to go to a much larger prime to keep the code sound.

Notices: *Have you followed developments in quantum coding?*

Gardner: Yes, I have a very low-level understanding of quantum codes. Apparently it's possible to base a code on quantum mechanics, though I don't know how it's done exactly. If I were younger, I would try to understand quantum mechanics. It's such a fascinating field. An illustration that ran with an article I did for *Discover*, called "Quantum Weirdness", shows an eye looking at a tree, illustrating the question of whether the tree exists if nobody is observing it. Of course, quantum mechanics is tinged with this kind of solipsism, because there is a sense in which an electron doesn't really have any properties until you measure it. There is a subjective aspect to quantum mechanics. Some experts like Eugene Wigner were convinced the universe wouldn't exist if it didn't have observers in it. He argued that, without a conscious mind observing the quantum events, the events don't really exist, which I think is a crazy point of view. But it is defended by a number of quantum mechanics experts. Einstein thought this approach was completely ridiculous. He liked to say, "Does the tree exist if a mouse observes it?" That was one of Einstein's famous rebuttals.

Notices: *So you don't believe in these ideas?*

Figure 6. An artist friend drew this picture for Gardner, illustrating the maximum number of pieces into which a bagel can be sliced by three planes.



Gardner: No, I'm a hardheaded realist. I think the universe exists even if life ceased to exist. Most philosophers of science are realists. Bertrand Russell certainly was. And of course Einstein and his friend Kurt Gödel were devout realists.

Notices: Did you ever get interested in the philosophy of mathematics and the question of the reality of mathematical objects?

Gardner: Yes, I have. I have published a number of pieces defending mathematical realism.

Notices: Have you ever met a mathematician who was not a realist?

Gardner: I have not actually met any, but there are a number of mathematicians who are not realists. Reuben Hersh is a marvelous example of a person who thinks that mathematics is entirely a human product and has no reality outside of human culture. He has written a whole book about this called *What Is Mathematics Really?* To Reuben Hersh, mathematics is no different from art or fashions in clothes. It's a cultural phenomenon. The postmodernists in France have essentially this point of view. And it drives me up the wall. I like to say, "If two dinosaurs met two other dinosaurs in a clearing, there would be four of them even though the animals would be too stupid to know that." Of course, the argument as to whether the universe exists outside of the human mind goes back to the middle ages.

Roger Penrose is a good example of a staunch realist in mathematics. He likes to talk about the Mandelbrot set as an example of something out there, independent of human minds, because as you keep magnifying portions of it and exploring it, you

discover new properties. It's like walking through a jungle and charting the mountains and rivers and so on. Something is out there, independent of your mind. It doesn't have the same kind of reality as sticks and stones, but it has its own peculiar reality. In the new book of Penrose, *The Road to Reality*, he has a whole chapter defending mathematical realism.

I once asked Raymond Smullyan, who is an expert on set theory, if he knew of any experts on set theory who are not realists. He could not think of a one.

Notices: That's an interesting example, of course, because set theorists use things that are really exotic, like inaccessible cardinals.

Gardner: They exist in this peculiar mathematical world of their own. They don't exist the way the Sun exists or the Moon exists. But they exist the way complex numbers exist, for example, or imaginary numbers. They have a peculiar reality.

The last math conference I went to was in some town in North Carolina. It was a conference to honor the mathematician Hermann Weyl. Penrose was speaking, and I went there partly to hear him speak and to meet him. I also went because Ed Witten was talking on superstrings. I understood everything that Penrose said in his lecture, and I didn't understand a single sentence of Witten. Not a single sentence. Superstring theory has been absorbed into membrane theory, or M-theory, as they call it. There is not a scintilla of empirical evidence to support it. Although I have only a partial understanding of M-theory, it strikes me as comparable to Ptolemy's epicycles. It's getting more and

Martin Gardner's Notes on the Illustrations

Some of the illustrations in this article are photographs of artworks owned by Martin Gardner and displayed on the walls in his home. He kindly wrote the following notes about each work.

Figure 1. Maurits Escher's *Circle Limit*, so called because the circle is the limit of an infinite set of smaller and smaller fishes. I devoted a *Scientific American* column to Escher many years before he became famous. I first learned of Escher from pictures in Donald Coxeter's classic *Introduction to Geometry*. Coxeter told me in a letter that Escher still had copies of this picture for sale. I bought it directly from Escher for sixty dollars. Had I anticipated his fame, I could have bought many of his black and white pictures for a paltry sum. The picture is based on Poincaré's model of the hyperbolic plane. The model is used to prove that if Euclidean geometry is consistent, so is hyperbolic geometry.

Figure 3. Einstein. This picture was taken by a college friend, David Eisendrath, a professional photographer in New York City. It ran on the first page of a short-lived newspaper called *PM* that had been funded by Marshall Field. Einstein had just become a U.S. citizen, as indicated by the tiny flag in his lapel. Dave told me that although Einstein was dressed in a business suit and tie, he wore tennis shoes with no socks. The cloud of smoke resembles a goatee.

Figure 5. The eye looking at a tree. This was an illustration for my article "Quantum Weirdness" that ran in *Discover* (October 1982). Quantum theory has a tinge of solipsism in the sense that basic particles have no definite properties until they are measured. A few physicists have argued that the Moon doesn't exist unless it is observed. Einstein, who disliked quantum mechanics, liked to ask: "Observed by a mouse?" Bishop Berkeley claimed that "to be is to be perceived." This prompted Ronald Knox to write a famous limerick:

There once was a man who said: "God
Must think it exceedingly odd
If he finds that this tree
Continues to be
When there's no one about in the Quad."

The answer was supplied by an anonymous author in an equally famous limerick:

Dear Sir, your astonishment's odd,
I am always about in the Quad.
And that's why the tree
Will continue to be
Since observed by yours faithfully, GOD.

Figure 6. The sliced doughnut. In an early *Scientific American* column I asked for the maximum number of pieces into which a torus could be sliced by three planes. An old puzzle concerned slicing a pie or cake with three cuts. I generalized it to a torus. An artist friend, John McClellan, who ran an art store in Woodstock, New York, sent me this picture as a gift. The answer is 13 pieces. The formula for n cuts is $\frac{n^3+3n^2+8n}{6}$.

Figure 7. The domino picture was made by Ken Knowlton, a mathematician who pioneered this technique. He makes similar pictures with other objects such as playing cards, sea shells, etc.

more baroque. Penrose thinks that M-theory is very ingenious and very beautiful but has no relation to physical reality. That's his opinion.

Notices: *Because of the lack of empirical evidence?*

Gardner: Yes. But Penrose has a rival theory that he calls twistor theory. I only partially understand it, but twistors are structures that he thinks are the basic elements of spacetime. The theory is based on earlier work on what are called spinors. I have only a very dim grasp of his twistor theory. He has a big section on it in his latest book, and he has published numerous papers on twistor theory. I noticed that when he discusses twistor theory in this new book, he speaks of efforts that

have been made to combine it with membrane theory. He comes to the conclusion that there is no way they could be combined, and he states flatly that if one is true, then the other has to be false. Now, whether twistor theory has any relevance to the universe, I haven't the foggiest notion. But there is a whole group of mathematicians working on it.

Notices: *So there is no empirical evidence for twistor theory either?*

Gardner: None whatever.

Debunking Pseudoscience

Notices: How have you managed the professional aspects of your writing career? Are you part of a professional author's guild or something like that?

Gardner: I used to be a member of the Author's League, and I finally dropped out of it because it kept getting more and more expensive to be a member, and they weren't really helping me in any special way. I don't have an agent, for example. I finally learned enough about contracts so I could do them on my own. I did have an agent for my first book, *Fads and Fallacies in the Name of Science*. A high school friend of mine was a literary agent. Actually, he persuaded me to do that book. I had done an article for the *Antioch Review* on pseudoscience called "Hermit Scientists". My friend said, "Why don't you expand this into a book?" So he handled the book for me and sold it to Putnam's. It did so poorly with Putnam's that they remaindered it after they sold a few copies! Then it was picked up by Dover, and it became one of Dover's best sellers. There was a nighttime radio program by a man named Long John Neville. He picked up on this book, and for about a year he had on his program cranks who attacked the book. It was the attacks on the Long John Neville show that boosted the sales. It hasn't been out of print since. I have chapters in the book attacking pseudosciences that at the time I wrote the book I would never have expected to survive.

Notices: But some of them have, like Scientology.

Gardner: Yes, I have a chapter on Scientology—in those days it was called Dianetics. It was such a crazy point of view I couldn't imagine that it would last more than a few years. It became a tremendous movement. There are Hollywood stars who are Scientologists. I think L. Ron Hubbard originally thought of it just as a way to make money. But then later on he began to believe it himself.

Notices: How did you get interested in debunking pseudoscience?

Gardner: First I have to talk about my religious background. When I was in high school, I was an evangelical Protestant, due mainly to the influence of a Sunday school teacher I knew. He had a

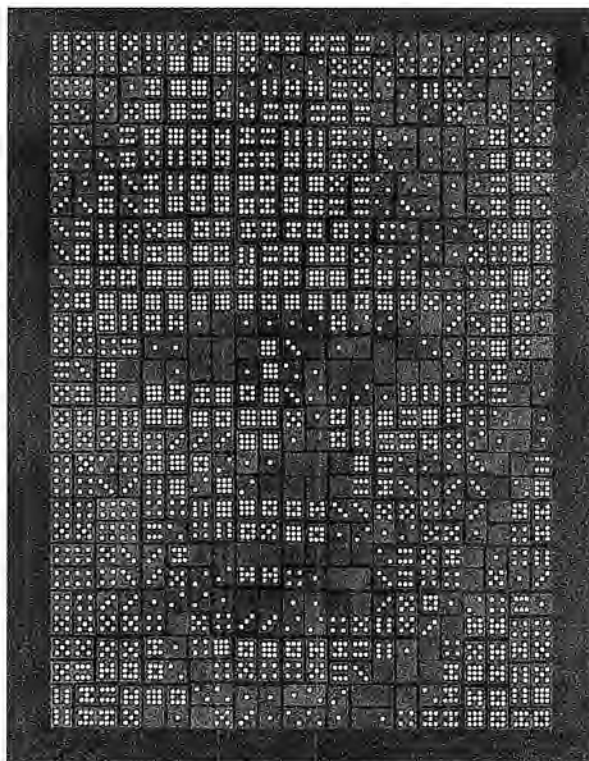


Figure 7. This enigmatic portrait of Martin Gardner is made of dominoes.

wonderful name for an evangelical Christian, George Getgood. He was also a counselor in a summer camp that I attended in Minnesota every year. I went through a temporary phase of considering myself an evangelical Christian. There was a period in which I was doubtful about the theory of evolution, mainly because of reading a crank book called *The New Geology*, by a creationist named George McCready Price. His attack on evolution was fairly sophisticated. He was a Seventh Day Adventist who believed that the fossils were remnants of life that perished at the time of the flood. He argued that the theory of evolution is largely based on the fact that when you

consider the fossils in the different strata, you find very simple forms in the older strata, and then as you get into younger and younger strata, you get more complicated forms. But, he said, this is circular reasoning, because the way they date the beds is by the type of fossils they contain. So his *New Geology* is filled with photographs of places where the fossils are in the wrong order: you find the complicated fossils in the lower beds and the simpler fossils in the higher beds. What he didn't realize is that these "upside-down" fossils are due to folding of the strata or cleavage along a fault line. But if you don't know this fact, his arguments are quite strong. It was not until I took courses in geology at the University of Chicago that I understood where Price went wrong. His book is one of the great crank works of all time. Modern creationists are still citing it and recommending it—sometimes without giving him credit! I think that was the first time that I became interested in pseudoscience. I probably would not have followed it up if my friend had not recommended I do a book about it. Later I got acquainted with the philosopher Paul Kurtz, the magician James Randi, the sociologist Marcello Truzzi, and the psychologist Ray Hyman. We started the Committee for Scientific Investigation of Claims of the Paranormal, or CSICOP, as we called it. I began doing a column in the *Skeptical Inquirer*, and those columns have come out as book collections.

Notices: Have you been present at demonstrations by psychics, like Uri Geller, who bends spoons?

Gardner: I have never actually seen Uri Geller, though I have written two booklets exposing his methods, under the pseudonym of Uriah Fuller. His methods are well known to magicians. The magicians understood what he was doing from the very start.

Notices: *When you wrote those booklets, didn't that break the magician's code of not giving away the secret of the tricks?*

Gardner: Not really, because the things that Uri Geller does are not done by magicians. Magicians would be ashamed to stand up in front of an audience and bend a spoon! It seems too silly. The booklets don't expose anything that magicians do. They just expose what Geller does.

Notices: *So how does he bend a spoon?*

Gardner: He gains access to the spoons before the demonstration. If you take an ordinary spoon, it's easy to bend it. You can bend it back and forth a few times to weaken the metal to the point where if you just stroke the spoon it bends. That's the whole secret of Uri Geller's metal bending—getting to the material in advance and preparing it.

Art and Aesthetics

Notices: *If you had been a mathematician, what area do you think you would have worked in?*

Gardner: Topology fascinates me, because you are dealing with such basic properties.

Notices: *You argue in your book *Whys of a Philosophical Scrivener* that there exist absolute aesthetic standards for art.*

Gardner: Yes, though it's very hard to state what they are. Ed Rinehart made a fortune painting canvases that were just one solid color. He had his black period in which the canvas was totally black. And then he had a blue period in which he was painting the canvas blue. He was exhibited in top shows in New York, and his pictures wound up in museums. I did a column in *Scientific American* on minimal art, and I reproduced one of Ed Rinehart's black paintings. Of course, it was just a solid square of pure black. The publisher insisted on getting permission from the gallery to reproduce it.

Notices: *And they gave it?*

Gardner: They gave it.

Notices: *If there are absolute standards for aesthetics in art, do they also exist in mathematics?*

Gardner: Dirac was a great believer in having beautiful equations. "There is no room in mathematics for ugly mathematics," was, I think, one of his statements. But in physics you can have very beautiful theories that turn out to be totally false. There is a predecessor of string theory called vortex theory, in which all the basic particles were supposed to be knots in the ether. Since there is no friction in the ether, once a little particle would form, it could not lose its shape. I was doing some checking on it, and I ran into statements by top

physicists (including James Maxwell, Lord Kelvin, J. J. Thomson, and Albert Michelson) that this theory is too beautiful not to be true. See Chapter 32 in my *New Ambidextrous Universe*.

Speaking of art, several times I met Salvador Dali in New York. We would have lunch together. He had read my writings about mathematics. He was interested in mathematics in a funny way. Some of his paintings show a reflection in a cylinder or a cone, which is called anamorphic art. He also did paintings that turn into other pictures when you give them a rotation of 90 degrees. He liked to experiment with strange art.

Notices: *What was he like as a person?*

Gardner: He seemed perfectly normal.

Notices: *Really? Even with that mustache!*

Gardner: Yeah, he had that funny mustache. I remember after one lunch, he wanted to go to Brentano's bookstore. We walked down Fifth Avenue, and we could take only about five steps before someone handed him a pen and a piece of paper and wanted his autograph. He would scribble really fast, and then we would walk on.

About the Cover

Martin Gardner, the subject of this month's feature interview, was photographed at his residence in Norman, Oklahoma, on March 3, 2005. Gardner is holding the 1999 "Definitive Edition" of his book *The Annotated Alice*, first published in 1960. There are now over 500,000 copies in print. In the background is Ken Knowlton's portrait of Gardner, constructed from dominos. (This photograph, in addition to the uncredited photos in the article, were taken for the *Notices* by Gilbert Jain Photography.)

—Andy Magid



On the AMS *Notices* Publication of Krieger's Translation of Weil's 1940 Letter

Serge Lang

Generalities

The March 2005, *Notices* published Martin Krieger's translation of André Weil's 1940 letter to Simone Weil. Weil himself included this letter in his collected mathematical papers, thereby taking professional responsibility toward the mathematical community and giving the letter the professional standing which it would not have as a "private" letter to his sister. A translation in the AMS *Notices* going to 30,000 AMS members reinforces this professional responsibility. As Weil himself states in line five, his letter consists of two parts, the first one concerning the history of number theory. He writes explicitly to his sister (my translation): "Maybe you will believe you understand the beginning; you will understand nothing after that." Krieger's translation is not accurate in that he renders the first part of the sentence "you may be able to understand the beginning."

Weil, in the second paragraph of this letter, makes a disclaimer (my translation): "I warn you that everything concerning the history of mathematics, in what follows, relies on a greatly insufficient erudition, that it is in large part an a priori reconstitution, and that, even if that's the way things did happen (which is not proved), I couldn't certify that they actually happened that way." However, my comments below are concerned with items Weil knew quite well, so this general disclaimer does not apply to the specific cases I discuss.

Krieger gives Weil's letter his unqualified endorsement: "The Weil letter is a gem, of wider interest to the mathematical and philosophical

community, concerned both with the actual mathematics and with how mathematicians describe their work." The *Notices* gave its imprimatur to Krieger's endorsement and to Weil's letter without warning to the reader. I don't find Weil's letter to be a gem in its usual praiseworthy sense. On the contrary, readers of the letter deserve being warned about the tendentious ways Weil gives some historical accounts. Furthermore, mathematicians do not usually publish (let alone as part of collected mathematical papers) purported historical accounts based on "insufficient erudition" and lack of scholarship. They don't call such publications "gems" either.

I thank the editors for publishing the present comments and my 2002 *Mitteilungen der Deutschen Mathematiker-Vereinigung* article in the current issue of the *Notices*. Among other things, that article contains a substantial analysis of some items in Weil's letter having to do with "nonreferences in Weil's works." See pp. 616–617.

Artin's Reciprocity Law

Here I wish to deal with one other specific item in Weil's letter, different from non-references. The item concerns Artin's reciprocity law. First, on page 244 of his *Collected Papers*, he makes a general statement concerning the history of number theory: "It is entirely dominated by the reciprocity law. It is the *theorema aureum* of Gauss..." Four pages later, he states, concerning abelian extensions of number fields and certain areas he mentions (my translation):

But these questions are well sorted out [débrouillées] and one can say that everything that has been done in arithmetic since Gauss up to these last few

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years consists in variations on the reciprocity law: starting with the one of Gauss; ending up with that of Artin, and *it's the same one*. This is beautiful, but a bit "vexant". We know a little more than Gauss, no doubt; but what we know in addition, is precisely (with a little leeway) ["ou peu s'en faut"] that we don't know more.

Some people may call this kind of general rhetoric "history" or a "gem, of wider interest in the mathematical and philosophical community, concerned both with the actual mathematics and with how mathematicians describe their work." I don't, and I urge people to get a more accurate view of number theory up to 1940 elsewhere.

Going further into Artin's reciprocity law, Weil's letter reads:

...Artin arriva d'abord à formuler cette loi à titre de conjecture hardie (il paraît que Landau se moqua de lui), quelque temps avant de pouvoir la démontrer (chose curieuse, sa démonstration est une simple transposition de la démonstration d'un autre résultat, paru entre temps, par Tchebotareff, qu'il ne manque pas d'ailleurs de citer; et cependant c'est Artin, et à juste titre, qui a la gloire de la découverte).

The characterization "conjecture hardie" already contradicts the absurd rhetorical assertion that we don't know more than Gauss (ou peu s'en faut). Krieger's translation reads:

...and this is the way Artin first arrived at this law as a bold conjecture (it seems that Landau made fun of him), some time before being able to prove it (a curious fact, his proof is a simple translation of another result by Tchebotareff that had just been published, which he cited; however it is Artin, justly having it bear his name, who had the glory of discovering it).

First, both expressions "simple transposition" and "simple translation" are inappropriate, starting with the ambiguous use of the word "simple". "Simple" to whom? Relative to what? Mathematicians are accustomed to making the distinction in situations when discovering some result, and making it simple was not a simple thing. It may become simple afterwards for some people to read the proof.

Second, the translation is defective, for instance, because Weil uses the word "transposition", not "translation". Artin's proof is not "a simple translation of another result by Tchebotarev." In 1926,

Tchebotarev published a proof of a conjecture of Frobenius, giving the density of primes having a given associated Frobenius conjugacy class in the (nonabelian) Galois group of a normal extension of a number field. He used a new method, crossing the extension with a cyclotomic extension. Artin recognized the possibility of applying this method to prove his own reciprocity law conjectured in 1923 and credits Tchebotarev by stating: "Einen der Grundgedanken des Beweises, die Verwendung von Kreiskörpererweiterungen, verdanke ich der wichtigen Arbeit von Herrn Tchebotareff". My translation: "I am indebted to the important work of Mr. Tchebotareff for one of the fundamental ideas [Grundgedanken] of the proof, the use of cyclotomic extensions."

Third, the use of the expression "à juste titre" ("justly") is tendentious in conjunction with the expression "simple translation" or "simple transposition", suggesting that there could be or that there is or that there ever was a question about attributing the reciprocity law to Artin in light of the proof being a "simple transposition" ("simple translation") of a proof by Tchebotarev. I have never seen any such suggestion from anyone else, and Hasse's account, which I reproduce below, is typical of the evaluations which I have heard throughout my life from other mathematicians.

Here is how Hasse described Artin's work in his "Bericht über neuere Untersuchungen und Probleme aus der Theorie der algebraischen Zahlkörper" (*Jahresbericht der Deutschen Mathematiker-Vereinigung*, 1930), page 1, (my translation):

Since the appearance of the first part of this Bericht, the theory of abelian extensions of number fields has made an advance of the very greatest significance, which concerns precisely the main theoretical topic with which this second part [of Hasse's Bericht] is concerned, the reciprocity law. Namely, Artin succeeded in proving his group-theoretic formulation of the reciprocity law, which he had already conjectured in 1923 and previously proved in special cases. In what follows, I call it after him, the Artin reciprocity law.

Original: Seit dem Erscheinen des ersten Teils dieses Berichts hat die Theorie der relativ-Abelschen Zahlkörper einen Fortschritt von der allgrössten Bedeutung gemacht, der gerade die für diesen zweiten Teil in Aussicht genommene Seite der Theorie, das Reziprozitätsgesetz, betrifft. Es gelang nämlich Artin, den allgemeinen Beweis für seine schon 1923 vermutete und in speziellen Fällen bewiesene gruppentheoretische

Formulierung des Reziprozitätsgesetzes zu geben, die ich im folgenden nach ihm das Artinsche Reziprozitätsgesetz nenne.

Later in the Bericht, Hasse deals with Tchebotarev's density theorem, and repeats the credit Artin gave to Tchebotarev when he states on page 133:

Tchebotarev erkannte, dass eine Idealklasseneinteilung in k , die einem geeigneten Kreiskörper K' über k entspricht, bei der Durchkreuzung mit einer gegebenen Primidealabteilung**) aus dieser gerade die einzelnen Primidealklassen heraushebt. Auf diesem wichtigen Grundgedanken fussend konnte dann Artin die Auflösung der Abteilungen auch bei seinem neuen Problem, dem Reziprozitätsgesetz in gruppentheoretischer Formulierung, bewerkstelligen.

In my book *Algebraic Number Theory*, I gave Artin's own simplification of his proof in courses from the late forties. I also reproduced Deuring's subsequent proof, showing how the Tchebotarev density theorem follows in half a page from Artin's reciprocity law (*Math. Ann.* 110 (1934)).

In any case, Artin did not only "discover" his reciprocity law in 1923; he proved it and published it in 1927, one year after Tchebotarev proved his density theorem. The "glory" did not pertain to just "discovering" the law but also to proving it. Both Weil's original account and the translation are tendentious, because of the way the "justly" clause is used to counterbalance the "simple translation" or even "simple transposition" expression, as if there were any question about who proved what, about the merit of finding a proof, "simple" or not, and about the greatness of finding a proof, not just making the conjecture.

Editor's Note: The following article appeared in the *Mitteilungen der Deutschen Mathematiker-Vereinigung*, Issue 1, 2002, 49–56.

Comments on Nonreferences in Weil's Works

Serge Lang

The following article does not claim to give a history of algebraic geometry and its connections with number theory as it developed in the 1920s, 1930s and 1940s. I need only provide enough documentation to substantiate its title. I make no claim to completeness. I had no responsibility to mention unpublished letters, whose existence is not generally known in the mathematical community. I am thankful to Schappacher, who made valuable comments as referee for Mitteilungen der DMV. In particular, to take his comments and questions into account, I had to expand my analysis and references.

A "history" would require much more extensive work, and in any case cannot be written with a claim of relative completeness until the Hasse-Weil correspondence from the thirties is published. In addition, there is an extensive correspondence with Deuring which deserves further study and description. I am grateful to Schappacher for bringing their existence to my attention.

I also add here an important mathematical point. Independently of history, endomorphisms and correspondences are mathematically united today, and have been for quite a while. Today, mathematically, one learns at once the fact that the ring of (equivalence classes of) correspondences is isomorphic to the ring of endomorphisms of the Jacobian (Albanese-Picard) varieties, not to speak of (co)homology rings. Historically, different parties arrived at this unification at different times, with different perspectives and different goals. One has to distinguish at least:

- Hurwitz;
- Castelnuovo's articles, especially those of 1905, 1906, 1921 (*Memorie Scelte* 1937);
- Severi and his *Trattato* (1926);
- The Hasse-Deuring development of the thirties;
- Weil's publications in 1940, 1941, 1946, 1948;
- Thereafter.

The paths and concerns of the above mentioned mathematicians crossed at different times, but are not identical. I am still unable to read the Italians, although when someone (like Kani) tells me what to look for and where, I can check it out to a large and hopefully sufficient extent. As far as I can make out, Castelnuovo links correspondences and endomorphisms without making any fuss about it. Anyhow, I don't have, and do not want to go into, a general commitment toward this history and the evolving mathematical viewpoint. As I wrote above, my commitment is simply to provide documentation to substantiate the title. I hope others will do a fuller historical job.

—S.L.

In 1999, the *Notices* of the American Mathematical Society published several articles on André Weil's works (April, June–July, September), especially one by Raynaud on Weil's contributions to algebraic geometry. These were complemented in the April 1999 *Notices* with an editorial on Weil by the *Notices* editor in chief Anthony Knapp. Concerning a comment at some Weil talk that proper credit was not given by Weil for some theorem, Knapp quoted Weil's answer: "I am not interested in priorities", and added his own comment: "This was the quintessential Weil. Mathematics to him was a collective enterprise." I object. Knapp created a reality which is askew from documentable facts. In the sense that mathematics progresses by using results of others, Knapp's assertion is tautologically true, and mathematics is a collective enterprise not only to Weil but to every mathematician.

However, there is also another sense. Mathematics is often a lonely business. Public recognition of the better mathematicians is a fact. Mathematicians are made aware early in their career of the need to attribute results properly. Weil transgressed certain standards of attribution several times throughout his life in significant ways. I documented at least one of these ways in my *Notices* Forum piece on the Shimura-Taniyama conjecture [La 95b]. In this piece, I reproduced a letter from Weil to me (3 December 1986), ending with Weil's own peremptory conclusion: "Concerning the controversy which you have found fit to raise, Shimura's letters seem to me to put an end to it, once and for all." A year after Knapp's editorial, Rosen returned to the Shimura-Taniyama conjecture with some comments [Ro 00] p. 476, where he did not accept Weil's own conclusion.

The *Gazette des Mathématiciens* also published a number of comments on Weil's works in 1999, Supplément au Numéro 80. The AMS *Notices* states editorially that the article [Ra 99a] which Raynaud wrote for the *Notices* is "expanded and translated from" the article [Ra 99b] which he wrote for the *Gazette*. We shall see that neither gave a proper account of Weil's contributions in relation to his predecessors. Unless otherwise specified, the passages I quote from Raynaud occur in both the *Notices* and *Gazette*. I quote the English version.

The questionable accounts in the *Notices* or *Gazette*, the Knapp editorial, and Rosen's comments, prompted me to complement my *Notices* Forum piece [La 95b] by further documentation showing how Weil several times throughout his life did not properly refer to his predecessors, but was "interested in priorities". These constitute significant examples when Weil does not regard mathematics as a "collective enterprise" in the sense that he hides the extent to which he uses previous work, and sets up or pokes fun at some of his predecessors, as we shall now document.

On Hasse's and Deuring's Work Concerning Endomorphisms and Correspondences

It was Hasse who uncovered the source of proof for the Riemann hypothesis in function fields (Artin's conjecture from his thesis), on curves of genus 1. Hasse dealt with the ring of endomorphisms of such a curve—an elliptic curve. He not only proved the theorem, but he uncovered the relation between characteristic 0 and characteristic p via reduction mod p [Ha 34]. After breaking open the whole question as above, Hasse [Ha 36] in three *Crelle* papers developed the theory purely algebraically on elliptic curves in characteristic > 0 , independently of reduction mod p . These works were followed by those of Deuring [De 37], [De 41a], [De 41b], who saw the connection with the theory of correspondences, as we shall summarize in greater detail below.

There are two articles and three books of Weil relevant to his continuation of Hasse's and Deuring's work and its interrelation with algebraic geometry stemming from Castelnuovo and Severi in the classical case: [We 40b], [We 41] where he announces his results, and [We 46], [We 48a], [We 48b] where he carries out complete proofs. Of these, only [We 41] contains bibliographical references (with the exception of one footnote in [We 48a]) as we shall see below in greater detail.

At the start of his announcement of a proof of the Riemann Hypothesis for function fields of genus > 1 over finite fields [We 40b], Weil writes (my translation):¹

I shall summarize in this Note the solution of the main problems of the theory of algebraic functions over a finite constant field; one knows that this theory has been the object of numerous works, and more specially, during these last years, those of Hasse and his students; as they have glimpsed, the theory of correspondences gives the key to these problems;...

There are no bibliographical references in Weil's 1940 paper to accompany the above comment. Weil's books on curves and abelian varieties [We 48a], [We 48b] published in the late forties do

¹ The original few lines of Weil's paper read: "Je vais résumer dans cette Note la solution des principaux problèmes de la théorie des fonctions algébriques à corps de constantes finis; on sait que celle-ci fait l'objet de nombreux travaux, et plus particulièrement, dans les dernières années, de ceux de Hasse et de ses élèves; comme ils l'ont entrevu, la théorie des correspondances donne la clef de ces problèmes; mais la théorie algébrique des correspondances, qui est due à Severi, n'y suffit point, et il faut étendre à ces fonctions la théorie transcendante de Hurwitz."

See below and footnote 5 for more precise information concerning the contributions of Hasse and Deuring.

not mention Hasse's and Deuring's contributions at all. Furthermore, Weil was indeed interested in priorities, as when he wrote at various times that some results of Severi were "rediscovered by Deuring", thereby minimizing his predecessors' discoveries, and misrepresenting the context in which they were made. For example, in his collected papers [We 79], Weil published a 1940 letter of his to Simone Weil [We 40a]. He calls this letter a sketch of a history of number theory ("esquisse d'histoire de la théorie des nombre") in the appended comments. At the beginning of this letter, Weil emphasizes its function by repeating twice that it is going to deal with the history of number theory. In that letter, Weil wrote (my translation):²

...it is incredible the extent to which people as distinguished as Hasse and his students, who gave their most serious thoughts to this subject for years, have not only neglected, but deliberately disdained the riemannian direction: it's to the point where they can't read works written in Riemannian (Siegel once poked fun at Hasse who had told him about not being able to read my paper in the Liouville journal), and that they rediscovered sometimes with considerable pain, in their dialect, important results which were already known, such as those of Severi on the ring of correspondences, rediscovered by Deuring.³

² "...il est incroyable à quel point des gens aussi distingués que Hasse et ses élèves, et qui ont fait de ce sujet la matière de leurs plus sérieuses réflexions pendant des années, ont, non seulement négligé, mais dédaigné de parti pris la voie riemannienne: c'est au point qu'ils ne savent plus lire les travaux rédigés en Riemannien (Siegel se moquait un jour de Hasse qui lui avait déclaré être incapable de lire mon mémoire de Liouville), et qu'ils ont retrouvé quelques fois avec beaucoup de peine, en leur dialecte, des résultats importants déjà connus, comme ceux de Severi sur l'anneau des correspondances, retrouvés par Deuring."

In [We 60], Weil wrote another similar put down of his predecessors, without citing them by name, stating that "les meilleurs spécialistes des théories arithmétiques 'galoisiennes' ne savaient plus lire le riemannien, ni à plus forte raison l'italien..." Collected Works Vol. II, p. 412, [My translation: "the best specialists of arithmetic and 'galois' theories didn't know any more how to read riemannian, let alone italian..."]

³ As Schappacher pointed out to me, in Weil's review of Chevalley's book on function fields in one variable [We 51], Weil confirms what he wrote previously: "...The algebraic method begins to show its weaknesses when it comes to dealing with extensions of the field of constants. Here also a new language and technique had to be invented by the author [Chevalley]...; in his introduction he acknowledges the considerable effort which this has cost him, and strangely enough, finds no better justification for it than a reference to a notably unsuccessful paper of Deuring on correspondences, where the latter rediscovered rather clumsily a few of Severi's more elementary results on the same subject."

This quote may be "quintessential Weil", but it shows something other than "mathematics to him was a collective enterprise." It is actually a tendentious presentation on several counts, passed off as history. To substantiate:

(a) Hasse and Deuring did not merely "rediscover ... in their dialect" results already known to Severi. Notably Hasse, who had just written major papers on complex multiplication (1927-1931), saw first the connection with the Riemann hypothesis in function fields of genus 1 [Ha 34], and he uncovered the connection between the existing problem of the Riemann hypothesis on elliptic curves and the theory of endomorphisms. Before Hasse, mathematicians had no inkling where a proof would come from. Thus Hasse made a fantastic step forward in connecting the complex theory with the purely algebraic theory in characteristic p , by showing how reduction mod p merges with complex multiplication in the theory of endomorphisms.⁴ Readers cannot get an inkling of the origins of such fundamental insights either from Weil's own works or from the accounts of Weil's works in the *Notices* (1999). Raynaud's account [Ra 99a] refers to Hasse in just one sentence: "[The Riemann hypothesis in the case of curves over finite fields] was first proved by Hasse [4] in the case of elliptic curves ($g = 1$). There isn't even a reference to Hasse in the *Gazette* [Ra 99b].

Deuring's published papers deal with the theory of correspondences and endomorphisms algebraically in characteristic > 0 for higher genus as well as genus 1.⁵ In a first paper [De 37], Deuring not only gives an algebraic version of certain results, but he points to the connection with the transcendental theory citing Hurwitz's work (p. 190).

⁴ Essentially, in [Ha 34], Hasse gives a one-line proof for the Riemann hypothesis on elliptic curves, assuming appropriate foundations. Indeed, he argues as follows. Lift the curve from characteristic p to characteristic 0, and also lift the Frobenius endomorphism to a complex endomorphism μ . The degree of Frobenius is q . Hence $\mu\bar{\mu} = q$, so $|\mu| = q^{1/2}$, which is one formulation of what one is after.

⁵ I am indebted to Schappacher for informing me precisely that it was Deuring who, in 1936, first had the idea to generalize Hasse's proof by replacing endomorphisms by correspondences. According to Schappacher, Deuring communicated this to Hasse in a letter dated 9 May 1936, and an extensive correspondence ensued. Again according to Schappacher: "After Deuring's first announcement and first version, and before the Oslo International Congress in 1936, Hasse wrote a long letter to Weil telling him of Deuring's idea, and developing quite explicitly why and how he thinks that this idea is going to give a proof of the Riemann hypothesis in general..." The exchange of letters between Hasse and Weil during this period is not yet publicly available.

The present article only provides what I hope is enough documentation to substantiate its title. It is based entirely on the published record, but I look forward to the unveiling of the complete Hasse-Weil correspondence. I also look forward to a further study of Deuring's correspondence.

Then Deuring determined the structure of the group of points of finite order for elliptic curves ([De 41a], p. 36, submitted in June 1939), and started the l -adic representation of the endomorphisms of the curve on the group of points of l -power order, especially with $l \neq p$ (the characteristic) for the purpose of determining the structure of this ring [De 41a,b]. He also saw that this provided an algebraization of the complex representation.

Raynaud in the *Notices* and the *Gazette* does not mention these fundamental contributions when he attributes to Weil the introduction of l -adic representations in algebraic geometry. Of course, Weil went beyond Hasse and Deuring, ultimately giving a complete proof for the higher genus case, and establishing systematically a completely algebraic theory of abelian varieties.

(b) The phrase “not only neglected but deliberately disdained” (“non seulement négligé, mais dédaigné de parti pris”) is an example of Weil’s tendentious attributions. Artin, Davenport, Hasse, Mordell, Siegel, Weil had limitations, like all of us, including me. One of Hasse’s limitations was that he was not able to read the classical transcendental versions of the theory of abelian functions, as in Poincaré, Castelnuovo, or Weil’s paper [We 38], and was not able to read the Italian geometers as well as Weil; but it was not a question of “disdain” or “neglect”.

I don’t know how justified Weil is in attributing to Siegel the reaction toward Hasse as Weil describes it. But Siegel and Weil had no reason to ridicule or poke fun at (“se moquait de”) Hasse for his limitation in not understanding Weil’s transcendental approach to abelian functions. Although Siegel himself understood and handled this type of analysis, Siegel’s limitations were evidenced later by his inability to understand much of the mathematics and especially algebraic geometry developed in the fifties and sixties, as partly described in my article concerning Siegel’s letter to Mordell [La 95a].

I myself have had my own limitation in that I was not (and still am not) able to read the papers of the Italian algebraic geometers. I needed the algebraic versions by van der Waerden, Chevalley, Zariski and Weil himself to get into the subject. It was not at all the case that I “not only neglected but deliberately disdained” the works of the Italian geometers.

(c) Whatever individual limitations existed, certain previous results of algebraic geometry, some coming from the more algebraic methods of Severi and others from more transcendental methods of Hurwitz and mixed transcendental-algebraic methods of Castelnuovo (see below), needed to be algebraicized completely because they were relevant in this generality for the applications to the Riemann Hypothesis on higher genus curves in

characteristic p . In footnote 1 of [We 41], referring to the theory of correspondences in Severi’s *Trattato*, Weil himself makes the point precisely: “It should be observed that Severi’s treatment, although undoubtedly containing all the essential elements for the solution of the problems it purports to solve, is meant to cover only the classical case where the field of constants is that of complex numbers, and doubts may be raised as to its applicability to more general cases, especially to characteristic $p \neq 0$. A rewriting of the whole theory, covering such cases, is therefore a necessary preliminary to the applications we have in view.” This “rewriting” is not a matter of “dialect”. Deuring (following Hasse) established the connection between more general algebraic geometry and the main problem of concern to Hasse and to him, showing what direction to take; and he started the process of developing parts of algebraic geometry relevant to this concern in a way sufficient to include characteristic > 0 .

On van der Waerden

Van der Waerden’s series of papers *Zur Algebraischen Geometrie* in *Math. Ann.* (see [vdW 83]) and his book *Einführung in die algebraische Geometrie* [vdW 39] both contributed to providing completely algebraic versions of some results known over the complex numbers, and went beyond. For example, van der Waerden introduced generic points, among other basic and important contributions to algebraic geometry, including the laying of algebraic foundations. These were basic to Weil’s book *Foundations of Algebraic Geometry* [We 46]. In [We 41] Weil himself refers to them in an appropriate manner, “in the precise sense defined by van der Waerden”. Weil reproduces the definition in the accompanying footnote, which refers to van der Waerden’s *Einführung in die algebraische Geometrie*. Weil also references two papers by van der Waerden for some questions of intersection theory, including the definition of intersection numbers and the application to the theory of correspondences. In addition, in the Introduction to *Foundations*, Weil states very appropriately:

...there is no doubt that, in this field [algebraic geometry], the work of consolidation has so long been overdue that the delay is now seriously hampering progress in this and other branches of mathematics. To take only one instance, a personal one, this book has arisen from the necessity of giving a firm basis to Severi’s theory of correspondences on algebraic curves, especially in the case of characteristic $p \neq 0$ (in which there is no transcendental method to guarantee the correctness

of the results obtained by algebraic means), this being required for the solution of a long outstanding problem, the proof of the Riemann hypothesis in function-fields. The need to remedy such defects has been widely felt for some time; and, during the last twenty years, various authors, among whom it will be enough to mention F. Severi, B. L. van der Waerden, and more recently O. Zariski, have made important contributions towards this end. To them the present book owes of course a great deal;

...As for my debt to my immediate predecessors, it will be obvious to any moderately well informed reader that I have greatly profited from van der Waerden's well-known series of papers¹, where, among other results, the intersection-product has for the first time been defined (not locally, however, but only under conditions which ensure its existence 'in the large'); from Severi's sketchy but suggestive treatment of the same subject, in his answer to van der Waerden's criticism of the work of the Italian school²;...

The notion of specialization, the properties of which are the main subject of Chap. II, and (in a form adapted to our language and purpose) the theorem on the extension of a specialization...(th. 6 of Chap. II, §2) will of course be recognized as coming from van der Waerden...

Thus Raynaud's assertion in [Ra 99a], [Ra 99b] that the book *Foundations* "marks a break ("rupture" in the French version) with respect to the works of his predecessors—B. L. van der Waerden [10] and the German school..." is not correct.⁶ It goes against Weil's own specific references in [We 41] and the expression of indebtedness expressed in the above Introduction. Weil went beyond van der Waerden in significant ways, but it was not a "break" or "rupture".

Raynaud goes on about what he calls the break resp. rupture: "To signal this clearly, the book [*Foundations*] contains no bibliography." The first

⁶ Incidentally, Raynaud adds: "The emphasis is systematically put on fields: fields of definition of varieties, fields of rational functions. Fifteen years later, Grothendieck [3], in developing the language of schemes, would bring out the role of rings." Actually, Chow and Igusa had already brought out the role of rings in several important papers dating back to 1957, 1958, 1959, cf. [La 96], §5.

part of this statement goes into intent, and is open to different interpretations which we shall leave to the reader. The second part is correct but somewhat misleading because it does not take into account Weil's substantial specific attributions in the Introduction to *Foundations*. It is in this context that Weil makes the assertion: "Our method of exposition will be dogmatic and unhistorical throughout, formal proofs without references, being given at every step."

On Castelnuovo's Work

The situation is very different with respect to Castelnuovo's work. Weil did not regard mathematics as a collective enterprise with Castelnuovo, by leaving out of his references throughout his life the extent to which he used Castelnuovo's ideas concerning the equivalence defect, the characteristic polynomial, and the Jacobian of a curve.

In the brief announcement [We 40b], Weil like Deuring only mentions Hurwitz when he states: "...but the algebraic theory of correspondences, which is due to Severi, does not suffice, and it is necessary to extend to these [algebraic] functions the transcendental theory of Hurwitz." There is no mention of Castelnuovo in [We 40b] or [We 41].

In my book on abelian varieties, I systematically gave Weil credit for his ability to make the contributions of Severi and Castelnuovo available to the postwar period of algebraic geometry, and to go beyond. In fact, in historical comments concerning Castelnuovo's equivalence defect, I stated that Weil "was the first to recognize that Castelnuovo's theorem on the equivalence defect of correspondences on a curve could be expressed as a theorem on abelian varieties." It turns out that I was wrong. I was taken to task for this erroneous attribution by Kani [Ka 84], see especially p. 27, footnote 12. Indeed, Weil makes only one reference to Castelnuovo in his book on abelian varieties [We 48b], for some of the basic theorems on abelian varieties. Referring to the principle that a rational map of a variety into an abelian variety is always defined at a simple point, and that if both varieties are abelian, then the map is a homomorphism, up to a translation, Weil states in the introduction to the book (my translation):⁷ "...already Castelnuovo had recognized how to use the latter⁽³⁾, although it is not easy to find in his works a formulation or even less a precise justification...The proof of Poincaré's theorem from the above principle, which one will

⁷ "...déjà Castelnuovo avait reconnu le parti qu'on peut tirer de ce dernier⁽³⁾, sans qu'il soit pourtant facile d'en trouver chez lui une formulation ni encore moins une justification précise...La démonstration du théorème de Poincaré à partir du principe en question, qu'on trouvera au n° 51 du présent travail, est par exemple substantiellement identique à celle qu'en donne Castelnuovo, pour le cas classique, au n° 9 de ce mémoire."

find in No. 51 of the present work, is for instance substantially the same as the proof given by Castelnuovo in the classical case, in No. 9 of his memoir." Weil's footnote (3) refers to "the beautiful paper" ("le beau mémoire") [Ca 05], specifying that it is reproduced as No. XXVI in the volume *Memorie Scelte* (*Selected Papers*), published in 1937 [Ca 37]. In particular, Weil was fully aware of the *Memorie Scelte* when he made that reference in [We 48b].

Weil's books [We 48a], [We 48b] contain no other bibliographical references besides the footnote (3) just mentioned. In [We 48a] p. 28, Weil only writes (my translation): "As will be recognized without pain, the present memoir is directly inspired by the works of Castelnuovo and Severi on the same subject."⁸ What does "directly inspired" mean? Weil does not refer to any other paper by Castelnuovo, and he omitted far more important and relevant references to at least two other Castelnuovo papers, namely the paper on the "positivity of the trace" [Ca 06], reproduced in *Memorie Scelte* [Ca 37] No. XXVIII, and the paper *Sulle funzione abeliane* [Ca 21], reproduced in *Memorie Scelte* No. XXX.

I learned of this second paper and of Castelnuovo's fundamental contributions from Kani [Ka 84]. In the complex case, the relation between Castelnuovo's equivalence defect and an intersection number on the Jacobian is clearly established in the paper [Ca 21] = [Ca 37] No. XXX. Furthermore, Castelnuovo defines the characteristic polynomial of an endomorphism of the Jacobian (determinant of the pfaffian of the complex representation) expressing it as an intersection power, pp. 536–537. He thus merges the complex analytic theory and the algebraic intersection theory. He develops systematically the theory of this characteristic polynomial. He thereby shows that the equivalence defect occurs as the penultimate coefficient of the characteristic polynomial, i.e. the trace, as on pp. 536, 538, and 541, and that all these coefficients can be expressed as intersection numbers. Castelnuovo also gives the intersection formulas of the sum of the curve with itself r times and the theta divisor, as well as powers of the theta divisor. See pp. 547–548. In the fifties, I learned such results from Weil's book and lectures on abelian varieties. Weil in his book [We 48b] gives Castelnuovo's formalism and generalizes it. Compare [We 48b] pp. 73, 74, 132 with Castelnuovo's paper pp. 537–547. But there are no references to this paper in Weil's works which deal with these matters, nor were there in his courses, nor are there in the AMS *Notices* or *Gazette* articles by

Raynaud. In [Ra 99a,b] Raynaud attributes to Weil Castelnuovo's algebraic definition of the characteristic polynomial via intersection theory. Whatever "directly inspired" means, Raynaud did not give a proper account of Weil's contribution to the subject in relation to Castelnuovo's.

At the end of his article [Ra 99b] Raynaud states (my translation): "Let us mention that Weil, who was very reserved with respect to the rigor of 'Italian geometry', nevertheless attributes to Castelnuovo the discovery of the positivity of the trace, in the theory of correspondences."⁹ In [Ra 99a], Raynaud states differently: "Castelnuovo had proved this in the complex case." Raynaud does not indicate any specific reference where Weil makes the attribution claimed in [Ra 99b]. There is no such attribution in the papers [We 40b], [We 41] where a proof of RH for curves over finite fields is first announced, nor in the books [We 48a], [We 48b] where a complete proof is given. To my knowledge, Weil made such an attribution only decades later, as a comment in his *Collected Papers*, Vol. I, (1979) p. 557. There, Weil calls it "one of the most beautiful discoveries of Castelnuovo", and refers to Castelnuovo's *Memorie Scelte* No. XXVIII, pp. 509–517. In whatever references he does make at different times, Weil gives no evidence of being "reserved" (let alone "very reserved") with respect to the "rigor" of Italian geometry, whether comparing results of Deuring to those of Severi (see footnote 3, "rediscovered rather clumsily"), or mentioning Castelnuovo's trace in 1979. Furthermore, Weil's specific references to items in the *Memorie Scelte* (XXVI in 1948 and XXVIII in 1979) document his awareness of this volume.

After the comment in Weil's *Collected Papers*, p. 557, which we have just cited, Weil adds (my translation): "But I read Castelnuovo only in 1945 in Brasil; I realized then that Severi, in his *Trattato* (pp. 286–287) had not credited his elder [predecessor?] to the extent he deserved."¹⁰ [sic!] Thus on the one hand, Weil knew the works of the Italians well enough to chide Hasse and Deuring for having "not only neglected but deliberately disdained the riemannian direction" and "rediscovered, sometimes with considerable pain, in their dialect, important results which were already known, such as those of Severi on the ring of correspondences, rediscovered by Deuring." On the other hand, Weil gives no references to Castelnuovo for the positivity of the trace or the theory of the characteristic polynomial in [We 40b], [We 41], [We 48a],

⁸ "Comme on le reconnaitra sans peine, le présent mémoire est directement inspiré des travaux de Castelnuovo et Severi sur le même sujet." I myself in [La 95a] was still misled as to what this phrase meant, and I still attributed the trace and its positivity to Weil.

⁹ "Signalons que Weil, qui était très réservé à l'égard de la rigueur de la 'géométrie italienne', attribue néanmoins à Castelnuovo la découverte de la positivité de la trace, en théorie des correspondances."

¹⁰ "Mais je ne lus Castelnuovo qu'en 1945 au Brésil; je constatai alors que Severi, dans le *Trattato* (pp. 286–287) n'avait guère fait à son ancien la part qu'il méritait."

Letter to the Editors

I regard it as unfortunate when addressing issues of professional or institutional responsibility is interpreted in terms of personal animosities. For instance, in his article "Adieu à un ami" (*Gazette des Mathématiciens*, 1999), Cartier writes: "Quel fut bien le déclencheur de la rupture entre Weil et son ancien disciple Serge Lang? Il est vrai que les deux parties étaient expertes en récriminations." Such a version is highly tendentious, and I reject it.

My documentation of certain aspects of mathematical history implies nothing concerning personal relationship, one way or another. I take this opportunity to put in the record some information concerning Hasse's behavior after France's defeat in 1940. In fall 1940, Hasse went to meet Elie Cartan at his home in Paris. Hasse was dressed in a German uniform. The only other person present was Elie Cartan's son, Henri Cartan, whom I heard personally report the encounter publicly in the late fifties, as follows. Hasse acted in a very friendly way, and proposed to Elie Cartan that French and German mathematicians should cooperate, independently of the circumstances which were otherwise occurring. Elie Cartan answered in an equally friendly fashion that it was an excellent idea, but that the Poles should also take part. Hasse then answered no, that the Polish people was a separate people with whom it was not possible to collaborate. Elie Cartan then answered that under these conditions, it was impossible to start a French-German mathematical cooperation.

Some 40 years later, in 2000–2001, at the Max-Planck Institut in Bonn, I heard for the first time an account from the Norwegian mathematician Arnfinn Laudal, of a similar visit that Hasse made to Thoralf Skolem in Oslo. Laudal got the story from Skolem himself, and the story was confirmed recently by Skolem's children. Hasse had shown up at Skolem's home dressed in German navy uniform ("Kommandeur-Kapitain-der See" uniform), but was refused entrance by Skolem, on the doorsteps. Hasse had come with a proposition like the one he had made to Elie Cartan. There occurred a vigorous and high-voiced exchange between Skolem and Hasse.

Thus Hasse's visit to Elie Cartan was not an isolated event. Different people react differently about recalling the painful past of Nazism, and the role of individual mathematicians during that period. We make ad hoc decisions about what to recall, and when, depending on circumstances. My current decision is represented by this letter and the accompanying article on some mathematical history.

—Serge Lang

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[We 48b]; nor does he refer to Severi's *Trattato* in [We 40b], [We 48a], [We 48b].

The extent to which Severi himself did not properly credit Castelnuovo in the *Trattato* remains to be analyzed separately.

To summarize: In the thirties and forties, the main motivation for Hasse, Deuring, and Weil was to carry out the program of developing enough algebraic geometry (geometric or transcendental) purely algebraically, and with complete proofs, in order to reach a proof of the Riemann hypothesis for curves of higher genus. What Weil did in the forties was to algebraicize completely Castelnuovo's theory [Ca05], [Ca 06], [Ca 21], as well as parts of Severi's *Trattato*, and extend them, following Hasse's and Deuring's fundamental discoveries and works on the subject, as described above. Of course, to carry out this plan was a first rate mathematical achievement. For two decades, Weil was the only one in the world capable of pulling it off, in large part because he was able to read Castelnuovo, Severi, and Hurwitz. I have the highest regard for his mathematics. But being a great mathematician is not a license for obscuring and misrepresenting works and original ideas of others who opened up the field, and for poking fun at them.

On Mordell's Conjecture

Weil correctly referred to Mordell's conjecture in his thesis [We 28], when he stated that (my translation)¹¹ "...this conjecture, already stated by Mordell (loc. cit. note 4) seems confirmed to some extent by an important result recently proved...", and then cites Siegel's theorem on the finiteness of integral points on curves of genus at least 1. Weil made a similar evaluation in *Arithmetic on algebraic varieties* [We 36], but without reference to Mordell, namely: "On the other hand, Siegel's theorem, for curves of genus > 1 , is only the first step in the direction of the following statement: On every curve of genus > 1 , there are only finitely many rational points."

Subsequently, Weil explicitly denigrated Mordell's contribution. In his *Two lectures on number theory, past and present* [We 74a], he wrote: "For instance, the so-called Mordell conjecture on Diophantine equations says that a curve of genus at least two with rational coefficients has at most finitely many rational points." Why "so-called"? Weil goes on: "It would be nice if this were so, and I would rather bet for it than against. But it is no more than wishful thinking

¹¹ "...cette conjecture, déjà énoncée par Mordell (loc. cit. note 4) semble confirmée en quelque mesure par un important résultat démontré récemment..."

because there is not a shred of evidence for it, and also none against." In his *Collected Papers* Vol III, p. 454, he goes one better (my translation):¹² "We are less advanced with respect to 'Mordell's conjecture'. This is a question which an arithmetician can hardly fail to raise; in any case, one sees no serious reason to bet for or against it."

I have several objections to Weil's tendentious evaluation ("quintessential Weil"). First, Weil puts Mordell's conjecture in quotes, as if there was some question about Mordell's famous insight.

Second, concerning a "question which an arithmetician can hardly fail to raise", I would ask when? It is quite a different matter to raise the question in 1921, as did Mordell, or decades later, especially following Mordell's insight. Furthermore, Weil here goes against the evaluations which he himself made in the two papers mentioned above, dating back to 1928 and 1936. Weil at the end of his 1928 thesis even proposed a generalization of Mordell's conjecture as follows (my translation):¹³ "The most important problem of the theory is no doubt precisely to know if, among all virtual systems of degree $\leq p - 1$ arising from a finite set of generators, there are infinitely many effective ones; if this question has a negative answer, it would follow in particular that on a curve of genus $p > 1$ there is only a finite number of rational points, whatever be the domain of rationality (for example, Fermat's equation $x^n + y^n = z^n$, would have only a finite number of solutions for each value of $n > 2$)." However, when I learned abelian varieties (from Weil's books and his course in Chicago in 1954), I observed that Weil's proposed generalization for effective $(p - 1)$ -cycles on curves was false because the theta divisor could contain an elliptic curve. At the time, I made my general conjecture that a subvariety of an abelian variety is Mordellian if (and only if) it does not contain the translation of a non-trivial abelian subvariety. My conjecture was proved by Faltings three decades later.¹⁴

¹² "Nous sommes moins avancés à l'égard de 'conjecture de Mordell'. Il s'agit là d'une question qu'un arithméticien ne peut guère manquer de se poser; on n'aperçoit d'ailleurs aucun motif sérieux de parier pour ou contre."

¹³ "Le problème le plus important de la théorie est sans doute précisément de savoir si, parmi tous les systèmes virtuels de degré $\leq p - 1$ qui se déduisent d'une base finie, il peut s'en trouver une infinité d'effectifs; si la question devait être résolue par la négative, il s'ensuivrait en particulier que sur une courbe de genre $p > 1$ il n'y a qu'un nombre fini de points rationnels quelque soit le domaine de rationalité (par exemple l'équation de Fermat, $x^n + y^n = z^n$, n'aurait qu'un nombre fini de solutions pour chaque valeur de $n > 2$)."

¹⁴ In his article [Fa 91] p. 549, Faltings states that the conjecture was made "by A. Weil and also by S. Lang"; (p. 549) later in [Fa 94] p. 175, it's "by A. Weil (as well as apparently independently by S. Lang)." (p. 175) I objected to Faltings about the attribution to Weil, which is incorrect. Cf. the quotes from Weil I give in the above text.

Third, concerning Weil's statements in 1974 and 1979 that there is no "shred of evidence" or "motif sérieux" [serious reason] for Mordell's conjecture, they not only went against his own evaluations in earlier decades, and similar evaluations by others since,¹⁵ but they were made after Manin proved the function field analogue in 1963; after Grauert gave his other proof in 1965; after Parshin gave his other proof in 1968, while indicating that Mordell's conjecture follows from Shafarevich's conjecture (which Shafarevich himself had proved for curves of genus 1); at the same time that Arakelov theory was being developed and that Zarhin was working actively on the net of conjectures in those directions (Shafarevich conjecture, Tate conjecture, isogeny conjecture, etc.); and within four years of Faltings' proof.

On the Shimura-Taniyama Conjecture

I gave a systematic account of this item in my *Notices Forum* article [La 95b], which I now urge readers to look at again in the present broader context. Weil's first reaction when Shimura told him the conjecture was to make the comment: "I don't see any reason against it, since one and the other of these sets are denumerable, but I don't see any reason either for this hypothesis." [We 79], Vol. III, p. 450. When others brought out the role of Shimura and Taniyama, Weil started inveighing against conjectures, and kept it up for the next decade. In my article, I quote from a letter where Shimura writes: "For this reason, I think, he [Weil] avoided to say in a straightforward way that I stated the conjecture... Of course Weil made a contribution to this subject on his own, but he is not responsible for the result on the zeta functions of modular elliptic curves, nor for the basic idea that such curves will exhaust all elliptic curves over \mathbb{Q} ." If Weil had started his 1967 paper with a couple of sentences stating that Shimura told him this basic idea, and that the paper was the result of his thinking about the idea, then there would be evidence in this instance for Knapp's purported description of Weil's motivation. As it is, Weil's suppression of Shimura's role in making the conjecture was evidence of something opposite to viewing mathematics as a "collective enterprise". It is unfortunate that the accumulated evidence was not taken into account by some people to follow Weil's own conclusion in his letter to me, already quoted in the introduction: "Concerning the controversy which you have found fit to raise, Shimura's letters seem to me to put an end to it, once and for all."

¹⁵ For instance, Parshin in 1968 [Pa 68] wrote: "Finally when $g > 1$, numerous examples provide a basis for Mordell's conjecture that in this case $X(\mathbb{Q})$ is always finite. The one general result in line with this conjecture is the proof by Siegel that the number of integral points (i.e. points whose affine coordinates belong to the ring \mathbb{Z} of integers) is finite."

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In Memoriam: S.-S. Chern



On December 3, 2004, the world lost a brilliant mathematician and a generous spirit. On that day, Shiing-Shen Chern died at his home in Tianjin, China, at the age of ninety-three. His profound mathematical gifts and ebullient personality were warmly remembered at a memorial service held on the campus of the University of California, Berkeley, on February 13, 2005. The service was organized by the Berkeley mathematics department, where Chern was a faculty member for two decades just before his retirement, and by the Mathematical Sciences Research Institute, which Chern helped to found.

Chern's prominence in the academic world was demonstrated at the memorial service by the presence of UC Berkeley's chancellor, Robert Birgeneau, and of the Consul General of the Chinese Consulate of San Francisco, Peng Keyu. Several members of Chern's family were in attendance, and his son, Paul Chern, presented remarks to close the service. Most of the speakers were Chern's students and colleagues, who warmly remembered him as a mathematician and as a friend. All mourned the passing of this great and distinguished man.

Chern was born on October 26, 1911, in Jiaxing, China. He showed an early interest in mathematics and enrolled at the age of fifteen in Nankai University, where he majored in mathematics. After receiving a master's degree from Tsinghua University in 1934, he left China for Germany and earned a doctorate from the Universität Hamburg in 1936 under the direction of Wilhelm Blaschke. He then spent a year in Paris, where he was deeply

influenced by Élie Cartan. At that time, the field of geometry was at a low ebb. Apart from Cartan's foundational work, which took decades to be fully understood, there were only isolated advances, and geometry was not thriving as were other areas, such as algebra, topology, functional analysis, and number theory. "Differential geometry paled by comparison," said Hung-Hsi Wu of UC Berkeley in his remarks at the memorial service.

When Chern produced his intrinsic proof of the Gauss-Bonnet theorem in 1944 and introduced what are now known as Chern classes in 1946, he was "far ahead of his time," Wu said. A few prescient mathematicians—such as Heinz Hopf, André Weil, and Hermann Weyl—understood the magnitude of what Chern had done, but it was quite a while before the mathematics community changed its perception of differential geometry as a field, Wu remarked. Chern told Wu that G. D. Birkhoff once asked him—very politely, of course—"But isn't geometry just a part of analysis?" "It is not every day that a single person is entrusted with the task of carrying a whole field forward, no matter how briefly," Wu remarked. "Professor Chern did what was given to very few to do, and he did it extremely well."

Chern took a position at the University of Chicago in 1949. At the time Isadore Singer was a graduate student there, working on his dissertation in functional analysis. He took a course in differential geometry from Chern and slowly began to understand the importance of the new ideas Chern was expounding. "I realized reluctantly that maybe

Speakers at the Memorial in Honor of Shiing-Shen Chern

Theodore Slaman
Chairman, Department of Mathematics,
University of California, Berkeley

Robert J. Birgeneau
Chancellor, University of California, Berkeley

Peng Keyu
Chinese Consul General

David Eisenbud
Director, Mathematical Sciences Research Institute

Isadore M. Singer
Massachusetts Institute of Technology

James Simons
President, Renaissance Technologies

Robert Uomini
Independent Software Developer

Calvin Moore
University of California, Berkeley

Alan D. Weinstein
University of California, Berkeley

Hung-Hsi Wu
University of California, Berkeley

I'd made a wrong choice in subject, that if only Chern had come a year earlier, I might have become a geometer," Singer recalled. When Singer went to the Massachusetts Institute of Technology as an instructor the following year, his colleague Warren Ambrose asked to be brought up to speed on Chern's course. Singer said it took them about ten years to really understand Chern's ideas and point of view. "Ambrose and I considered ourselves disciples of Chern during that period," Singer said. Later on, in the 1970s, Chern and Singer became colleagues at Berkeley.

As a student at MIT, James Simons absorbed Chern's ideas through Ambrose and Singer. In anticipation of Chern's arrival in Berkeley in 1960, Simons went there for his Ph.D. One day while he was giving a seminar talk, Chern walked in. Simons said he was doubly surprised: He did not expect such a distinguished professor to come to a seminar by a mere graduate student, and he did not expect Chern to be Chinese. "I assumed [his name] was a shortening of Chernowsky or something like that," Simons said. "I expected him to be a Jewish

fellow." Chern did not end up directing Simons's thesis, and they overlapped only that one year in Berkeley, but they became fast friends and remained in contact. It was some years later that Simons came to Chern with an idea he had been working on that was an application of something Chern had done years earlier. Chern suggested they collaborate, and in this way the Chern-Simons invariants were born. "That was certainly the high spot of my mathematical life," Simons said, "and I would think that anyone collaborating on a project with Chern would probably have said the same thing."

Simons also recalled Chern's impish sense of humor. In 1972 Simons was a member at the Institute for Advanced Study in Princeton and Chern had come for a short visit. This was at the time when the formidable André Weil was on the faculty. At the end of Chern's stay, Simons was to drive Chern to the train station. Chern had a good deal of luggage, and he mused over how to deal with it. Then he said, "I know. You and I will go ahead in the car, and Weil will follow with the bags." "Anyone who knew André Weil would laugh a lot at that notion," Simons remarked. "Chern had quite a twinkle in his eye when he said that."

"In some ways Chern was an enigma," Singer said. He was unassuming, direct, cordial, always eager to be helpful. At the same time, his revolutionary achievements established differential geometry as a major and thriving branch of mathematics. "And overriding these two parts of him was his personal presence, indeed a personal nobility that I have not found elsewhere."

The day after the memorial service, Wu gave a lecture in the Berkeley mathematics department about Chern's work. Wu noted that this work lay between two extremes in geometry: the study of intrinsic metric structures on Riemannian manifolds on the one hand, characterized by the work of, for example, Marcel Berger and Wilhelm Klingenberg; and on the other hand, the hard estimates of geometric analysis, the domain of practitioners like Shing-Tung Yau and Richard Schoen. In that in-between area, it is easy to fall into purely formal, empty mathematics, Wu said. "But when a master does it, there is a magical feeling to it." He made the point that Chern was always on the lookout for important problems that would advance the field. Sometimes he succeeded in solving them, sometimes he did not, and sometimes he simply suggested the problems to others. But he was always ambitious and forward-looking in what he chose to focus on. This spirit also imbued Chern's teaching. Wu remembered that Chern "was sweating blood" over a graduate course he taught on the Atiyah-Singer index theorem. Chern had not mastered the topic, but he understood its centrality to geometry and wanted the students to be exposed to it.

One of the speakers at the memorial service was Robert Uomini. As an undergraduate student at Berkeley, he took a course in differential geometry with Chern. Despite the huge number of students—undergraduate as well as graduate—attending the course, Uomini said each lecture was like “an individual conversation with Chern.” It was through Chern’s personal intervention that Uomini was accepted as a graduate student at Berkeley. He earned a Ph.D. in 1976 under the direction of Blaine Lawson and went on to become a software developer. As the years passed, Uomini came to realize how greatly his experiences in graduate school had enriched his life and how much he owed to Chern. In 1995 Uomini was able to express his appreciation: He won \$22 million in the state lottery and used part of the funds to endow a visiting professorship in the Berkeley mathematics department, named in honor of Chern. In the following years he and his family established a close and warm friendship with the Cherns. In 2002 Uomini traveled to China to see Chern; this was the last time the two would meet.

Chern embodied an unusual combination: a great mathematical thinker with a talent for knowing what practical measures would benefit the field. Together with his Berkeley colleagues Calvin Moore and Isadore Singer, he was the driving force behind the establishment of the Mathematical Sciences Research Institute (MSRI) in Berkeley in 1980 and served as its first director. Few could resist a phone call from Chern with an invitation to come to a workshop or to organize one or to serve on a committee, Singer recalled. “If Chern called and asked, everyone said yes. That was part of the success of MSRI in attracting really great people.” Since those early years MSRI has come to be a model for many other institutes around the world and stands as one of the most successful. As current MSRI director David Eisenbud noted in his remarks at the memorial service, Chern remained very supportive of the institute over the years and was a key figure in the drive for a new addition to the MSRI building, now under construction. After the addition is completed, the building will be named Chern Hall.

MSRI was actually the third institute founded by Chern. The first was the mathematics institute at the Academia Sinica, which he created in 1946, first in Shanghai and then in Nanking. In 1984 he founded the Nankai Institute of Mathematics at Nankai University in Tianjin. When he moved to Nankai permanently after his wife’s death in 2001, he lived in a home that the university had built for him near the institute so that he could come in every day, even though he was by then in a wheelchair. He served as honorary director of the Nankai Institute until his death. In his remarks during the memorial service, Calvin Moore noted that Chern’s creation of the geometry group in the Berkeley



Photographs by Peg Skorpinski.

mathematics department could almost be considered a fourth institute founded by Chern.

While Chern spent most of his career outside of China, his ties to his homeland were always strong. He was one of the most influential figures in promoting mathematical ties between China and the United States. His fame in China was tremendous. At the International Congress of Mathematicians held in Beijing in 2002, whenever Chern would appear, a crowd would collect around his wheelchair. In recalling other occasions in China when Chern was mobbed by enthusiastic young people wanting his picture or autograph, more than one speaker at the memorial service likened his fame to that of a rock star.

In China the outpouring of feeling upon Chern’s death was extraordinary. According to his son, Paul, a continuous stream of people, totaling perhaps 10,000, came to pay their respects during Chern’s four-day lying-in-state at Nankai University. A musical concert performed in his honor was broadcast on television monitors so that the crowd outdoors could listen. Students held an all-night vigil on the night he died. They ringed his home and a lake with lighted candles and folded a thousand white origami cranes, which symbolize the journey to heaven.

Because Chern was considered such an important national figure, some of the arrangements for his funeral were handled by Chinese government officials. There was some discussion of whether he should be draped in the flag of the People’s Republic of China or in the flag of the Communist Party, of which he was not a member. His daughter, May, stepped in with a solution: he would be draped in a plain white cloth. Chern was not a political figure. He was simply a mathematician.

—Allyn Jackson

Property (τ)?

Alex Lubotzky

Property (τ) is a baby version of Kazhdan's property (T) from the representation theory of semi-simple Lie groups. It is the crucial ingredient in Margulis's construction of expanders—graphs that are basic building blocks in many communication network constructions. Property (τ) appears also in the theory of automorphic forms and in hyperbolic geometry and found its way to applications in computational group theory and in the combinatorics of finite simple groups.

So what is property (τ)? The story begins with (T) as a property of a locally compact (e.g., discrete) group G . Property (T) requires that the trivial one-dimensional representation of G is “bounded away” from all other irreducible unitary representations of G . For a group like $\Gamma = \text{SL}_n(\mathbb{Z})$ generated by a finite set S , it means that whenever Γ acts nontrivially and irreducibly on a Hilbert space H , every vector v of H is moved by “at least ε ” away from v for some $\varepsilon > 0$ independent of H and v .

In 1973 Margulis realized that this “pushing property” is exactly what is needed to construct expanding graphs. These graphs—expanders—are highly connected sparse graphs that play an important role in combinatorics and computer science (see [3]). Loosely speaking, they are “fat and round”: One cannot cut them into two large subsets without cutting a lot of edges. Or, equivalently, for every subset A of the vertices of the graphs, its boundary, i.e., the vertices outside A that are connected to A , form a fairly large set compared to A . Such graphs were known to exist by random consideration (à la Erdős), but explicit constructions are desired.

Property (T) gave them: Let Γ be a group generated by a finite set S and $\mathcal{L} = \{N_m\}_{m \in I}$ a family of finite index normal subgroups of Γ . The finite quotients Γ/N_m give rise to a family of Cayley graphs $X_m = \text{Cay}(\Gamma/N_m; S)$, where the vertices of X_m are the elements of Γ/N_m , and two vertices a and b are connected if there exists $s \in S$ such that either $b = sa$ or $a = sb$.

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Now the group Γ acts on Γ/N_m , and hence we have a unitary representation on $L^2(\Gamma/N_m)$. Property (T) now implies that for every subset A of Γ/N_m , the characteristic function χ_A of A is “pushed by at least ε ” by one of the elements in S . This means that sA is “substantially different” from A and implies that the boundary of A is large. Hence $\text{Cay}(\Gamma/N_m; S)$ form a family of expanders.

A more careful look at the above argument shows that we were not using the full power of (T); property (T) says that all the representations have the “pushing” property, but we have used (T) only with respect to those unitary representations that factor through the finite quotients Γ/N_m ; they are, in particular, finite dimensional. This led to the definition of (τ):

Definition. Let Γ be a group and $\mathcal{L} = \{N_m\}_{m \in I}$ a family of finite index normal subgroups in Γ . Then Γ **has property (τ) with respect to \mathcal{L}** if the nontrivial irreducible representations of Γ factoring through Γ/N_m (for some $m \in I$) are bounded away from the trivial representation. We say that Γ **has (τ)** if \mathcal{L} is the family of all finite index normal subgroups.

In fact, (τ) is exactly what is needed to make $\text{Cay}(\Gamma/N_m; S)$ expanders; they are expanders if and only if Γ has (τ) with respect to \mathcal{L} .

So the representation-theoretic property (τ) has an equivalent combinatorial form. But this is not the only one: Property (τ) can be expressed in equivalent analytic, geometric, and even measure-theoretic formulations. For example, assume $\Gamma = \pi_1(M)$ is the fundamental group of a compact Riemannian manifold M and M_m ($m \in I$) is the finite sheeted covers of M corresponding to N_m ($m \in I$). Let $\lambda_1(M_m)$ be the smallest positive eigenvalue of the Laplacian (= Laplace-Beltrami operator) of M_m . Then Γ has (τ) with respect to $\mathcal{L} = \{N_m\}_{m \in I}$ if and only if there exists $\varepsilon > 0$ such that $\lambda_1(M_m) \geq \varepsilon$ for every $m \in I$. The point of this equivalence is that the Cayley graphs of Γ/N_m are discrete approximations of the manifolds M_m . The graphs are expanders if and only if their λ_1 's are bounded away from zero and their λ_1 's approximate those of M_m .

The various equivalent forms of property (τ) not only indicate its intrinsic interest but also allow

some quite diverse and unexpected applications. Let us mention a few of them.

A celebrated theorem of Selberg from 1965 asserts that $\lambda_1(\Gamma(m)\backslash\mathbb{H}) \geq \frac{3}{16}$ when \mathbb{H} is the upper half-plane $\{z = x + yi \mid x, y \in \mathbb{R}, y > 0\}$ on which $\mathrm{SL}_2(\mathbb{R})$ (and hence also $\mathrm{SL}_2(\mathbb{Z})$) acts by Möbius transformations:

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} (z) = \frac{az + b}{cz + d}.$$

Here $\Gamma(m)$ is the congruence subgroup $\Gamma(m) = \mathrm{Ker}(\mathrm{SL}_2(\mathbb{Z}) \rightarrow \mathrm{SL}_2(\mathbb{Z}/m\mathbb{Z}))$, and as before $\lambda_1(\Gamma(m)\backslash\mathbb{H})$ is the bottom of the positive spectrum of the Laplacian. This is a deep result whose proof involves analysis of the Riemann surface $\Gamma(m)\backslash\mathbb{H}$ as well as Weil's estimates on Kloosterman sums, which in turn boil down to the Riemann hypothesis over finite fields.

In light of the above, Selberg's theorem implies that $\mathrm{SL}_2(\mathbb{Z})$ (which has neither (T) nor (τ)) does have (τ) with respect to the family of congruence subgroups. Selberg's results have been generalized by various authors, and recently Clozel showed that the same holds for all (characteristic zero) S -arithmetic subgroups of semisimple groups.

Since $\mathrm{SL}_2(\mathbb{Z})$ is generated by $a = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$ and $b = \begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$, we can deduce that the Cayley graphs of $\mathrm{SL}_2(\mathbb{Z}/p\mathbb{Z})$ with respect to these generators a and b form a family of expanding graphs. It is not difficult to see that the diameter of expanders is logarithmic in their size. From this one deduces

Corollary. *The matrix*

$$u_p = \begin{pmatrix} 1 & \frac{p-1}{2} \\ 0 & 1 \end{pmatrix} \in \mathrm{SL}_2(\mathbb{Z}/p\mathbb{Z})$$

can be written as a word of length $O(\log p)$ using the generators a and b and their inverses.

Note that $u_p = a^{(p-1)/2}$. It is, however, not at all clear how b can help us to write u_p as a shorter word. In fact, the proof of the corollary is not constructive, and no such explicit word is known. The only known proof of this elementary statement is via the Selberg theorem and property (τ) .

The above types of arguments were the starting point of an elaborate study of the diameter of finite simple groups with respect to various choices of generators.

Another surprising connection to computing arises in computational (finite) group theory. In this area the goal is to design algorithms to study specific groups. Here is a typical example to keep in mind: Given two invertible 100×100 matrices A and B over the field of two elements \mathbb{F}_2 , find the order of the group G generated by them. A basic subroutine in many of these algorithms is one that provides a random element from the group G . Finding such a random element in G (before G has been computed or before its order is known) is an interesting challenge. The naive approach—to take

a random long word in A and B —can be nicely analyzed theoretically but gives poor (i.e., slow) results. A new method was presented ten years ago called “the product replacement algorithm” (PRA, for short), which is a kind of noncommutative Gaussian elimination. Its implementation showed outstanding results. In computation—as in physics—if something works, everyone uses it. Still, its rigorous justification was somewhat mysterious. Surprisingly, (τ) came into the picture: The analysis of the PRA boils down to analyzing random walks on some graphs. These graphs turned out to be Cayley graphs of some finite quotients of $\mathrm{Aut}(F)$ —the automorphism group of the free group. So if $\mathrm{Aut}(F)$ has (τ) , these graphs are expanders and the random walks on them converge very fast to the uniform distribution, giving a full explanation of the outstanding performance of the PRA. As of now, the question of whether $\mathrm{Aut}(F)$ has (τ) is still open—but enough is known to get some partial results and new insight on the PRA.

Also (τ) has found its way into geometry. A well-known conjecture attributed to Thurston asserts that an n -dimensional closed hyperbolic manifold has a finite sheeted cover with positive first Betti number. The conjecture, if true, would reveal a lot of the geometry and topology of these manifolds. Property (τ) came unexpectedly into a proof of this conjecture for the subfamily of arithmetic manifolds.

The case of hyperbolic 3-manifolds is of special interest. Recent work of Lackenby may open the door to an even more dramatic application of (τ) to geometry: Lubotzky and Sarnak conjectured that the fundamental group of a compact hyperbolic 3-manifold does not have property (τ) (it is well known that it does not have the stronger property (T)). Lackenby shows that this conjecture (together with another quite plausible conjecture on the Heegard splitting) would imply the “virtual Haken conjecture”. This last conjecture falls short of Thurston's conjecture but gives essentially all the geometric and topological corollaries. This work shows that property (τ) may play a significant role in the theory of hyperbolic 3-manifolds.

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Mathematics in Nature: Modeling Patterns in the Natural World

Reviewed by Brian D. Sleeman

Mathematics in Nature: Modeling Patterns in the Natural World

John A. Adam

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And while I have sought to shew the naturalist how a few mathematical concepts and dynamical principles may help and guide him, I have tried to shew the mathematician a field for his labour—a field which few have entered and no man explored. Here may be found homely problems, such as often tax the highest skill of the mathematician, and reward his ingenuity all the more for their trivial associations and outward semblance of simplicity.

So writes D'Arcy Wentworth Thompson (1860–1948) [8], the great biologist, in the epilogue to his magnum opus *On Growth and Form* in 1917. In this classic work Thompson states his task in the following words:

The terms Growth and Form, which make up the title of this book, are to be understood, as I need hardly say, in their relation to the study of organisms. We want to see how, in some cases at least, the forms of living things, and of the parts of living things, can be explained by physical considerations, and

to realise that in general no organic form exists save as are in conformity with physical and mathematical laws.

The torch lit by D'Arcy Thompson has been taken up, in the last quarter of the twentieth century, by a growing band of mathematicians and theoreticians to the extent that mathematical or theoretical biology is well recognised as an important discipline in many undergraduate and graduate schools in universities and colleges. Mathematicians have indeed brought their skills to address biological questions. The Fields Medallist René Thom brought a great wealth of new topological and analytic ideas to the fundamental problems of modelling and understanding morphogenesis [7]. Here Thom introduces his idea of a catastrophe to build mathematical models of embryology, the structure of cells, as well as models of thought and language. In the two-volume work on mathematical biology [5], Murray has brought to bear a wealth of modelling ideas and mathematical techniques, ranging from the most elementary to the cutting edge of modern nonlinear mathematical analysis, to describe a vast array of biological phenomena. Indeed, Murray's books have had and continue to have a major impact on current mathematical biological research.

Much more recently, in this postgenomic era of biomedical research, a key objective is to systematically catalogue all the molecules and their interactions within a living cell. This in turn has given rise to the concepts of network biology, which finds its mathematical expression in terms of the theory of random graphs. Indeed, recent advances in network biology suggest that cellular networks are governed by universal laws and offer a

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new conceptual framework that may revolutionise our view of biology [1], [2].

In the drive to bring these exciting developments to the lay audience and to aid the public understanding of science, eminent scientists have written some excellent books on the theoretical underpinning of biology. In this regard the books of Brian Goodwin, *How the Leopard Changed Its Spots: The Evolution of Complexity* [3]; Ian Stewart, *Life's Other Secret* [6]; and Hans Meinhardt, *The Algorithmic Beauty of Sea Shells* [4], are just a few examples.

At the start of the new millennium it is natural and even fortuitous that John Adam has written a book that in some ways attempts to light a new torch. However, the torch that Adam carries illuminates a different path from that of D'Arcy Thompson. John Adam's quest is a very simple one: that is, to invite one to look around and observe the wonders of nature, both natural and biological; to ponder them; and to try to explain them at various levels with, for the most part, quite elementary mathematical concepts and techniques. No mathematical technique, however sophisticated, can lead to a deeper understanding of the natural world unless the practitioner has been able to ask the right questions and to express the problem in terms of a mathematical model that can be explored and tested against experimental or observable evidence.

Mathematics in Nature begins by using simple arithmetical ideas to investigate some quite intriguing and fun problems. For instance, Adam relates the apparently true story of an inmate at a correctional center in West Virginia who escaped from the prison grounds by using a rope made from dental floss to pull himself over the courtyard wall. Given that the rope was estimated to be the thickness of a telephone cord (about 4 mm in diameter) and the wall 18 feet high, how many packets of dental floss were required? This question can be answered by estimating the diameter of dental floss to be 1/2 mm and noting that a typical packet contains 55 yards. A very different kind of problem is that of estimating the weight of the atmosphere, a calculation that might seem daunting but is in fact surprisingly simple. There is also the problem of saving the world from an alien attack! Here Adam recalls the sci-fi novel *The Black Cloud* by the late astronomer Sir Fred Hoyle, in which one of the characters does a "back-of-an-envelope" calculation to estimate the time of arrival of a mysterious and seemingly intelligent cloud of dust and gas that is directly approaching Earth.

Next, one is introduced to the ideas of dimensional analysis. This was the starting point for D'Arcy Thompson and essentially concerns the way in which physical characteristics vary with

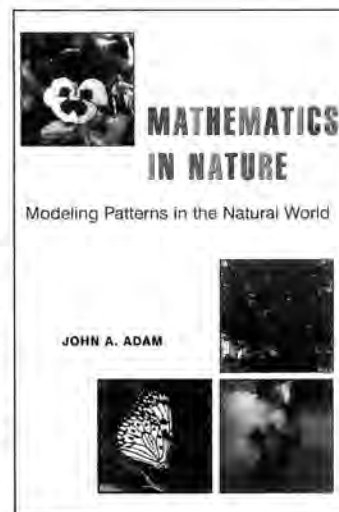
size. Dimensional analysis is perhaps the first modelling technique required in order to begin to understand any physical or natural phenomenon. Here we meet the problem of estimating how long a sea mammal can endure a dive or how high a flea can jump. Another interesting application is to use dimensional analysis to study the question, why do cells divide when they reach a certain size?

A wonder of nature that is familiar to everyone is the rainbow. It is one of the most beautiful and intangible manifestations of nature, and the history of its theorisation goes back to Descartes, Newton, and Snell. John Adam writes a very accessible account of the structure of rainbows using elementary trigonometry and basic differential calculus. In addition, he leads one into related phenomena such as the halo and the glory, the formation of ice crystals and snowflakes, and even a discussion of the iridescence of the wing cases of beetles. It is a delight to see how quite basic mathematical techniques can be used to help one understand and appreciate the beauty of the world around us.

In the chapter "Clouds, Sand Dunes, and Hurricanes" a variety of modelling ideas are introduced, and here Adam reemphasises his basic philosophy, i.e., "try to understand a given phenomenon at as many complementary levels as possible."

Waves occur in many situations in the natural world. Ocean waves and the ripples on a pond are commonly observed by everyone. The evidence for the presence of waves can sometimes be seen in cloud formations and the shape of sand dunes. Adam devotes considerable time to the study and structure of waves. Beginning with linear wave theory, he leads one to examine dispersion relations and matters of stability. There are applications of the theory to shallow and deep-water waves as well as to ship waves. There are of course limitations to the linear theory. An example of a wave phenomena that cannot be modelled by linear theory is that of a remarkable "solitary wave" observed by J. Scott-Russell in 1834:

I was observing the motion of a boat which was rapidly drawn along a narrow channel by a pair of horses, when the boat suddenly stopped—not so the mass of water in the channel which it had put in motion; it accumulated round the prow of the vessel in a state of violent agitation, then suddenly leaving it behind, rolled forward with great



velocity assuming the form of a large solitary elevation, a rounded, smooth and well-defined heap of water, which continued its course along the channel apparently without change of form or diminution of speed. I followed it on horseback, and overtook it still rolling at a rate of some eight to nine miles an hour, preserving its original figure some thirty feet long and a foot to a foot and a half in height. Its height gradually diminished, and after a chase of one or two miles I lost it in the windings of the channel. Such, in the month of August 1834, was my first chance interview with that singular and beautiful phenomenon.

This phenomenon led to a mathematical description in 1895 by Korteweg and de Vries and gave birth not only to the so-called KDV equation but also to the modern studies of integrable partial differential equations and the inverse scattering method.

Although KDV is beyond the scope of this book, there is a nice treatment of the somewhat more tractable Burger's equation, which models, for example, the mechanisms which maintain a tidal bore.

Once more one is invited to look around for more of nature's symmetries. Look up and you may see hexagonal convection-cell clouds; look around and you may see mud cracks of polygonal shape. Look at a bees' honeycomb with its very regular hexagonal cells. In this latter phenomenon John Adam argues that while bees are not optimisation experts, they do like to construct polygonal cells that enclose a region of maximum area but with minimum perimeter. This then leads to a discussion of the areas and perimeters of regular polygons and the problem of tiling two-dimensional space. It is easy to see that the hexagonal cell does the trick here. However, when one recognises that honeycomb cells are essentially three-dimensional, the problem is much more challenging and involves the so-called Kelvin Problem: What is the most efficient (i.e., minimum of the surface area of the boundary) partition of space into equal volumes? It is surprising how far one can investigate such problems with the use of elementary geometry and calculus. In the same chapter Adam takes up a similar line of enquiry in the discussion of soap bubbles and foams, which is the term used for an agglomeration of bubbles. Polygonal mud cracks are a different phenomenon altogether, and different modelling ideas are required. A good start is to recognise that tension forces are involved, and this suggests that Hooke's law—namely, tension is proportional to displacement—

is a good idea, combined with the principle of least work.

In Chapter 12 Adam looks at the problems of meandering rivers and river draining patterns, as well as the mechanical forces experienced by trees. In the former case an appeal is made to the hypothesis due to Langbein and Leopold that "meanders are not mere accidents of nature, but the form in which a river does the least work in turning." Here Adam considers the mean square curvature of a river bend and uses the basic ideas drawn from the calculus of variations to obtain conditions under which the mean square derivative of the curvature is a minimum. He also draws out a connection with stresses in an elastic wire.

In the discussion of river drainage patterns one is introduced to the cellular automata rules which are invoked. A river or stream is said to be of class 1. When any two rivers merge they form a branch of class 2, and after merging with yet another river, they form a branch of class 3, and so on. This can be generalised through defining the following rules:

1. If two tributaries of the same class i merge, the resulting branch is of class $i + 1$.
2. If two tributaries of different classes, i and j , merge, where $j > i$, the resulting branch is of class j .

The next step is to consider N_i , the total number of tributaries of class i , and let m be the class of the main stream. Then by assuming that N_i obeys simple power laws or, more interestingly, is equal to a particular Fibonacci number, then some quite realistic drainage patterns may be computed. Adam then goes on to use beam theory to discuss the bending and shaking of trees as well as to estimate how high a tree can grow without buckling under its own weight.

Bird flight is the subject of Chapter 13. Here it is interesting to learn that it is much more efficient for flocks of birds to fly in V formations rather than individually. Adam develops the basic equations of bird flight, which involves the concepts of drag, lift, and wingloading. Using these concepts together with dimensional analysis and Bernoulli's theorem, he discusses gliding and hovering, and also describes how soaring birds take advantage of thermals and sea birds of wind shear just above the surface of the sea.

How did the leopard get its spots? One answer to this question is given by Rudyard Kipling in his *Just So* stories. While this account is a delightful legend, it does not help us to understand how animal coat markings arise in general. For this we turn to the great scientist Alan Turing of *Enigma* fame and, to some, better known as a founding father of computing. In a groundbreaking paper [9] that appeared in 1952, he showed that diffusion can destabilise a chemical concentration to produce patterns in place of a uniform homogeneous steady state. This rather counterintuitive observation has

led to an enormous body of work on the study of reaction-diffusion equations with far-reaching biological consequences. J. D. Murray [5] and many others have taken up Turing's ideas and developed many models of animal coat markings, limb-bud development, and even how the crocodile got its teeth!

The underlying assumptions of patterning models are:

1. Certain chemicals (called morphogens) stimulate cells to produce melanin, high concentrations of which produce colouration, but low concentrations do not.

2. Two chemicals are produced in the skin. One activates the production of melanin, and the other inhibits it.

3. Production of the "activator" initiates the production of the "inhibitor".

4. The inhibitor diffuses faster than the activator.

These assumptions, combined with Turing's discovery, lead to the construction of activator-inhibitor systems of reaction-diffusion equations that can be used to model a wide range of patterns in nature.

As Adam points out, there are alternatives to the reaction-diffusion embryological pattern-forming models. One example, not discussed in this book, is Lewis Wolpert's [10] idea of "positional information", suggesting that cells are preprogrammed to read a chemical (i.e., morphogen) concentration and differentiate accordingly into different kinds of cells destined to become, for example, cartilage, bone, tissue, hair, etc. Indeed, there is still much controversy surrounding this fundamental problem of developmental biology.

A related and fascinating study modelled by reaction-diffusion equations is the colouring and patterning of a butterfly wing. The wing pattern is laid down during the pupation stage. One suggestion is that a morphogen that "switches on" a particular gene in the wing cells is released from sources located somewhere on the wing. The morphogens diffuse throughout the wing cells and "throw" biochemical switches when they exceed some threshold concentration. It also turns out that the wing pattern depends crucially on the geometry and scale of the wing.

Adam illustrates these ideas in application to a simple one-dimensional model of diffusing morphogen that introduces the fundamental solution of the heat equation and the method of separation of variables. There is also a brief discussion of the development of plankton blooms.

The book concludes with a little appetising dip into fractal geometry, which is currently reshaping some of the ways one thinks about patterns in nature.

Unlike D'Arcy Thompson, John Adam did not write an epilogue to his book, but it does deserve

one. To paraphrase D'Arcy Thompson, such an epilogue could read:

And while I have sought to show the natural observer how a few mathematical concepts and dynamical principles may help and guide him, I have tried to show students and practitioners of mathematics and the just plain curious a field of adventure for their labour. Here may be found homely problems to tax the highest skills of mathematical students and reward their ingenuity.

On Growth and Form is a classic; *Mathematics in Nature* has the potential to become one too.

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Lax Receives Abel Prize



Peter D. Lax

The Norwegian Academy of Science and Letters has decided to award the Abel Prize for 2005 to PETER D. LAX of the Courant Institute of Mathematical Sciences, New York University, for his groundbreaking contributions to the theory and application of partial differential equations and to the computation of their solutions. The prize amount is 6 million

Norwegian kroner (about US\$980,000).

Ever since Newton, differential equations have been the basis for the scientific understanding of nature. Linear differential equations, in which cause and effect are directly proportional, are reasonably well understood. The equations that arise in such fields as aerodynamics, meteorology, and elasticity are nonlinear and much more complex: their solutions can develop singularities. Think of the shock waves that appear when an airplane breaks the sound barrier.

In the 1950s and 1960s, Lax laid the foundations for the modern theory of nonlinear equations of this type (hyperbolic systems). He constructed explicit solutions, identified classes of especially well-behaved systems, introduced an important notion of entropy, and, with Glimm, made a penetrating study of how solutions behave over a long period of time. In addition, he introduced the widely used Lax-Friedrichs and Lax-Wendroff numerical schemes for computing solutions. His work in this area was important for further theoretical developments. It has also been extraordinarily fruitful for practical applications, from weather prediction to airplane design.

Another important cornerstone of modern numerical analysis is the "Lax Equivalence Theorem". Inspired by Richtmyer, Lax established with this theorem the conditions under which a numerical implementation gives a valid approximation to the solution of a differential equation. This result brought enormous clarity to the subject.

A system of differential equations is called "integrable" if its solutions are completely characterized by some crucial quantities that do not change in time. A classical example is the spinning top or gyroscope, where the conserved quantities are energy and angular momentum.

Integrable systems have been studied since the nineteenth century and are important in pure as well as applied mathematics. In the late 1960s a revolution occurred when Kruskal and coworkers discovered a new family of examples that have "soliton" solutions: single-crested waves that maintain their shape as they travel. Lax became fascinated by these mysterious solutions and found a unifying concept for understanding them, rewriting the equations in terms of what are now called "Lax pairs". This developed into an essential tool for the whole field, leading to new constructions of integrable systems and facilitating their study.

Scattering theory is concerned with the change in a wave as it goes around an obstacle. This phenomenon occurs not only in fluids, but also, for instance, in atomic physics (Schrödinger equation). Together with Phillips, Lax developed a broad theory of scattering and described the long-term behavior of solutions (specifically, the decay of energy). Their work also turned out to be important in fields of mathematics apparently very distant from differential equations, such as number theory. This is an unusual and very beautiful example of a framework built for applied mathematics leading to new insights within pure mathematics.

Peter Lax has been described as the most versatile mathematician of his generation. The impressive list above by no means states all of his achievements. His use of geometric optics to study the propagation of singularities inaugurated the theory of Fourier integral operators. With Nirenberg, he derived the definitive Gårding-type estimates for systems of equations. Other celebrated results include the Lax-Milgram lemma and Lax's version of the Phragmén-Lindelöf principle for elliptic equations.

He is also one of the founders of modern computational mathematics. Among his most important contributions to the high performance computing and communications community was his work on the National Science Board (NSB) from 1980 to 1986. He also chaired the committee convened by the NSB to study large-scale computing in science and mathematics—a pioneering effort that resulted in the “Lax Report”.

A distinguished educator who has mentored a large number of students, Lax has also been a tireless reformer of mathematics education. His work with differential equations has for decades been a standard part of the mathematics curriculum worldwide.

Lax stands out for having joined together pure and applied mathematics, combining a deep understanding of analysis with an extraordinary capacity to find unifying concepts. He has had a profound influence not only by his research, but also by his writing, his lifelong commitment to education, and his generosity to younger mathematicians.

Peter Lax was born on May 1, 1926, in Budapest, Hungary. He was on his way to New York with his parents on December 7, 1941, when the United States joined the war. He received his Ph.D. in 1949 from New York University with Richard Courant as his thesis advisor. In 1950 Lax went to Los Alamos for a year and later worked there for several summers as a consultant. He joined the faculty at NYU in 1951 and became a full professor in 1958. Lax served as director of the Courant Institute from 1972 to 1980. At NYU he has also served as director of the AEC (Atomic Energy Commission) Computing and Applied Mathematics Center.

His work has been recognized by many honors and awards. He was awarded the National Medal of Science in 1986, the Wolf Prize in 1987, and the Chauvenet Prize of the Mathematical Association of America in 1974. He received the AMS Steele Prize for Lifetime Achievement in 1993 and the AMS-SIAM Norbert Wiener Prize in 1975. He served as both president (1977–80) and vice president (1969–71) of the AMS. He was elected to the U.S. National Academy of Sciences in 1982.

—From a Norwegian Academy of Science and Letters news release



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Young mathematicians with interests in the above research areas are encouraged to apply. Applicants for a senior position should have good teaching and strong international research records, and the ability to raise research funding and develop strong research programmes in their fields of interest. Candidates should indicate for which level of position they are applying. Level of appointment will be commensurate with experience and standing of applicants.

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de Boor and Luce Receive National Medal of Science



Carl R. de Boor



R. Duncan Luce

On March 14, 2005, President George W. Bush presented the 2003 National Medals of Science in a White House ceremony. The medal is the nation's highest honor for researchers in science and engineering. The medals also recognize contributions to innovation, industry, or education.

Among those receiving the medals were two in the mathematical sciences. R. DUNCAN LUCE, the Distinguished Research Professor of Cognitive Science at the University of California, Irvine, was awarded the medal in behavioral and social sciences. CARL R. DE BOOR, professor emeritus, University of Wisconsin, Madison, received the medal in mathematics.

Duncan Luce has been world-renowned as a theoretical mathematician of behavior of the past fifty years. His theory of choice helped launch the field of behavioral economics and gave scientists a powerful tool for understanding how animal and human learning occurs. He sparked the development of gaming theory, which is now applied to diverse systems including improving the accuracy of predictions of stock market fluctuation. His mathematical tools also developed the scientific study of judgment and decision-making across disciplines. Luce's early work in demonstrating the laws governing behavior in humans and his development of measurement theory helped shape research in psychology, cognitive neuroscience, and sociology for more than three decades. It

formed part of the theoretical base on which computer modeling of behavior was developed.

Carl de Boor is a leading researcher in approximation theory and its practical numerical implementation. A master of approximations by splines, an essential tool in computer-aided design and manufacture, computer graphics, and image processing, de Boor was one of the pioneers in numerical computing, attacking the challenging problem of producing practical algorithms that can be applied to real software. More than anyone else, de Boor is credited with the phenomenal success of spline functions—mathematical expressions that describe free-form curves and surfaces. De Boor was the first to understand their scientific potential and to put forward the novel theory that developed their important properties. Subsequently, he developed algorithms for the fast computation and visualization of spline functions. Much of his work has been applied to fields relying on precise geometrics, such as film special effects and the aircraft and automotive industries.

The National Medal of Science was established in 1959 as a presidential award to be given to individuals for their outstanding contributions to knowledge in the physical, biological, mathematical, or engineering sciences. In 1980, Congress expanded this recognition to include the social and behavioral sciences. The president appoints a committee of twelve scientists and engineers to evaluate nominees for the award. The medal has been given to over 400 distinguished scientists and engineers whose careers span decades of research and development, as well as support and outreach to students and society.

—From a National Science Foundation
news release

The Panel

Reviewed by Andy Magid

The Panel

William Rundell

Performed January 7, 2005, Atlanta, GA

Reginald Rose's classic 1954 television play *Twelve Angry Men* (the terrific 1957 movie version directed by Sidney Lumet is available on DVD) enjoyed an unexpectedly successful revival on Broadway recently, its limited engagement extended seven times as of this writing. The play recounts the deliberations of the jury in a murder trial. As Ben Brantley wrote in the *New York Times* in his October 29, 2004, review of the current production: "This 90-minute, intermissionless show, built around the dissection of a murder, is for folks who would usually rather stay home with 'Law & Order' or Agatha Christie than schlep to the theater. It combines the methodical suspense of an old-fashioned murder mystery with the healthy glow of a civics lesson. As the jurors debate the probable guilt of an inner-city adolescent accused of stabbing his father to death, prejudices and preconceptions are aired and exorcised." Brantley also notes that the play is short, with one simple set and a dozen good speaking parts, reasons that contribute to its frequent production by amateur and student theatre groups. The civics lesson, by the way, is that jurors are human beings who bring to their deliberations their personal histories and personalities, as well as the understandings (or misunderstandings) they gained from the presentations in the trial. And despite this, or perhaps because of this, truth emerges and justice is done.

Which brings us to *The Panel*, an immensely entertaining and important one-act play about the deliberations of a National Science Foundation

(NSF) Division of Mathematical Sciences (DMS) review panel. It was written by William Rundell, director of the DMS, and had its world premier performance at the Joint Mathematics Meetings in Atlanta, January 7, 2005. As with *Twelve Angry Men*, the audience gets to be fly-on-the-wall voyeurs at confidential deliberations, in this case of a panel reviewing NSF proposals. As the panelists discuss and ultimately rate each proposal, we see their mathematical history, personality, and prejudices on display, and we also see justice done. This is the stuff of drama, although Rundell's play is more of a comedy, despite claims to the contrary by the author. (At the Atlanta production he bemoaned the difficulty of humor in the government setting, noting, for example, that "jokes about religion were not kosher.") Much of the humor comes from the fanciful names given the mathematical subjects being discussed—"abstract fantasy theory" is a typical example—and the deadpan delivery with which the panelists read such lines as "the theory of periodic cohomologies that is a hot area in surreal theory these days has some potential for making headway on the Rothko conjecture."

Underneath the lighthearted lines, however, lies a serious purpose: NSF proposals are not read by machines. They are read by mathematicians, who make judgments based on what they know about the mathematics in the proposal and about the proposer as a mathematician. Each of the proposals evaluated in *The Panel*, as with all proposals submitted to the NSF, have been read in advance by the panelists, and in addition one panelist has been designated to present a summary report. Then the rest of the panelists express views, discussion ensues, and ultimately a collective rating is given. An NSF program officer sits with the panel and functions as facilitator. In *The Panel* the program officer is actually standing at a



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GRANT FUNDING ENDED

The Calculus Consortium for Higher Education (CCHE) is a small non-profit public charity which was an outgrowth of an NSF funded project in innovative coursework in undergraduate education (the "Calculus Consortium based at Harvard"). The mission of CCHE was to improve the teaching of mathematics in secondary schools, two-year colleges, colleges and universities. It supported workshops, meetings, conferences or research projects in innovative coursework, making 41 grants totaling \$455,280 over a period of 7 years. The scope of these projects was broad, ranging from small grants for rural school districts to national grants to the MAA to support curricular recommendations and to the AMS to support teaching workshops for graduate students. We hope these projects have made a difference. CCHE will be dissolving by the end of this year and is no longer accepting proposals. We want to thank all of the members of the mathematics community who sent in grant requests; we are sorry we couldn't fund them all.

whiteboard recording results as well as offering guidance.

The play opens in the middle of the panel's deliberations. Proposals are presented that exemplify typical strengths, such as careful exposition, systematic description of the problem and proposed methods, good discussions of prior work, and so forth, and that exemplify typical flaws. These include lack of attention to all the previous, as well as those related to the proposer, such as unrealistically ambitious proposed research or unmentioned potential collaborations, lack of consideration of recent developments, or simple hubris. As one watches and listens to the panel, one begins to sense what makes for a successful proposal. At the very least, one learns what makes a proposal unsuccessful.

The play ends cinematically in a freeze frame in the middle of deliberations on a proposal; a narrator (Rundell in the Atlanta production) takes the stage and declaims, after a quotation from Puck's speech ending *A Midsummer Night's Dream*:

...if you've some attention paid
proposals' basis can be laid
Ideas creative and specific
expounded clearly are terrific
NSF will do its duty
and fund the best with all its booty.

The author's note to the script reads: "This one-act play is set in Ballston, Va., at the headquarters of mathematicians' favorite federal agency. It is a historical drama based on, and accurately adhering to, actual events, but typical of the genre it also seeks to entertain while penetrating facets of the human (and of course mathematical) condition." Entertain it does. And while the Reginald Rose drama is of practical educational value to (at most) murder defendants and their prosecutors, defense attorneys, and jury consultants, William Rundell's *The Panel* should be obligatory viewing for any mathematical proposal writer.

The parts of the panelists in the Atlanta production were played by Joanna Kania-Bartoszynska, Tomek Bartoszynski, Tony Chan, Brian Conrey, John Conway, and Deborah Lockhart; Henry Warchall was the program officer. In addition to reciting the envoi, William Rundell introduced the production.

The Budget Vise Tightens: NSF Fiscal Year 2006 Budget Request

This article is the 33rd in a series of annual reports outlining the president's request to Congress for the budget of the National Science Foundation. Last year's report appeared in the June/July 2004 issue of the *Notices*, pages 651-55.

Mathematicians taking a look at the fiscal year 2006 budget request for the National Science Foundation (NSF) will find their field highlighted as a "priority area". And yet when they get to the fine print and check the numbers, they will see that the NSF's Division of Mathematical Sciences (DMS) is slated for a zero increase.

This paradoxical state of affairs for mathematics is just one of many disappointments for the research community as the highly constrained budget process for 2006 gets under way. In February 2005 the Bush administration sent to Congress its budget request for fiscal year 2006, which begins on October 1, 2005. Tax cuts, an economy that has remained in low gear, and mounting bills for the war in Iraq and for national security have all combined to push the federal deficit to record proportions. As a result, many government activities are squeezed in the fiscal 2006 budget, and funding for research is no exception. Congress, which generally favors research, will rework the president's budget during the appropriations process, but the legislators do not have much wiggle room. The reality of too many priorities chasing too few dollars will not go away.

According to an analysis by the American Association for the Advancement of Science, under the terms of the fiscal 2006 request, total federal spending on research and development would rise \$84 million for a total of \$132.3 billion, a 0.1% increase over fiscal year 2005. Basic and applied research would decline by 1.4%, a decrease that comes on the heels of a small increase of just 1.4% the previous year. Against that backdrop the

requested increase of 2.4% for the NSF looks at first glance to be pretty good. The outlook for, say, the Department of Energy's Office of Science, for which the Bush administration has requested a 4.5% cut, is far worse. But this relative good news for the NSF masks a troubling reality. The NSF absorbed a 3.2% cut last year, so if the new request is enacted, the foundation's budget for fiscal 2006 would actually fall below the level of fiscal 2004. This would amount to a substantial cut when attrition by inflation is taken into account.

As Table 1 shows, NSF funding for research activities, outside of the mathematical sciences, would grow by 4.5%. But again, a closer look at the numbers gives a bleaker picture. Out of the \$189 million increase, \$48 million will go toward covering costs associated with the management of the polar icebreaking fleet, a responsibility formerly held by the Coast Guard. According to congressional testimony by NSF director Arden Bement Jr., the reason for the transfer of responsibility is increased participation by the Coast Guard in homeland security. Some have questioned whether \$48 million suffices, with some estimates holding that the true cost of the icebreaking activities could be as much as \$75 million annually.

Another big part of the increase for NSF research activities comes in the "Major Research Equipment and Facilities Construction" account, which would receive an increase of 44%, or \$76 million. While no new starts are planned, several construction projects that were put on hold will begin in fiscal 2006. If one sets aside the increases for the icebreaking fleet and for facilities construction,



the increase for the rest of the NSF's "Research and Related Activities" account would be just 1.5%.

But the hardest hit area within the NSF is the Education and Human Resources (EHR) directorate, which is slated for a 12.4% reduction. This cut comes on top of a 10.9% cut for EHR in fiscal 2005 (the administration actually requested an even larger cut of 17.9%). In recent years Congress has typically given EHR higher budgets than the administration has requested, so this proposed reduction might not become a reality. Indeed, some have speculated that the administration proposed a big cut for EHR anticipating that Congress would not let such a cut go through.

In past years the NSF appropriation was overseen by House and Senate subcommittees called Veterans' Affairs, Housing and Urban Development, and Independent Agencies. The NSF was one of the "independent agencies", as was the National Aeronautics and Space Administration (NASA). This year has seen a revamping of the appropriations

subcommittees. Among the newly created subcommittees are Science, State, Justice, and Commerce and Related Agencies on the House side, and its counterpart Commerce, Justice, and Science on the Senate side. The NSF and NASA, along with the National Institute of Standards and Technology, are now under the jurisdiction of these subcommittees. While the NSF was not well placed in the VA-HUD subcommittees, it is not clear it will fare better in the new scenario. Sharing the appropriations pie with NASA may make for stiff competition. NASA is slated for a 4.6% increase in the 2006 request, as President Bush's initiative for increased space exploration gets under way.

From Priority Area to a Flat Budget

When the 3.2% cut hit the NSF in the current fiscal year, the DMS was protected, relatively speaking. As other divisions sustained reductions of up to 5%, the DMS received a tiny increase in fiscal 2005 to \$200.38 million, up from \$200.35 million. This

Table 1: National Science Foundation (Millions of Dollars)

	2002 Actual	Change	2003 Actual	Change	2004 Actual	Change	2005 Plan	Change	2006 Request
(1) Mathematical Sciences Research Support	\$ 151.5	18.0%	\$ 178.8	12.0%	\$ 200.3	0.0%	\$ 200.4	0.0%	\$ 200.4
(2) Other Research Support (Note a)	3579.8	13.3%	4054.7	5.5%	4277.0	-1.9%	4193.8	4.5%	4383.1
(3) Education and Human Resources (Note b)	866.1	7.9%	934.9	1.0%	944.1	-10.9%	841.4	-12.4%	737.0
(4) Salaries and Expenses (Note c)	176.6	13.8%	201.0	14.7%	230.6	2.9%	237.2	19.9%	284.5
(5) Totals	\$4774.1	12.5%	\$5369.3	5.3%	\$5652.0	-3.2%	\$5472.8	2.4%	\$5605.0
(6) (1) as a % of the sum of (1) and (2)	4.06%		4.22%		4.47%		4.56%		4.37%
(7) (1) as a % of (5)	3.17%		3.33%		3.54%		3.66%		3.57%

Tables prepared by Notices staff.

Note a: Support for research and related activities in areas other than the mathematical sciences. Includes scientific research facilities and instrumentation. Note b: Support for education in all fields, including the mathematical sciences. Note c: Administrative expenses of operating the NSF, including the National Science Board and the Office of the Inspector General.

Table 2: Directorate for Mathematical and Physical Sciences (Millions of Dollars)

	2 0 0 2		2 0 0 3		2 0 0 4		2 0 0 5		2 0 0 6	
	Actual	% of Total	Actual	% of Total	Actual	% of Total	Plan	% of Total	Request	% of Total
(1) Mathematical Sciences	\$151.5	16.5%	\$ 178.8	17.2%	\$ 200.3	18.3%	\$ 200.4	18.7%	\$ 200.4	18.4%
(2) Astronomical Sciences	166.0	18.0%	187.1	18.0%	196.6	18.0%	195.1	18.2%	198.6	18.3%
(3) Physics	195.9	21.3%	224.5	21.6%	227.8	20.9%	224.9	21.0%	230.1	21.2%
(4) Chemistry	162.8	17.7%	181.6	17.4%	185.1	17.0%	179.4	16.8%	181.4	16.7%
(5) Materials Research	219.4	23.8%	241.4	23.2%	250.6	23.0%	240.5	22.5%	245.7	22.6%
(6) Office of Multidisciplinary Activities	24.8	2.7%	27.3	2.6%	31.1	2.8%	29.5	2.8%	30.0	2.8%
(7) Totals	\$920.4	100.0%	\$1040.7	100.0%	\$1091.6	100.0%	\$1069.9	100.0%	\$1086.2	100.0%

year it is the DMS's turn to take a hit: The other divisions within the Mathematical and Physical Sciences directorate are slated for increases of 1% or 2%, while the DMS is flat. Although the designation of the mathematical sciences as an NSF "priority area" did not help the DMS in the fiscal 2006 request, it did have a substantial impact on the division's budget in earlier years: As Table 3 shows, between 2000, when talk of a "priority area" first began, and 2004 the DMS budget rose 72% in constant dollars.

At the beginning of that period, when the economy was booming and government coffers were full, there was talk of even quadrupling the budget of the DMS—and of doubling that of the NSF as a whole. In late 2002 Congress passed a bill authorizing year-by-year increases, with the aim of doubling the NSF budget by 2007. But the bill was an authorization, not an appropriation, so as the fiscal condition of the government worsened, the bill's provisions fell by the wayside. In anticipation of large increases promised by the bill, some NSF divisions made commitments that are proving hard to keep with the current restricted budget. William Rundell, director of the DMS, said that his division managed to avoid becoming dangerously over-committed. Nevertheless, he said, "We built programs that, frankly, we would never have done were it not for the prospect and likelihood that the budget would increase still further." As Rundell put it, "The mood around here certainly isn't what it was two years ago."

While this year the DMS has "tightened every belt imaginable," Rundell said, the division's main priority has been to protect core funding for research grants. In fact, in the current fiscal year the DMS increased slightly the funding for single-investigator

grants "by clamping down on anything we can cut." Rundell said that the priority given to research grants will be the same in fiscal 2006. The AMS Committee on Science Policy (CSP) seems to be in tune with this strategy. At its meeting in April 2005 the CSP passed a resolution that states: "The AMS Committee on Science Policy recommends to DMS that it consider redirecting some NSF funds in order to increase the number of individual investigator grants, focused research grants and their equivalent." However, the constraints on the DMS may reach a point where this priority can be sustained only by cutting something fairly large out of the budget.

Last fall, rumors circulated that one of the five NSF-funded mathematics institutes might be eliminated. (These institutes are the Mathematical Sciences Research Institute in Berkeley, the Institute for Mathematics and its Applications at the University of Minnesota, the Institute for Pure and Applied Mathematics at the University of California at Los Angeles, the Mathematical Biosciences Institute at Ohio State University, and the Statistical and Applied Mathematical Sciences Institute at the Research Triangle Park. In addition, the School of Mathematics at the Institute for Advanced Study, the American Institute of Mathematics Research Conference Center in Palo Alto, and the Banff International Research Station in Banff, Canada, also receive institute funding from the NSF.) Asked if one of the institutes might be eliminated if the fiscal situation worsens, Rundell replied that this is a possibility: "Nothing is a given." Since the DMS has put top priority on research grants and since it received "priority area" designation in part by establishing work force programs like EMSW21 (Enhancing the Mathematical Sciences Workforce

Table 3: Compilation of NSF Budget, 2000–2006 (Millions of Dollars)

	2000 Actual	2001 Actual	2002 Actual	2003 Actual	2004 Actual	2005 Plan	2006 Request	2000–2004 Change	2000–2006 Change
(1) Mathematical Sciences Research Support	\$ 106.0	\$ 121.4	\$ 151.5	\$ 178.8	\$ 200.3	\$ 200.4	\$ 200.4	89.0%	89.1%
Constant Dollars	61.6	68.5	84.2	97.2	106.0			72.1%	
(2) Other Research Support (Note a)	2978.9	3370.2	3579.8	4054.7	4277.0	4193.8	4383.1	43.6%	47.1%
Constant Dollars	1729.9	1903.0	1989.9	2203.6	2264.2			30.9%	
(3) Education and Human Resources (Note b)	683.6	795.4	866.1	934.9	944.1	841.4	737.0	38.1%	7.8%
Constant Dollars	397.0	449.1	481.4	508.1	499.8			25.9%	
(4) Salaries and Expenses (Note c)	154.9	172.9	176.6	201.0	230.6	237.2	284.5	48.9%	83.7%
Constant Dollars	89.9	97.6	98.2	109.2	122.1			35.8%	
(5) Totals	\$3923.4	\$4459.9	\$4774.1	\$5369.3	\$5652.0	\$5472.8	\$5605.0	44.1%	42.9%
Constant Dollars	2278.4	2518.3	2653.8	2918.1	2992.0			31.3%	

Current dollars are converted to constant dollars using the Consumer Price Index (based on prices during 1982–84).

For Notes a, b, and c, see Table 1.

NSF Director Addresses Committee on Science Policy

On April 8, 2005, Arden Bement Jr., director of the National Science Foundation, spoke before a meeting of the AMS Committee on Science Policy. He began by noting that investments in research and education "contribute not only to economic growth and societal well-being but also to the increasing demands of national security." With this in mind, the NSF is developing a strategic plan that takes into account the constraints imposed by the federal budget. A key part of this plan will be to strengthen core research, since strong and healthy core disciplines lay the foundation on which quality interdisciplinary work is built. Bement said that increased funding in the past has also allowed the NSF to "improve the training of the future work force and to launch new, interdisciplinary programs." He pointed to the successes of programs like VIGRE (Vertical Integration of Research and Education in the Mathematical Sciences) in increasing the number of graduate students in mathematics and emphasizing mentoring and the preparation of students for research.

Bement said that "these are the success stories that resonate with policymakers and the public—people who want to know that their investments in research and education are worthwhile." Another sign that the investment has paid off is the emerging and unexpected applications of core research to interdisciplinary research. He pointed to several examples of how mathematical tools from topology and complex variables have had an impact on biomedical research. Partnerships between the mathematical sciences and the other sciences allow the NSF to demonstrate reasons for public support and also to leverage its resources in times of budget constraints. He pointed to opportunities not only in the biological sciences but also in the information sciences, where the ability to store, analyze, and visualize vast quantities of data is crucial to applications ranging from medical diagnosis to homeland security.

Bement finished his prepared remarks by emphasizing the need to continue to publicize research activities and engage in policy discussions. "To keep mathematics in the forefront of science and engineering and to sustain public support, we must clearly communicate both critical needs and brilliant results."

in the 21st Century), it is the other elements of the NSF portfolio that might end up on the chopping block—and the institutes are among them.

In the current restrained budget climate, one new idea the DMS may pursue is funding travel and workshops on a scale that is something between, say, a one-time \$20,000 conference, and a \$2-million-a-year institute. One model would be to establish research networks of the type that have developed in Europe with funding from the European Union. These networks—which sport clever acronyms like EAGER (European Algebraic Geometry Research Training Network) and EDGE (European Differential Geometry Endeavor)—link researchers at different institutions across several countries and are supported by multiyear grants on the order of \$500,000 per year to fund meetings, research visits, postdoctoral researchers, and graduate students. If the DMS began funding such

Bement then invited questions from the audience. When asked if there will be changes in the types of programs the NSF sponsors and in how they are administered, Bement lamented the erosion in the success rate of proposals and its demoralizing and counterproductive influence. He hopes to support more unsolicited single researcher proposals and narrow the focus on solicited proposals as well as cut back on some initiatives. In response to a question on the future of funding for mathematics education, Bement mentioned a bill that will be introduced in Congress to forgive interest on loans to students in science education programs in return for a two-year commitment to public service. Several people raised the question of whether it is better for mathematicians to push for support for basic science across the board or to emphasize mathematics. Bement cautioned that too narrow a strategy would minimize its effect and suggested that mathematicians need to help legislators understand how science works and its impact on society. A recurrent theme in many questions was the need to fund young researchers and active individual researchers and the concern that bigger grants, pluridisciplinary programs, and the review structure have had a negative impact on this need. Bement reiterated his desire to rebuild the core and increase the success rate.

—Michael F. Singer

Michael Singer is professor of mathematics at North Carolina State University and an AMS Council representative on the Committee on Science Policy.

The full text of Bement's prepared remarks may be found at <http://www.ams.org/ams/ArdenBement.PreparedRemarks.CSP2005.pdf>.

networks, a key aim would be to broaden participation by women, minorities, and those in nonelite institutions.

"There are no entitlements," Rundell said of the decisions the DMS will be making. "Everything is getting looked at very carefully. If something does not look first class, it may not be funded [in order] to make way for priorities."

Groundswell of Discontent


In the weeks and months after the release of the administration's fiscal 2006 budget request, many protested what they saw as inadequate increases for scientific research. During a February hearing of the House Science Committee, Vernon Ehlers (R-MI) summed up the general feeling: "I recognize the tough budget, I recognize tough times, I recognize the military necessities we have. But we seem to forget the important role that research and

education play in our national defense and also in our national prosperity." Many suggested that it is shortsighted for the U.S. to rein in its support for research just at a time when its competitors around the world—notably in Asia—are expanding theirs.

Discontent over the low increase for science is being heard not just from strong science supporters like Ehlers, who holds a Ph.D. in physics, and not just from the science community itself. Representatives of industry are also weighing in. Some of their concerns came out during a press briefing held in February 2005 by the Task Force on the Future of American Innovation, a coalition of high-tech companies, business associations, higher education groups, and scientific organizations (including the AMS). At the briefing, one of the speakers was Craig Barrett, president of Intel Corporation, who described how low investment in science in the U.S. has translated into a shortage of science and engineering talent. "This is the first time in a while that I have seen industry mobilized," remarked Samuel M. Rankin III, director of the AMS Washington office. "We've reached a point where people are beginning to worry," he continued. "In science, yes, they are concerned, but now it's starting to resonate with industry. The more we can get industry involved in preaching the value of basic research, the better chance we have to get an increase."

In March 2005 the Coalition for National Science Funding, an advocacy group that includes the AMS, issued a call for Congress to pass a \$6-billion budget for the NSF. Not long afterward, supporters of science in Congress drafted a letter proposing just such a budget. Are these efforts likely to bear fruit? Rankin says he does not know. "But we are in a situation where we simply have to make the case that the NSF is important," he said. And it is especially important in mathematics. The NSF provides more than three-quarters of all federal funding for academic research in mathematics, a much higher percentage than in most other areas of science. What the last few years have shown is, while it is great to be dubbed a "priority area", what really makes a difference for mathematics funding is having a strong budget for the NSF overall. And for fiscal 2006, that is unlikely to happen.

—Allyn Jackson


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Mathematical Sciences in the FY 2006 Budget

Samuel M. Rankin III



Highlights

- Federal support for the mathematical sciences is slated to grow from an estimated \$390.68 million in FY 2005 to an estimated \$397.58 million in FY 2006, an increase of 1.8 percent. This is the lowest rate of increase for the mathematical sciences in several years.
- The National Science Foundation's (NSF) Division of Mathematical Sciences (DMS) would have no increase in FY 2006. The DMS budget for FY 2006 would remain at \$200.38 million.
- The aggregate funding for the mathematical sciences in the Department of Defense agencies (Air Force Office of Scientific Research (AFOSR), Army Research Office (ARO), Defense Advanced Research Projects Agency (DARPA), National Security Agency (NSA), and Office of Naval Research (ONR)) would increase by 4.7 percent. The majority of this increase comes from DARPA, where the mathematical sciences budget would grow by 13.5 percent.
- The Department of Energy (DOE) Applied Mathematics Division would receive a 9.8 percent increase.

Introduction

The mathematical sciences are funded through the National Science Foundation, the Department of Defense (including the National Security Agency), the Department of Energy, and the National Institutes of Health (NIH). As in the past, the majority of federal support for the mathematical sciences in FY 2006 would come from the NSF, contributing approximately 50.4 percent of the federal total. The DOD accounts for around 23.1 percent of the total, with the NIH supplying 19.2 percent, and the DOE around 7.3 percent. The NSF currently accounts for

over 70.0 percent of the federal support for academic research in the mathematical sciences and is the only agency that supports mathematics research broadly across all fields. The DOD, DOE, and NIH support research in the mathematical sciences that contributes to missions of these agencies.

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; the Mathematical Sciences Division within the Army Research Office; the Mathematical, Computer, and Information Sciences Division within the Office of Naval Research; the Applied and Computational Mathematics Program within the Defense Advanced Research Projects Agency; and the Mathematical Sciences Program within the National Security Agency.

The DOE funds mathematics through its Applied Mathematics Program within the DOE Mathematical, Information and Computational Sciences Division. The National Institutes of Health funds mathematical sciences research primarily through the National Institute of General Medical Sciences (NIGMS) and through the National Institute of Biomedical Imaging and Bioengineering (NIBIB).

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

Trends in Federal Support for the Mathematical Sciences

The FY 2006 estimated aggregate spending for mathematical sciences research and related activities would be \$397.58 million, a potential increase of 1.8 percent over FY 2005 estimated spending.

Samuel M. Rankin III is director of the AMS Washington office. His email address is smr@ams.org.

The NSF Division of Mathematical Sciences budget would have no increase in FY 2006, greatly impacting the growth of overall federal support for the mathematical sciences. The increase at DOE for FY 2006 would be 9.8 percent over the FY 2005 level. DARPA surprises with a projected 13.5 percent increase. The remaining DOD agencies would essentially have no growth in FY 2006.

More and more the mathematical sciences are contributing to advances in life science research, a trend that will grow in the future. Realizing that the mathematical sciences can be critical to certain areas of biomedical research, the NIH, over the last several years, has been actively pairing mathematicians and biomedical researchers through funded projects.

The mathematical sciences are making major contributions to the country's intellectual capacity, and the need for the mathematical sciences in scientific discovery and technological innovation is accelerating. Yet many mathematical scientists who are performing excellent research and submitting grant proposals deemed of very high quality are either not funded or are underfunded. According to the *Science and Engineering Indicators*, 2004 Edition, only 30.1 percent of full-time academic doctoral mathematicians receive federal research support. This is much lower than most other fields of science.

National Science Foundation (NSF)

The Division of Mathematical Sciences is housed in the NSF Directorate of the Mathematical and Physical Sciences (MPS). This directorate also contains the Divisions of Astronomical Sciences, Chemistry, Materials Research, Physics, and Multidisciplinary Activities.

The mathematical sciences would continue to be an NSF-wide priority area in FY 2006. The foundation has budgeted \$88.63 million to carry out the priority area activities in FY 2006, with \$70.23 million of this amount coming from the Division of Mathematical Sciences (DMS) and the remaining \$18.40 million coming from throughout the foundation. The NSF-wide allocation (\$18.40 million) depends on cooperative funding opportunities with other NSF directorates and requires matching funds from the DMS. The mathematical sciences were first designated an NSF priority area in FY 2002, and currently this designation is to last through FY 2007. Tentatively, this priority area will receive \$88.63 million in FY 2007.

The DMS is slated to receive a budget of \$200.38 million in FY 2006. The division has essentially had the same budget since FY 2004. However, from FY 2003 to FY 2006 the DMS budget will have grown by 12.1 percent, while for the same period the MPS budget will have grown by 4.4 percent. All

Table 1. Federal Funding for the Mathematical Sciences (millions of dollars)¹

	FY 04 Actual	FY 05 Estimate	FY 06 Request	Change 2005-06 Amount	Change 2005-06 Percent
National Science Foundation					
DMS	\$200.35	\$200.38	\$200.38	\$0.0	0.0%
Department of Defense					
AFOSR	\$ 30.00	\$ 30.90	\$ 31.00	\$0.1	0.3%
ARO	9.50	10.00	10.00	0.0	0.0
DARPA	16.30	29.70	33.70	4.0	13.5
NSA	3.00	3.50	3.50	0.0	0.0
ONR	13.10	13.60	13.60	0.0	0.0
Total DOD	\$ 71.90	\$ 87.70	\$ 91.80	\$4.1	4.7
Department of Energy					
Applied Mathematics	\$ 22.60	\$ 26.40	\$ 29.00	\$2.6	9.8%
National Institutes of Health					
NIGMS	\$ 35.00*	\$ 38.00*	\$ 38.00*	\$0.0	0.0%
NIBIB	37.10	38.20	38.40	0.2	0.5
Total NIH	\$ 72.10	\$ 76.20	\$ 76.40	\$0.2	0.3
Total All Agencies	\$366.95	\$390.68	\$397.58	\$6.9	1.8%

*Estimates based on conversation with program officer.

¹Budget information comes from agency documents and conversations with agency program managers and representatives.

the growth for the DMS occurred from FY 2003 to FY 2004.

The DMS has essentially two modes of support: research and education grants, and institutes. Grants include individual-investigator awards, awards for multidisciplinary groups of researchers, and educational and training awards aimed at increasing the number of U.S. students choosing careers in the mathematical sciences. Approximately 72 percent of the DMS funds are available for new awards and activities. The remaining 28 percent funds awards made in previous years.

For FY 2006 the DMS has the following priorities:

- maintaining a strong program of research grants,
- investing in algorithm development and computational tools for large-scale problems of scientific importance,
- broadening participation in the mathematical sciences,
- maintaining research training activities in the mathematical sciences,
- continuing support for the Mathematical Sciences Priority Area.

Air Force Office of Scientific Research (AFOSR)

The Directorate of Mathematics and Space Sciences provides funds for research in the mathematical sciences in support of the Air Force mission. Current program emphases include cooperative control, quantum computing, and Maxwell's equations. Beginning perhaps as early as FY 2005, a new initiative in nanoscience is anticipated. The AFOSR mathematics program includes specific portfolios in dynamics and control, physical mathematics and applied analysis, computational mathematics, optimization and discrete mathematics, systems and software, electromagnetics, and signals communication and surveillance. The AFOSR budget would increase slightly, by 0.3 percent, over FY 2005.

Army Research Office (ARO)

The Mathematical Sciences Division manages the following programs: modeling of complex systems, computational mathematics, discrete mathematics and computer science, probability and statistics and stochastic analysis, and cooperative systems. The Mathematical Sciences Division plays an essential role in the modeling, analysis, and control of complex phenomena and large-scale systems that are of critical interest to the army. The areas of application include wireless communication networks, image analysis, visualization and synthetic environments, pattern recognition, test and evaluation of new systems, sensor networks, and autonomous systems. The division also works closely with the Computer and Information Sciences Division of the ARO to develop mathematical theory for information processing, information assurance, and data fusion. The FY 2006 budget for the Mathematical Sciences Division is the same as for FY 2005.

Defense Advanced Research Projects Agency (DARPA)

DARPA's Applied and Computational Mathematics program is structured around focused program initiative areas in interdisciplinary and core mathematics. Current program areas include: Integrated Sensing and Processing, Mathematical Time-Reversal Methods, Predicting Real Optimized Materials, Quantum Information Science and Technology, Geospatial Representation and Analysis, Topological Data Analysis, Stochastic and Perturbation Methods in PDE Systems, Geometric Langlands, Discovery and Exploitation of Structure in Algorithms, and Femtosecond Adaptive Spectroscopy Techniques. The FY 2006 budget for the mathematical sciences would increase by approximately 13 percent over FY 2005.

Department of Energy (DOE)

Mathematics is funded through the Applied Mathematics Program of the Mathematical, Information, and Computational Sciences Division (MICS) of the DOE. Research is conducted on the underlying mathematical understanding of physical, chemical, and biological systems and advanced numerical algorithms that enable effective description, modeling, and simulation of such systems on high-end computing systems. Research in applied mathematics supported by MICS underpins computational science throughout the DOE. The FY 2005 budget for the Applied Mathematics Program continues the Computational Sciences Fellowship program at its current level of \$3.5 million. The FY 2006 budget also includes \$8.5 million for the Atomic to Macroscopic Mathematics (AMM) effort, which provides the research support in applied mathematics needed for understanding complex physical processes that occur on a wide range of interacting length- and time-scales. Current state-of-the-art theory and modeling of complex physical systems require that the physical phenomena being modeled either occur at a single scale or widely separated scales with little or no interaction. The AMM effort supports university researchers, partnerships between universities and national laboratories, and multidisciplinary research teams at national laboratories. The Applied Mathematics Program FY 2006 budget would increase by 9.8 percent over FY 2005.

National Institutes of Health (NIH)

The NIH funds mathematical sciences research through the National Institute of General Medical Sciences (NIGMS) and the National Institute of Biomedical Imaging and Bioengineering (NIBIB). Mathematical sciences areas of interest are those that support the missions of the NIGMS and the NIBIB. Currently the NIGMS is supporting a biomathematics initiative in cooperation with the National Science Foundation, and the NIBIB is participating in a joint initiative with the NSF and

other NIH institutes: "Collaborative Research in Computational Neuroscience". The aggregate budget for the mathematical sciences in the NIBIB and the NIGMS would grow only slightly, 0.3 percent, in FY 2006.

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, probability, and statistics. The grants program also accepts proposals for conferences and workshops in these research areas. Additional funding (non-grant) is available to support an in-house faculty sabbatical program. The program administrators are especially interested in funding initiatives that encourage the participation of underrepresented groups in mathematics (such as women, African-Americans, and other minorities). The NSA is the largest employer of mathematicians in the United States. As such, it has a vested interest in maintaining a healthy academic mathematics community in the United States. The grants program's budget would remain unchanged for FY 2006.

Office of Naval Research (ONR)

The ONR Mathematical, Computer, and Information Sciences Division's scientific objective 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; and formal methods for verifiably correct software construction. The Mathematical, Computer, and Information Sciences Division's budget would remain unchanged in FY 2006.

Note: Information gathered from agency documents and from agency representatives.

This article was originally written for a chapter on funding in the mathematical sciences in the AAAS Report XXX, Research & Development, FY 2006.

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Rotating at the National Science Foundation

John B. Conway



The activity referred to in the title means that the National Science Foundation (NSF) has temporarily employed me to supervise a part of its grant-awarding business.

The staff members with whom the mathematical public interacts at the NSF are called program officers (POs).¹ Some of these are permanent professional staff and some are rotators. These latter are temporary employees who come from outside the foundation for a short period and then return to their jobs. They stay for two or three years, although a few leave after one year, others stay for four, and still others eventually become permanent. How long they stay depends on them, the NSF, and for how long their permanent employers are willing to let them be gone. In the Division of Mathematical Sciences (DMS) the rotators are a bit less than two-thirds of the approximately twenty-one POs. That fraction fluctuates, and there is a move to decrease it. Some other divisions have far fewer rotators. The virtue of having rotators is that they bring a fresh perspective to NSF's business as well as, presumably, the opinions of people fresh from an involvement in research.

I have been a rotator at the NSF for a year and a half. Why did I do this? What is it like? Do I enjoy it? What are the best and worst parts of the job? How does it compare to being a department head? Is there time to do research? I have been asked those questions ever since I started working here. Of all those questions, perhaps the easiest to answer is the comparison between a PO and a head. There is indeed a similarity between the two jobs, and each is good preparation for the other. In both cases you have to be organized, capable of articulating a position, able to hear what others have to say, and know how to cooperate. I think I am a better PO for having been a head, and, conversely, were I to return to being a head, I am certain I would be better at it for having been a PO.

There are also many distinctions between the two positions. At the DMS all of my colleagues are adults.

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The views and opinions expressed in this article are those of the author and should not be interpreted as representing those of the National Science Foundation.

¹*They are also called program managers and program directors, an ambiguity that initially perplexed me.*

Of course that sounds like a harsh indictment of academia, and it has induced more than one person to draw some unintended conclusions. But I will stick with it in all its starkness if you allow me to specify the definition of the word *adult*: a person who realizes they live in an environment inhabited by others and that this calls for cooperation, accommodation, and flexibility. I have yet to find a department where there aren't faculty who think they are the center of the universe and refuse to believe that there are issues that call for them to make a sacrifice. At the NSF there is enormous cooperation among POs. I have yet to make a request for help to another PO and not get their assistance. In fact, it is almost always the case that they stop whatever they are doing and give me their attention. I found that attitude attractive when I first arrived, and I still do. I have had university colleagues who were similar, but they were far from the dominant species.

Another difference is that as a PO, when I give someone bad news, he/she is usually several hundred miles away. Turning down a reasonable request that will aid another mathematician in his/her professional life is not pleasant. I don't think that is unique to me, and, indeed, your sadistic streak would have to be rather pervasive for it to be otherwise. But there is an enormous difference between saying no as you are looking a friend in the eye and doing so by email to a person far removed from you whom you may have met only at a conference or two.

Another distinction is that when I go home at night, I am away from the job. That was not true while I was a head, where I frequently mulled over departmental matters well into the night. Now my mind is free when I leave the office. I might think a bit about some DMS matter, but usually by the time I get off the subway my mind is clear. That allows me to spend my evenings on whatever mental activity I want.

There are as many reasons for becoming a rotator as there are rotators. Almost all share a desire to be involved in setting national mathematical policy. Some, for personal reasons, want a break from their university routine. Some want to spend time in the Washington area. Some want to add a dimension to their professional résumés. Some,

like me, are nearing retirement and use this as a coda to their careers.

I was attracted by the specific prospect of starting the two new progeny of the VIGRE (Vertical Integration of Research and Education) program: The Mentoring at Critical Transition Points and Research Training Groups programs. These programs address problems about the education and training of mathematicians that have been on my mind for years. Another attraction was that the programs were new and I felt I could put my stamp on them. Finally, the prospect of living in the Washington area was very appealing. (I also handle a couple of dozen research proposals in analysis, but that was less compelling.)

There was another factor. People often complain about the NSF and criticize its actions. At times that group of grumblers has numbered me among its members. If mathematicians are not willing to come to work at the NSF, then when things do not go their way, they should blame themselves. In addition, there is something that I have often said and, as time goes on, I have begun to realize more fully: Mathematics has given me a good life, so some service to the profession makes a lot of personal sense.

What is the work like? Most are familiar with the process of submitting proposals. It is the PO who handles the proposals once they enter the DMS, makes sure they are properly reviewed, and then makes a decision whether to recommend them for funding. When you first start work here you are often told that you make recommendations only; you do not make awards. After the PO recommends an award or declines a proposal (a "dec"), the division director either concurs in your judgment or sends it back to you. If (s)he agrees, it goes to the Division of Grants and Agreements, which makes the actual award. The point is, however, that in all but a tiny fraction of cases, the PO's recommendation is followed. Therefore, in a practical sense the PO does make awards.

It might be that in very large grants, like those for VIGRE or the two programs I am in charge of, there will be extensive discussion with the director as well as with a sizable portion of the DMS staff. In other words, there is a lot of input from many that determines the recommendation. But for individual grants the PO effectively determines the fate of the proposal. Of course the decision must be justified, and the POs must fully explain how they arrive at their decisions. The POs do an analysis of the reviews and explain why they agree or disagree. If they disagree and properly explain why, it is likely that decision will stand. That is probably more power than most mathematicians think resides in the hands of POs, and it is more power than most rotators anticipate having. Realize that POs are not robotic, blindly following review ratings. They use judgment and their perspective.

If in reading the preceding paragraph you think any part of the decision making proceeds with whimsy, you have not understood the process. To begin, there are some measures that are taken that help assure fairness. There are government laws and NSF regulations about what constitutes a conflict of interest. For example, I cannot have anything to do with a proposal that involves any former Ph.D. student, a collaborator I've had in the last four years, or anyone from my university. I am not even supposed to read their proposals. Unlike congressmen, I cannot accept gifts, such as a meal, or have a university pay my expenses to come give a talk. Violate one of these conflicts and you are subject to legal penalties. Yes, there have been POs at the NSF who were prosecuted for such transgressions (but not, as far as I know, in the DMS).

I long ago stopped defending the social and ethical practices of fellow faculty, so I am not going to try to say that all POs are totally fair 100 percent of the time. They are, after all, human beings. But I will say that I am very impressed with the level of professionalism I observe in the mathematics POs. They work hard and are extremely conscientious. They contradict the judgment of a review panel with great reluctance. If your proposal is declined, you may disagree with the assessment, but you can be assured, with a probability approaching one, that the process was fair.

What is the worst part of the job? It is a lot of work. More than that. The tasks you have to do come at you unpredictably, randomly, and unrelentingly. It starts with your assignment. To add some interest and variety to the job, each PO is given several different tasks for the year. Some jobs, like managing the Focused Research Groups program, are too small to need someone's complete attention throughout the year. Others are too large for a single mathematician to handle, like the analysis program. So each PO wears several different hats in any given year. That adds interest to the job, but it also means you must frequently switch gears from one program to the other. Many is the morning when I enter my office with a specific task to accomplish and find when I go home that I have hardly begun it.

Also there is a lot of routine and tedious work that you must personally do. A very large percentage of your time is spent sitting at the computer clicking away at various buttons on the screen to route and process documents. The NSF is highly computerized. In fact, it is supposed to be working toward being a paperless operation. For example, for each proposal that goes before a panel, I must upload a copy of the panel's minutes into its computer file. The designers of the software apparently never saw the need to be able to do this en masse. So I must do this for each proposal in a one-at-a-time process. It takes less than two minutes to do one, but I have a hundred proposals. So that is on the order of three hours. OK, it is not a lifetime. But first, it is tedious. Second, it is just one of several similar

operations I have to perform for each proposal. Finally, I was meant for better things—my apologies to those misguided souls who think all work is noble.

On the other hand, if you talk to those who were here at the NSF before this paperless reform took hold, you hear about an environment where twelve copies of each proposal arrived on your desk. Understand that you handle a hundred proposals, so we are talking 1,200 stapled packages, each having upward of forty pages. While that is a sure-fire way to build your upper-body strength, on the whole I guess I would rather click away at the monitor screen.

There are other tasks that are important and require my education and experience, like writing justifications for my decisions. These take two forms. The first is called PO Comments and is sent to the PI. This is important, especially when the proposal is dec'd, not because I am going to convince him/her that was a good decision, but because it is important to let the PI know why you have arrived at your decision. This takes some time to do well, and there is a value in gaining experience honing your talents at this. Frankly, it is not clear that I have gotten there yet. Also, especially when the PI is a rather young Ph.D., I can make some suggestions for improving the proposal and encouraging a resubmission.

The other document you write for each proposal is called a Review Analysis. This is pretty much what it sounds like and is a document that never leaves the NSF. It seems to have two purposes: to convince the division director that you made a sound decision and for use in case the PI asks that the decision be reconsidered or the foundation is sued. Of course you can be a bit more open when you write this, since there is no chance of violating confidentiality. The important thing here is that if there is a request for reconsideration by the division director, this is what (s)he is going to read before making a decision.

Then there are some personal things that upset me, like declining a proposal by someone I have known and respected for a very long time. Not so personal but disturbing nonetheless is that we fund less than 30 percent of the proposals we receive. If there were money, we could easily fund 50 percent and not feel that a dime was wasted. I have never seriously tried to find where that "comfort line" is, but I would not be surprised if it is at the 75 percent mark or higher.

Given this situation, you cannot help but question the robustness of the rankings arrived at by a review panel. I suspect that the proposals that fall into the top half or so of the panel rankings are rather stable and would not change much if I perturbed the membership of the panel. A similar statement holds for the very top 10 percent. But the ordering of those proposals that fall between

the 10 percent and 50 percent marks might well change enough so that those that are funded are likely dependent on a panel's makeup. That is not particularly pleasant to contemplate, but we have to live with it as long as the funding is the way it is. We certainly are not going to abandon research funding because we lack a perfect system.

Finally, there is something that I would not label as horrible, but it is grating: the difference between permanent staff and rotators. This starts with our having different colored badges, something that strikes me as either a bureaucrat's nonsense or an attempt to institute a caste system. A more disquieting fact is that there are certain discussions where no rotators take part. There seem to be certain issues where our advice is not deemed valuable.

Adding to the list of the irksome is something I experienced before I arrived here: the penchant for the DMS to be obscure and uninformative about what is going on. Part of this is bureaucratic, a disease that affects even the DMS and hence is probably part of human nature. The prevailing attitude seems to be that unless there is a rule saying you have to give out information, you should withhold it. I found that frustrating before I arrived and so I decided to give out all information unless there is a reason why I shouldn't. I am sure that will strike some at the NSF as risky behavior, but it seems to be appreciated by the mathematicians I deal with, and I have experienced no aftershocks.

What is the best part? Helping to set policy was what I thought it would be before I arrived, and to a large extent it is. The difficulty is that I spend so much time doing the routine and mundane that I do not have enough time to think and reflect about general issues the way I thought I would. But the division has many staff meetings; an occasional retreat; and, of course, all the hall, office, and coffee room discussions. These give ample opportunity to express your opinion and advocate your point of view on a variety of important issues. So I still feel I am having an influence on what happens, but less than what I had anticipated.

When I finish, will I feel as though I made a difference? I don't know, but that question has less importance for me than it might for others. The reason for that lies more in my personal approach to life and career and my view of how the world works, both topics best left for my autobiography.

You have to keep your goals for doing this job realistic. For example, when I arrived I had a desire to increase the interaction between the DMS and the Education and Human Resources (EHR) Directorate. I have made some progress here, with EHR's Division of Undergraduate Education participating with us in conducting the mentoring competition. I was not so dumb or arrogant as to think I was going to reshape the entire structure of these two divisions to mesh their educational activities.

To begin, EHR focuses on helping large numbers of students. A program that affects one hundred students would not be thought of as one of their shining lights. By that standard, the DMS is an elitist organization. When we discuss an educational or training program, we are interested only in reaching the best and brightest of students. No one is going to come in and change that cultural difference. In fact, such a change would be a disaster, since both approaches have merit.

Another goal I had was to increase communication between the NSF and the mathematics community. I don't think I have made much progress on that. I did discover that one of the community's pet complaints about the NSF, their unwillingness to dispense small grants to a large number of mathematicians, is misdirected. Increasing grant size is mandated by the National Science Board, a presidentially appointed group that oversees federal science policy. You can complain about this, but doing so to the DMS is pointless. Were the DMS to fight this policy, the budgetary consequences would not be to our liking.

On the other hand, why didn't I understand this before I came to the NSF? I think that I was more aware of policy matters than most, but I had never heard about this one. I had been to several meetings with NSF-DMS folks where this issue arose, and the response was always "It can't be done." It was sometimes mentioned that to try this would jeopardize mathematics funding, but never a word as to why. That strikes me as a bad job of communicating by the DMS.

Something I enjoy that was totally unanticipated before I started working here is organizing and conducting a review panel. We still use the classical mail review system, where a proposal is sent to several mathematicians to review at their university. But to achieve increased efficiency with an increased number of proposals, the division uses a panel review system for something in excess of 80 percent of the proposals. A panel of 10–16 mathematicians is assembled in Arlington for two or three days to review between 30 and 75 proposals. The panelists read the proposals and write their reviews before the meeting, then assemble at the NSF headquarters to discuss their findings and rank the proposals.

Organizing this takes time, but it certainly is not tedious. There is even some skill involved in selecting a good blend of panelists to suit the proposals, choosing the proposals to assign each panelist, and making sure the written reviews arrive before the meeting. But the real enjoyment is the meeting itself. The intellectual involvement is very high, the arguments for or against a proposal are almost always well reasoned, and the debate very productive. What I get out of a panel review far exceeds what I get from mail reviews, where no one is available to challenge any-

thing that is written. Given my curiosity about people and human behavior, this is also a splendid opportunity to observe interchanges, foibles, personality traits, and character.

Another highlight of the job is lunch. This is not a comment on the abundance of excellent cuisine near the NSF headquarters, though what's here certainly beats the university cafeterias that I am familiar with. Rather it is a comment on the quality of social conversation that takes place. The people who are prone to accept positions at the DMS seem to have a very broad range of interests, and this makes for interesting conversation. This is one of the highlights of my day, and when we interview candidates for rotator positions, I find that I ask myself what they will contribute to the lunch discussions.

There is also considerable opportunity to broaden your familiarity with mathematics. You see proposals with lots of different mathematics pass through your hands, and you have an opportunity to become familiar with much of what is happening in your area.

How about personal research? You are allowed fifty days a year to pursue your individual research projects. You can take a bunch in the summer if you want, or you can take one a week. It's up to you. That is, it's up to you provided you get your work done. On the other hand, the DMS administration is very supportive, and the travel possibilities far exceed anything a university can offer. Also, as I said before, when I hit home I leave the NSF behind and I am not drained of psychic energy, so I have something to devote to my personal work. But if you have done a lot of research, you know there are hot spells when you want to minimize everything in your life except for the mathematics. That cannot happen while you are a rotator, except possibly in the summer, when the pace of work really slows down. You have deadlines, and many others are depending on you—far too many obligations to shunt to the side. I prefer to spend my personal time writing, where a measured pace is more easily realized. Some rotators have done research, but I am sure they would admit that they did not do as much as while teaching.

If you have concluded that I am happy for having come to the NSF, you are correct. In fact, without hesitation I can advocate that others emulate my decision. It is not the easiest work around, but if your expectations are realistic, if you approach this with an open mind, if you keep the important goals in focus, and if you eschew bureaucratic nonsense, it can be a very satisfying experience.

MathSciNet Matters

The "MathSciNet Matters" column appears in the *Notices* several times a year. It includes information on new features of MathSciNet and on the underlying Mathematical Reviews Database, together with tips on how to use MathSciNet to make the most of its richness of structure and content.

Calling All Postdocs. The reviewers for *Mathematical Reviews* perform an invaluable service to the mathematical community around the world. Although there are over 11,000 reviewers, that number has not grown as rapidly as the literature has grown in the last decade. Many more are needed. Younger mathematicians active in research are encouraged to become reviewers. The list of reviewers in Volume 1 of the print publication *Mathematical Reviews* is quite impressive, including such names as Norbert Wiener, John von Neumann, Olga Taussky-Todd, Richard Courant, and Marshall Stone. The list can be seen at <http://www.ams.org/publications/60ann/ReviewersVolume1.html>. Edward Titchmarsh's review of a paper by Paul Turán (MR0000836 (1,135e)) appears in the illustration:

Turán, Paul. Über die Primzahlen der arithmetischen Progression. (II.) Acta Litt. Sci. Szeged 9, 187–192 (1939). [MF 610]

Let $P(k, l)$ denote the smallest prime of the form $kx + l$. It was proved by Chowla [J. Indian Math. Soc. (2) 1, 1–3 (1934)] that if no L -function vanishes for $\sigma > 1/2$, then $P(k, l) < c_1 \phi(k)^{2+\epsilon}$, where ϵ is arbitrarily small and $c_1 = c_1(\epsilon)$. The author now shows that a similar result follows from a weaker hypothesis. Suppose that there are constants δ , $0 < \delta \leq 1/2$, and α , such that no L -function vanishes for $1 - \delta < \sigma \leq 2$, $|\iota| \leq \alpha$. Then $P(k, l) < c_2 \phi(k)^{c_4}$, where c_2 is an absolute constant, and $c_4 = c_4(\alpha, \delta)$, $c_4 > 1/\delta$.

E. C. Titchmarsh (Oxford).

To join these notables, send email to mathrev@ams.org.

The Citation Database. As we mentioned in the April column, a new version of the MathSciNet interface is released each September. Here is a sneak preview of the expanded scope of the citation information that will be available in September 2005. For several years we have been reproducing the reference lists from the papers in selected journals, matching each item in each list, where possible, with items in the MR Database. As the collection of reference lists has become more substantial, this has provided a view of the development of mathematical ideas, forward and

backward over time. The forward view is provided by the Reference Citations link for each item, which links to all references to the given item found in reference lists in MathSciNet. The backward view is provided by following the links in a given reference list backward in time. The plan is to exploit the connectivity provided by this citation information, giving new information tied to authors and journals. By the time of the September release, we are hoping to have the reference lists for about two hundred journals back to 2000 (and for some journals back to 1997). The Citation Database in MathSciNet involves a significant effort on the part of the AMS. The matching of reference list entries to MathSciNet items uses a free AMS tool called MRef (<http://www.ams.org/mref>), which will be discussed in a future column.

Author Challenge. Who is XXX? The MR Author Database contains many interesting names, for example pseudonyms, one of which is Tom Odda. Another is XXX, the author of one paper in the database. (Look them up!) The database does not currently connect the name XXX to any other "real" author in the database. Do you have information about who XXX is? Send your documented answer to mrcontest@ams.org by September 1, 2005. Our author identification staff will assess the validity of the answers and choose a correct one—we don't know the answer, or it would be in the database already. All correct answers will be entered into a drawing for a \$25 AMS gift certificate. XXX him/herself is an automatic winner.

Reviewers' Corner. Links inside MathSciNet to other MathSciNet items are a powerful component of the electronic presentation of information in the Mathematical Reviews Database. Reviewers frequently ask about the right way to enter these links in the text of their reviews. All references in reviews are carefully checked for accuracy and then formatted according to MR style during the editing process. Reviewers should include as much bibliographic information as possible, including the MR number, if there is one, to facilitate the accuracy checking. In particular, while the MR number is sufficient in principle, it is best that the rest of the bibliographic information be present so that the correspondence can be verified. The style of reference found in the Clipboard is a very good one. Reviewers play an invaluable role in creating the rich internal connectivity of the MR Database.

—Norman Richert
Mathematical Reviews

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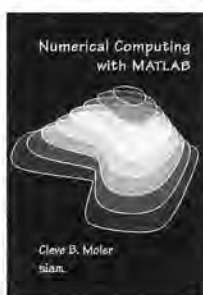
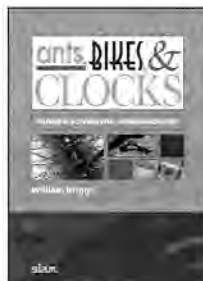
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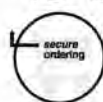
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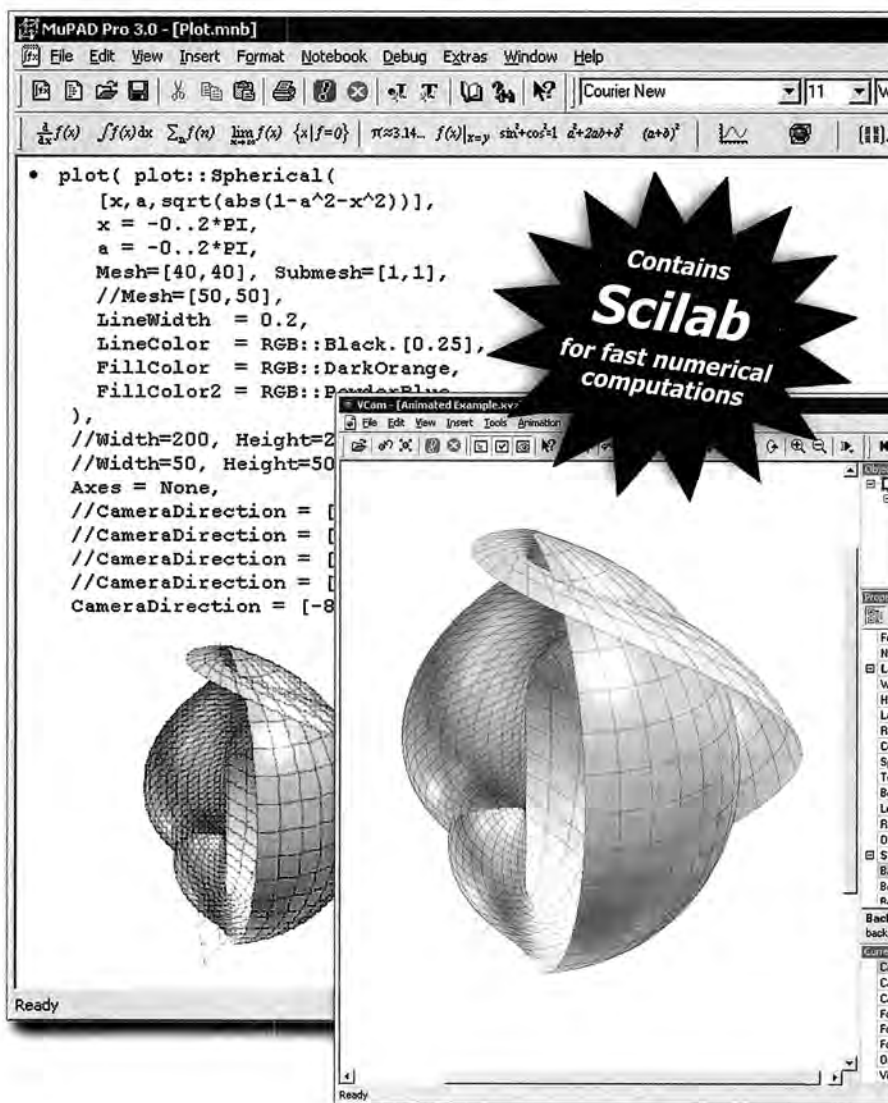
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Mathematics People

2005–2006 AMS Centennial Fellowships Awarded

The AMS has awarded two Centennial Fellowships for 2005–2006. The recipients are YUAN-PIN LEE of the University of Utah and MIHNEA POPA of Harvard University. The amount of each fellowship is \$62,000. The Centennial



Yuan-Pin Lee



Mihnea Popa

Fellows also receive an expense allowance of \$3,000 and a complimentary Society membership for one year.

Yuan-Pin Lee

Yuan-Pin Lee received his Ph.D. in 1999 from the University of California at Berkeley under the direction of Alexander Givental. Lee was a Hedrick Assistant Professor at the University of California, Los Angeles, from 1999 to 2002. Since 2002 he has been an assistant professor at the University of Utah. He spent the year 2002–2003 at Princeton University as a visiting research mathematician. His research interest is in Gromov-Witten theory and its relations with K-theory, integrable systems, and moduli of curves. He plans to use the fellowship to visit Rahul Pandharipande at Princeton University and Instituto Superior Técnico in Lisbon, and Yongbin Ruan at the Mathematical Sciences Research Institute in Berkeley.

Mihnea Popa

Mihnea Popa received his Ph.D. in 2001 from the University of Michigan under the direction of Robert Lazarsfeld. He has been a Benjamin Peirce Assistant Professor at Harvard University since 2001. Starting in the fall of 2005 he will be an assistant professor at the University of Chicago. Popa's research is in the field of algebraic geometry. He uses cohomological and vector bundle techniques in the study of divisors or linear series on moduli spaces (of vector bundles or curves) and on abelian varieties. His recent work has involved studying a notion of regularity for coherent sheaves on abelian varieties, based on the

Fourier-Mukai transform. He is also working on understanding the structure of cones of divisors on smooth projective varieties by analyzing asymptotic invariants associated to base loci of linear series. He plans to use his Centennial Fellowship at the University of Michigan and the University of Rome, as well as at the University of Chicago.

Please note: Information about the competition for the 2006–2007 AMS Centennial Fellowships will be published in the "Mathematics Opportunities" section of an upcoming issue of the *Notices*.

—Allyn Jackson

Cerf and Kahn Receive Turing Award

The Association for Computing Machinery (ACM) has named VINTON G. CERF and ROBERT E. KAHN the winners of the 2004 A. M. Turing Award, considered the "Nobel Prize of Computing", for pioneering work on the design and implementation of the Internet's basic communications protocols. Cerf is the senior vice president for technology strategy at MCI. Kahn is chairman, chief executive officer, and president of the Corporation for National Research Initiatives (CNRI), a not-for-profit organization for research in the public interest on strategic development of network-based information technologies.

The Turing Award, first awarded in 1966 and named for British mathematician Alan M. Turing, carries a \$100,000 prize, with financial support provided by Intel Corporation. Cerf and Kahn developed TCP/IP, a format and procedure for transmitting data that enables computers in diverse environments to communicate with each other. This computer networking protocol, widely used in information technology for a variety of applications, allows networks to be joined into a network of networks now known as the Internet.

—From an ACM news release

Parisi Awarded 2005 Heineman Prize

GIORGIO PARISI of the University of Rome has been awarded the Dannie Heineman Prize for Mathematical Physics for his "fundamental theoretical discoveries in broad areas of elementary particle physics, quantum field theory, and statistical mechanics; especially for work on spin glasses and disordered systems."

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 Institute of Physics (AIP) and the American Physical Society (APS). The prize is presented annually.

—From an AIP announcement

Vakil Awarded André Aisenstadt Prize

RAVI VAKIL of Stanford University has been awarded the 2005 André Aisenstadt Mathematics Prize of the Centre de Recherches Mathématiques (CRM) at the University of Montreal. Vakil was honored for his work in algebraic geometry, including the enumerative geometry of projective algebraic curves and the study of degenerations in a Grassmannian. The prize, consisting of CA\$3,000 and a medal, is given in recognition of talented young Canadian researchers in pure and applied mathematics who have held a Ph.D. for no longer than seven years.

—From a CRM announcement

Klartag and Speyer Named Clay Research Fellows

The Clay Mathematics Institute (CMI) has announced the appointment of two Research Fellows: BO'AZ KLARTAG of the Institute for Advanced Study and DAVID SPEYER of the University of California, Berkeley. They were selected for their research achievements and for their potential to make significant future contributions. BEN GREEN of the University of Bristol, who received the 2005 Clay Research Award, was also named a Clay Research Fellow.

Bo'az Klartag, born in 1978, is a native of Israel and is currently a postdoctoral fellow at the Institute for Advanced Study in Princeton. He received his Ph.D. degree in 2004 from Tel Aviv University under the direction of Vitali Milman. In his thesis Klartag showed that a small number of Minkowski and Steiner symmetrizations suffice to bring a convex body in n -space close to a Euclidean ball. His current research interests include geometric problems in high dimension, in particular asymptotic convex geometry.

David Speyer, born in 1980, is currently completing his Ph.D. at the University of California, Berkeley, under the direction of Bernd Sturmfels. Much of his research is in the emerging area of tropical geometry, to which he has contributed both fundamental results and applications, a new proof of Horn's conjecture on eigenvalues of hermitian matrices, and, working with Lior Pachter, the reconstruction of phylogenetic trees from subtree weights. His current research interests include continuing work in tropical geometry, cluster algebras, and the geometry of Grassmannians and flag varieties.

Current Clay Research Fellows include Manjul Bhargava, Daniel Biss, Alexei Borodin, Maria Chudnovsky, Sergei Gukov,

Elon Lindenstrauss, Ciprian Manolescu, Maryam Mirzakhani, Igor Rodnianski, Andras Vasy, and Akshay Venkatesh.

—From a CMI news release

Sloan Fellows Announced

The Alfred P. Sloan Foundation has announced the names of the recipients of the 2005 Sloan Research Fellowships. Each year the foundation awards 116 fellowships in the fields of mathematics, chemistry, computational and evolutionary molecular biology, computer science, economics, neuroscience, and physics. 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.

Following are the names of the 2005 Sloan Fellows who work in the mathematical sciences: CAMIL MUSCALU, Cornell University; JONATHAN MATTINGLY, Duke University; DENIS AUROUX, Massachusetts Institute of Technology; JASON STARR, Massachusetts Institute of Technology; FENGBO HANG, Michigan State University; DMITRY E. TAMARKIN, Northwestern University; VLADA LIMIC, University of British Columbia; ELCHANAN MOSSEL, University of California, Berkeley; ROMAN VERSHYNIN, University of California, Davis; NATASHA KOMAROVA, University of California, Irvine; NARUTAKA OZAWA, University of California, Los Angeles; JEFF MOEHLIS, University of California, Santa Barbara; MILEN YAKIMOV, University of California, Santa Barbara; JESPER GRODAL, University of Chicago; DHURV MUBAYI, University of Illinois at Chicago; JINHO BAIK, University of Michigan; TOBIAS EKHOLM, University of Southern California; GAVRIL FARKAS, University of Texas, Austin; TAMAS HAUSEL, University of Texas, Austin; and JORDAN ELLENBERG, University of Wisconsin, Madison.

—From a Sloan Foundation announcement

Birgé Awarded Brouwer Medal

LUCIEN BIRGÉ of the Laboratoire de Probabilité, Université Paris VI, has been awarded the 2005 L. E. J. Brouwer Medal of the Royal Dutch Mathematical Society (Koninklijk Wiskundig Genootschap, KWG). Birgé was honored for his research on fundamental aspects of the asymptotic theory of statistics applied, in particular, to nonparametric model choice and to asymptotic optimality of estimators in infinite-dimensional spaces.

The Brouwer Prize is the Netherlands' most prestigious award in mathematics. It was established shortly after the death of the distinguished mathematician L. E. J. Brouwer and is awarded every three years. For each award the Society chooses an important field in mathematics; the 2005 award honors the field of mathematical statistics. The recipient is awarded a gold medal and presents a lecture at the annual meeting of the Dutch Mathematical Society.

—Richard Gill, University of Utrecht

Fulbright Awards Announced

The J. William Fulbright Foundation and the United States Department of State, Bureau of Educational and Cultural Affairs, have announced the names of the recipients of the Fulbright Foreign Scholarships for 2004–2005. 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.

CRISTINA M. BALLANTINE (College of the Holy Cross), Germany; DIPKA CHOUDHURY (Loyola College, Baltimore), Bangladesh; ERIC I. GOTTLIEB (Rhodes College), Chile; JACOB KOGAN (University of Maryland, Baltimore County), Israel; HUI-HSIUNG KUO (Louisiana State University, Baton Rouge), Italy; ROBERT A. LESLIE (Agnes Scott College), Nicaragua; ABDESSAMAD MORTABIT (Metropolitan State University, St. Paul), Morocco; JAYARAM SETHURAMAN (Florida State University), India; DRITAN ZELA (Scottsdale Community College), Albania.

—From a Fulbright Foundation announcement

Guggenheim Fellowships Awarded

The John Simon Guggenheim Memorial Foundation has announced the names of 185 United States and Canadian artists, scholars, and scientists who were selected as Guggenheim Fellows for 2005. 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 in the mathematical sciences, together with their affiliations and areas of research interest: IAN AGOL, University of Illinois at Chicago: Studies in 3-manifold geometry and topology; YANNIS G. KEVREKIDIS, Princeton University: Equation-free studies of complex systems; DAVID R. MORRISON, Duke University: Mirror symmetry in mathematics and physics; CHRISTOPHER D. SOGGE, Johns Hopkins University: Solutions of wave equations on Riemannian manifolds; MADHU SUDAN, Massachusetts Institute of Technology: Algebraic methods in error correction; MOSHE Y. VARDI, Rice University: Studies in logic and algorithms; and SANTOSH SRINIVAS VEMPALA, Massachusetts Institute of Technology: Algorithmic convex geometry.

—From a Guggenheim Foundation news release

Intel Science Talent Search Winners Announced

Two high school students working in mathematics have been awarded Intel Science Talent Search Scholarships for 2005. ROBERT T. CORDWELL, a seventeen-year-old student at Manzano High School in Albuquerque, New Mexico, won fourth place and a \$25,000 scholarship for his

mathematics project “Some Results on Inclusive and Exclusive Partitions of Complete Graphs”. PO-LING LOH, an eighteen-year-old student at James Madison Memorial High School in Madison, Wisconsin, won the tenth-place scholarship of \$20,000 for her project in finite group theory, “Closure Properties of D_{2p} in Finite Groups”.

—From an Intel Corporation announcement

National Academy of Engineering Elections

The National Academy of Engineering (NAE) has announced the election of seventy-four new members and ten foreign associates, including twelve whose work involves the mathematical sciences. Their names, institutions, and the research for which they were elected follow.

IVO M. BABUSKA, University of Texas, Austin, for contributions to the theory and implementation of finite element methods for computer-based engineering analysis and design; MARSHA J. BERGER, Courant Institute of Mathematical Sciences, New York University, for developing adaptive mesh refinement algorithms and software that have advanced engineering applications, especially the analysis of aircraft and spacecraft; DIMITRIS J. BERTSIMAS, Massachusetts Institute of Technology, for contributions to optimization theory and stochastic systems and innovative applications in financial engineering and transportation; A. ROBERT CALDERBANK, Princeton University, for leadership in communications research, from advances in algebraic coding theory to signal processing for wire-line and wireless modems; EDMUND M. CLARKE, Carnegie Mellon University, for contributions to the formal verification of hardware and software correctness; DOMINIC M. DI TORO, University of Delaware, Newark, for his leadership in the development and application of mathematical models for establishing water-quality criteria and making management decisions; SHAFRIRA GOLDWASSER, Massachusetts Institute of Technology, for contributions to cryptography, number theory, and complexity theory and their applications to privacy and security; JOHN S. HUNTER, Princeton University, for the development and application of statistical methods for efficiently designed experiments and data interpretation; ROBERT M. MCMEEKING, University of California, Santa Barbara, for contributions to the computational modeling of materials and for the development of codes widely used by industry; and THOMAS L. SAATY, University of Pittsburgh, for the development and generalization of the analytic hierarchy process and the analytic network process in multicriteria decision making.

Elected as foreign associates were WILLIAM M. KAHAN, University of California, Berkeley, for the development of techniques for reliable floating point computation, especially the IEEE Floating Point Standards; and WALTER M. WONHAM, University of Toronto, for work on the geometric theory of linear systems and for bridging the gap between control theory and computer science.

—From an NAE announcement

Mathematics Opportunities

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 05-579. Information is available at <http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf05579>. The deadline for submission of proposals is **July 21, 2005**.

—From an NSF announcement

ADVANCE: New NSF Program to Increase Women's Participation

The National Science Foundation (NSF) has instituted the ADVANCE Program in an effort to increase the representation and advancement of women in academic science and engineering careers.

In 2005–2006 the program will support three types of projects. Leadership Awards will support the efforts of individuals, small groups, or organizations in developing national and/or discipline-specific leadership in enabling the full participation and advancement of women in academic science and engineering careers.

Institutional Transformation Awards will support transformational efforts in academic institutions intended to increase participation and advancement of women scientists and engineers in academe. These awards support innovative and comprehensive programs for institution-wide change.

Partnerships for Adaptation, Implementation, and Dissemination Awards support the analysis, adaptation, dissemination, and use of existing innovative materials and practices that have been demonstrated to be effective in increasing representation and participation of women in academic science and engineering careers.

The NSF is seeking proposals from both men and women for creative strategies to realize the goals of the ADVANCE

Program. Members of underrepresented minority groups and individuals with disabilities are especially encouraged to apply. Proposals that address the participation and advancement of women from underrepresented minority groups are encouraged.

The deadlines for proposals are as follows: for Leadership Awards, **July 15, 2005**; for Institutional Transformation Awards, **July 22, 2005**; for Partnerships for Adaptation, Implementation, and Dissemination Awards, **January 27, 2006**. For further details see http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5383.

—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, 2005**. 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 10111-0242; or consult the foundation's Web page: http://www.sloan.org/programs/fellowship_brochure.shtml.

—From a Sloan Foundation announcement

Call for Nominations for the ICTP/IMU Ramanujan Prize

The Abdus Salam International Centre for Theoretical Physics (ICTP), in conjunction with the International Mathematical Union (IMU), is seeking nominations for the first annual Ramanujan Prize for Young Mathematicians from Developing Countries. Researchers under forty-five years old who work in any branch of the mathematical sciences are eligible. The prize carries a \$10,000 cash award and a travel and subsistence allowance to deliver a prize

lecture at the ICTP. The deadline for receipt of nominations is **July 31, 2005**. For further information see http://www.ictp.trieste.it/~sci_info/awards/Ramanujan/Ramanujan.html.

—From an ICTP announcement

News from the Clay Mathematics Institute

The Clay Mathematics Institute (CMI) announces a program of small workshops, generally ten to twenty persons, to be held at its One Bow Street offices in Cambridge, Massachusetts. The aim is to bring a small set of researchers together quickly, outside the usual grant and application cycle, when this is likely to result in significant progress. An application submitted three months before the workshop is sufficient. Funding for at least ten people is available for each workshop.

CMI, located on Massachusetts Avenue five blocks from the Harvard Square subway station, offers excellent space and facilities for workshops. There is a hotel across the street, bed and breakfasts within easy walking distance, and a great variety of nearby restaurants and cafes.

The first of these workshops, organized by Haynes Miller (Massachusetts Institute of Technology) and Jack Morava (Johns Hopkins), was held March 11 to 13 on the subject "Operads and the Goodwillie Calculus".

See <http://www.claymath.org/workshops> for further information.

—CMI announcement

NSF Launches Math Website

The National Science Foundation (NSF) has added to its website a special section called "Mathematics: An Overview of NSF Research". Separate from the Web pages of the NSF's Division of Mathematical Sciences, the new section provides accessible, nontechnical explanations of some of the mathematical sciences research topics sponsored by the NSF. Among the topics discussed are managing and modeling complexity, pattern recognition, and the "double-bubble" problem. There is also an interactive feature focusing on fractal geometry. The URL for the main page is <http://www.nsf.gov/news/overviews/mathematics/index.jsp>.

—Allyn Jackson

Special Meetings in the Mathematical Sciences

The Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) has long supported conferences, workshops, and similar activities that aim to

widely disseminate scholarly work, reveal and plan new directions and opportunities for research, and engage and encourage students and junior scientists early in their careers. To emphasize such opportunities for mathematical scientists, especially opportunities that go beyond what ordinary conferences might provide, the DMS has revised its conference solicitation. The new announcement, NSF 05-540, is called "Conferences, Workshops, and Special Meetings in the Mathematical Sciences". In this solicitation the DMS invites proposals of two types: (1) regular conference, symposia, and workshop proposals; and (2) proposals for special meetings, which comprise longer-term or larger-scale activities that more widely engage and connect the mathematical sciences community, such as special research years or semesters, multi-institutional regional meetings, and "summer schools".

As in the past, regular conference proposals are submitted to the cognizant DMS programs according to those programs' usual deadlines or target dates. These proposals normally request funding in the range of \$5,000 to \$25,000, although awards of up to \$50,000 have occasionally been made. Their duration is normally for one year.

What we wish to emphasize here is the opportunity for special meetings. Proposals for special meetings are submitted to the cognizant DMS programs but at a distinct, common deadline. Special meetings proposals may request funding of any amount and for durations of up to three years, but most awards are expected to be in the range of \$50,000 to \$150,000 per year. This is not a change in the sort of proposals that the DMS is willing to accept or to fund. But it is an invitation to the mathematical sciences research community to pursue more ambitious ideas than the usual conference mechanism might accommodate.

The deadline for the next Special Meetings competition is **October 18, 2005**. Later competitions will have deadlines of the fourth Thursday in August each year. For more information about this opportunity, see the website http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=11701&org=DMS.

—DMS announcement

Inside the AMS

Fan China Exchange Program Names Awardees

The Society's Fan China Exchange Program awards grants to support collaborations between Chinese and U.S. or Canadian researchers. Institutions in the United States or Canada apply for the funds to support a visitor from China or vice versa. This funding is made possible through a generous gift to the AMS from Ky and Yu-Fen Fan in 1999.

The names of the awardees for 2005 follow. Host: YONGQING LI, Fujian Normal University, China; visitor: YUM-TONG SIU, Harvard University, U.S., length of stay to be determined. Host: JIANYA LIU, Shandong University, China; visitor: YANGBO YE, University of Iowa, U.S., three months. Host: BRUCE DRIVER, University of California, San Diego, U.S.; visitors: YUXIN DONG, Fudan University, and YU ZHENG, East China Normal University, China, two months. Host: DAVID GRIFFEATH, University of Wisconsin, Madison, U.S.; visitor: YINGI WU, University of Science and Technology of China, three months.

For information about the Fan China Exchange Program, visit the website <http://www.ams.org/outreach/chinaexchange.html>, or contact the AMS Membership and Programs Department, email: prof-serv@ams.org, telephone 401-455-4058 (within the U.S. call 800-321-4267, ext. 4058).

—Allyn Jackson

Epsilon Awards for 2005

The AMS Epsilon Fund for Young Scholars was established in 1999 to provide financial assistance to summer programs for mathematically talented high school students in the United States. For many years these programs have provided mathematically talented youngsters with their first serious mathematical experiences. The name for the fund was chosen in remembrance of the late Paul Erdős, who was fond of calling children "epsilons".

The AMS has chosen nine summer mathematics programs to receive Epsilon grants for activities in the summer of 2005. The grants will support program expenses and student scholarships and, in some cases, scholarships only. The programs were chosen on the basis of mathematical excellence and enthusiasm. Award amounts were governed by the varying financial needs of each program and totaled \$80,000.

The programs receiving grants are: All Girls/All Math Summer Camp for High School Girls, University of Nebraska, Lincoln; Canada/USA Mathcamp, Reed College, Portland, Oregon; Hampshire College Summer Studies in Mathematics, Amherst, Massachusetts; MathPath, Colorado College, Colorado Springs; Michigan Math and Science Scholars Program, University of Michigan, Ann Arbor; PROMYS, Boston University; Ross Mathematics Program, Ohio State University; Texas State Honors Summer Math Camp, Texas State University, San Marcos; University of Chicago Young Scholars Program.

The grants for summer 2005 are paid for by the AMS Epsilon Fund for Young Scholars (supplemented by the AMS Program Development Fund). The AMS is continuing to build the endowment for the Epsilon Fund, with a goal of raising \$2 million through individual donations and grants. Once the Epsilon Fund endowment has reached the targeted amount, the AMS intends to award a total of \$100,000 in Epsilon grants each year.

For further information about the Epsilon Fund for Young Scholars, visit the website <http://www.ams.org/giving-to-ams/>, or contact development@ams.org, telephone 800-321-4267, extension 4111, or 401-455-4111. Information about how to apply for Epsilon grants is available at <http://www.ams.org/outreach/epsilon.html>. A fairly comprehensive listing of summer programs for mathematically talented high school students (including those with and without Epsilon grants) is available at <http://www.ams.org/outreach/mathcamps.html>.

—Allyn Jackson

AMS Sponsors Mass Media Fellow

The American Mathematical Society (AMS) is pleased to announce that BRENT DESCHAMP has been awarded its 2005 Mass Media Fellowship. Deschamp is a graduate student in civil engineering/mathematics at the University of Wyoming. He will be working at WOSU-AM in Columbus, Ohio, for ten weeks over the summer under the sponsorship of the AMS.

The Mass Media Fellowship program is organized by the American Association for the Advancement of Science (AAAS) and is intended to strengthen the connections between science and the media, to improve public understanding of science, and to sharpen the ability of the fellows to communicate complex scientific issues to non-specialists. The program is available to college or university students (in their senior year, or in any graduate or postgraduate level) in the natural, physical, or health sciences; engineering; computer science; social sciences; or mathematics who have outstanding written and oral communication skills and a strong interest in learning about the media. It is a highly competitive program, and the AMS wishes to congratulate Brent Deschamp on his accomplishment.

The program is in its thirty-first year and has supported nearly 500 fellows. The AMS has sponsored 10 fellows since it began participating in the program in 1997. For more information on the AAAS Mass Media Science and Engineering Fellows Program, visit the AAAS website <http://www.aaas.org/programs/education/MassMedia/>. For information on the AMS program, contact Anita Benjamin, AMS Washington office, amsdc@ams.org.

—Anita Benjamin, AMS Washington office

Deaths of AMS Members

DALLAS O. BANKS, professor emeritus, from Davis, CA, died on June 27, 2003. Born on October 21, 1928, he was a member of the Society for 44 years.

HELEN P. BEARD, retired, from Lynchburg, VA, died on January 8, 2004. Born in November 1915, she was a member of the Society for 62 years.

KENNETH P. BOGART, professor, Dartmouth College, died on March 30, 2005. Born on October 6, 1943, he was a member of the Society for 40 years.

TRUMAN BOTTS, retired, from Arlington, VA, died on February 4, 2005. Born on November 26, 1917, he was a member of the Society for 64 years.

BERNARD EPSTEIN, retired, from Potomac, MD, died on March 30, 2005. Born on August 10, 1920, he was a member of the Society for 60 years.

BRUCE FRECH, Planalytics Energy, Wayne, PA, died on January 29, 2005. Born on December 11, 1956, he was a member of the Society for 27 years.

ROBERT FULTON, professor, University of Louisville, KY, died on March 10, 2005. Born on April 11, 1938, he was a member of the Society for 5 years.

HERBERT GOLDSTEIN, professor, Columbia University, died in January 2005. Born on June 26, 1922, he was a member of the Society for 37 years.

J. RAY HANNA, retired, from Cheyenne, WY, died on March 11, 2005. Born on January 26, 1914, he was a member of the Society for 52 years.

PETER HANNA, retired, from Santa Cruz, CA, died on April 8, 2005. Born on December 9, 1918, he was a member of the Society for 39 years.

GEORGE E. HAY, professor, University of Michigan, Ann Arbor, died on January 12, 2005. Born on June 11, 1914, he was a member of the Society for 65 years.

VIRGIL C. KOWALIK, professor emeritus, Texas A&M University, Kingsville, died on March 19, 2005. Born on February 8, 1932, he was a member of the Society for 41 years.

ZHENXIU MAO, professor, MIT, died on February 28, 2005. He was a member of the Society for one year.

THOMAS A. METZGER, associate professor, University of Pittsburgh, died on February 24, 2005. Born on July 14, 1944, he was a member of the Society for 38 years.

MIRCEA MIȘICU, prin. sci. res., National Institute for Earth Physics, Romania, died on March 23, 2005. Born on February 27, 1926, he was a member of the Society for 9 years.

MICHIHIRO NAGASE, professor, Osaka University, died on January 10, 2004. Born on February 13, 1944, he was a member of the Society for 17 years.

EDWARD A. NORDHAUS, professor emeritus, Michigan State University, died on November 18, 1998. Born on February 23, 1912, he was a member of the Society for 62 years.

IGOR V. SKRYPNIK, director, National Academy of Sciences of Ukraine, (Inst. of Applied Math. and Mech.), died in February 2005. Born on November 13, 1940, he was a member of the Society for 10 years.

JAMES SNOVER, retired, Florida State University, died on June 9, 2001. Born on November 23, 1920, he was a member of the Society for 52 years.

THEODOR D. STERLING, from Vancouver, Canada, died on January 26, 2005. Born on July 3, 1923, he was a member of the Society for 50 years.

SAURO TULIPANI, professor, University of Perugia, died in March 2005. Born on August 6, 1946, he was a member of the Society for 22 years.

JACOBUS H. VAN LINT, retired, Eindhoven University of Technology, the Netherlands, died on September 20, 2004. Born on September 1, 1932, he was a member of the Society for 44 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.ou.edu in the case of the editor and notices@ams.org in the case of the managing editor. The fax numbers are 405-325-7484 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

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 com-

pleted 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 its activities, and other such topics of interest to *Notices* readers. Each

Where to Find It

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

AMS Bylaws—November 2003, p. 1283

AMS E-mail Addresses—December 2004, p. 1365

AMS Ethical Guidelines—June/July 2004, p. 675

AMS Officers 2004 and 2005 (Council, Executive Committee, Publications Committees, Board of Trustees)—May 2005, p. 564

AMS Officers and Committee Members—October 2004, p. 1082

Conference Board of the Mathematical Sciences—September 2004, p. 921

Information for *Notices* Authors—June/July 2005, p. 660

Mathematics Research Institutes Contact Information—August 2004, p. 810

National Science Board—January 2005, p. 76

New Journals for 2004—June/July 2005, p. 662

NRC Board on Mathematical Sciences and Their Applications—March 2005, p. 361

NRC Mathematical Sciences Education Board—April 2005, p. 465

NSF Mathematical and Physical Sciences Advisory Committee—February 2005, p. 261

Program Officers for Federal Funding Agencies—October 2004, p. 1078 (DoD, DoE); December 2004, p. 1368 (NSF)

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 limited 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 $\mathcal{A}_{\text{M}}\text{S-}\text{T}_{\text{E}}\text{X}$. 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.

Instructions for Authors of "WHAT IS...?" Columns

The purpose of the "WHAT IS...?" column is to provide brief, nontechnical descriptions of mathematical objects in use in current research. The target audience for the columns is first-year graduate students.

Each "WHAT IS...?" column provides an expository description of a single mathematical object being used in contemporary research. Thus "WHAT IS M-Theory?" would be too

broad, but "WHAT IS a Brane?" would be appropriate; ideally, "WHAT IS a Brane?" would give a flavor of what M-theory is.

The writing should be nontechnical and informal. The level should be a little higher than the level of popular articles about mathematical developments one finds in magazines like *Science* that are aimed at a general audience.

There is a strict limit of two *Notices* pages (1,400 words with no picture, or 1,200 words with one picture). A list of "Further Reading" should contain no more than three references.

Inquiries and comments about the "WHAT IS...?" column are welcome and may be sent to notices-whatis@ams.org.

Upcoming Deadlines

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

July 15, 2005: Proposals for Leadership Awards of the NSF ADVANCE program. See "Mathematics Opportunities" in this issue.

July 21, 2005: Proposals for NSF CAREER Program. See "Mathematics Opportunities" in this issue.

July 22, 2005: Proposals for Institutional Transformation Awards of the NSF ADVANCE program. See "Mathematics Opportunities" in this issue.

July 31, 2005: Nominations for the Ramanujan Prize of the Abdus Salam International Centre for Theoretical Physics (ICTP). See "Mathematics Opportunities" in this issue.

July 31, 2005: Nominations for the SASTRA Ramanujan Prize. See <http://www.math.ufl.edu/sastra-prize>.

July 31, 2005: Nominations and applications for the Monroe H. Martin Prize. Contact R. Roy, Director, Institute for Physical Science and Technology, University of Maryland, College Park, MD 20742-2431.

August 1, 2005: Submissions for Competition 2005 of the European Mathematical Society. See <http://www.mat.dtu.dk/people/V.L.Hansen/rpa/secondartcomp.html>.

September 15, 2005: Nominations for Sloan Research Fellowships. See

"Mathematics Opportunities" in this issue.

September 16, 2005: Proposals for NSF program on Enhancing the Mathematical Sciences Workforce in the 21st Century. See <http://www.nsf.gov/pubs/2003/nsf03575/nsf03575.htm>.

October 1, 2005: Nominations for Lucien Godeaux Prize. Contact J. Aghion, c/o Secretariat of the Royal Society of Sciences of Liege, Institute of Mathematics of the University of Liege, 12 Grande Traverse, Sart Tilman Bat. B37, B-4000 Liege 1, Belgium; email: jaghion@ulg.ac.be.

October 18, 2005: Applications for NSF Department of Mathematical Sciences program "Conferences, Workshops, and Special Meetings in the Mathematical Sciences". See "Mathematics Opportunities" in this issue.

October 19, 2005: Applications for NSF Postdoctoral Research Fellowships (MSPRF). See <http://www.nsf.gov/pubs/ods.getpub.cfm?nsf05510>.

January 1, 2006: Submissions for Competition 2006 of the European Mathematical Society. See <http://www.mat.dtu.dk/people/V.L.Hansen/rpa/secondartcomp.html>.

January 1, 2006: Applications for ICM 2006 Travel Grants. See <http://www.icm2006.org> or email: grants@icm2006.org.

January 27, 2006: Proposals for Partnerships for Adaptation, Implementation, and Dissemination Awards of the NSF ADVANCE program. See "Mathematics Opportunities" in this issue.

New Journals for 2004

Below is a list of mathematical journals appearing for the first time in 2004, 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 Difference Equations, 1687-1839, Hindawi Publishing, \$195/4 issues/yr.

Contributions to Discrete Mathematics, 1715-0868, University of Calgary, Canada, e-journal, free of charge,

<http://cdm.ucalgary.ca>. Issue 1 expected January 2006.

Fixed Point Theory and Applications, 1687-1820, Hindawi Publishing, \$195/4 issues/yr.

International Journal of Geometric Methods in Modern Physics, 0219-8878, World Scientific, \$280/6 issues/yr.

International Mathematics Research Surveys, 1687-1308, Hindawi Publishing, \$195/4 issues/yr.

Journal of Hyperbolic Differential Equations, 0219-8916, World Scientific, \$190/4 issues/yr.

Book List

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

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

13: *The Story of the World's Most Popular Superstition*, by Nathaniel Lachenmeyer. Thunder's Mouth Press, October 2004. ISBN 1-568-58306-0.

1089 and All That. A Journey into Mathematics, by David Acheson. Oxford University Press, July 2002. ISBN 0-19-851623-1. (Reviewed February 2005.)

Action This Day, edited by Michael Smith and Ralph Erskine. Random House of Canada, February 2003. ISBN 0-593-04910-1.

Alfred Tarski: Life and Logic, by Anita Burdman Feferman and Solomon Feferman. Cambridge University Press, October 2004. ISBN 0-521-80240-7.

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

Beyond Reason: Eight Great Problems That Reveal the Limits of Science, by A. K. Dewdney. Wiley, April 2004. ISBN 0-471-01398-6.

* *A Brief History of Infinity*, by Paolo Zellini. Penguin Books (paperback), March 2005. ISBN 0-141-00762-1.

* *The Calculus Gallery: Masterpieces from Newton to Lebesgue*, by William Dunham. Princeton University Press, December 2004. ISBN 0-691-09565-5.

* *Chance: A Guide to Gambling, Love, the Stock Market and Just About Everything Else*, by Amir D. Aczel. Four Walls Eight Windows, October 2004. ISBN 1-568-58316-8.

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

* *The Colours of Infinity: The Beauty and Power of Fractals*, by Michael Barnsley, Nigel Lesmoir-Gordon, Benoit B. Mandelbrot, Ian Stewart, Gary Flake, Robert Prechter, and Arthur C. Clarke. Clear Press, March 2004. ISBN 1-904-55505-5.

* *Complexities: Women in Mathematics*, edited by Bettie Anne Case and Anne M. Leggett. Princeton University Press, January 2005. ISBN 0-691-11462-5.

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

The Constants of Nature: From Alpha to Omega—The Numbers That Encode the Deepest Secrets of the Universe, by John D. Barrow. Jonathan Cape, September 2002. Pantheon Books, January 2003. ISBN 0-375-42221-8. (Reviewed November 2004.)

* *Converging Realities: Toward a Common Philosophy of Physics and Mathematics*, by Roland Omnès. Princeton University Press, November 2004. ISBN 0-691-11530-3.

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

The Curious Incident of the Dog in the Nighttime, by Mark Haddon. Vintage, May 2004. ISBN 1-400-03271-7.

Dark Hero of the Information Age: In Search of Norbert Wiener, by Flo Conway and Jim Siegelman. Basic

Books, December 2004. ISBN 0-738-20368-8.

The Essential Turing, edited by B. Jack Copeland. Oxford University Press, September 2004. ISBN 0-198-25080-0.

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

From Eudoxus to Einstein: A History of Mathematical Astronomy, by C. M. Linton. Cambridge University Press, August 2004. ISBN 0-521-82750-7.

From Newton to Hawking: A History of Cambridge University's Lucasian Professors of Mathematics, edited by Kevin C. Knox and Richard Noakes. Cambridge University Press, November 2003. ISBN 0-521-66310-5.

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

* *Geometry and Meaning*, by Dominic Widdows. Center for the Study of Language and Information, November 2004. ISBN 1-575-86448-7.

The Golden Ratio: The Story of Phi, the World's Most Astonishing Number, by Mario Livio. Broadway Books, October 2002. ISBN 0-767-90815-5. (Reviewed March 2005.)

* *Graphic Discovery: A Trout in the Milk and Other Visual Adventures*, by Howard Wainer. Princeton University Press, October 2004. ISBN 0-691-10301-1.

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

The Heart of Mathematics: An Invitation to Effective Thinking, by Edward B. Burger and Michael Starbird. Key College Publishing (Springer-Verlag), April 2000. ISBN 0-555953-407-9. (Reviewed February 2005.)

Incompleteness: The Proof and Paradox of Kurt Gödel, by Rebecca Goldstein. W. W. Norton & Company, February 2005. ISBN 0-393-05169-2.

The Infinite Book: Where Things Happen That Don't, by John D. Barrow. Jonathan Cape, February 2005. ISBN 0-224-06917-9.

* *John Pell (1611-1685) and His Correspondence with Sir Charles Cavendish: The Mental World of an Early Modern Mathematician*, by Noel Malcolm and Jacqueline Stedall. Oxford University Press, second edition, January 2005. ISBN 0-198-56484-8.

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

Kepler's Conjecture: How Some of the Greatest Minds in History Helped Solve One of the Oldest Math Problems in the World, by George G. Szpiro. Wiley, January 2003. ISBN 0-471-08601-0. (Reviewed January 2005.)

The Knot Book: An Elementary Introduction to the Mathematical Theory of Knots, Colin C. Adams. AMS, September 2004. ISBN 0-8218-3678-1.

* *Knots and Links*, by Peter R. Cromwell. Cambridge University Press, October 2004. ISBN 0-691-10301-1.

The Liar Paradox and the Towers of Hanoi: The Ten Greatest Math Puzzles of All Time, by Marcel Danesi. Wiley, August 2004. ISBN 0-471-64816-7.

* *Luck, Logic, and White Lies: The Mathematics of Games*, by Jorg Bewersdorff. Translated by David Kramer. A K Peters, November 2004. ISBN 1-568-81210-8.

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

Math and the Mona Lisa: The Art and Science of Leonardo da Vinci, by Bulent Atalay. Smithsonian Books, April 2004. ISBN 1-588-34171-2.

Math Magic: How to Master Everyday Math Problems, by Scott Flansburg. Perennial Currents, revised edition, August 2004. ISBN 0-060-72635-0.

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

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

* *Mathematical Illustrations: A Manual of Geometry and PostScript*, by Bill

Casselman. Cambridge University Press, December 2004. ISBN 0-521-54788-1.

* *A Mathematician at the Ballpark: Odds and Probabilities for Baseball Fans*, by Ken Ross. Pi Press, July 2004. ISBN 0-131-47990-3.

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

Mathematicians under the Nazis, by Sanford L. Segal. Princeton University Press, July 2003. ISBN 0-691-00451-X. (Reviewed April 2005.)

Mathematics: A Very Short Introduction, by Timothy Gowers. Oxford University Press, October 2002. ISBN 0-192-85361-9. (Reviewed February 2005.)

The (Mis)Behavior of Markets: A Fractal View of Risk, Ruin and Reward, by Benoit Mandelbrot and Richard Hudson. Basic Books, August 2004. ISBN 0-465-04355-0.

More Damned Lies and Statistics: How Numbers Confuse Public Issues, by Joel Best. University of California Press, August 2004. ISBN 0-520-23830-3.

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

* *Musings of the Masters: An Anthology of Miscellaneous Reflections*, edited by Raymond G. Ayoub. Mathematical Association of America, 2004. ISBN 0-88385-549-6.

Number Theory from an Analytic Point of View, by Badi H. Ghusayni. Komati, December 2003. ISBN 9953-0-0282-7.

* *Numbers, The Language of Science*, by Tobias Dantzig. Pi Press, fifth edition, March 2005. ISBN 0-131-85627-8.

The Oxford Murders, by Guillermo Martinez. Abacus, January 2005. ISBN 0-349-11721-7.

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

Probability Theory: The Logic of Science, by E. T. Jaynes, edited by G. Larry Bretthorst. Cambridge

University Press, April 2003. ISBN 0-521-59271-2.

* *R. L. Moore: Mathematician and Teacher*, by John Parker. Mathematical Association of America, 2004. ISBN 0-88385-550-X.

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

The Road to Reality: A Complete Guide to the Laws of the Universe, by Roger Penrose. Knopf, February 2005. ISBN 0-679-45443-8.

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

* *Sneaking a Look at God's Cards: Unraveling the Mysteries of Quantum Mechanics*, by Giancarlo Ghirardi, translated by Gerald Malsbary. Princeton University Press, revised edition, January 2005. ISBN 0-691-12139-7.

Stalking the Riemann Hypothesis: The Quest to Find the Hidden Law of Prime Numbers, by Dan Rockmore. Pantheon, April 2005. ISBN 0-375-42136-X.

Strange Curves, Counting Rabbits, and Other Mathematical Explorations, by Keith Ball. Princeton University Press, November 2003. ISBN 0-691-11321-1. (Reviewed in December 2004.)

* *A Tour Through Mathematical Logic*, by Robert S. Wolf. Mathematical Association of America, January 2005. ISBN 0-88385-036-2.

Towards a Philosophy of Real Mathematics, by David Corfield. Oxford University Press, April 2003. ISBN 0-521-81722-6.

The Transformation of Mathematics in the Early Mediterranean World: From Problems to Equations, by Reviel Netz. Cambridge University Press, June 2004. ISBN 0-521-82996-8.

The Universal Book of Mathematics: From Abracadabra to Zeno's Paradoxes, by David Darling. Wiley, July 2004. ISBN 0-471-27047-4.

The Works of Archimedes: Translation and Commentary. Volume I: The Two Books on the Sphere and the Cylinder. Translated by Reviel Netz. Cambridge University Press, April

2004. ISBN 0-521-66160-9. (Reviewed May 2005.)

A World without Time: The Forgotten Legacy of Gödel and Einstein, by Pallo Yourgrau. Basic Books, January 2005. ISBN 0-465-09293-4.

You Can Do the Math: Overcome Your Math Phobia and Make Better Financial Decisions, by Ron Lipsman. Praeger Publishers, November 2004. ISBN 0-275-98341-2.

Mathematics Calendar

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

June 2005

1-3 Workshop on PDE and Harmonic Analysis, Norwegian University of Science and Technology, Trondheim, Norway. (May 2005, p. 566)

1-4 ACMS 15th Biennial Conference, Huntington College, Huntington, Indiana. (Feb. 2005, p. 289)

1-4 Classics in PDE: A meeting in Honor of Nina Nikolaevna Uraltseva 70th Birthday, KTH, Stockholm, Sweden. (May 2005, p. 566)

1-5 10th International Conference Mathematical Modelling and Analysis and 2nd International Conference Computational Methods in Applied Mathematics, Trakai, Lithuania. (Apr. 2005, p. 473)

1-5 Stochastic Modeling in Financial Mathematics (joint with SAMSI), Centre de Recherches Mathématiques, Université de Montréal, Montréal, Québec, Canada. (Aug. 2004, p. 834)

2-10 Seventh International Conference on Geometry, Integrability and Quantization with a special session on Multisymplectic Geometry and Classical Field Theory, Sts. Constantine and Elena resort (near Varna), Bulgaria. (Feb. 2005, p. 289)

4 8th Annual Workshop on Applications and Generalizations of Complex Analysis, University of Aveiro, Aveiro, Portugal. (May 2005, p. 566)

*** 4-8 International Conference on Nonlinear Waves, Integrable Systems and Their Applications**, University of Colorado at Colorado Springs, Colorado Springs, Colorado.

Information: <http://math.uccs.edu/~soliton>.

4-8 International Conference on Scientific Computing (ICSC05), Nanjing, P. R. China. (Oct. 2004, p. 1096)

4-9 Second International Conference on Abstract and Applied Analysis: ICAAA 2005, Quy Nhon, Vietnam. (May. 2005, p. 567)

5-9 Representation Theory, Geometry and Automorphic Form. International Conference in honor of J. Bernstein's 60th birthday, Tel-Aviv University, Tel-Aviv, Israel. (May 2005, p. 567)

5-10 31st International Conference "Applications of Mathematics in Engineering and Economics", Sozopol, Bulgaria. (Apr. 2005, p. 473)

5-July 21 Joint Summer Research Conference, Snowbird Resort, Snowbird, Utah. (May 2005, p. 567)

6-8 Nonlinear Partial Differential Equations and Applications: Conference in honor of Jim Serrin on the occasion of the awarding of the title of Doctor Honoris Causa of Université François Rabelais, Faculty of Sciences-Université, François Rabelais-Tours, France. (Feb. 2005, p. 289)

6-8 SEM Annual Conference & Exposition on Experimental and Applied Mechanics, Marriott Portland Downtown, Portland, Oregon. (May 2004, p. 576)

6-10 (REVISED) International Mediterranean Congress of Mathematics Almeria 2005, Almeria, Spain. (Dec. 2004, p. 1377)

6-10 Moduli Spaces of Properly Embedded Minimal Surfaces, AIM Research Conference Center, Palo Alto, California. (Jun/Jul. 2004, p. 693)

6-11 14th Summer St. Petersburg Meeting in Mathematical Analysis, Euler IMI, St. Petersburg, Russia. (Feb. 2005, p. 289)

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

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

In general, announcements of meetings and conferences held in North America carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with

respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of the *Notices* in care of the American Mathematical Society in Providence or electronically to notices@ams.org or mathcal@ams.org.

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

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

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

- * 6-11 CIME Conference: Enumerative invariants in algebraic geometry and string theory**, Cetraro (Cosenza), Italy.
Lectures (Six hours each): D. Abramovich, Brown University, Providence, Gromov-Witten invariant for orbifolds; M. Marino, CERN, Geneva, Switzerland, Open strings; M. Thaddeus (Columbia), Moduli of sheaves; R. Vakil (Stanford), Gromov-Witten theory and the moduli space of curves.
Information: <http://www.math.unifi.it/~cime/Courses/2005/01.html>.
- 6-24 Summer School and Conference on Geometry and Topology of 3-Manifolds**, ICTP, Trieste, Italy. (Apr. 2005, p. 473)
- 7-10 SIAM Conference on Mathematical and Computational Issues in the Geosciences**, Palais des Papes, The International Conference Center, Avignon, France. (Nov. 2004, p. 1265)
- 7-12 25th Great Plains Operator Theory Symposium (GPOTS-05)**, University of Central Florida, Orlando, Florida. (Feb. 2005, p. 289)
- 7-17 Fields Institute Summer School on Operator Algebras**, University of Ottawa, Ottawa, Ontario, Canada. (Nov. 2004, p. 1265)
- 8-10 Eleventh Conference on Integer Programming and Combinatorial Optimization (IPCO XI)**, Berlin, Germany. (Dec. 2004, p. 1377)
- 8-11 Second Advanced Course in Operator Theory and Complex Analysis**, Seville, Spain. (Apr. 2005, p. 473)
- 8-11 IMA Workshop: Effective Theories for Materials and Macromolecules**, University of Minnesota, Minneapolis, Minnesota. (Jun/Jul. 2004, p. 693)
- 8-12 Computability in Europe 2005 (CiE 2005): New Computational Paradigms**, Amsterdam, The Netherlands. (Feb. 2005, p. 289)
- 10-11 (REVISED) Cryptology Conference**, University of Central Oklahoma, Edmond, Oklahoma. (May 2005, p. 567)
- 10-12 Groups, Rings and Algebras—A Conference in Honor of Donald S. Passman**, University of Wisconsin, van Vleck Hall, Madison, Wisconsin. (Jan. 2005, p. 80)
- 10-15 Summer School on Harmonic, Wavelet, P-adic analysis**, Quy Nhon, Vietnam. (May 2005, p. 567)
- 12-24 Foliations 2005**, Lodz, Poland. (Sept. 2004, p. 973)
- 12-July 23 DIMACS Reconnect Conferences 2005: Reconnecting Teaching Faculty to the Mathematical Sciences Research Enterprise**, DIMACS, CORE Building, 4th Floor, Rutgers, the State University of New Jersey, 96 Frelinghuysen Road, Piscataway, New Jersey. (Feb. 2005, p. 290)
- * 13-14 DIMACS Workshop on Information Processing by Protein Structures in Molecular Recognition**, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.
Description: In this workshop we discuss the development of algorithms for discovery of spatial patterns important for recognition, for uncovering deep evolutionary relationship of proteins, for predicting binding partners, and for simulating the protein-protein and protein-DNA recognition process. We hope further development in these areas will be likely to formulate new research problems and motivate new algorithms in combinatorics, optimization, discrete mathematics, mathematical programming, and additional areas.
Organizer: Bhaskar DasGupta, University of Illinois at Chicago, email: dasgupta@cs.uic.edu; Jie Liang, University of Illinois at Chicago, email: jliang@uic.edu.
Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.
Information: <http://dimacs.rutgers.edu/Workshops/InformationProcessing/>.
- 13-17 Boundaries in Geometric Group Theory**, AIM Research Conference Center, Palo Alto, California. (Jan. 2005, p. 80)
- 13-17 Recent Developments and Open Questions in Iwasawa theory (in honor of Ralph Greenberg's 60th birthday)**, Boston University, Boston, Massachusetts. (Apr. 2005, p. 474)
- 13-18 Computational Methods and Function Theory (CMFT 2005)**, Joensuu, Finland. (Feb. 2004, p. 279)
- 13-25 (REVISED) CIMPASummerSchoolAGAHP2005—Arithmetic and Geometry around Hypergeometric Functions**, Galatasaray University, Ortakoy, Istanbul, Turkey. (Aug. 2004, p. 834)
- * 14-17 2005 World Conference on Natural Resource Modeling**, Humboldt State University, Arcata, California.
Theme: Getting the Details Right, Modeling for the Management of Complex Systems.
Description: This multidisciplinary conference is being sponsored by the Resource Modeling Association to provide a forum for new developments in modeling and analysis of natural resource systems, particularly ecological, economic and management aspects in forestry, fisheries, wildlife, agriculture, ecosystem and biodiversity conservation, and management of multiple use resources.
Deadlines: Submission of Abstracts & Early Registration May 1, 2005.
Organizers: Roland H. Lamberson, Math Dept, HSU, Arcata, California; email: rma2005@humboldt.edu.
Speakers: John Goss-Custard, Centre for Ecology and Hydrology, Dorchester, United Kingdom; Carlos Castillo-Chavez, Arizona State University; Steve Railsback, Mathematics Department, Humboldt State University.
Information: <http://www.humboldt.edu/~ecomodel/conference2005/index.htm>.
- 14-18 Random Media and Stochastic Partial Differential Equations**, University of Southern California, Los Angeles, California. (Apr. 2005, p. 474)
- 15-18 Algebraic and Topological Methods in Non-classical Logics II**, University of Barcelona, Barcelona, Spain. (Apr. 2005, p. 474)
- * 16-18 Current Geometry**, Naples, Italy.
Scientific Committee: E. Arbarello (Roma), F. Baldassarri (Padova), U. Bruzzo (Trieste), F. Catanese (Bayreuth), 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), J. Stasheff (Chapel Hill), A. M. Vinogradov (Salerno).
Organizing committee: G. Sparano (Salerno), A. M. Vinogradov (Salerno), R. Vitolo (Lecce).
Contact: email: sparano@bridge.diima.unisa.it. Prof. A. M. Vinogradov, Dipartimento di Matematica e Informatica, Univ. di Salerno, Via Ponte del Melillo, 84084 Fisciano (SA), Italy.
Information: <http://diffiety.ac.ru/conf/curgeo05/index.html>.
- 16-19 Second Joint International Meeting with the Deutsche Mathematiker-Vereinigung (DMV) and the Oesterreichische Mathematische Gesellschaft (OMG)**, Mainz, Germany. (May 2004, p. 576)
- 17-23 (NEW DATE) Algebraic Geometry and Number Theory**, Euler IMI, St. Petersburg, Russia. (Feb. 2005, p. 290)
- 19-24 33rd Canadian Operator Symposium (COSy), dedicated to George Elliott's 60th birthday**, University of Ottawa, Ottawa, Ontario, Canada. (Nov. 2004, p. 1265)
- 19-24 First Announcement: Conference on Applied Mathematics and Scientific Computing 4: On the occasion of Professor Aganovic's 70th birthday**, Brijuni, Croatia. (Nov. 2004, p. 1265)
- 19-24 Conference on Applied Mathematics and Scientific Computing 4: On the occasion of Professor Aganovic's 70th Birthday**, Brijuni, Croatia. (Nov. 2004, p. 1265)

20-22 **DIMACS Workshop on Detecting and Processing Regularities in High Throughput Biological Data**, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey. (Dec. 2004, p. 1377)

20-24 **Second Conference on Self-Similarity and Applications**, INSA Toulouse, Toulouse, France. (Aug. 2004, p. 834)

20-24 **The Fourth International Conference on High Dimensional Probability (HDP)**, St. John's College, Santa Fe, New Mexico. (Feb. 2005, p. 290)

20-25 **Asymptotic and Probabilistic Methods in Geometric Group Theory**, Geneva, Switzerland. (Jun/Jul. 2004, p. 693)

20-25 **FPSAC'05 : 17th Annual Conference on Formal Power Series and Algebraic Combinatorics**, Taormina, Sicily (Italy). (Dec. 2004, p. 1377)

20-26 **Sixth International Conference "Symmetry in Nonlinear Mathematical Physics"**, Institute of Mathematics, National Academy of Sciences of Ukraine, Kyiv (Kiev), Ukraine. (Dec. 2004, p. 1377)

20-July 8 (REVISED) **Random matrices, random processes, and integrable systems (C.R.M. Short Program)**, Centre de recherches mathématiques, Université de Montréal, Montréal. (Nov. 2004, p. 1265)

20-July 15 **Clay Mathematics Institute Summer School: Ricci Flow, 3-Manifolds and Geometry**, MSRI, Berkeley, California. (Feb. 2005, p. 290)

*20-August 12 **Summer Program for Undergraduate Students in Computational Biology**, University of Maryland, Baltimore, Maryland.

Topics: Student scholars select a research topic in Bioinformatics or Computational Neurobiology.

Structure: There will be preparatory workshops, work on a significant research project, and preparation and delivery of a report and scientific poster. There will also be various educational and social activities with other undergraduate researchers, including a summer GRE prep course and the 2005 UMBC Summer Undergraduate Research Fest.

Sponsor: Funded by the NSF as a Research Experiences for Undergraduates (REU) site.

Deadline: April 30th.

Information: For information on student scholar benefits and stipends, eligibility and application requirements, and to send application: Dr. Jonathan Bell, SPCB Program Director; Dept. of Mathematics and Statistics; UMBC; Baltimore, MD 21250; or email: jbell@math.umbc.edu.

20-August 15 **Computational Prospects of Infinity**, Institute for Mathematical Sciences, National University of Singapore, Singapore. (Jun/Jul. 2004, p. 693)

21-24 **International Workshop on Function Theory in Seoul**, Korea University, Seoul, Korea. (Apr. 2005, p. 474)

21-24 **MAM 5—Fifth International Conference on Matrix Analytic Methods in Stochastic Models**, Pisa, Italy. (Sept. 2004, p. 974)

22-24 **Inverse Problems, Multi-Scale Analysis and Homogenization**, Seoul National University, San56-1 Shinrim-dong, Kwanak-gu, Seoul 151-747, Korea. (May 2005, p. 567)

22-24 **Logic, Game Theory and Social Choice 4**, University of Caen, Caen, France. (Apr. 2005, p. 474)

22-25 **International Seminar "Control Theory and Theory of Generalized Solutions of Hamilton-Jacobi Equations" (CGS-2005)**, Institute of Mathematics and Mechanics of the Ural Branch of the Russian Academy of Sciences, Yekaterinburg (Ekaterinburg), Russia. (May 2005, p. 567)

25-July 1 **The Twentieth IEEE Symposium on Logic In Computer Science (LICS 2005): Call for Workshop Proposals**, Chicago, Illinois. (Feb. 2005, p. 290)

26-29 **12th International Linear Algebra Society Conference**, Regina Inn Hotel and Conference Centre, Regina, Canada. (Dec. 2004, p. 1378)

26-July 1 **ERLOGOL-2005: Intermediate Problems of Model Theory and Universal Algebra**, State Technical University/Mathematics Institute, Novosibirsk, Russia. (Jun/Jul. 2004, p. 694)

26-July 1 **30th Conference on Stochastic Processes and Their Applications**, University of California at Santa Barbara (UCSB), Santa Barbara, California. (Jun/Jul. 2004, p. 694)

*26-July 2 **Topological and variational methods of nonlinear analysis and their applications (TVMNA2005)**, Voronezh, Russia. **Topic:** The work of conference will be divided into 8 sections: Contemporary topology and its applications. Variational methods. Topological methods in non-linear problems of partial differential equations. The theory of set-valued mappings and differential inclusions. Dynamical systems, differential and functional-differential equations. Global and stochastic analysis and applications to mathematical physics. Mathematical modeling; Contemporary problems of education in mathematics.

Organizer: Voronezh State University, M. V. Lomonosov Moscow State University, Moscow State University of Communications, Moscow State Institute of electronics and mathematics (Technical University).

Information: <http://www.vsu.ru/activity/infoletters.do?mid=2&aid=180>; email: confer@alq.vsu.ru.

27-30 **14th International Scientific Congress CNIC 2005: 40 Years at the Service of Science and Technology**, Havana, Cuba. (May 2005, p. 567)

27-July 1 **Algebraic K- and L-theory of Infinite Groups**, ICMS, Edinburgh, Scotland. (Apr. 2005, p. 474)

*27-July 1 **International Workshop on Dynamic Equations on Time Scales in Memory of Bernd Aulbach**, Istanbul, Turkey.

Aim: The workshop focuses on various aspects related to dynamic equations on time scales. This theory handles the continuous case (differential equations) and the discrete case (difference equations) simultaneously and extends them to many other dynamic equations.

Organizers: M. Bohner (Rolla), A. Celebi (Ankara), M. Unal (Istanbul), Y. Akyildiz (Istanbul).

Supporters: Bahcesehir University and TUBITAK (National Science Foundation of Turkey).

Plenary Speakers: M. Bohner (Rolla, USA); O. Dosly (Brno, Czech Republic); S. Elaydi (San Antonio, USA); G. Guseinov (Ankara, Turkey); S. Hilger (Eichstatt, Germany); D. Lutz (San Diego, USA); A. Ruffing (Munich, Germany); C. Tisdell (Sydney, Australia).

Information: <http://www.fed.bahcesehir.edu.tr/workshop/>; email: bohner@umr.edu or munal@bahcesehir.edu.tr.

27-July 1 **Nonlinear Modelling and Control, An International Seminar**, Nayanova University, Samara, Russia. (Feb. 2005, p. 290)

*27-July 2 **CIME Conference: Calculus of variations and nonlinear partial differential equations**, Cetraro (Cosenza), Italy.

Lectures (5 hours each): Luigi Ambrosio, Scuola Normale Superiore, Pisa, Italy, Transport equation and Cauchy problem for non-smooth vector fields; Luis A. Caffarelli, University of Texas at Austin, Homogenization methods for non divergence equations; Michael Crandall, University of California at Santa Barbara, The infinity-Laplace equation and elements of the calculus of variations in L-infinity; Craig L. Evans, University of California at Berkeley, Weak KAM theory and partial differential equations; Pierre-Louis Lions, Université de Paris Dauphine, France, From atomic physics to non linear elasticity: A mathematical approach.

Information: <http://www.math.unifi.it/~CIME>.

27-July 5 **Probability and Mathematical Physics**, Centre de recherches mathématiques, Montréal, Québec, Canada. (Apr. 2005, p. 474)

28-July 1 **DAYS on DIFFRACTION-2005**, St. Petersburg Branch of Steklov's Math. Inst. and St. Petersburg Univ., St. Petersburg, Russia. (Dec. 2004, p. 1378)

30-July 2 **Primeras Jornadas de Teoría de Números**, EPSVG-UPC, Vilanova i la Geltrú (Barcelona), Spain. (Apr. 2005, p. 474)

July 2005

2-7 **SRTL-4: The Fourth International Research Forum on Statistical Reasoning, Thinking, and Literacy**, The University of Auckland, Auckland, New Zealand. (Jun/Jul. 2004, p. 694)

2-9 **Mile High Conference on Quasigroups, Loops and Nonassociative Systems**, University of Denver, Denver, Colorado. (Nov. 2004, p. 1266)

3-9 **XXIVièmes Journées Arithmétiques**, Marseilles, France. (Sept. 2004, p. 975)

4-8 **8th International Symposium on "Generalized Convexity and Monotonicity"**, Insubria University, Varese, Italy. (Dec. 2004, p. 1378)

4-8 **Conference on Universal Algebra and Lattice Theory**, University of Szeged, Szeged, Hungary. (Dec. 2004, p. 1378)

4-8 **MODELLING 2005 - Third IMACS Conference on Mathematical Modelling in Applied Sciences and Engineering**, University of West Bohemia, Pilsen, Czech Republic. (May 2005, p. 567)

6-23 **35th Saint-Flour Probability Summer School**, Saint-Flour, France. (May 2005, p. 568)

4-8 **Workshop on Coagulation-Fragmentation Processes: Theory and Applications**, International Centre for Mathematical Sciences, Edinburgh, UK. (May 2005, p. 568)

7-9 **OTFUSA2005: Conference on Operator Theory, Function Spaces and Applications-Dedicated to the 60th birthday of Frank-Olme Speck**, Department of Mathematics, University of Aveiro, Aveiro, Portugal. (May 2005, p. 568)

9-11 **Joint Meeting of the Chinese Society of Probability and Statistics (CSPS) and the Institute of Mathematical Statistics (IMS)**, Beijing, China. (Aug. 2004, p. 834)

9-15 **Nonlinear dispersive wave phenomena**, Anogia Academic Village, Crete, Greece. (Apr. 2005, p. 474)

10-13 **The 20th Summer Conference on Topology and Its Applications**, Denison University, Granville, Ohio. (Jan. 2005, p. 80)

*10-13 **Workshop and Conference on Probability, Financial Derivatives, and Asset Pricing**, University of Virginia, Charlottesville, Virginia.

Description: This will be a very broad workshop/conference on quantitative Finance, with some emphasis on topics from probability, such as Levy process modeling, or the use of characteristic functions. Other topics may relate to probability in less direct ways, and in most cases will be more directly focused what is generally considered the subject of finance. The workshop portion will include talks accessible to advanced graduate students.

Workshop/Conference Speakers: Wake Epps (University of Virginia), Dilip Madan (University of Maryland), Ken Singleton (Stanford University).

Conference Speakers: Gurdip Bakshi (University of Maryland), David Bates (University of Iowa), Nick Bollen (Vanderbilt University), Robert Jarrow (Cornell University), Stewart Mayhew (SEC), Alex Szimayer (University of Western Australia).

Organizers: Patrick Dennis, Wake Epps, Jeff Holt, Leonard Scott (all at University of Virginia).

Sponsors: Institute of Mathematical Science, University of Virginia; Department of Mathematics, University of Virginia; Bankard Foundation; McIntire School of Commerce, University of Virginia.

Financial Support: Support for local expenses is available, with preference given to graduate students and junior researchers.

Information: <http://conferences.math.virginia.edu/finance/>; email: finance@conferences.math.virginia.edu.

10-14 **12th International Conference on Mathematical Modelling and Applications (ICTMA12)**, City University, London, England. (Jan. 2004, p. 64)

10-15 **20th British Combinatorial Conference**, University of Durham, United Kingdom. (Sept. 2004, p. 975)

10-15 **Counting Complexity: An International Workshop on Statistical Mechanics and Combinatorics: In Celebration of the 60th Birthday of Tony Guttmann**, Dunk Island, Queensland, Australia. (Apr. 2005, p. 474)

10-15 **SampTA05 (Sampling Theory and applications)**, Ondokuz Mayıs University Samsun, Turkey. (Nov. 2004, p. 975)

10-16 **Stochastic Modelling of Complex Systems (SMOCS-05)**, Daydream Island resort (Whitsundays, Queensland, Australia). (Nov. 2004, p. 1266)

10-17 **Dimitsana Summer School on Stochastic Differential Geometry and Applications in Finance**, Thermo Aitolokarnanias, Greece. (May 2005, p. 568)

10-23 **Cornell Summer School in Probability**, Cornell University, Ithaca, New York. (Aug. 2004, p. 834)

11-14 **Sixth SIAM Conference on Control and its Applications**, Hilton New Orleans Riverside Hotel, New Orleans, Louisiana. (Dec. 2004, p. 1378)

*11-14 **Workshop on D-Modules and Hypergeometric Functions**, Faculty of Sciences of Lisbon University, Lisbon, Portugal.

Organizers: Alicia Dickenstein (Buenos Aires), Teresa Monteiro Fernandes (Lisbon), Claude Sabbah (Paris).

Topics: Interaction between D-Modules and Hypergeometric Functions in the generalized sense. Eduardo Cattani and Claude Sabbah give two short courses based on the work now well known as GKZ. This workshop aims to be useful for Ph.D. students as well as for researchers on related areas.

Information: <http://caul.cii.fc.ul.pt/DModHyp>.

*11-15 **2005 SIAM Annual Meeting**, New Orleans, Louisiana. **Information:** <http://www.siam.org/meetings/an05/>.

11-15 **Gravitational Lensing in the Kerr Spacetime Geometry**, AIM Research Conference Center, Palo Alto, California. (Nov. 2004, p. 1266)

11-15 **Novi Sad Algebraic Conference 2005**, University of Novi Sad, Novi Sad, Serbia/Serbia and Montenegro. (Apr. 2005, p. 474)

11-16 **Strings 2005, Toronto**, University of Toronto, Toronto, Ontario, Canada. (Nov. 2004, p. 1266)

11-22 **SMS 2005-NATO Advanced Summer Institute: Equidistribution in Number Theory**, Université de Montréal, Montréal, Canada. (Apr. 2005, p. 475)

16-August 1 **The Eighth International Diffiety school**, Santo Stefano del Sole (Avellino), Italy. (Apr. 2005, p. 475)

17-30 **Advances in Sensing with Security Applications: A NATO Advanced Study Institute**, Ciocco Resort, Tuscany. (Jan. 2005, p. 81)

18-22 **Algorithms for Approximation V**, University College, Chester, UK. (Nov. 2004, p. 1266)

18-22 **VI Brazilian Workshop on Continuous Optimization**, West Side Hotel Residence, Av. República do Líbano, 2526, Setor Oeste,

in Goiânia, Brazil. (Jan. 2005, p. 81)

18–24 Methods of Logic in Mathematics 2005, Euler International Mathematical Institute, St. Petersburg, Russia. (May 2005, p. 568)

20–23 Asian Mathematical Conference 2005 (AMC2005), National University of Singapore, Singapore.

Topics: Algebra and Group Theory, Algebraic Geometry, Analysis, Applications of Mathematics in Sciences, Combinatorics and Graph Theory, Computing/Logic, Differential Equations, Geometry and Topology, Lie Theory, Mathematics Education, Number Theory & Applications, Numerical Analysis, Operations Research, Probability & Stochastic Processes, Scientific Computation, Statistics.

Plenary Speakers: Noga Alon (Israel); Tony F. Chan (USA); Ching-Shui Cheng (USA/Taiwan); Chi Tat Chong (Singapore); Martin Golubitsky (USA); Lei Guo (China); Masaki Kashiwara (Japan); Ngaiming Mok (Hong Kong SAR).

Information: <http://ww1.math.nus.edu.sg/AMC/>; email: amc2005@math.nus.edu.sg.

20–27 The 5th International Algebraic Conference in Ukraine, Odessa I. I. Mechnikov National University, Odessa, Ukraine. (Nov. 2004, p. 1266)

22–27 AMSI Workshop entitled "Noncommutative Geometry and Index Theory", Australian National University, Canberra, Australia. (Feb. 2005, p. 291)

23–29 (REVISED) Number fields and curves over finite fields, Anogia Academic Village, Crete, Greece. (Apr. 2005, p. 475)

24–27 International Symposium in Symbolic and Algebraic Computation ISSAC'2005, Beijing, China. (Feb. 2005, p. 291)

24–28 25th European Meeting of Statisticians, University of Oslo, Oslo, Norway. (Dec. 2004, p. 1379)

24–August 5 Control Theory with Modeling Applications to Physiology and Medicine, University of Graz, Schloss Seggau, Austria.

Information: http://www.uni-graz.at/biomath/summer_school/index.html.

25–29 IMA Workshop: Mixed Integer Programming, University of Minnesota, Minneapolis, Minnesota. (Jun/Jul. 2004, p. 694)

25–30 First Announcement: International Conference on Difference Equations, Special Functions and Applications, Munich, Germany. (Feb. 2005, p. 291)

25–August 12 Summer Research Institute on Algebraic Geometry, University of Washington, Seattle, Washington. (May 2005, p. 568)

28–August 3 Logic Colloquium '05: ASL European Summer Meeting, Athens, Greece. (Oct. 2004, p. 1097)

30–August 6 Groups St Andrews 2005, University of St Andrews, St Andrews, Scotland. (Jan. 2005, p. 81)

31–August 3 Bridges: Mathematical Connections in Art, Music, and Science, The Banff Centre, Banff, Canada. (Jan. 2005, p. 81)

August 2005

Mathematical Modeling of Infectious Diseases: Dynamics and Control, Institute for Mathematical Sciences, National University of Singapore, Singapore 118402. (May 2005, p. 568)

1–5 14th USENIX Security Symposium, Baltimore, Maryland. (May 2005, p. 568)

1–9 XVI Coloquio Latinoamericano de Algebra, Colonia, Uruguay. (Apr. 2005, p. 475)

1–December 23 Pattern Formation in Large Domains, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Aug. 2004, p. 834)

2–6 Eighth IMS North American New Researchers Conference, Minneapolis, Minnesota. (Jan. 2005, p. 81)

***2–17 International Workshop on Representation Theory in Differential Geometry and Physics**, Country Institut de Mathématiques et de Sciences Physiques (IMSP), PortoNovo, Benin Republic, West Africa.

Organisers: K. Brown (University of Glasgow, UK); J. P. Ezin, (IMSP, PortoNovo, Benin Republic); A. O. Kuku (Ohio State University, Columbus, USA).

Major speakers: Will each give six expository lectures: I. Gordon (University of Glasgow, UK); A. Kirillov (University of Pennsylvania, USA); S. Majid (Queen Mary College, Univ. of London, UK); J. Rawnsley, (University of Warwick, Coventry, UK).

Information: Jean-Pierre Ezin, Director, IMSP, BP 613, PortoNovo, Benin Republic; Phone/fax (229) 222455 or Phone: (229) 925959; email: jpezin1@yahoo.fr.

3–5 DIMACS Workshop on Yield Management and Dynamic Pricing, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey. (Dec. 2004, p. 1379)

3–5 30th Sapporo Symposium on Partial Differential Equations, Sapporo, Japan. (Apr. 2005, p. 475)

***3–6 XV Capricornio Mathematical Congress**, Universidad de Antofagasta, Antofagasta, Chile.

Topics: Algebra, Physical Mathematical, Control Theory, Partial Differential Equation, Matrix Theory, Numerical Analysis, Differential Geometry, Industrial Statistics, Educational Mathematical and others.

Deadline: May 31, 2005.

Speakers: Justin Peters, Iowa State University; Gustavo Perla Menzala, LNCC, Brazil; Carlos Marijuan, Universidad de Valladolid, Spain; Miriam Pisonero, Universidad de Valladolid, Spain; Juan Carlos Gutierrez, Universidad de Sao Paulo, Brazil; Juan Rivera, Universidad Católica del Norte, Chile; Oscar Rojo, Universidad Católica del Norte, Chile; Carlos Conca, CMM Universidad de Chile; Roberto Cominetti, CMM Universidad de Chile; Rodolfo Rodriguez, Universidad de Concepción, Chile; Claudio Fernández, Pontificia Universidad Católica de Chile; Héctor Gómez, Universidad de Atacama, Chile; Rolando Rebolledo, Pontificia Universidad Católica de Chile.

Information: <http://www.uantof.cl/comca2005>.

***4–5 Beyond The Formula IX "Constantly Improving the Teaching of Introductory Statistics"**, Monroe Community College, Rochester, New York.

Program: Beyond the Formula is a two-day conference intended for all teachers of Introductory Statistics (2-yr & 4-yr college and AP & non-AP HS). It is planned for all, the novice as well as the experienced. This year's focus is on teaching techniques and classroom teaching strategies. There will also be sessions on assessment strategies/techniques, use of technology, service learning and writing across the curriculum, to name a few. Please visit our website for a full listing.

Speakers: These sessions are being led by Jessica Utts, UC Davis; Deb Nolan, UC Berkeley; Dick DeVaux, Williams College; Mark Earley, Bowling Green State, and many others.

Information: <http://www.monroec.edu/go/beyondtheformula>; email: BeyondTheFormula@MonroeCC.edu or phone: 585-292-2930.

5–11 Logic In Hungary, 2005, Budapest, Hungary. (Apr. 2005, p. 475)

7–12 High-dimensional Partial Differential Equations in Science and Engineering, Centre de recherches mathématiques, Université de Montréal Montréal, Québec, Canada. (Apr. 2005, p. 475)

7–12 International Conference: Mathematics in Finance, Kruger-National Park, South Africa. (Dec. 2004, p. 1379)

8-12 **NSF-CBMS Regional Conference on Algebraic and Topological Combinatorics of Ordered Sets**, San Francisco State University, San Francisco, California. (Apr. 2005, p. 475)

8-13 **XX Nevanlinna Colloquium**, ETH Lausanne, Lausanne, Switzerland. (Nov. 2004, p. 1266)

8-December 23 **Global Problems in Mathematical Relativity**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Aug. 2004, p. 834)

14-19 **International Conference on Complex Analysis and Related Topics: The 10th Romanian-Finnish Seminar, "Babes-Bolyai" University**, Cluj-Napoca, Romania. (Apr. 2005, p. 475)

*15-17 **DIMACS Workshop on Machine Learning Approaches for Understanding Gene Regulation**, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.

Description: This three-day workshop is designed to encourage interaction among innovators in computational biology and innovators in machine learning; to illuminate recent successes as well as pressing challenges; and to inspire the development of novel, biologically relevant, and biologically interpretable machine learning approaches to the current problems in biology.

Organizer: Christina Leslie, Columbia University, email: cleslie@cs.columbia.edu; Chris Wiggins, Columbia University, email: chris.wiggins@columbia.edu.

Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.

Information: <http://dimacs.rutgers.edu/Workshops/MachineLearning/>.

15-19 **Eisenstein Series and Applications**, AIM Research Conference Center, Palo Alto, CA. (May 2005, p. 569)

15-19 **Workshop on PDE and Mathematical Finance**, Institut Mittag-Leffler, Stockholm, Sweden. (May 2005, p. 569)

17-21 **Third Pacific Rim Conference on Mathematics**, Fudan University, Shanghai, China. (Apr. 2005, p. 476)

*20-22 **6th International Pure Mathematics Conference 2005**, Islamabad, Pakistan.

Description: The 6th International Pure Mathematics Conference 2005 (6th IPMC 2005) is a thematic conference on Algebra, Geometry, Analysis, and Mechanics. The entire conference is organized under one roof at a four-star hotel in the modern, peaceful, and beautiful federal capital of Pakistan located at the footsteps of the scenic Margalla Hills. There will be free housing and lodging for foreign participants. Several recreational trips will be organized in and around Islamabad introducing the unique local and multi-ethnic culture.

Information and registration: Please fill in the on-line registration form at <http://www.pmc.org.pk> and find more information therein. The conference is convened by Qaiser Mushtaq in collaboration with Mathematics Division, Institute of Basic Research (Florida, USA), Higher Education Commission, Pakistan Telecommunication Ltd, and Pakistan Mathematical Society.

20-26 **Algebraic and Geometric Combinatorics**, Anogia Academic Village, Crete, Greece. (Apr. 2005, p. 476)

*22-27 **International Symposium on Analytic Function Theory, Fractional Calculus and their Applications: In Honour of Professor H. M. Srivastava on his 65th Birthday**, University of Victoria, Victoria, British Columbia, Canada.

Organizers: S. Owa (Kinki Univ., Higashi-Osaka, Japan; email: owa@math.kindai.ac.jp); T. Sekine (Nihon Univ., Chiba, Japan; email: tsekine@pha.nihon-u.ac.jp); H. Nishiwaki (Slow Mathematics Incorporated, Kyoto, Japan).

Information: Ms. Merina Brisdon (Univ. of Victoria, Victoria, British Columbia, Canada); email: merina@math.uvic.ca.

*27-29 **CCA 2005, Second International Conference on Computability and Complexity in Analysis**, Kyoto University, Kyoto, Japan.

Scope: Theory of computability and complexity over real-valued data.

Deadlines: Submission: May 1, 2005; Notification: June 5, 2005; Camera-ready version: July 3, 2005; Satellite seminars and reception: August 25-26, 2005; Main conference: August 27-29, 2005.

Information: <http://cca-net.de/cca2005>.

28-September 2 **5th Conference on Differential Geometry**, Mangalia, Romania. (May 2005, p. 569)

29-31 **Algebraic Methods and Applications in Dynamical Systems-Special session in the 5th IASTED International Conference on Modeling, Simulation, and Optimization (MSO 2005)**, Oranjestad, Aruba. (May 2005, p. 569)

29-September 2 **Numerical Methods for Optimal Control in High Dimensions**, AIM Research Conference Center, Palo Alto, CA. (May 2005, p. 569)

*29-September 3 **CIME Conference: SPDE in hydrodynamics: recent progress and prospects**, Cetraro (Cosenza), Italy.

Lectures (8 hours each): Sergio Albeverio, Bonn University, Germany, Deterministic and Stochastic models of hydrodynamics; Franco Flandoli, Università di Pisa, Italy, Statistics of vortex filaments: From the Navier-Stokes equations to the laws of turbulence; Yakov G. Sinai, Princeton University, Mathematics of Navier-Stokes system.

Information: <http://www.math.unifi.it/~CIME>.

September 2005

5-8 **8th International Conference on Logic Programming and Nonmonotonic Reasoning (LPNMR'05)**, Diamante, Cosenza, Italy.

5-9 **IVth International Workshop on Functional Analysis**, Liège, Belgium. (May 2005, p. 569)

5-9 **Workshop on: Modular Forms, Automorphic Forms and Related Moduli Spaces**, INDAM-institute on the campus of the Università di Roma "La Sapienza", Rome, Italy. (Mar. 2005, p. 371)

5-11 **The Seventh International Workshop on Differential Geometry and its Applications**, Deva, Romania. (Feb. 2005, p. 291)

*8-10 **Fabes Lectures 2005: First Announcement**, Università di Trieste, Trieste, Italy.

Speakers: The following speakers have accepted to contribute with a talk: Russell Brown (University of Kentucky), Luis Escauriaza (EHU, Bilbao), Hyeonbae Kang (Seoul National University), C. Kenig (University of Chicago), R. Magnanini (Firenze), A. Morassi (Udine), L. Paivrintă (Rolf Nevanlinna-Institute, Helsinki), Alberto Ruiz Gonzalez (Universidad Autónoma, Madrid), J. K. Seo (Yonsei University, Seoul), G. Uhlmann (University of Washington, Seattle).

Organizers: Giovanni Alessandrini, Università di Trieste, Italy; Sandro Salsa, Politecnico di Milano, Italy.

Information: The relevant information shall be posted in due time on the web page <http://www.dmi.units.it/~rondi/fabes/>. Those interested in attending are invited may write to: email: rondi@units.it.

*10-13 **36th Annual Iranian Mathematics Conference**, Department of Mathematics, Yazd University, Yazd, Iran.

Description: The Annual Iranian Mathematics Conference (AIMC) is the oldest scientific gathering which takes place regularly each year at one of Iranian universities.

Sponsors: The Iranian Mathematical Society and Yazd University have jointly sponsored the 36th AIMC. This conference is an international conference and includes invited speakers and presentations of contributed research papers.

Deadlines: June 5, 2005: Registration and extended abstract submission. July 5, 2005: Complete paper submission. Registered

participants who wish their paper to be published in the conference proceedings must submit their paper.

Information: If you have any questions and to get the announcement for the AIMC36, please send an email to: B. Davvaz, Chairman of Scientific Committee; email: aimc36@yazduni.ac.ir; davvaz@yazduni.ac.ir.

12-15 Third International Workshop Meshfree Methods for Partial Differential Equations, Rheinische Friedrich-Wilhelms Universität Bonn, Bonn, Germany. (Apr. 2005, p. 476)

12-16 p-Adic Representations, Centre de recherches mathématiques, Univ. de Montréal, Montréal, Québec, Canada. (Apr. 2005, p. 476)

12-16 CASC'2005: The 8th International Workshop on Computer Algebra in Scientific Computing, CASC'2005, Kalamata, Greece. (Apr. 2005, p. 476)

12-17 International Conference on Mathematical Analysis of Random Phenomena, Hotel Abou Nawas Hammamet, Hammamet, Tunisia. (May 2005, p. 569)

12-19 Small Deviation Probabilities and Related Topics, Euler IMI, St. Petersburg, Russia. (Feb. 2005, p. 291)

13-17 5th International Conference on Words, Centre de recherches mathématiques, Université de Montréal, Montréal, Québec, Canada. (Apr. 2005, p. 476)

16-20 International Conference of Numerical Analysis and Applied Mathematics 2005 (ICNAAM 2005), Hotel Esperides, Rhodes, Greece. (Feb. 2005, p. 291)

***18-23 The 11th Workshop on Graph Theory-Colourings, Independence and Domination**, Karpacz, Poland.

Organizers: Organized by the Faculty of Mathematics, Computer Science and Econometrics of University of Zielona Góra, Poland.

Organizing committee: Mieczysław Borowiecki, Alina Szelecka; email: cid@wmie.uz.zgora.pl; <http://www.cid.uz.zgora.pl>.

***18-24 XII EWM (European Women in Mathematics)**, Volgograd, Russia.

Information: Associate secretary: Tatiana Vassilieva; email: ewm@volsu.ru; <http://ewm.volsu.ru/>.

***19-21 French Moroccan Meeting on Approximation and Optimization**, Faculty of Sciences of Rabat, Morocco.

Scope: Of this meeting covers a range of major topics in Numerical Analysis, Optimization, also in Approximation and Engineering and related disciplines, ranging from theoretical developments to industrial applications and modelling of problems.

Organizer: Faculty of Sciences of Rabat (Morocco), Mohammadia School of Engineers (Morocco), Hassania School Public works (Morocco), National School of Mineral Industry (Morocco), University Paul Sabatier Toulouse (France), National Institut of Applied Sciences Toulouse (France). Programme Committee: M-N. Benbourhim (UPS Toulouse, France), M. CHIDAMI (FSR Rabat, Morocco), R. Ellaia (EMI Rabat, Morocco), L. Ghannam (UPS Toulouse, France), A. Hassouni (FSR Rabat, Morocco), A. ISMAIL (EHTP Casablanca, Morocco), K. Najib (ENIM Rabat, Morocco), C. Rabut (INSA Toulouse, France).

Deadline: With abstract: May 19, 2005.

Information: Address: Université Mohammed V, Faculté Des Sciences, Avenue Ibn Batouta, B.P. 1014, Rabat, Morocco; email: rfmao@fsr.ac.ma; phone: 212 (0) 37775471; <http://www.fsr.ac.ma/rfmao/>.

19-23 IMA Tutorial: Radar and Optical Imaging, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

20-22 International Conference: Problems of Modern Mathematics and Mechanics, Institute of Mathematics, Almaty, Kazakhstan. (May 2005, p. 569)

20-27 International Conference Harmonic Analysis and Approximations, III, Tsahkadzor, Armenia. (Apr. 2005, p. 477)

21-26 International Conference of Computational Methods in Sciences and Engineering 2005 (ICCMSE 2005), Hotel Poseidon, Loutraki, Korinthos, Greece. (May 2005, p. 570)

26-30 49th Annual Meeting of the Australian Mathematical Society, The University of Western Australia, Perth, Australia. (Jan. 2005, p. 82)

***27-30 Workshop on Graphs, Morphisms and Applications**, Centre de Recerca Matemàtica, Bellaterra, Spain.

Tentative list of participants: J. Barajas, M. Boudirsky, P. Cameron, V. Dalmau, J. Díaz, J. Fiala, G. Hahn, P. Hell, W. Imrich, J.B. Jensen, A.V. Kostochka, D. Kral, J. Kratochvil, H. Lefmann, A. Lladó, M. Loeb, L. Lovasz, C. McDiarmid, B. Mohar, A. Montejano, J. Moragas, R. Naserasr, M. Noy, P. Ossona, A. Raspaud, V. Rödl, M. Ruszinko, M.J. Serna, E. Sopena, C. Szabo, Cl. Tardif, J.A. Telle, D. Thililös, B. Toft, G.J. Woeginger and X. Zhu.

Information: <http://www.crm.es/> or email: WorkshopGraphs@crm.es.

October 2005

***3-7 2nd Workshop on Tutte Polynomials and Applications**, Centre de Recerca Matemàtica, Bellaterra, Spain.

Tentative list of participants: M. Bousquet-Mélou, P. Cameron, R. Cordovil, R. Cori, J.E. Ellis-Monaghan, G. Farr, I. Gitler, L. Helme-Guizon, P. Hlineny, B. Jackson, J.P. Kung, M. Las Vergnas, M. Loeb, J. Makowsky, C. Merino, R. Read, D. Rossin, J. Salas, I. Sarmiento, G. Schaeffer, R. Shrock, A. Sokal and D.G. Wagner.

Information: <http://www.crm.es/> or email: WorkshopTutte@crm.es.

7-8 Twenty-Fifth Annual Southeastern-Atlantic Regional Conference on Differential Equations, University of Dayton, Dayton, Ohio. (May 2005, p. 570)

***7-9 19th Midwest Conference on Combinatorics, Cryptography and Computing**, Department of Mathematics, Rochester Institute of Technology, Rochester, New York.

Keynote speaker: P. Winkler (Dartmouth College).

Invited Speakers: Walter Wallis (Southern Illinois University), Earl Glen Whitehead, Jr., (University of Pittsburgh), Eric Mendelsohn (University of Toronto), Jon Lee (IBM), Ruth Haas (Smith College), Ralph Grimaldi (Rose Hulman Institute of Technology).

Organizers: Hossein Shahmohamad, R.I.T., Ebrahim Salehi, UNLV, Darren Narayan, R.I.T., Carl Lutzer, R.I.T., Bernard Brooks, R.I.T.

Deadline: For submission of contributed talks: September 28, 2005.

Contact person: Hossein Shahmohamad, email: hxssma@rit.edu.

Information: <http://www.math.rit.edu/~cvlsma/MCCCC/>.

8-9 AMS Eastern Section Meeting, Bard College, Annandale-on-Hudson, New York. (Dec. 2004, p. 1379)

***14-15 Prairie Analysis Seminar 2005**, Kansas State University, Manhattan, Kansas.

Description: This is the fifth in a series of annual conferences co-organized by Kansas State University and the University of Kansas.

Speakers: Carlos Kenig (University of Chicago) will give two one-hour lectures. James Colliander (University of Toronto) and Alexandru Ionescu (University of Wisconsin) will each give an hour lecture. There will be sessions for contributed talks.

Sponsor: The conference is co-sponsored by the Mathematical Sciences Research Institute, Berkeley, and the National Science Foundation.

Information: There is no registration fee and support is available for participants. See <http://www.math.ksu.edu/pas/2005/prairie05-index.html>.

15-16 **AMS Southeastern Section Meeting**, East Tennessee State University, Johnson City, Tennessee. (Dec. 2004, p. 1379)

17-21 **IMA Workshop: Imaging from Wave Propagation**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

17-21 **Nonlinear Parabolic Problems**, Helsinki, Finland. (Jan. 2005, p. 82)

*18-20 **DIMACS Short Course: Statistical De-identification of Confidential Health Data with Application to the HIPAA Privacy Regulations**, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey.

Short Description: This two-and-a-half day short course will provide participants with a detailed overview of the HIPAA privacy regulations, theory and methods for statistical disclosure limitation, and applied experience with disclosure limitation methods. Participants completing the course should be able to: 1) understand the permissible uses of healthcare data for various purposes under the HIPAA regulations; 2) conceptualize and document data intrusion scenarios; 3) conduct and document statistical disclosure analyses measuring disclosure risks; 4) select and use appropriate disclosure limitation methods; 5) evaluate the associated trade-offs between disclosure risks and statistical information quality. Development of these skills should enable participants to supervise and work successfully with an expert certifying statistician.

Organizer: Larry Cox, CDC, email: lcox@cdc.gov; Daniel Barth-Jones, Wayne State University, email: dbjones@med.wayne.edu.

Local Arrangements: Maria Mercado, DIMACS Center, email: mercado@dimacs.rutgers.edu, 732-445-5928.

Information: <http://dimacs.rutgers.edu/Workshops/Hipaa/>;

20-22 **3rd Symposium on Stochastic Algorithms: Foundations and Applications (SAGA'05)**, Moscow State University, Moscow, Russia. (May 2005, p. 570)

21-22 **AMS Central Section Meeting**, University of Nebraska, Lincoln, Nebraska. (Dec. 2004, p. 1379)

21-26 **International Conference of Computational Methods in Sciences and Engineering 2005 (ICCMSE 2005)**, Hotel Poseidon, Loutraki, Korinthos, Greece. (Apr. 2005, p. 477)

24-26 **SIAM Conference on Mathematics for Industry: Challenges and Frontiers**, Detroit Marriott Renaissance Center, Detroit, Michigan. (Apr. 2005, p. 477)

24-28 **International Conference on Computing and Mathematical Modeling for Environmental, Social-Economical, and Technical Systems-2005**, East China Normal University, Shanghai, China. (Apr. 2005, p. 477)

30-November 3 **SIAM**, Hilton Phoenix East, Phoenix, Arizona. (May 2005, p. 570)

November 2005

3-4 (NEW DATE) **DIMACS Workshop on The Epidemiology and Evolution of Influenza**, DIMACS Center, CoRE Bldg, Rutgers University, Piscataway, New Jersey. (Oct. 2004, p. 1096)

4-6 **Geometric and Probabilistic Methods in Group Theory and Dynamical Systems**, Texas A & M University, College Station, Texas. (Apr. 2005, p. 477)

7-11 **IMA Workshop: Frontiers in Imaging**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

12-13 **AMS Western Section Meeting**, University of Nebraska, University of Oregon, Eugene, Oregon. (Dec. 2004, p. 1379)

25-December 1 **Reform, Revolution and Paradigm Shifts in Mathematics Education**, Johor Bharu, Southern Malaysia (very close to Singapore). (Feb. 2005, p. 291)

*27-30 **ICDM '05: The 5th IEEE International Conference on Data Mining**, New Orleans, Louisiana.

Description: The conference draws researchers and application developers from a wide range of data mining related areas such as statistics, machine learning, pattern recognition, databases and data warehousing, data visualization, knowledge-based systems and high performance computing. As an important part of the conference, the workshops program will focus on new research challenges and initiatives, and the tutorials program will cover emerging data mining technologies and the latest developments in data mining.

Sponsor: IEEE Computer Society.

Deadline: June 15, 2005.

Important Dates: June 15, 2005: Paper submissions, Tutorial proposals, Workshop proposals, Panel proposals. August 20, 2005: Paper acceptance notices. September 7, 2005: Final camera-readies. November 27, 2005: Tutorials and Workshops. November 28-30, 2005: Conference.

All paper submissions will be handled electronically. Detailed instructions are provided on the conference home page at <http://www.cacs.louisiana.edu/~icdm05/>.

Information: Vijay Raghavan, University of Louisiana, Lafayette, Louisiana; phone: 337-482-6603; fax: 337-482-5791; email: raghavan@cacs.louisiana.edu.

*27-30 **Understanding and Creating Music: UCM 2005**, Caserta, Italy.

Topics: The subject of the UCM 2005 is Music, investigated by different approaches, namely: Mathematics, Physics; Artificial Intelligence; Cognitive Psychology of Music; Linguistics and Logic models; Algorithmic methods, sound granular synthesis etc.; Music performance via real-time devices and algorithmic procedures; Music and Fine Arts via computer graphics.

Program: The scientific programme will consist of 5 thematic sessions with plenary lectures (invited speakers) and contributed talks. On November 26, 2005, there will be a concert of electronic and computer music.

Information: More information (aims, committees, contributing institutions, submissions, deadlines, etc.) is available at the UCM 2005 Conference website: <http://www.unina2.it/capirelamusica.sun/>.

*28-December 3 **International Conference on Operator Algebras and their Connection to Mathematical Physics**, University Hassan I, Settat, Morocco.

Information: <http://www.math.uni-muenster.de/math/inst/reine/inst/cuntz/icoamp/index.htm>.

December 2005

5-9 **IMA Workshop: Integration of Sensing and Processing**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

5-9 **30th Australasian Conference in Combinatorial Mathematics and Combinatorial Computing (30ACCMCC)**, The University of Queensland, Brisbane, Australia. (May 2005, p. 570)

*12-15 **The Second International Conference on Technology, Knowledge and Society**, Hyderabad, India.

Description: The conference will take a broad and cross-disciplinary approach to technology in society. With a particular focus on digital information and communications technologies, the interests addressed by the conference include: human usability, technologies for citizenship and community participation, and learning technologies. Participants will include researchers, teachers and practitioners whose interests are either technical or humanistic, or whose work crosses over between the applied technological and social sciences.

As well as an impressive line up of international main speakers, the conference will also include numerous paper, workshop and

colloquium presentations. We would particularly like to invite you to respond to the conference call for papers. If you are unable to attend the conference in person, virtual registrations are also available which allow you to submit a paper for refereeing and possible publication in this fully refereed academic journal, as well as access to the electronic version of the conference proceedings. **Information:** Full details of the conference, including an online call for papers form, are to be found at the conference website: <http://www.Technology-Conference.com>.

- * 27-30 **ASL Winter Meeting (with APA)**, New York, New York.
Abstracts: Must be received by September 9, 2005 at the ASL Business Office: ASL, Box 742, Vassar College, 124 Raymond Ave., Poughkeepsie, New York 12604; fax: 1-845-437-7830; email: asl@vassar.edu.

January 2006

- * 3-7 **Moduli spaces of knots**, AIM Research Conference Center, Palo Alto, California.
Topics: This workshop, sponsored by AIM and the NSF, will be devoted to the study of the global topology of spaces of embedded curves in Euclidean spaces and other manifolds.
Organizers: Fred Cohen, Allen Hatcher, and Dev Sinha.
Deadline: October 3, 2005.
Information: <http://aimath.org/ARCC/workshops/spaceofknots.html>.

- * 6-11 **Enumerative invariants in algebraic geometry and string theory**, Cetraro, Italy.
Lecture series: Dan Abramovich (Brown): Gromov-Witten invariants for orbifolds; Marcos Mariño (CERN): Open strings; Michael Thaddeus (Columbia): Moduli of sheaves; Ravi Vakil (Stanford): Gromov-Witten theory and the moduli space of curves.
Information: <http://www.math.unifi.it/~cime/Courses/2005/01.html>.

9-12 **IMA Workshop: New Mathematics and Algorithms for 3-D Image Analysis**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

9-June 30 **Principles of the Dynamics of Non-Equilibrium Systems**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Aug. 2004, p. 835)

12-15 **Joint Mathematics Meetings**, San Antonio, Texas. (May 2005, p. 570)

- * 14-15 **ASL Winter Meeting (with Joint Mathematics Meetings)**, San Antonio, Texas.
Abstracts: Must be received by September 9, 2005 at the ASL Business Office: ASL, Box 742, Vassar College, 124 Raymond Ave., Poughkeepsie, New York 12604; fax: 1-845-437-7830; email: asl@vassar.edu.

- * 16-18 **5th Annual Hawaii International Conference on Statistics, Mathematics, and Related Fields**, Waikiki, Honolulu, Hawaii.
Goal: Of the 2006 Hawaii International Conference on Statistics, Mathematics and Related Fields is to provide an opportunity for academicians and professionals from various statistics and/or mathematics related fields from all over the world to come together and learn from each other. An additional goal of the conference is to provide a place for academicians and professionals with cross-disciplinary interests related to statistics and mathematics to meet and interact with members inside and outside their own particular disciplines.

Deadline: August 29, 2005.

Information: On on web: click on Call for Papers for information on submitting a paper; email: statistics@hicstatistics.org.

16-27 **"Propagation of Waves" CIMPA school and workshop**, Instituto de Matemáticas, UNAM, Cuernavaca, Mexico. (Apr. 2005,

p. 478)

16-July 7 **Logic and Algorithms**, Isaac Newton Institute for Mathematical Sciences, Cambridge, England. (Aug. 2004, p. 835)

- * 23-27 **The property of rapid decay**, AIM Research Conference Center, Palo Alto, California.

Organizers: Indira Chatterji and Laurent Saloff-Coste.

Topics: This workshop, sponsored by AIM and the NSF, will be devoted to the property of Rapid Decay.

The property of Rapid Decay (abbreviated by property RD) is a property of convolution operators that captures certain aspects of the asymptotic geometry of a finitely generated group. Property RD is a very focused area of research in harmonic analysis and operator algebra. However, it has ramifications in geometry, topology and algebra

Deadline: October 20, 2005.

Information: <http://aimath.org/ARCC/workshops/rapiddecay.html>.

- * 30-February 3 **Mathematics-in-Industry Study Group 2005**, Massey University, Auckland, New Zealand.

Program: Australian and New Zealand Industrial Organisations will present problems for formulation, possible solution, and interpretation.

Director: Professor Graeme Wake, Centre for Mathematics in Industry, Massey university, Auckland, New Zealand.

Deadlines: Problems will be listed on the website by November 2005. Registration is free to problem investigators, with costs covered by problem presenters. Student grants available to bona fide research students, supported by their supervisors. Applications received up to November 2005.

Information: <http://misg2006.massey.ac.nz>.

- * 30-February 3 **The Caccetta-Haggkvist conjecture**, AIM Research Conference Center, Palo Alto, California.

Organizers: Maria Chudnovsky, Matt Devos, Paul Seymour, and Robin Thomas.

Topics: This workshop, sponsored by AIM and the NSF, will focus on the Caccetta-Haggkvist conjecture, which in its simplest form asserts the following: If G is an n -vertex directed graph with minimum outdegree at least n/k , then G has a directed cycle of length at most k . This has a number of variants and strengthenings, and in particular it has numerous connections with additive number theory. The workshop aims to clarify and develop these variants, and to bring together people working on different aspects of the conjecture in the hope of finding a solution.

Deadline: October 30, 2005.

Information: <http://aimath.org/ARCC/workshops/caccetta.html>.

February 2006

6-10 **IMA Workshop: The Mathematics and Art of Film Editing and Restoration**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

- * 13-17 **Barcelona Conference in Planar Vector Fields**, Centre de Recerca Matemàtica, Bellaterra, Spain.

Speakers: Freddy Dumortier, Lubomir Gavrilov, Yu Ilyashenko, Chengzhi Li, Francesc Mañosas, James S. Muldowney, Robert Roussarie, Marco Sabatini, Jorge Sotomayor, Marco Antonio Teixeira, Jiazhong Yang, Michal Zhitomirskii.

Information: <http://www.crm.es/oremail:PlanarVectorFields@crm.es>.

13-18 **L-functions and Related Themes**, Centre de recherche mathématiques, Univ. de Montréal, Montréal, Québec, Canada. (Apr. 2005, p. 478)

- * 20-24 **p -adic representations, modularity, and beyond**, AIM Research Conference Center, Palo Alto, California.

Organizers: Kiran Kedlaya and David Savitt.

Topics: This workshop, sponsored by AIM and the NSF, will be devoted to interactions between p -adic Hodge theory, p -adic Langlands correspondences, and the modularity of Galois representations. The main goals of the workshop are to clarify the connections between the aforementioned fields, and to identify some target results for both the short and long term.

Deadline: For application: November 20, 2005.

Information: <http://aimath.org/ARCC/workshops/padicmodularity.html>.

*20-25 **Advanced Course on Arakelov Geometry and Shimura Varieties**, Centre de Recerca Matemàtica, Bellaterra, Spain.

Speakers: Ching-Li Chai (University of Pennsylvania), Henri Darmon (Mc Gill University), Damian Roessler (Université Paris 7).

Information: <http://www.crm.es/> or email: ShimuraVarieties@crm.es.

March 2006

6-10 **IMA Workshop: Natural Images**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

13-17 **Anatomy of Integers**, Centre de recherche mathématiques Université de Montréal, Montréal, Québec, Canada. (Apr. 2005, p. 478)

*20-30 **Functional Analysis**, Shiraz University, Shiraz, Iran.

Information: email: r_laghaei_84@yahoo.com.

April 2006

1-2 **AMS Southeastern Section Meeting**, Florida International University, Miami, Florida. (May 2005, p. 570)

3-7 **IMA Workshop: Shape Spaces**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

*3-8 **International Workshop on Multi-Rate Processes & Hysteresis**, University College Cork, Cork, Ireland.

Organizers: J. Gleeson (Cork, Ireland), M. Mortell (Cork, Ireland) (Co-Chairman), A. Pokrovskii (Cork, Ireland) (Co-Chairman); email: a.pokrovskii@ucc.ie.

Scientific Committee: R. O'Malley (Seattle, USA) (Co-Chairman), V. Sobolev (Samara, Russia), (Co-Chairman).

Description: The aim of this conference is to bring together leading researchers willing to learn and share problems and techniques related to the singular perturbations and hysteresis in applied problems.

Topics: singular perturbations; hysteresis; random effects and noise; economic dynamics; laser dynamics; chemical kinetics; optoelectronics; control.

Information: Further details will become available on the conference website <http://euclid.ucc.ie/murphys2006.htm>.

6-12 **Additive Combinatorics**, Centre de recherche mathématiques, Université de Montréal, Montréal, Québec. (Apr. 2005, p. 478)

8-9 **AMS Central Section Meeting**, University of Notre Dame, Notre Dame, Indiana. (May 2005, p. 570)

22-23 **AMS Eastern Section Meeting**, University of New Hampshire, Durham, New Hampshire. (May 2005, p. 570)

29-30 **AMS Western Section Meeting**, San Francisco State University, San Francisco, California. (May 2005, p. 570)

May 2006

*5-10 **Combinatorial and Geometric Group Theory**, Vanderbilt University, Nashville, Tennessee.

Organizers: Goulmira Arzhantseva, Mike Mihalik, Denis Osin, Mark Sapir, Efim Zelmanov.

Speakers: M. Bestvina (University of Utah), M. Bridson (Imperial College), R. Grigorchuk (Texas A & M), V. Guba (Vologda State University), S. Ivanov (University of Illinois), I. Mineyev (University of Illinois), A. Myasnikov (McGill University), V. Nekrashevich (Bremen), A. Olshanskii (Vanderbilt), D. Osin (Vanderbilt), E. Rips (Hebrew University of Jerusalem), D. Wise (McGill University), E. Zelmanov (UC San Diego)

Information: <http://www.math.vanderbilt.edu/~msapir/cggt/cggt.html>; email: m.sapir@vanderbilt.edu.

*8-19 **CANT 2006: Combinatorics, Automata and Number Theory**, University of Liege, Belgium.

Aim: The proposed international school is aimed at presenting and developing recent trends in Combinatorics (with emphasis on Combinatorics on Words), Automata Theory and Number Theory. On the one hand, the newest results in these areas shall benefit from a synthetic exposition, and on the other hand, emphasis on the connections existing between the main topics of the school will be sought. Concurrently to the school, there will be an international conference focusing on the same topics. Courses and lectures will be organized in the morning, while the afternoon sessions will be devoted to the conference.

Main Invited Speakers: J.-P. Allouche (CNRS, Univ. Paris-Sud), Y. Bugeaud (Univ. of Strasbourg), F. Durand (Univ. of Picardie, Amiens), P. Grabner (Techn. Univ. of Graz), J. Karhumäki (Turku Univ.), H. Prodinger (Univ. of Stellenbosch), J. Sakarovitch (CNRS, ENS Télécom.), J. Shallit (Univ. of Waterloo), B. Solomyak (Univ. of Washington), W. Thomas (RWTH Aachen).

Format: Five invited lecturers per week. Participants can decide to attend to one of the two weeks of this event. Talks will be selected on the basis of an extended abstract (max. 6 pages).

Deadline: For the submission of abstracts: April 1, 2006.

Information: <http://http://www.cant2006.ulg.ac.be>; email: M. Rigo@ulg.ac.be.

13-18 **Analytic methods for Diophantine equations**, Banff International Research Station, Banff, Alberta, Canada. (Apr. 2005, p. 478)

*17-21 **ASL Annual Meeting**, Montreal, Canada.

Abstracts: Must be received by February 10, 2006 at the ASL Business Office: ASL, Box 742, Vassar College, 124 Raymond Ave., Poughkeepsie, New York 12604; fax: 1-845-437-7830; email: asl@vassar.edu.

22-26 **IMA Workshop: Visual Learning and Recognition**, University of Minnesota, 207 Church St. SE, 400 Lind Hall, Minneapolis, Minnesota. (Jan. 2005, p. 82)

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 2006

*12-16 **Function Theories in Higher Dimensions**, Tampere University of Technology, Tampere, Finland.

Topics: Clifford analysis and applications, Several complex variables, Harmonic analysis.

Organizing committee: Professor Sirkka-Liisa Eriksson, Tampere University of Technology, Finland; Heinz Leutwiler, Universität Erlangen-Nürnberg, Germany; Helmuth Malonek, University of Aveiro, Portugal; Mika Koskenoja, University of Helsinki, Finland; Soeren Kraussbar, University of Ghent, Belgium; Katja Kaunistmaa (Secretary), Tampere University of Technology, Finland.

Information: The home pages of the conference will be updated at the following address: <http://www.tut.fi/fthd>.

*19-23 **Free Analysis**, AIM Research Conference Center, Palo Alto, California.

Organizers: Dimitri Shlyakhtenko and Dan Voiculescu.

Topics: This workshop, sponsored by AIM and the NSF, will be devoted to the non-commutative analysis underlying problems in areas related to free probability theory. Typical examples of these are L2 questions for free difference quotient derivations. The topics of the workshop are: Free entropy (the analog of entropy in free probability theory), L2 Betti numbers for von Neumann algebras, Large deviations for random multi-matrix systems.

Deadline: March 19, 2006.

Information: <http://aimath.org/ARCC/workshops/freeanalysis.html>.

*25-28 **The Sixth AIMS Conference on Dynamical Systems, Differential Equations and Applications**, University of Poitiers, Poitiers, France.

Description: The conference will provide a unique international forum for the international community of mathematicians and scientists working in analysis, differential equations, dynamical systems, and their applications to real world problems in the forms of modeling and computation. The aim of this conference is to bring together the worldwide senior experts and young researchers as well to this beautiful city, Poitiers, to report recent achievements, exchange ideas, and address future trends of research, in a relaxing and stimulating environment. This is the first time ever for an AIMS conference to be held in the European continent. Sponsors: American Institute of Mathematical Sciences (AIMS) and University of Poitiers.

Topics: The conference covers all the major research areas in analysis, dynamics and applications including modeling and computations.

Format: There will be one-hour plenary talks, 30-minute special session talks, and 20-minutes contributed talks.

Conference Coordinator: Xin Lu; email: lux@uncw.edu.

Funding: Some limited funding from NSF is expected to support graduate students and young researchers.

Information: <http://www.aimSciences.org> for updates.

July 2006

*27-August 2 **ASL European Summer Meeting (Logic Colloquium '06)**, Nijmegen, Netherlands.

Abstracts: Rules for Abstracts (including those submitted by title) may be found at http://www.aslonline.org/rules_abstracts.html.

September 2006

*4-8 **Satellite Conference on Differential Equations and Singularities, in honor of J. M. Aroca's 60th birthday**, Tordesillas(Valladolid, Spain).

Topics: Resolution of singularities, local study of singularities, singular foliations, differential algebra, asymptotic analysis, and differential and geometrical study of dynamical systems.

Scientific Committee: Felipe Cano (Univ. Valladolid), Frank Loray (Univ. Rennes I), Juan Jose Morales (U. Politecnica Catalunya), Paulo Sad (IMPA), Mark Spivakovsky (Univ. Paul Sabatier).

Organizers: Jorge Mozo Fernández, José Cano and Fernando Sanz (Univ. Valladolid).

Confirmed speakers: H. Hironaka, Lê-Dung-Tràng, J. M. Lion, I. Luengo, J. F. Mattei, R. Moussu, J. V. Pereira, J. P. Ramis, J. P. Rolin, J. Seade, M. Singer, B. Teissier, H. Umemura, H. Yoshida.

Information: <http://www.uva.es/tordesillas2006>; email: sedf2006@ieip.uva.es.

December 2006

*16-20 **DION 2005: An International Conference on Diophantine Equations: in honour of Professor T. N. Shorey on his 60th Birthday**, Tata Institute of Fundamental Research, Mumbai, India.

Information: Conference is open to mathematicians working in Number Theory and allied areas. Interested persons may find information at: email: math.tifr.res.in; <http://www.math.tifr.res.in/~dion2005>.

*26-January 6, 2006 **CIMPA School on Commutative Algebra**, Institute of Mathematics, Hanoi, Vietnam.

Objective: The aim of the School is to introduce mathematicians from developing countries to some fundamental techniques and recent developments in Commutative Algebra and to promote the collaboration between mathematicians of different developing and developed countries.

Scientific program: The school will be divided into two parts. The first week (26 - 30.12.05) is a school with 4 instructional courses on the following topics: Local cohomology (M. Brodmann), Toric rings and varieties (D. Cox), Finite free resolutions (J. Herzog), Blow-up algebras (B. Ulrich). The second week (January 3-6, 2006) is devoted to an international conference. Besides invited lectures on recent development in Commutative Algebra, there will be opportunities for mathematicians from developing countries to present their research works.

Participation: The school and the conference are open to all mathematicians. The local organizers will arrange for visa and accommodation. Conference fees: 100 USD.

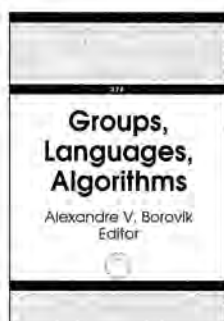
Support: There are a limited number of grants which cover travel and living expenses for mathematicians from developing countries.

Deadlines: Requests for participation and applications for support should be sent to the local coordinator before July 31, 2005.

Address for correspondences: L. T. Hoa, Institute of Mathematics, 18 Hoang Quoc Viet, 10307 Hanoi, Vietnam; Tel.: 0084-4-8361317 (Ext. 202); fax: 0084-4-7564303; email: cimpa@math.ac.vn.

New Publications Offered by the AMS

Algebra and Algebraic Geometry



Groups, Languages, Algorithms

Alexandre V. Borovik,
University of Manchester, UK,
Editor

Since the pioneering works of Novikov and Maltsev, group theory has been a testing ground for mathematical logic in its many manifestations, from the theory of algorithms to model theory. The interaction between logic and

group theory led to many prominent results which enriched both disciplines.

This volume reflects the major themes of the American Mathematical Society/Association for Symbolic Logic Joint Special Session (Baltimore, MD), Interactions between Logic, Group Theory and Computer Science. Included are papers devoted to the development of techniques used for the interaction of group theory and logic. It is suitable for graduate students and researchers interested in algorithmic and combinatorial group theory.

A complement to this work is Volume 349 in the AMS series, Contemporary Mathematics, *Computational and Experimental Group Theory*, which arose from the same meeting and concentrates on the interaction of group theory and computer science.

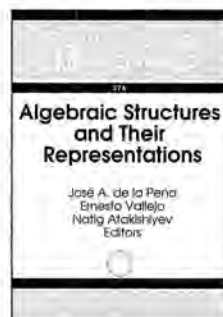
This item will also be of interest to those working in logic and foundations.

Contents: R. H. Gilman, Formal languages and their application to combinatorial group theory; A. G. Myasnikov, V. N. Remeslennikov, and D. E. Serbin, Regular free length functions on Lyndon's free $\mathbb{Z}[t]$ -group $F^{\mathbb{Z}[t]}$; I. Chiswell, A-free groups and tree-free groups; O. Kharlampovich and A. G. Myasnikov, Effective JSJ decompositions; O. Kharlampovich and A. Myasnikov, Algebraic geometry over free groups: Lifting solutions into generic points; E. S. Esyp, I. V. Kazatchkov, and V. N. Remeslennikov,

Divisibility theory and complexity of algorithms for free partially commutative groups.

Contemporary Mathematics, Volume 378

July 2005, 348 pages, Softcover, ISBN 0-8218-3618-8, LC 2005043610, 2000 *Mathematics Subject Classification*: 20B40, 20E05, 20F28, 81P68; 68Q05, 68Q17, 68Q42, 68Q45, 68T05, All AMS members US\$71, List US\$89, Order code CONM/378



Algebraic Structures and Their Representations

José A. de la Peña, Ernesto
Vallejo, and Natig Atakishiyev,
*Universidad Nacional
Autónoma de México*, Editors

The Latin-American conference on algebra, the XV Coloquio Latinoamericano de Álgebra (Cocoyoc, México), consisted of plenary sessions

of general interest and special sessions on algebraic combinatorics, associative rings, cohomology of rings and algebras, commutative algebra, group representations, Hopf algebras, number theory, quantum groups, and representation theory of algebras.

This proceedings volume contains original research papers related to talks at the colloquium. In addition, there are several surveys presenting important topics to a broad mathematical audience. There are also two invited papers by Raymundo Bautista and Roberto Martínez, founders of the Mexican school of representation theory of algebras.

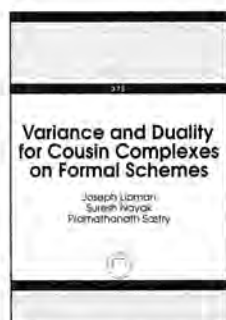
The book is suitable for graduate students and researchers interested in algebra.

Contents: R. Alfaro and A. Kelarev, Recent results on ring constructions for error-correcting codes; I. Assem, F. U. Coelho, M. Lanzilotta, D. Smith, and S. Trepode, Algebras determined by their left and right parts; E. L. Green, The work of Roberto Martínez-Villa; E. Guardo, A survey on fat points on a smooth quadric; C. M. Ringel, Bautista and the development of the representation theory of Artin algebras; M. Takeuchi, A survey on Nichols algebras; Y. Yoshino, Approximations by modules of G-dimension zero; M. Aguiar

and N. Andruskiewitsch, Representations of matched pairs of groupoids and applications to weak Hopf algebras; V. A. Artamonov, On symmetries of quasicrystals; M. J. Asiaín, Frattini-type and Fitting-type subgroups; N. M. Atakishiyev and A. U. Klimyk, Representations of the quantum algebra $su_q(1, 1)$ and duality of q -orthogonal polynomials; G. Böhm, Internal bialgebroids, entwining structures and corings; R. Coquereaux, The A_2 Ocneanu quantum groupoid; W. Cortes, Skew Armendariz rings and annihilator ideals of skew polynomial rings; D. Flores de Chela, Quantum symmetric algebras as braided Hopf algebras; I. Gitler, E. Reyes, and R. H. Villarreal, Blowup algebras of ideals of vertex covers of bipartite graphs; D. Happel and L. Unger, Minimal elements in the poset of tilting modules; E. Karolinsky, A. Stolin, and V. Tarasov, Dynamical twists and quantization; V. K. Kharchenko and A. Andrade, On the combinatorial rank of Hopf algebras; I. Lizasoain, A tensor product of projective G -groups; L. Marino, The minimum degree of a surface that passes through all the points of a 0-dimensional scheme but a point P ; S. Montgomery, Primitive ideals and Jacobson radicals in Hopf Galois extensions; R. C. Orellana, On the algebraic decomposition of a centralizer algebra of the hyperoctahedral group; S. Rodríguez-Romo, Quantum group global symmetries of quantum chains. States for linear chains with left end open and right end closed; S. Rodríguez-Romo and E. J. Taft, One-sided Hopf algebras; F. L. Williams, BTZ black hole and Jacobi inversion for fundamental domains of infinite volume; T. Yanai, Galois correspondence theorem for Hopf algebra actions; A. G. Zavadskij, On two-point differentiation and its generalization.

Contemporary Mathematics, Volume 376

July 2005, 436 pages, Softcover, ISBN 0-8218-3630-7, LC 2005042812, 2000 *Mathematics Subject Classification*: 13D05, 13H10, 16E10, 16G20, 16G70, 16S36, 16W30, 94B60, All AMS members US\$87, List US\$109, Order code CONM/376



Variance and Duality for Cousin Complexes on Formal Schemes

Joseph Lipman, Suresh Nayak, and Pramathanath Sastry, *Purdue University, West Lafayette, IN*

Robert Hartshorne's book, *Residues and Duality* (1966, Springer-Verlag),

introduced the notion of residual complexes and developed a duality theory (Grothendieck duality) on the category of maps of noetherian schemes.

The three articles in this volume constitute a reworking of the main parts of the corresponding chapters in Hartshorne's 1966 book in greater generality using a somewhat different approach.

In particular, throughout this volume, the authors work with arbitrary (quasi-coherent, torsion) Cousin complexes on formal schemes, not only with residual complexes on ordinary schemes. Additionally, their motivation is to help readers gain

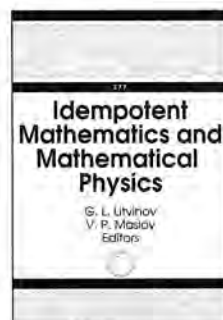
a better understanding of the relation between local properties of residues and global properties of the dualizing pseudofunctor.

The book is suitable for graduate students and researchers working in algebraic geometry.

Contents: J. Lipman, S. Nayak, and P. Sastry, Part 1. Pseudofunctorial behavior of Cousin complexes on formal schemes; P. Sastry, Part 2. Duality for Cousin complexes; S. Nayak, Part 3. Pasting pseudofunctors; Index.

Contemporary Mathematics, Volume 375

June 2005, 276 pages, Softcover, ISBN 0-8218-3705-2, LC 2005041986, 2000 *Mathematics Subject Classification*: 14F99, 14B15, 18A99, 18E99, 32C37, All AMS members US\$63, List US\$79, Order code CONM/375



Idempotent Mathematics and Mathematical Physics

G. L. Litvinov, *Independent University of Moscow, Russia*, and V. P. Maslov, *Moscow Institute of Electrical Engineering, Russia*, Editors

Idempotent mathematics is a rapidly developing new branch of the mathematical sciences that is closely related to mathematical physics. The existing literature on the subject is vast and includes numerous books and journal papers.

A workshop was organized at the Erwin Schrödinger Institute for Mathematical Physics (Vienna) to give a snapshot of modern idempotent mathematics. This volume contains articles stemming from that event. Also included is an introductory paper by G. Litvinov and additional invited contributions.

The resulting volume presents a comprehensive overview of the state of the art. It is suitable for graduate students and researchers interested in idempotent mathematics and tropical mathematics.

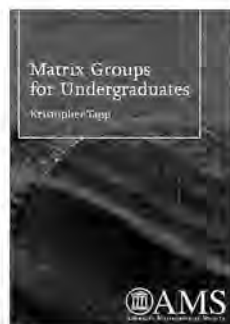
This item will also be of interest to those working in mathematical physics.

Contents: G. L. Litvinov, The Maslov's dequantization, idempotent and tropical mathematics: A very brief introduction; M. Akian, S. Gaubert, and V. Kolokoltsov, Set coverings and invertibility of functional Galois connections; M. Akian, S. Gaubert, and C. Walsh, Discrete max-plus spectral theory; A. Baklouti, Dequantization of coadjoint orbits: Moment sets and characteristic varieties; P. Butkovič, On the combinatorial aspects of max-algebra; G. Cohen, S. Gaubert, J.-P. Quadrat, and I. Singer, Max-plus convex sets and functions; A. Di Nola and B. Gerla, Algebras of Lukasiewicz's logic and their semiring reducts; W. H. Fleming and W. M. McEneaney, Max-plus approaches to continuous space control and dynamic programming; K. Khanin, D. Khmelev, and A. Sobolevskii, A blow-up phenomenon in the Hamilton-Jacobi equation in an unbounded domain; G. L. Litvinov and G. B. Shpiz, The dequantization transform

and generalized Newton polytopes; **P. Loreti** and **M. Pedicini**, An object-oriented approach to idempotent analysis: Integral equations as optimal control problems; **P. Lotito**, **J.-P. Quadrat**, and **E. Mancinelli**, Traffic assignment & Gibbs-Maslov semirings; **D. McCaffrey**, Viscosity solutions on Lagrangian manifolds and connections with tunnelling operators; **E. Pap**, Applications of the generated pseudo-analysis to nonlinear partial differential equations; **E. Pap**, A generalization of the utility theory using a hybrid idempotent-probabilistic measure; **M. Passare** and **A. Tsikh**, Amoebas: Their spines and their contours; **J. Richter-Gebert**, **B. Sturmfels**, and **T. Theobald**, First steps in tropical geometry; **I. V. Roublev**, On minimax and idempotent generalized weak solutions to the Hamilton-Jacobi equation; **E. Wagneur**, Dequantisation: Semi-direct sums of idempotent semimodules; **J. van der Woude** and **G. J. Olsder**, On $(\min, \max, +)$ -inequalities; **K. Zimmermann**, Solution of some max-separable optimization problems with inequality constraints.

Contemporary Mathematics, Volume 377

July 2005, 370 pages, Softcover, ISBN 0-8218-3538-6, LC 2005043637, 2000 *Mathematics Subject Classification*: 00B10, 81Q20, 06F07, 35Q99, 49L99, 46S99, 81S99, 52B20, 52A41, 14P99, **All AMS members US\$79**, List US\$99, Order code CONM/377



Matrix Groups for Undergraduates



Kristopher Tapp, *Williams College, Williamstown, MA*

Matrix groups are a beautiful subject and are central to many fields in mathematics and physics. They touch upon an enormous spectrum within the mathematical arena. This textbook

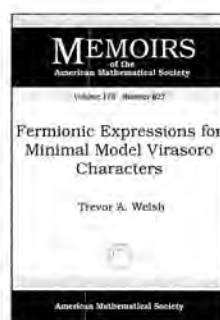
brings them into the undergraduate curriculum. It is excellent for a one-semester course for students familiar with linear and abstract algebra and prepares them for a graduate course on Lie groups.

Matrix Groups for Undergraduates is concrete and example-driven, with geometric motivation and rigorous proofs. The story begins and ends with the rotations of a globe. In between, the author combines rigor and intuition to describe basic objects of Lie theory: Lie algebras, matrix exponentiation, Lie brackets, and maximal tori. The volume is suitable for graduate students and researchers interested in group theory.

Contents: Why study matrix groups?; Matrices; All matrix groups are real matrix groups; The orthogonal groups; The topology of matrix groups; Lie algebras; Matrix exponentiation; Matrix groups are manifolds; The Lie bracket; Maximal tori; Bibliography; Index.

Student Mathematical Library, Volume 29

July 2005, 166 pages, Softcover, ISBN 0-8218-3785-0, LC 2005041182, 2000 *Mathematics Subject Classification*: 20-02, 20G20; 22C05, 22E15, **All AMS members US\$23**, List US\$29, Order code STML/29



Fermionic Expressions for Minimal Model Virasoro Characters

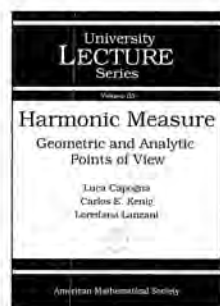
Trevor A. Welsh, *University of Melbourne, Parkville, Victoria, Australia*

Contents: Prologue; Path combinatorics; The \mathcal{B} -transform; The \mathcal{D} -transform; Mazy runs; Extending and truncating paths; Generating the fermionic expressions; Collating the runs; Fermionic character expressions; Discussion; Appendix A. Examples; Appendix B. Obtaining the bosonic generating function; Appendix C. Bands and the floor function; Appendix D. Bands on the move; Appendix E. Combinatorics of the Takahashi lengths; Bibliography.

Memoirs of the American Mathematical Society, Volume 175, Number 827

March 2005, 160 pages, Softcover, ISBN 0-8218-3656-0, LC 2005041982, 2000 *Mathematics Subject Classification*: 82B23; 05A15, 05A19, 17B68, 81T40, **Individual member US\$37**, List US\$61, Institutional member US\$49, Order code MEMO/175/827

Analysis



Harmonic Measure Geometric and Analytic Points of View

Luca Capogna, *University of Arkansas, Fayetteville*,
Carlos E. Kenig, *University of Chicago, IL*, and **Loredana Lanzani**, *University of Arkansas, Fayetteville*

Recent developments in geometric measure theory and harmonic analysis have led to new and deep results concerning the regularity of the support of measures which behave "asymptotically" (for balls of small radius) as the Euclidean volume. A striking feature of these results is that they actually characterize flatness of the support in terms of the asymptotic behavior of the measure. Such characterizations have led to important new progress in the study of harmonic measure for non-smooth domains.

This volume provides an up-to-date overview and an introduction to the research literature in this area. The presentation follows a series of five lectures given by Carlos Kenig at the 2000 Arkansas Spring Lecture Series at the University of Arkansas. The original lectures have been expanded and updated to reflect the rapid progress in this

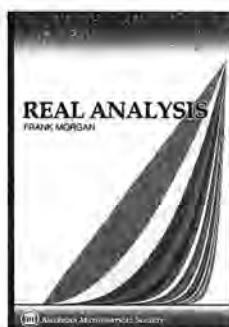
field. A chapter on the planar case has been added to provide a historical perspective.

Additional background has been included to make the material accessible to advanced graduate students and researchers in harmonic analysis and geometric measure theory.

Contents: Introduction; Motivation and statement of the main results; The relation between potential theory and geometry for planar domains; Preliminary results in potential theory; Reifenberg flat and chord arc domains; Further results on Reifenberg flat and chord arc domains; From the geometry of a domain to its potential theory; From potential theory to the geometry of a domain; Higher codimension and further regularity results; Bibliography.

University Lecture Series, Volume 35

June 2005, 155 pages, Softcover, ISBN 0-8218-2728-6, 2000 *Mathematics Subject Classification:* 35-02, 31-XX, 34A26, 35R35, 28A75, All AMS members US\$28, List US\$35, Order code ULECT/35



Real Analysis

Frank Morgan, Williams College, Williamstown, MA

This book is written by award-winning author, Frank Morgan. It offers a simple and sophisticated point of view, reflecting Morgan's insightful teaching, lecturing, and writing style.

Intended for undergraduates studying real analysis, this book builds the

theory behind calculus directly from the basic concepts of real numbers, limits, and open and closed sets in \mathbb{R}^n . It gives the three characterizations of continuity: via epsilon-delta, sequences, and open sets. It gives the three characterizations of compactness: as "closed and bounded," via sequences, and via open covers. Topics include Fourier series, the Gamma function, metric spaces, and Ascoli's Theorem.

This concise text not only provides efficient proofs, but also shows students how to derive them. The excellent exercises are accompanied at the back of the book by select solutions. Ideally suited as an undergraduate textbook, this complete book on real analysis will fit comfortably into one semester.

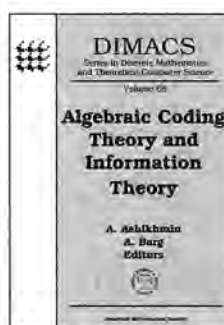
Frank Morgan received the first national Haimo teaching award from the Mathematical Association of America. He has also garnered top teaching awards from Rice University (Houston, TX) and MIT (Cambridge, MA).

Contents: *Part I: Real numbers and limits:* Numbers and logic; Infinity; Sequences; Functions and limits; *Part II: Topology:* Open and closed sets; Continuous functions; Composition of functions; Subsequences; Compactness; Existence of maximum; Uniform continuity; Connected sets and the intermediate value theorem; The Cantor set and fractals; *Part III: Calculus:* The derivative and the mean value theorem; The Riemann integral; The fundamental theorem of calculus;

Sequences of functions; The Lebesgue theory; Infinite series $\sum a_n$; Absolute convergence; Power series; Fourier series; Strings and springs; Convergence of Fourier series; The exponential function; Volumes of n -balls and the gamma function; *Part IV: Metric spaces:* Metric spaces; Analysis on metric spaces; Compactness in metric spaces; Ascoli's theorem; Partial solutions to exercises; Greek letters; Index.

July 2005, approximately 160 pages, Hardcover, ISBN 0-8218-3670-6, LC 2005041221, 2000 *Mathematics Subject Classification:* 26-XX, All AMS members US\$31, List US\$39, Order code REAL

Applications



Algebraic Coding Theory and Information Theory

A. Ashikhmin, Bell Labs, Lucent Technologies, Murray Hill, NJ, and A. Barg, University of Maryland, College Park, Editors

Collected here are papers that were presented at or inspired by the

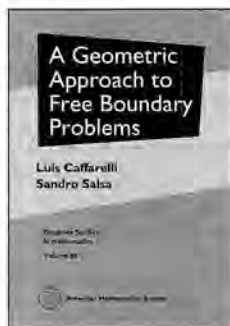
DIMACS workshop, Algebraic Coding Theory and Information Theory (Rutgers University, Piscataway, NJ). Among the topics discussed are universal data compression, graph theoretical ideas in the construction of codes and lattices, decoding algorithms, and computation of capacity in various communications schemes. The book is suitable for graduate students and researchers interested in coding and information theory.

Contents: G. Caire, S. Shamai, A. Shokrollahi, and S. Verdú, Fountain codes for lossless data compression; G. I. Shamir, Applications of coding theory to universal lossless source coding performance bounds; K. W. Shum and I. F. Blake, Expander graphs and codes; A. Barg and G. Zémor, Multilevel expander codes; M. R. Sadeghi and D. Panario, Low density parity check lattices based on construction D' and cycle-free Tanner graphs; J. S. Yedidia, Sparse factor graph representations of Reed-Solomon and related codes; M. El-Khamy and R. J. McEliece, Interpolation multiplicity assignment algorithms for algebraic soft-decision decoding of Reed-Solomon codes; S. Litsyn and A. Shpunt, On the capacity of two-dimensional weight-constrained memories; G. Kramer and S. A. Savari, On networks of two-way channels; R. G. Cavalcante, H. Lazari, J. d. D. Lima, and R. Palazzo, Jr., A new approach to the design of digital communication systems.

DIMACS: Series in Discrete Mathematics and Theoretical Computer Science, Volume 68

August 2005, 176 pages, Hardcover, ISBN 0-8218-3626-9, LC 2005047070, 2000 *Mathematics Subject Classification*: 94A24, 94A29, 94B15, 94B25, 94B35, 94B70, All AMS members US\$63, List US\$79, Order code DIMACS/68

Differential Equations



A Geometric Approach to Free Boundary Problems

Luis Caffarelli, *University of Texas, Austin*, and Sandro Salsa, *Politecnico di Milano, Italy*

Written by the well-known mathematician, Luis Caffarelli, and

Sandro Salsa, this book offers an excellent exposition on free boundary problems.

Free or moving boundary problems appear in many areas of analysis, geometry, and applied mathematics. A typical example is the evolving interphase between a solid and liquid phase: if we know the initial configuration well enough, we should be able to reconstruct its evolution, in particular, the evolution of the interphase.

In this book, the authors present a series of ideas, methods, and techniques for treating the most basic issues of such a problem. In particular, they describe the very fundamental tools of geometry and real analysis that make this possible: properties of harmonic and caloric measures in Lipschitz domains, a relation between parallel surfaces and elliptic equations, monotonicity formulas and rigidity, etc. The tools and ideas presented here will serve as a basis for the study of more complex phenomena and problems.

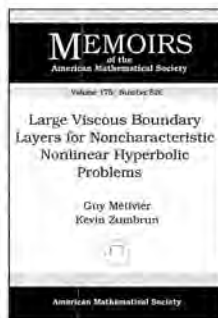
This book is useful for supplementary reading or will be a fine independent study text. It is suitable for graduate students and researchers interested in partial differential equations.

Also available from the AMS by Luis Caffarelli is *Fully Nonlinear Elliptic Equations* as volume 43 in the AMS series Colloquium Publications.

Contents: *Elliptic problems:* An introductory problem; Viscosity solutions and their asymptotic developments; The regularity of the free boundary; Lipschitz free boundaries are $C^{1,\gamma}$; Flat free boundaries are Lipschitz; Existence theory; *Evolution problems:* Parabolic free boundary problems; Lipschitz free boundaries: Weak results; Lipschitz free boundaries: Strong results; Flat free boundaries are smooth; *Complementary chapters:* Main tools: Boundary behavior of harmonic functions; Monotonicity formulas and applications; Boundary behavior of caloric functions; Bibliography; Index.

Graduate Studies in Mathematics, Volume 68

July 2005, 270 pages, Hardcover, ISBN 0-8218-3784-2, LC 2005041181, 2000 *Mathematics Subject Classification*: 35-01, 35R35; 35J25, 35K20, All AMS members US\$39, List US\$49, Order code GSM/68



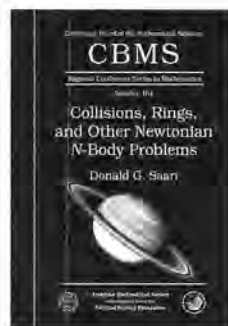
Large Viscous Boundary Layers for Noncharacteristic Nonlinear Hyperbolic Problems

Guy Métivier, *University of Bordeaux, Talence, France*, and Kevin Zumbrun, *Bloomington, IN*

Contents: Introduction; Linear stability: the model case; Pieces of paradifferential calculus; L^2 and conormal estimates near the boundary; Linear stability; Nonlinear stability; Appendix A. Kreiss symmetrizers; Appendix B. Para-differential calculus; Appendix; Bibliography.

Memoirs of the American Mathematical Society, Volume 175, Number 826

March 2005, 107 pages, Softcover, ISBN 0-8218-3649-8, LC 2005041981, 2000 *Mathematics Subject Classification*: 35L60; 35B35, Individual member US\$34, List US\$57, Institutional member US\$46, Order code MEMO/175/826



Collisions, Rings, and Other Newtonian N-Body Problems

Donald G. Saari, *University of California, Irvine*

Written by leading expert Donald Saari, this book is directed toward readers who want to learn about the Newtonian N -body problem. It is also

intended for students and experts who are interested in new expositions of past results in this area, previously unpublished research conclusions, and new research problems.

Professor Saari has written the book for a broad audience, including readers with no previous knowledge about this fascinating area. He begins each chapter with introductory material motivated by unanswered research questions. He then includes some history, discussions intended to develop intuition, descriptions of open problems, and examples taken from real problems in astronomy.

The first chapter starts with simple explanations of the apparent "looping" orbit of Mars and the unexpected "Sunrise, Sunset" behavior as viewed from Mercury and then leads up to the unexplained and weird dynamics exhibited by Saturn's F-

ring. The second chapter, which introduces a way to decompose the velocity of the system, is motivated by a seemingly easy but unanswered conjecture involving the dynamics of the system when the system's diameter is a constant. The third chapter, which describes questions about the structure of the rings of Saturn, introduces new and surprisingly simple ways to find configurations of the particles that are "central" to any discussion of the N -body problem. The fourth chapter analyzes collisions, and the last chapter discusses the likelihood of collisions and other events.

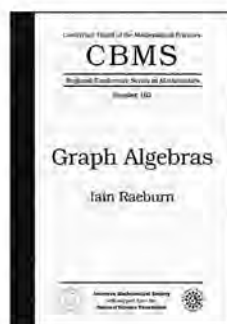
The book is suitable for graduate students and researchers interested in celestial mechanics.

Contents: Introduction; Central configurations; Finding central configurations; Collisions—Both real and imaginary; How likely is it?; Bibliography; Index.

CBMS Regional Conference Series in Mathematics, Number 104

June 2005, 235 pages, Softcover, ISBN 0-8218-3250-6, LC 2005041205, 2000 *Mathematics Subject Classification*: 70F10; 70F15, **All Individuals US\$36**, List US\$45, Order code CBMS/104

Discrete Mathematics and Combinatorics



Graph Algebras

Iain Raeburn, *University of Newcastle, Callaghan, NSW, Australia*

Graph algebras are a family of operator algebras which are associated to directed graphs. These algebras have an attractive structure theory in which algebraic properties of the algebra are related to the behavior of

paths in the underlying graph. In the past few years there has been a great deal of activity in this area, and graph algebras have cropped up in a surprising variety of situations, including non-abelian duality, non-commutative geometry, and the classification of simple C^* -algebras.

The first part of the book provides an introduction to the subject suitable for students who have seen a first course on the basics of C^* -algebras. In the second part, the author surveys the literature on the structure theory of graph algebras, highlights some applications of this theory, and discusses several recent generalizations which seem particularly promising.

The volume is suitable for graduate students and research mathematicians interested in graph theory and operator algebras.

This item will also be of interest to those working in algebra and algebraic geometry.

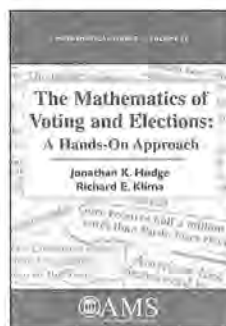
Contents: Introduction; Directed graphs and Cuntz-Krieger families; Uniqueness theorems for graph algebras; Proofs of the uniqueness theorems; Simplicity and ideal structure;

Arbitrary graphs; Applications to non-abelian duality; K -theory of graph algebras; Cuntz-Pimsner algebras; Topological graphs; Higher-rank graphs; Background material; Bibliography; Index.

CBMS Regional Conference Series in Mathematics, Number 103

May 2005, 113 pages, Softcover, ISBN 0-8218-3660-9, LC 2005041206, 2000 *Mathematics Subject Classification*: 46L05; 46L08, 46L35, 46L55, 46L80, 22D35, **All Individuals US\$28**, List US\$35, Order code CBMS/103

General and Interdisciplinary



The Mathematics of Voting and Elections: A Hands-On Approach

Jonathan K. Hodge, *Grand Valley State University, Allendale, MI*, and **Richard E. Klima**, *Appalachian State University, Boone, NC*

Have you ever wondered ... why elections often produce results that seem to be displeasing to many of the voters involved? Would you be surprised to learn that a perfectly fair election can produce an outcome that literally *nobody* likes? When voting, we often think about the candidates or proposals in the election, but we rarely consider the procedures that we use to express our preferences and arrive at a collective decision.

The Mathematics of Voting and Elections: A Hands-On Approach will help you discover answers to these and many other questions. Easily accessible to anyone interested in the subject, the book requires virtually no prior mathematical experience beyond basic arithmetic, and includes numerous examples and discussions regarding actual elections from politics and popular culture. It is recommended for researchers and advanced undergraduates interested in all areas of mathematics and is ideal for independent study.

Contents: What's so good about majority rule?; Perot, Nader, and other inconveniences; Back into the ring; Trouble in democracy; Explaining the impossible; One person, one vote?; Calculating corruption; The ultimate college experience; Trouble in direct democracy; Proportional (mis)representation; Bibliography; Index.

Mathematical World, Volume 22

June 2005, approximately 240 pages, Softcover, ISBN 0-8218-3798-2, LC 2005041034, 2000 *Mathematics Subject Classification*: 91-01; 91B12, **All AMS members US\$28**, List US\$35, Order code MAWRLD/22

Mathematical Publishing

A Guidebook

Stephen G. Krantz



AMERICAN MATHEMATICAL SOCIETY

Mathematical Publishing A Guidebook

Steven G. Krantz, *Washington University, St. Louis, MO*

Mathematicians are expected to publish their work: in journals, conference proceedings, and books. It is vital to advancing their careers. Later, some are asked to become

editors. However, most mathematicians are trained to *do* mathematics, not to publish it.

But here, finally, for graduate students and researchers interested in publishing their work, Steven G. Krantz, the respected author of several "how-to" guides in mathematics, shares his experience as an author, editor, editorial board member, and independent publisher. This new volume is an informative, comprehensive guidebook to publishing mathematics. Krantz describes both the general setting of mathematical publishing and the specifics about all the various publishing situations mathematicians may encounter.

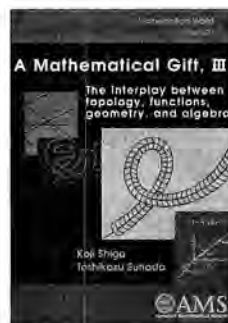
As with his other books, Krantz's style is engaging and frank. He gives advice on how to get your book published, how to get organized as an editor, what to do when things go wrong, and much more. He describes the people, the language (including a glossary), and the process of publishing both books and journals.

Steven G. Krantz is an accomplished mathematician and an award-winning author. He has published more than 130 research articles and 45 books. He has worked as an editor of several book series, research journals, and for the *Notices of the AMS*. He is also the founder of the *Journal of Geometric Analysis*.

Other titles available from the AMS by Steven G. Krantz are *How to Teach Mathematics*, *A Primer of Mathematical Writing*, *A Mathematician's Survival Guide*, and *Techniques of Problem Solving*.

Contents: *Introductory thoughts:* Why publish?; What do I publish?; Different types of publishing; *Publishing an article or paper:* Journal publishing; How to write an article or paper; *Publication of a book:* Your magnum opus; How to write a book; *Publishing personnel:* The people in publishing; The role of book editors; The nitty gritty of editing; *Parts of the publishing process:* The manuscript; What happens to your book at the publishing house; *Legal matters:* Copyright and author rights; Details of the book contract; *Closing thoughts:* Putting the scholarly life into perspective; Copy editor's/proofreader's marks; Use of copy editor's marks; Specialized mathematics symbols; Alternative mathematical notations; \TeX , Postscript®, Acrobat®, and related internet sites (plus tips on how to ftp); The AMS consent to publish agreement; The AMS guidelines for journal editors; Glossary; References; Index.

August 2005, approximately 320 pages, Softcover, ISBN 0-8218-3699-4, 2000 *Mathematics Subject Classification:* 00A99, All AMS members US\$23, List US\$29, Order code MATPUB



A Mathematical Gift, III

The interplay between topology, functions, geometry, and algebra

Koji Shiga, *Yokohama, Japan*,
and Toshikazu Sunada, *Tohoku University, Sendai, Japan*



This book brings the beauty and fun of mathematics to the classroom. It offers serious mathematics in a lively, reader-friendly style. Included are exercises and many figures illustrating the main concepts.

The first chapter talks about the theory of manifolds. It includes discussion of smoothness, differentiability, and analyticity, the idea of local coordinates and coordinate transformation, and a detailed explanation of the Whitney imbedding theorem (both in weak and in strong form). The second chapter discusses the notion of the area of a figure on the plane and the volume of a solid body in space. It includes the proof of the Bolyai-Gerwien theorem about scissors-congruent polynomials and Dehn's solution of the Third Hilbert Problem.

This is the third volume originating from a series of lectures given at Kyoto University (Japan). It is suitable for classroom use for high school mathematics teachers and for undergraduate mathematics courses in the sciences and liberal arts. The first and second volumes are available as Volume 19 and Volume 20 in the AMS series, *Mathematical World*.

Contents: *The story of the birth of manifolds:* The prelude to the birth of manifolds; The birth of manifolds; *The story of area and volume from everyday notions to mathematical concepts:* Transition from the notion of "size" to the concept of "area"; Scissors-congruent polygons; Scissors-congruent polyhedra.

Mathematical World, Volume 23

July 2005, approximately 128 pages, Softcover, ISBN 0-8218-3284-0, LC 2003062778, 2000 *Mathematics Subject Classification:* 00A05; 53-01, All AMS members US\$23, List US\$29, Order code MAWRLD/23



A Mathematical Gift, I, II, III

This three-volume set addresses the interplay between topology, functions, geometry, and algebra. Bringing the beauty and fun of mathematics to the classroom, the authors offer serious mathematics in a lively, reader-friendly style. Included are exercises and many figures

illustrating the main concepts. It is suitable for advanced high-school students, graduate students, and researchers.

The three-volume set includes *A Mathematical Gift I, II, and III*.

Contents: Part I: Invitation to topology (Viewing figures globally); Introduction; The Euler characteristic; Vortices created by winds and the Euler characteristic; Curvature of a surface and the Euler characteristic; *The story of dimension*: Introduction; Learning to appreciate dimension; What is dimension?; Three-dimensional figures; Physics and dimension; **Part II: The legacy of trigonometric functions**: Introduction; Trigonometric functions and infinite series; Elliptic functions; *Intersection of geometry and algebra*: Introduction; The Poncelet closure theorem; The Poncelet theorem for circles; The Poncelet theorem in the world of complex numbers; Proof of the Poncelet theorem using plane geometry; Conclusion; **Part III: The story of the birth of manifolds**: The prelude to the birth of manifolds; The birth of manifolds; *The story of area and volume from everyday notions to mathematical concepts*: Transition from the notion of "size" to the concept of "area"; Scissors-congruent polygons; Scissors-congruent polyhedra.

Mathematical World

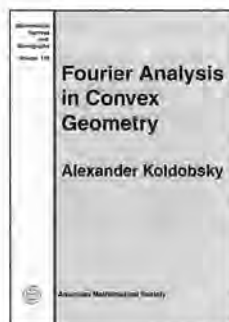
A Mathematical Gift, I: 2003, 136 pages, Softcover, ISBN 0-8218-3282-4, All AMS members US\$23, List US\$29, Order code MAWRD/19

A Mathematical Gift, II: 2004, 128 pages, Softcover, ISBN 0-8218-3283-2, All AMS members US\$23, List US\$29, Order code MAWRD/20

A Mathematical Gift, III: July 2005, approximately 128 pages, Softcover, ISBN 0-8218-3284-0, All AMS members US\$23, List US\$29, Order code MAWRD/23

Set: July 2005, Softcover, ISBN 0-8218-3859-8, All AMS members US\$60, List US\$75, Order code MAWRD-GSET

Geometry and Topology



Fourier Analysis in Convex Geometry

Alexander Koldobsky,
University of Missouri,
Columbia

The study of the geometry of convex bodies based on information about sections and projections of these bodies has important applications in

many areas of mathematics and science. In this book, a new Fourier analysis approach is discussed. The idea is to express certain geometric properties of bodies in terms of Fourier analysis and to use harmonic analysis methods to solve geometric problems.

One of the results discussed in the book is Ball's theorem, establishing the exact upper bound for the $(n-1)$ -dimensional volume of hyperplane sections of the n -dimensional unit cube (it is $\sqrt{2}$ for each $n \geq 2$). Another is the Busemann-Petty problem: if K and L are two convex origin-symmetric n -dimensional bodies and the $(n-1)$ -dimensional volume of each

central hyperplane section of K is less than the $(n-1)$ -dimensional volume of the corresponding section of L , is it true that the n -dimensional volume of K is less than the volume of L ? (The answer is positive for $n \leq 4$ and negative for $n > 4$.)

The book is suitable for graduate students and researchers interested in geometry, harmonic and functional analysis, and probability. Prerequisites for reading this book include basic real, complex, and functional analysis.

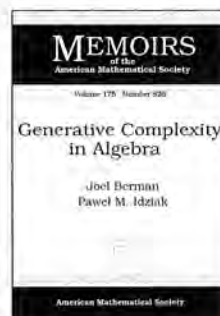
This item will also be of interest to those working in analysis.

Contents: Introduction; Basic concepts; Volume and the Fourier transform; Intersection bodies; The Busemann-Petty problem; Intersection bodies and L_p -spaces; Extremal sections of ℓ_q -balls; Projections and the Fourier transform; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 116

April 2005, 170 pages, Hardcover, ISBN 0-8218-3787-7, LC 2005041147, 2000 *Mathematics Subject Classification*: 52A20, 52A38, 46B04, 46B07; 42A38, 42A82, 46F12, 60E07, 60E10, All AMS members US\$47, List US\$59, Order code SURV/116

Logic and Foundations



Generative Complexity in Algebra

Joel Berman, University of
Illinois, Chicago, and Paweł M.
Idziak, Jagiellonian University,
Krakow, Poland

This item will also be of interest to those working in algebra and algebraic

geometry.

Contents: Introduction; Background material; *Part 1. Introducing Generative Complexity*: Definitions and examples; Semilattices and lattices; Varieties with a large number of models; Upper bounds; Categorical invariants; *Part 2. Varieties with Few Models*: Types 4 or 5 need not apply; Semisimple may apply; Permutable may also apply; Forcing modular behavior; Restricting solvable behavior; Varieties with very few models; Restricting nilpotent behavior; Decomposing finite algebras; Restricting affine behavior; A characterization theorem; *Part 3. Conclusions*: Application to groups and rings; Open problems; Tables; Bibliography.

Memoirs of the American Mathematical Society, Volume 175, Number 828 March 2005, 159 pages, Softcover, ISBN 0-8218-3707-9, LC 2005041979, 2000 *Mathematics Subject Classification*: 08A05; 03C13, 03C45, 05A16, 08B20, Individual member US\$37, List US\$61, Institutional member US\$49, Order code MEMO/175/828



Hausdorff on Ordered Sets

J. M. Plotkin, *Michigan State University, East Lansing*, Editor

Georg Cantor, the founder of set theory, published his last paper on sets in 1897. In 1900, David Hilbert made Cantor's Continuum Problem and the challenge of well-ordering the real numbers the first problem of his famous lecture at the international

congress in Paris. Thus, as the nineteenth century came to a close and the twentieth century began, Cantor's work was finally receiving its due and Hilbert had made one of Cantor's most important conjectures his number one problem. It was time for the second generation of Cantorians to emerge.

Foremost among this group were Ernst Zermelo and Felix Hausdorff. Zermelo isolated the Choice Principle, proved that every set could be well-ordered, and axiomatized the concept of set. He became the father of abstract set theory. Hausdorff eschewed foundations and developed set theory as a branch of mathematics worthy of study in its own right, capable of supporting both general topology and measure theory. He is recognized as the era's leading Cantorian.

Hausdorff published seven articles in set theory during the period 1901-1909, mostly about ordered sets. This volume contains translations of these papers with accompanying introductory essays. They are highly accessible, historically significant works, important not only for set theory, but also for model theory, analysis and algebra.

This book is suitable for graduate students and researchers interested in set theory and the history of mathematics.

Also available from the AMS by Felix Hausdorff are the classic work, *Grundzüge der Mengenlehre*, and its English translation, *Set Theory*, as Volume 69 and Volume 119 in the AMS Chelsea Publishing series.

This item will also be of interest to those working in general and interdisciplinary areas.

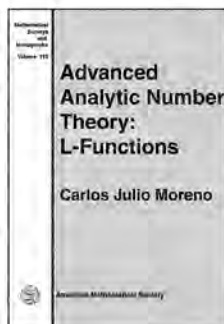
Copublished with the London Mathematical Society. Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners.

Contents: J. M. Plotkin, Selected Hausdorff bibliography; J. Plotkin, Introduction to "About a certain kind of ordered sets"; F. Hausdorff, About a certain kind of ordered sets [H 1901b]; J. M. Plotkin, Introduction to "The concept of power in set theory"; F. Hausdorff, The concept of power in set theory [H 1904a]; J. Plotkin, Introduction to "Investigations into order types, I, II, III"; F. Hausdorff, Investigations into order types [H 1906b]; J. Plotkin, Introduction to "Investigations into order types IV, V"; F. Hausdorff, Investigations into order types [H 1907a]; J. Plotkin, Introduction to "About dense order types"; F. Hausdorff, About dense order types [H 1907b]; J. Plotkin, Introduction to "The fundamentals of a theory of ordered sets"; F. Hausdorff, The fundamentals of a theory of ordered sets [H 1908]; J. Plotkin, Introduction to "Graduation by final behavior"; F. Hausdorff, Graduation by final behavior [H 1909a]; F. Hausdorff, Appendix. Sums of \aleph_1 sets [H 1936b]; Bibliography.

History of Mathematics, Volume 25

July 2005, 322 pages, Softcover, ISBN 0-8218-3788-5, LC 2005045328, 2000 *Mathematics Subject Classification*: 01A75, 01A60, 03-03, 06-03, 26-03, All AMS members US\$55, List US\$69, Order code HMATH/25

Number Theory



Advanced Analytic Number Theory: L-Functions

Carlos Julio Moreno, *The City University of New York (CUNY)*

Since the pioneering work of Euler, Dirichlet, and Riemann, the analytic

properties of L-functions have been used to study the distribution of prime numbers. With the advent of the Langlands Program, L-functions have assumed a greater role in the study of the interplay between Diophantine questions about primes and representation theoretic properties of Galois representations.

This book provides a complete introduction to the most significant class of L-functions: the Artin-Hecke L-functions associated to finite-dimensional representations of Weil groups and to automorphic L-functions of principal type on the general linear group. In addition to establishing functional equations, growth estimates, and non-vanishing theorems, a thorough presentation of the explicit formulas of Riemann type in the context of Artin-Hecke and automorphic L-functions is also given.

The survey is aimed at mathematicians and graduate students who want to learn about the modern analytic theory of L-functions and their applications in number theory and in the theory of automorphic representations. The requirements for a profitable study of this monograph are a knowledge of basic number theory and the rudiments of abstract harmonic analysis on locally compact abelian groups.

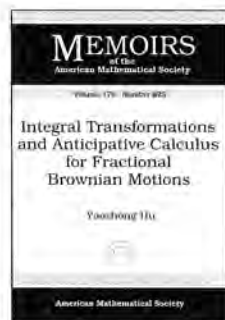
Contents: Hecke L-functions; Artin-Hecke L-functions; Analytic properties of L-functions; The explicit formulas; Bounds on discriminants and conductors; Non-vanishing theorems; The local theory of root numbers: A survey; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 115

June 2005, 291 pages, Hardcover, ISBN 0-8218-3641-2, LC 2005041057, 2000 *Mathematics Subject Classification*: 11Mxx, 11Rxx, 22Exx; 11Sxx, All AMS members US\$61, List US\$76, Order code SURV/115



Probability



Integral Transformations and Anticipative Calculus for Fractional Brownian Motions

Yaozhong Hu, *University of Kansas, Lawrence*

Contents: Introduction; Representations; Induced

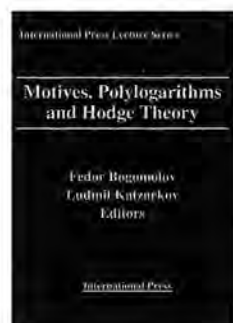
transformation I; Approximation; Induced transformation II; Stochastic calculus of variation; Stochastic integration; Nonlinear translation (Absolute continuity); Conditional expectation; Integration by parts; Composition (Itô formula); Clark type representation; Continuation; Stochastic control; Appendix; Bibliography.

Memoirs of the American Mathematical Society, Volume 175, Number 825

March 2005, 127 pages, Softcover, ISBN 0-8218-3704-4, LC 2005041980, 2000 *Mathematics Subject Classification*: 60H05, 60H07, 60G30, 60G15, 26A33, 44A05, **Individual member US\$35**, List US\$58, Institutional member US\$46, Order code MEMO/175/825

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Motives, Polylogarithms and Hodge Theory

Part I: Motives and Polylogarithms
Part II: Hodge Theory

Fedor Bogomolov, *New York University, Courant Institute,*
and Ludmil Katzarkov,

University of California, Irvine, Editors

These two volumes contain papers of the participants in the International Press Conference on Motives, polylogarithms and non-abelian Hodge theory which took place at UC Irvine in June 1998. The conference commemorated the twentieth anniversary of the remarkable Irvine lectures of Spencer Bloch on "Higher regulators, algebraic K -theory and zeta functions of elliptic curves". The conference presented some of the best recent research in algebraic K -theory, Hodge theory, motivic cohomology and polylogarithms.

Fourteen papers explore the frontiers of motivic cohomology and motivic homotopy theory, the periods of modular forms and the variational aspects of Hodge theory. Contributions include a program paper of V. Voevodsky outlining the outstanding open questions in the stable homotopy theory of motives, as well as papers on motivic cohomology, Galois cohomology and algebraic differential characters by A. Beilinson, S. Bloch, F. Bogomolov, H. Esnault, and Y. Tschinkel; a paper of D. Zagier describing in detail the traces of the values of modular functions at quadratic irrationalities, works on theory of classical and elliptic polylogarithms by A. Goncharov and A. Levin, as well as works of J. Wildeshaus and Z. Wojtkowiak describing the recent progress towards a proof of various versions of Zagier's conjecture; a foundational paper of C. Simpson on geometric n -stacks and their applications to non-abelian Hodge structures, and papers on the geometric applications of non-abelian Hodge theory by D. Arapura, L. Katzarkov, T. Pantev, A. Reznikov, and C. Teleman.

This item will also be of interest to those working in number theory.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

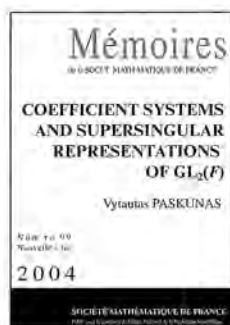
Contents: **Part I:** V. Voevodsky, Open problems in the motivic stable homotopy theory, I; A. Beilinson, Remarks on n -motives and correspondences at the generic point; S. Bloch and H. Esnault, Relative algebraic differential characters; F. Bogomolov and Y. Tschinkel, Commuting elements in Galois groups of function fields; Z. Wojtkowiak, Mixed Hodge structures and iterated integrals, I; **Part II:** D. Zagier, Traces of singular moduli; A. B. Goncharov, Explicit regulator maps on polylogarithmic motivic complexes; A. Levin, An explicit formula for the motivic elliptic polylogarithm; J. Wildeshaus, On the Eisenstein symbol; C. Simpson, Algebraic aspects of higher nonabelian Hodge theory; D. Arapura, Higgs bundles, integrability, and holomorphic forms; L. Katzarkov and T. Pantev, Nonabelian (p, p) classes; A. Reznikov, The structure of Kähler groups, I: second cohomology; C. Teleman, Some Hodge theory from Lie algebras.

International Press

Part I: December 2002, 420 pages, Hardcover, ISBN 1-57146-090-X, **All AMS members US\$52**, List US\$65, Order code INPR/52.1

Part II: December 2002, 334 pages, Hardcover, ISBN 1-57146-091-8, **All AMS members US\$52**, List US\$65, Order code INPR/52.2

Set: December 2002, 754 pages, Hardcover, ISBN 1-57146-092-6, **All AMS members US\$80**, List US\$100, Order code INPR/52



Coefficient Systems and Supersingular Representations of $GL_2(F)$

Vytautas Paskunas,
Universität Bielefeld

Let F be a non-Archimedean local field with the residual characteristic p . The author constructs a "good" number of smooth irreducible \bar{F}_p -representations of $GL_2(F)$, which are supersingular in the sense of Barthel and Livné. If $F = \mathbb{Q}_p$, then results of Breuil imply that our construction gives all the supersingular representations up to the twist by an unramified quasi-character. The author conjectures that this is true for an arbitrary F .

The book is suitable for graduate students and research mathematicians interested in algebra and algebraic geometry.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; Hecke algebra; Irreducible representations of $GL_2(F_q)$; Principal indecomposable representations; Coefficient systems; Supersingular representations; Bibliography.

Mémoires de la Société Mathématique de France, Number 99
February 2005, 84 pages, Softcover, ISBN 2-85629-165-1, 2000 *Mathematics Subject Classification*: 22E50, **Individual member** US\$33, List US\$37, Order code SMFMEM/99

Analysis



Analysis I

Claus Gerhardt, *University of Heidelberg, Germany*

Analysis I is based on the courses given by the author at Heidelberg. It comprises material for a one and a half semester course and can be used as a textbook. The contents range from elementary calculus to fairly advanced topics in functional analysis, measure theory and differential geometry.

The volume covers the convergence of sequences, topological concepts including continuity, compactness and connectedness, differentiation in one variable, theorems of Arzela-Ascoli and Stone-Weierstraß and analytic functions in several variables, as well as Riemann integral. It demands minimum prerequisites and is intended for first year graduate students or undergraduates who want to pursue the mathematics or physics fields.

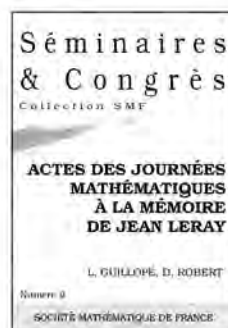
A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: Foundations; Convergence; Continuity; Differentiation in one variable; Spaces of continuous functions; Integration in one variable; Bibliography; List of symbols; Index.

International Press

February 2004, 281 pages, Softcover, ISBN 1-57146-153-1, All **AMS members** US\$40, List US\$50, Order code INPR/59

Differential Equations



Actes des journées mathématiques à la mémoire de Jean Leray

Laurent Guillopé and Didier Robert, *Université de Nantes, France*, Editors

On the 17th and 18th of June 2002, the Laboratory of Mathematics of Nantes University (supported by

CNRS) organized a meeting to celebrate the memory of Jean Leray. At this time, the laboratory was named **Laboratoire Jean Leray**. This volume begins with the lecture by Yves Meyer, which relates the scientific life of Jean Leray. The lectures that follow illustrate most aspects of the scientific works of J. Leray and show the wide spectrum of his work.

The book is suitable for graduate students and research mathematicians interested in differential equations, geometry, and topology.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Y. Meyer, Jean Leray et la recherche de la vérité; S. Agmon, On the asymptotics of Green's functions of elliptic operators with constant coefficients; D. Barlet, Singularités réelles isolées et développements asymptotiques d'intégrales oscillantes; P. Bolley and P. T. Lai, Réduction au bord d'un problème modèle de Kelvin; R. Camalès, Problème de Cauchy ramifié pour une classe d'opérateurs dont les racines caractéristiques sont en involution; J.-Y. Chemin, Le système de Navier-Stokes incompressible soixante dix ans après Jean Leray; Y. Choquet-Bruhat, Asymptotic solutions of nonlinear wave equations and polarized null conditions; M. Fontes and E. Saksman, Optimal results for the two dimensional Navier-Stokes equations with lower regularity on the data; J.-L. Loday, Scindement d'associativité et algèbres de Hopf; P. Schapira, Sheaves: from Leray to Grothendieck and Sato; J.-C. Sikorav, Dual elliptic planes.

Séminaires et Congrès, Number 9

February 2005, 208 pages, Softcover, ISBN 2-85629-160-0,
2000 *Mathematics Subject Classification*: 16A24, 16W30,
18D50, 32C30, 32C38, 32Q65, 32S40, 34A12, 35A10, 35A20,
35A27, 35C15, 35C20, 35E05, 35J25, 35Q30, 35S99, 53C15,
53C42, 53D35, 57R17, 58J60, 76B20, 76B99, 76D05,
Individual member US\$53, List US\$59, Order code SECO/9

Geometry and Topology



Collected Papers on Ricci Flow

H. D. Cao, *Texas A & M University, College Station*,
B. Chow, *University of California, San Diego, La Jolla*,
S.-C. Chu, *National Chung Cheng University, Chia-Yi, Taiwan*, and **S.-T. Yau**,
Harvard University, Cambridge, MA, Editors

The Ricci flow is currently a hot topic at the forefront of mathematics research. The recent developments of Grisha Perelman on Richard Hamilton's program for Ricci flow are exciting. This collection is intended to make readily available to a wide audience one book containing the work of Hamilton and others on Ricci flow.

In the past two decades, the Ricci flow, and in particular Richard Hamilton's work in it, has received attention as both having a profound influence on geometric evolution equations and as a possible approach to studying Thurston's Geometrization Conjecture.

This selection of papers on the Riemannian Ricci flow is intended for a variety of purposes. The graduate student or researcher unfamiliar with the Ricci flow may use it as an introduction to the Ricci flow quickly leading to current research topics and open problems. Geometers already familiar with the Ricci flow may use it as a handy reference which contains almost all of Richard Hamilton's papers on the subject to date.

This item will also be of interest to those working in differential equations.

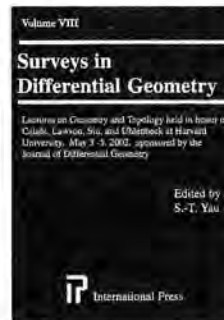
A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: **R. S. Hamilton**, The formation of singularities in the Ricci flow; **R. S. Hamilton**, Three-manifolds with positive Ricci curvature; **D. DeTurck**, Deforming metrics in the direction of their Ricci tensors; **G. Huisken**, Ricci deformation of the metric on a Riemannian manifold; **R. S. Hamilton**, Four-manifolds with positive curvature operator; **R. S. Hamilton**, The Ricci flow on surfaces; **B. Chow**, The Ricci flow on the 2-sphere; **B. Chow**, On the entropy estimate for the Ricci flow on

compact 2-orbifolds; **R. S. Hamilton**, An isoperimetric estimate for the Ricci flow on surfaces; **R. S. Hamilton**, The Harnack estimate for the Ricci flow; **R. S. Hamilton**, Eternal solutions to the Ricci flow; **B. Chow** and **S.-C. Chu**, A geometric interpretation of Hamilton's Harnack inequality for the Ricci flow; **R. S. Hamilton**, A compactness property for the solutions of the Ricci flow; **R. S. Hamilton**, Non-singular solutions of the Ricci flow on three-manifolds; **R. S. Hamilton**, Four-manifolds with positive isotropic curvature; **R. S. Hamilton** and **S. T. Yau**, The Harnack estimate for the Ricci flow on a surface-Revisited; **P. Li** and **S. T. Yau**, On the parabolic kernel of the Schrödinger operator; **R. Schoen** and **S. T. Yau**, Existence of incompressible minimal surfaces and the topology of three dimensional manifolds with non-negative scalar curvature; **W. Meeks III**, **L. Simon**, and **S.-T. Yau**, Embedded minimal surfaces, exotic spheres, and manifolds with positive Ricci curvature; **B. L. Chen** and **X. P. Zhu**, Complete Riemannian manifolds with pointwise pinched curvature; **R. S. Hamilton**, Three-orbifolds with positive Ricci curvature; **X.-P. Zhu**, The Ricci flow on complete noncompact Kähler manifolds; Appendix: Kähler-Ricci flow references.

International Press

December 2003, 539 pages, Hardcover, ISBN 1-57146-110-8,
All AMS members US\$51, List US\$64, Order code INPR/51



Surveys in Differential Geometry, Vol. VIII

S.-T. Yau, *Harvard University, Cambridge, MA*, Editor

The annual *Surveys in Differential Geometry* volume is received with anticipation each year as it summarizes many of the recent discoveries in the field. This year's volume is dedicated to Professors

Calabi, Lawson, Siu, and Uhlenbeck. It contains important contributions by their students and colleagues and reflects the important work in the field by these great mathematicians.

A publication of International Press. Distributed worldwide by the American Mathematical Society.

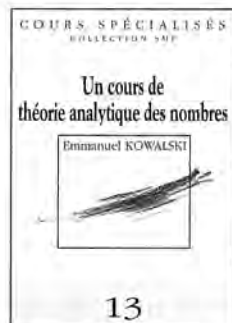
Contents: **M. Atiyah** and **J. Berndt**, Projective planes, Severi varieties and spheres; **J. Cheeger**, Degeneration of Einstein metrics and metrics with special holonomy; **T. H. Colding** and **C. De Lellis**, The min-max construction of minimal surfaces; **C. B. Croke** and **M. Katz**, Universal volume bounds in Riemannian manifolds; **J.-P. Demailly** and **T. Peternell**, A Kawamata-Viehweg vanishing theorem on compact Kähler manifolds; **S. K. Donaldson**, Moment maps in differential geometry; **D. Fisher** and **G. A. Margulis**, Local rigidity for cocycles; **C. LeBrun**, Einstein metrics, four-manifolds, and differential topology; **N. C. Leung**, Topological quantum field theory for Calabi-Yau threefolds and G_2 -manifold; **W. H. Meeks III**, Geometric results in classical minimal surface theory; **A. Nahmod**, On global existence of wave maps with critical regularity; **E. Viehweg** and **K. Zuo**, Discreteness of minimal models of Kodaira dimension zero and subvarieties

of moduli stacks; S. A. Wolpert, Geometry of the Weil-Petersson completion of Teichmüller space.

International Press

December 2003, 397 pages, Hardcover, ISBN 1-57146-114-0,
All AMS members US\$52, List US\$65, Order code INPR/53

Number Theory



Un cours de théorie analytique des nombres

Emmanuel Kowalski,
*University of Bordeaux I,
Talence, France*

This book is an introduction to the multiplicative theory of prime numbers. It is divided roughly into two parts. The first part introduces

the classical methods based on analytic properties of Dirichlet series, leading to the fundamental results about the prime number theory in arithmetic progressions. The second part presents methods in the forefront of current research to prove a theorem of Duke, Friedlander and Iwaniec on equidistribution of roots of a quadratic polynomial modulo primes. This result is discussed throughout the book. The two main points are a sieve result not restricted to “almost primes”, and the use of results coming from the spectral theory of automorphic forms.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; Préparatifs pour le théorème des nombres premiers; Le théorème des nombres premiers; Discussion du théorème des nombres premiers; Crible et sommes oscillantes sur les nombres premiers; Formes automorphes et décomposition spectrale; Estimation d’une série de Poincaré; Équirépartition des racines de congruences quadratiques et applications; Examen—Bordeaux, Mai 2002; Bibliographie; Index.

Cours Spécialisés—Collection SMF, Number 13

February 2005, 232 pages, Softcover, ISBN 2-85629-161-9,
2000 *Mathematics Subject Classification*: 11N05, 11N35,
11N75, 11L20, 11F72, **Individual member US\$53**, List US\$59,
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R. Gary Parker
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There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: August 2005 issue-May 26, 2005; September 2005 issue-June 27, 2005; October 2005

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U.S. laws prohibit discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the U.S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U.S. laws. Details and specific wording may be found on page 1373 (vol. 44).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940; or via fax: 401-331-3842; or send email to classads@ams.org. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Advertisers will be billed upon publication.

should have outstanding research credentials and a proven commitment to teaching and graduate student direction.

The Department of Mathematics and Statistics includes 47 full-time faculty members, more than 200 undergraduate majors, and 80 master's and Ph.D. students. Faculty have established a successful record of generating funded research and engaging in cooperative research efforts, within the department and with other departments and universities. The successful candidate will be expected to provide leadership in advancing research and academic programs and to enhance the national and international reputation of the department. Exceptional candidates from all areas of mathematics and statistics will be considered.

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Applications, with curriculum vitae and addresses of five references, and nominations should be sent to Lawrence Schovanec, Chair, Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX 79409. For additional information see <http://www.math.ttu.edu/hiring.html>. Texas Tech is an Affirmative Action/Equal Opportunity Employer.

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HONG KONG

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY Department of Mathematics

The Department of Mathematics invites applications for faculty positions at any rank from all areas of mathematics, with preference for pure mathematics.

Exceptionally strong research and teaching experience are required. Applicants must demonstrate excellence in teaching and proven ability to teach effectively in English.

Starting rank and salary will depend on qualifications and experience. Fringe benefits include medical/dental benefits and annual leave; housing will also be provided where applicable. Initial appointment will be on a three-year contract. A gratuity will be payable upon successful completion of the contract.

Applicants should send curriculum vitae and provide the names of at least three referees preferably before December 1, 2005, to the Personnel Office, HKUST, Clear Water Bay, Kowloon, Hong Kong; Fax: (852) 2358 0700. More information about the

university is available on the university's homepage <http://www.ust.hk/>.

(Information provided by applicants will be used for recruitment and other employment-related purposes.)

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PAKISTAN

LAHORE UNIVERSITY OF MANAGEMENT SCIENCES (LUMS) Department of Mathematics

LUMS, a premier institute of higher learning in Pakistan, invites applications for faculty positions at all levels for the Department of Mathematics. The department has recently started a Ph.D. program. Candidates are expected to have demonstrated excellence in both teaching and research after the Ph.D. LUMS is an Equal Opportunity Employer and offers excellent academic environment, as well as growth and development prospects with competitive remuneration package. For more information, visit the university website: <http://www.lums.edu.pk>. Interested candidates should send a letter of application, copy of résumé, research plan, and teaching interests with three names of references to facultyjobs@lums.edu.pk.

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SWITZERLAND

UNIVERSITY OF FRIBOURG Faculty of Science Full Professor in Mathematics

The Faculty of Science of the University of Fribourg (Switzerland) invites applications for a position of a Full Professor in Mathematics at the Department of Mathematics starting from October 1, 2006. We are seeking candidates with an internationally recognized research record in any area of algebra, geometric topology, or mathematical physics and proven ability to direct research of high quality. The candidate should reinforce the existing research groups. Duties of the new professor include teaching of mathematics at undergraduate and graduate level, in particular in algebra and geometry. He or she will also have to teach in French or German (if necessary, after a convenient time of adaptation), to become acquainted with both languages, and to assume administrative duties. Applications with curriculum vitae, a list of publications and a short outline of the current and planned research should be sent by July 31, 2005, to the Dean of the Faculty of Science, University of Fribourg, Perolles, CH-1700 Fribourg, Switzerland. Further information may be obtained from Prof. Ruth Kellerhals (Ruth.Kellerhals@unifr.ch) or at <http://www.unifr.ch/math/OpenPosition>. The Faculty of

Science encourages female candidates to apply.

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UNIVERSITY OF FRIBOURG Faculty of Science Full Professor in Statistics or Probability Theory

The Faculty of Science of the University of Fribourg (Switzerland) invites applications for a position of a Full Professor in Statistics or Probability Theory at the Department of Mathematics starting from March 1, 2006, or at the earliest convenience. We are seeking candidates with an internationally recognized research record in any area of statistics or probability theory and proven ability to direct research of high quality. Duties of the new professor include teaching of mathematics at undergraduate and graduate level, in particular in statistics and probability theory, and the management of the statistical consulting service. He or she will also have to teach in French or German (if necessary, after a convenient time of adaptation), to become acquainted with both languages, and to assume administrative duties. Applications with curriculum vitae, a list of publications, and a short outline of the current and planned research should be sent by July 31, 2005, to the Dean of the Faculty of Science, University of Fribourg, Perolles, CH-1700 Fribourg, Switzerland. Further information may be obtained from Prof. Jean-Paul Berrut (Jean-Paul.Berrut@unifr.ch) or at <http://www.unifr.ch/math/OpenPosition>. The Faculty of Science encourages female candidates to apply.

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UNIVERSITY OF GENEVA Department of Mathematics

The Department of Mathematics invites applications for a position in probability and statistics at the full/associate professor level beginning in or after October 2006. For more information and deadline see <http://www.unige.ch/math/secretariat/postes/>.

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NEW AND NOTEWORTHY FROM CAMBRIDGE

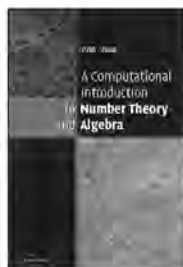
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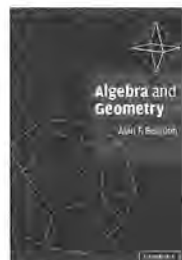
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Monthly Essays on Mathematical Topics

Math in the Media is a new centralized tracker of articles about mathematics that appear in the media. The collection—*Tony Phillips' Take on Math in the Media*; *Math Digest* (summaries of mathematics in the news); and *Reviews* of books, plays, and films with mathematical themes—is a great way to keep abreast of math news as reported in newspapers and general science magazines. The **Feature Column** is a series of essays on various mathematical themes, such as voting, bin-packing, and networks.

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Author: Claus Gerhardt
Bindings: Softcover

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Analysis II
ISBN: 1-57146-154-X
Published: 2005
Page: 404 pp
List Price: \$70

Analysis I & II

Analysis I and II grew out of the author's extensive teaching experience in Analysis at Heidelberg.

- Analysis I is an ideal text for a 1- or 2- semester course for advanced undergraduates or first-year graduate students. Topics for this volume include convergence of sequences and series, topology (continuity, compactness, connectedness), differentiation in one variable, the Arzela–Ascoli and Stone–Weierstraß theorems, analytic functions in several variables, and the Riemann integral.

- Analysis II comprises a 3-4 semester course for advanced undergraduates or graduate students. Topics include functional analysis, differentiation in Banach spaces, the fundamental existence theorems, ordinary differential equations, Lebesgue's theory of integration, tensor analysis, and the theory of submanifolds in semi-Riemannian spaces.



Authors: I. Anshel and D. Goldfeld

Published: 1996
ISBN: 1-57146-038-1
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ISBN: 1-57146-039-X
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Edited By:
C. C. Hsiung
ISBN: 1-57146-046-2
Published: 1997
Page: 357 pp
Binding: Hardcover
List Price: \$45

A First Course in Differential Geometry

This book introduces differential geometry to both beginning graduate students and advanced undergraduate students. In recent years, differential geometry has seen extensive development. In this book we will study only the traditional topics, namely, curves and surfaces in a three-dimensional Euclidean space E^3 . Unlike most classical books on the subject more attention is paid to the relationships between local and global properties, as opposed to local properties only. Although we restrict our attention to curves and surfaces in E^3 , most global theorems for curves and surfaces in this book can be extended to higher dimensional spaces or more general curves and surfaces, or both. Moreover, geometric interpretations are given along with analytic expressions. This will enable students to make use of geometric intuition, a precious tool for studying geometry and related problems.



Authors: D. Bleecker
and G. Csordas
ISBN: 1-57146-036-5
Published: 1996/2003
Page: 750 pp
Binding: Hardcover
List Price: \$70

Basic Partial Differential Equations

For students with three semesters of calculus, this book is self-contained. In particular, Section 1.1 contains a complete treatment of the relevant types of ordinary differential equations. No previous course in ordinary differential equations or linear algebra is necessary.

There are approximately 280 examples worked out in detail, and 600 exercises ranging from routine to challenging. Answers to selected problems appear in the back of the book. Rigorous proofs of nearly all results used are given after ample physical motivation. The book documents extensive applications in physics, including heat conduction, wave propagation, vibrations of strings and drums, and quantum mechanics (including the determination of the bound states of the hydrogen atom). Convenient summaries appear at the end of each section, and theorems and definitions are clearly off-set in boxes.



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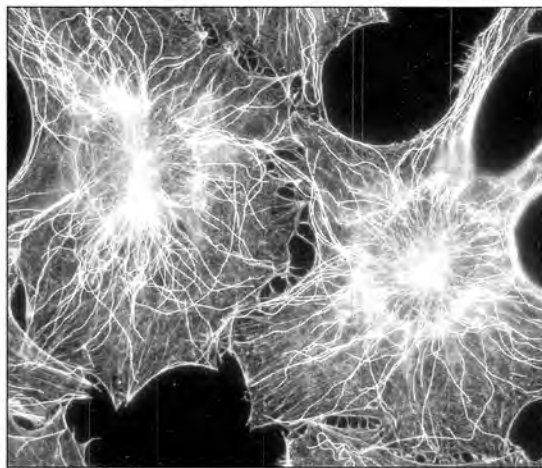


Image: Fluorescence-activated cell sorting (FACS) analysis of cells. Courtesy of Nikon Small World.



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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.

Mainz, Germany

June 16–19, 2005

Thursday – Sunday

Meeting #1008

Joint International Meeting with the Deutsche Mathematiker-Vereinigung (DMV) and the Oesterreichische Mathematische Gesellschaft (OMG)

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: February 2005

Program first available on AMS website: 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:
Expired

For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/internmtgs.html.

Invited Addresses

Hélène Esnault, University of Essen, *Deligne's integrality theorem in unequal characteristic and rational points over finite fields*.

Richard Hamilton, Columbia University, *The Ricci flow*.

Michael J. Hopkins, Massachusetts Institute of Technology, *Solving algebraic equations, up to homotopy*.

Christian Krattenthaler, University of Lyon-I, *Exact and asymptotic enumeration of vicious walkers with a wall interaction*.

Frank Natterer, University of Muenster, *Imaging and inverse problems for partial differential equations*.

Hong-Tzer Yau, New York University and Stanford University, *Dynamics of Bose-Einstein condensates*.

Special Sessions

Affine Algebraic Geometry, **Shreeram Abhyankar**, Purdue University, **Hubert Flenner**, Ruhr University Bochum, and **Makar Limanov**, Wayne State University.

Algebraic Combinatorics, **Patricia Hersh**, Indiana University-Bloomington, **Christian Krattenthaler**, University of Lyon-I, and **Volkmar Welker**, Philipps University Marburg.

Algebraic Cryptography, **Dorian Goldfeld**, Columbia University, **Martin Kreuzer** and **Gerhard Rosenberger**, Universität Dortmund, and **Vladimir Shpilrain**, The City College of New York.

Algebraic Cycles, **Eric Friedlander** and **Marc Levine**, Northwestern University, and **Fabien Morel**, Université Paris.

Algebraic Geometry, **Yuri Tschinkel**, Georg-August-Universität Göttingen, and **Brendan E. Hassett**, Rice University.

Dirac Operators, Clifford Analysis and Applications, **Klaus Gürlebeck**, University of Weimar, **Mircea Martin**, Baker University, **John Ryan**, University of Arkansas, and **Michael Shapiro**, IPN Mexico.

Discrete Geometry, **Jacob Eli Goodman**, The City College of New York (CUNY), **Emo Welzl**, Eidgen Technische Hochschule, and **Gunter M. Ziegler**, Technical University of Berlin.

Function Spaces and Their Operators, **Ernst Albrecht**, Universität des Saarlandes, **Raymond Mortini**, Université de Metz, and **William Ross**, University of Richmond.

Functional Analytic and Complex Analytic Methods in Linear Partial Differential Equations, **R. Meise**, University of Dusseldorf, **B. A. Taylor**, University of Michigan, and **Dietmar Vogt**, University of Wuppertal.

Geometric Analysis, **Victor Nistor**, Pennsylvania State University, and **Elamr Schrohe**, Universität Hannover.

Geometric Topology and Group Theory, **Cameron McA Gordon**, The University of Texas at Austin, **Cynthia Hog-Angeloni**, Johann Wolfgang Goethe-Universität, and **Wolfgang Metzler**, University of Frankfurt.

Group Theory, **Luise-Charlotte Kappe**, SUNY at Binghamton, **Robert Fitzgerald Morse**, University of Evansville, and **Gerhard Rosenberger**, University of Dortmund.

Hilbert Functions and Syzygies, **Uwe Nagel**, University of Kentucky, **Irena Peeva**, Cornell University, and **Tim Römer**, Universität Osnabrück.

History of Mathematics (including a special workshop on Mathematics and War), **Thomas W. Archibald**, Acadia University, **John H. McCleary**, Vassar College, **Moritz Eppler**, University of Stuttgart, and **Norbert Schappacher**, Technische Universität Darmstadt.

Homotopy Theory, **Paul G. Goerss**, Northwestern University, **Hans-Werner Henn**, Institut de Recherche Mathématique Avancée, Strasbourg, and **Stefan Schwede**, Universität Bonn.

Hopf Algebras and Quantum Groups, **M. Susan Montgomery**, University of Southern California, and **Hans-Jurgen Schneider**, University of Munich.

Mathematical Physics, **Laszlo Erdős**, Mathematisches Institut der Albert Ludwigs Universität, and **Michael P. Loss**, Georgia Institute of Technology.

Mathematics Education, **Gunter Torner**, Universität Duisburg-Essen, and **Alan Schoenfeld**, School of Education, Berkeley.

Modules and Comodules, **Sergio López-Permouth**, Ohio University, and **Robert Wisbauer**, University of Düsseldorf.

Multiplicative Arithmetic of Integral Domains and Monoids, **Scott Chapman**, Trinity University, San Antonio, **Franz Halter-Koch**, University of Graz, and **Ulrich Krause**, Universität Bremen.

Nonlinear Elliptic Boundary Value Problems, **Thomas Bartsch**, Universität Giessen, and **Zhi-Qiang Wang**, Utah State University.

Nonlinear Waves, **Herbert Koch**, University of Dortmund, and **Daniel I. Tataru**, University of California Berkeley.

Ordinary Differential, Difference, and Dynamic Equations, **Werner Balser**, Universität Ulm, **Martin Bohner**, University of Missouri-Rolla, and **Donald Lutz**, San Diego State University.

Quantum Knot Invariants, **Anna Beliakova**, Universität Zürich, and **Uwe Kaiser**, Boise State University.

Representations and Cohomology of Groups and Algebras, **Dave Benson**, University of Georgia, and **Henning Krause**, Universität Paderborn.

Set Theory, **Joel Hamkins**, City University New York, **Peter Koepke**, Universität Bonn, and **Benedikt Löwe**, Universiteit van Amsterdam.

Spectral Analysis of Differential and Difference Operators, **Evgeni Korotyaev**, Humboldt-University Berlin, **Boris Mityagin**, The Ohio State University, and **Gerald Teschl**, University of Vienna.

Stochastic Analysis on Metric Spaces, **Laurent Saloff-Coste**, Cornell University, **Karl-Theodor Sturm**, University of Bonn, and **Wolfgang Woess**, Graz Technical University.

Topics in Applied Mathematics: Algebraic Approaches to Preconditioning, **Heike Fassbender**, Technical University of Braunschweig, and **Andreas Frommer**, University of Wuppertal.

Topics in Applied Mathematics: Control Theory, **Peter Benner**, Technical University of Chemnitz.

Topics in Applied Mathematics: Mathematical Problems of Mechanics, **Friedrich Pfeiffer** and **Jurgen K. Scheurle**, Technical University of Munich.

Topics in Applied Mathematics: Multiscale Problems, Oscillations in Partial Differential Equations, and Homogenization, **Alexander Mielke**, University of Hannover.

Topics in Applied Mathematics: Numerical Partial Differential Equations/Equations with Inherent Conditions, **Rolf Jeltsch**, Eidgen Technische Hochschule, **Maria Lukacova-Medvidova**, Technical University of Hamburg, and **J. Mac Hyman**, Los Alamos National Laboratory.

Topology of Manifolds, **Matthias Kreck**, University of Heidelberg, and **Andrew Ranicki**, University of Edinburgh.

Annandale-on-Hudson, New York

Bard College

October 8–9, 2005

Saturday – Sunday

Meeting #1009

Eastern Section

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: August 2005

Program first available on AMS website: August 25, 2005

Program issue of electronic *Notices*: October 2005

Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
June 21, 2005

For abstracts: August 16, 2005

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Persi Diaconis, Stanford University, *Erdős picture of "most things"* (Erdős Memorial Lecture).

Harold Rosenberg, University of Paris VII, *Minimal and constant mean curvature surfaces in homogeneous 3-manifolds*.

Alice Silverberg, University of California Irvine, *Applying number theory and algebraic geometry to cryptography*.

Christopher Sogge, Johns Hopkins University, *Estimates for eigenfunctions of the Laplacian*.

Benjamin Sudakov, Princeton University, *Probabilistic reasoning and Ramsey theory*.

Special Sessions

Algebraic and Geometric Combinatorics (Code: SS 12A), **Cristian P. Lenart**, State University of New York at Albany, and **Lauren L. Rose** and **Sheila Sundaram**, Bard College.

Extremal and Probabilistic Combinatorics (Code: SS 11A), **Benjamin Sudakov**, Princeton University.

Geometric Group Theory (Code: SS 1A), **Sean Cleary**, The City College of New York, and **Melanie I. Stein**, Trinity College.

Geometric Transversal Theory (Code: SS 3A), **Richard Pollack**, Courant Institute, New York University, and **Jacob Eli Goodman**, The City College of New York.

Global Theory of Minimal Surfaces (Code: SS 6A), **David A. Hoffman**, Mathematical Sciences Research Institute, and **Harold Rosenberg**, University of Paris VII.

History of Mathematics (Code: SS 2A), **Patricia R. Allaire**, Queensborough Community College, CUNY, **Robert E. Bradley**, Adelphi University, and **Jeff Suzuki**, Bard College.

Homological Aspects of Commutative Algebra (Code: SS 4A), **Alexandre Tchernev**, University of Albany, SUNY, and **Janet Vassilev**, University of Arkansas.

Infinite Groups (Code: SS 10A), **Anthony M. Gaglione**, United States Naval Academy, **Benjamin Fine**, Fairfield University, and **Dennis Spellman**, Philadelphia University.

Invariants of Graphs and Matroids (Code: SS 8A), **Gary Gordon** and **Lorenzo Traldi**, Lafayette College.

Mathematical Methods for the Analysis of Images and High-Dimensional Data (Code: SS 13A), **Erik M. Bollt**, Clarkson University, and **Rick Chartrand**, Los Alamos National Laboratory.

Measurable, Symbolic, and Tiling Dynamical Systems (Code: SS 9A), **Natalie Preibe Frank**, Vassar College, and **Samuel J. Lightwood**, Western Connecticut State University.

Special Functions and Orthogonal Polynomials: Theory and Applications (Code: SS 7A), **Diego Dominici**, State University of New York at New Paltz.

Theory of Infinite-Dimensional Lie Algebras, Vertex Operator Algebras, and Related Topics (Code: SS 5A), **Antun Milas**,

SUNY at Albany, **Alex J. Feingold**, Binghamton University, and **Yi-Zhi Huang**, Rutgers University.

Johnson City, Tennessee

East Tennessee State University

October 15–16, 2005

Saturday – Sunday

Meeting #1010

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: August 2005

Program first available on AMS website: September 1, 2005

Program issue of electronic *Notices*: October 2005

Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
June 28, 2005

For abstracts: August 23, 2005

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Alberto Bressan, Pennsylvania State University, *Optimal transportation metrics and nonlinear wave equations*.

Assaf Naor, Microsoft Research, *The b -Lipschitz theory of metric spaces: A survey of recent progress and algorithmic applications*.

Prasad V. Tetali, Georgia Institute of Technology, *Title to be announced*.

Rekha R. Thomas, University of Washington, *Groebner bases: From theory to applications and back*.

Special Sessions

Approximation Theory (Code: SS 5A), **Robert Gardner**, East Tennessee State University, and **Narendra Kumar Govil**, Auburn University.

Commutative Ring Theory (Code: SS 1A), **David F. Anderson** and **David E. Dobbs**, University of Tennessee at Knoxville.

Discrete Models in Biology (Code: SS 7A), **Debra Knisley**, East Tennessee State University, and **Michael A. Langston**, University of Tennessee, Knoxville.

Geometry and Algorithms in Metric Spaces (Code: SS 8A), **W. J. Bo Brinkman** and **Beata Randrianantoanina**, Miami University.

Mathematical Applications in Survival Analysis and Biostatistics (Code: SS 6A), **Don Hong** and **Tiejian Wu**, East Tennessee State University.

Mathematical Aspects of Wave Propagation Phenomena (Code: SS 2A), **Boris P. Belinskiy**, University of Tennessee at Chattanooga, and **Anjan Biswas**, Tennessee State University.

Mathematical Education of Teachers (Code: SS 3A), **Frederick Norwood** and **Michel Helfgott**, East Tennessee State University.

Nonlinear PDE Evolutionary Systems and Their Control (Code: SS 9A), **George Avalos**, University of Nebraska-Lincoln, and **Irena M. Lasiecka**, University of Virginia.

Nonlinear Wave Equations and Applications (Code: SS 4A), **Alberto Bressan** and **Yuxi Zheng**, Pennsylvania State University.

Lincoln, Nebraska

University of Nebraska in Lincoln

October 21–23, 2005

Friday – Sunday

Meeting #1011

Central Section

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: August 2005

Program first available on AMS website: September 8, 2005

Program issue of electronic *Notices*: October 2005

Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
July 5, 2005

For abstracts: August 30, 2005

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgsectional.html.

Invited Addresses

Howard A. Masur, University of Illinois at Chicago, *Billiards in polygons: Connections of geometry and complex analysis to dynamical systems*.

Alejandro Uribe, University of Michigan, *Title to be announced*.

Judy Walker, University of Nebraska, *Title to be announced*.

Jack Xin, University of Texas, *Title to be announced*.

Special Sessions

Algebraic Geometry (Code: SS 1A), **Brian Harbourne**, University of Nebraska-Lincoln, and **Bangere P. Purnaprajna**, University of Kansas.

Analysis of Partial Differential and Integral Equations (Code: SS 18A), **Congming Li**, University of Colorado.

Association Schemes and Related Topics (Code: SS 22A), **Sung Yell Song**, Iowa State University, and **Paul M. Terwilliger**, University of Wisconsin.

Calculus of Variations (Code: SS 17A), **Mikil Foss**, University of Nebraska-Lincoln, and **Giovanni Leoni**, Carnegie Mellon University.

Combinatorial Matrix Theory (Code: SS 10A), **Leslie Hogben**, Iowa State University, and **Bryan L. Shader**, University of Wyoming.

Commutative Algebra (Code: SS 14A), **Lars Winther Christensen**, **Srikanth B. Iyengar**, and **Sean M. Sather-Wagstaff**, University of Nebraska-Lincoln.

Dynamic Equations on Time Scales (Code: SS 5A), **Lynn H. Erbe** and **Allan C. Peterson**, University of Nebraska-Lincoln.

Geometric Methods in Group Theory and Semigroup Theory (Code: SS 6A), **Susan M. Hermiller** and **John C. Meakin**, University of Nebraska-Lincoln, and **Zoran Sunik**, Texas A&M University.

Geometry of Differential Equations (Code: SS 11A), **Jeanne Nielsen Clelland**, University of Colorado, **Irina A. Kogan**, North Carolina State University, and **Zhijun Qiao**, University of Texas-Pan American.

Graph Theory (Code: SS 8A), **Andrew J. Radcliffe**, University of Nebraska-Lincoln, **Zsuzsanna Szaniszló**, Valparaíso University, and **Jonathan Cutler**, University of Nebraska-Lincoln.

K-Theory and Algebraic Cycles (Code: SS 16A), **Christian Haesemeyer**, University of Illinois at Urbana-Champaign, and **Gregory Grant Piepmeyer** and **Mark Edward Walker**, University of Nebraska-Lincoln.

Large Cardinals in Set Theory (Code: SS 4A), **Paul B. Larson**, Miami University, **Justin Tatch Moore**, Boise State University, and **Ernest Schimmerling**, Carnegie Mellon University.

Mathematical and Engineering Aspects of Coding Theory (Code: SS 3A), **Lance Perez** and **Judy Walker**, University of Nebraska-Lincoln.

Mathematical Ecology (Code: SS 9A), **David Logan**, University of Nebraska-Lincoln, and **William Robert Wolessensky**, College of St. Mary.

Mathematical Education of Teachers (Code: SS 15A), **W. James Lewis**, University of Nebraska-Lincoln, **Cheryl Lynn Olsen**, Shippensburg University of Pennsylvania, and **Ira J. Papick**, University of Missouri-Columbia.

Mathematical and Engineering Aspects of Coding Theory (Code: SS 13A), **Lance Perez**, University of Nebraska-Lincoln, **Judy Walker**, University of Nebraska-Lincoln.

Nonlinear Analysis and Control of Partial Differential Equations (Code: SS 13A), **George Avalos**, **Petronela Radu**, **Mohammad A. Rammaha**, and **Richard L. Rebarber**, University of Nebraska-Lincoln.

Randomness in Computation (Code: SS 7A), **John M. Hitchcock**, University of Wyoming, **Aduri Pavan**, Iowa State University, and **Vinodchandran Variyam**, University of Nebraska-Lincoln.

Recent Progress in Operator Algebras (Code: SS 2A), **Allan P. Donsig** and **David R. Pitts**, University of Nebraska-Lincoln.

Representation Theory of Noetherian Rings (Code: SS 12A), **Roger A. Wiegand** and **Sylvia Margaret Wiegand**, University of Nebraska-Lincoln.

Scattering and Spectral Problems in Geometry (Code: SS 21A), **Peter A. Perry**, University of Kentucky, and **Alejandro Uribe**, University of Michigan.

Undergraduate Research (Code: SS 19A), **Richard L. Rebarber** and **Gordon S. Woodward**, University of Nebraska-Lincoln.

Universal Algebra and Order (Code: SS 20A), **John William Snow**, Sam Houston State University, and **Japheth L. M. Wood**, Chatham College.

Eugene, Oregon

University of Oregon

November 12–13, 2005

Saturday – Sunday

Meeting #1012

Western Section

Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: September 2005

Program first available on AMS website: September 29, 2005

Program issue of electronic *Notices*: November 2005

Issue of *Abstracts*: Volume 26, Issue 4

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
July 26, 2005

For abstracts: September 20, 2005

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgsectional.html.

Invited Addresses

Matthew Foreman, University of California Irvine, *Title to be announced.*

Mark Haiman, University of California Berkeley, *Title to be announced.*

Wilhelm Schlag, California Institute of Technology, *Title to be announced.*

Hart H. Smith, University of Washington, *Title to be announced.*

Special Sessions

Algebraic Combinatorics and Geometry (Code: SS 7A), **Sara C. Billey**, University of Washington, and **Mark Haiman**, University of California Berkeley.

Algebraic Geometry Motivated by Physics (Code: SS 9A), **Alexander Polishchuk** and **Arkady Vaintrob**, University of Oregon.

Algebraic Topology of Moduli Spaces (Code: SS 8A), **Boris I. Botvinnik**, University of Oregon, **Uwe Kaiser**, Boise State University, and **Dev Sinha**, University of Oregon.

Applications of Algebraic Topology (Code: SS 12A), **Daniel Dugger** and **Hal Sadofsky**, University of Oregon.

K-Theory in M-Theory (Code: SS 6A), **Gregory D. Landweber**, University of Oregon, and **Charles F. Doran**, University of Washington.

New Directions in Spectral Theory and Geometric Analysis (Code: SS 11A), **Leon Friedlander**, University of Arizona, and **Patrick McDonald**, New College of Florida.

Noncommutative Algebra and Noncommutative Birational Geometry (Code: SS 3A), **Arkady Dmitrievich Berenstein**, University of Oregon, and **Vladimir Retakh**, Rutgers University.

Partial Differential Equations with Applications (Code: SS 4A), **Alexander Panchenko**, Washington State University, **R. E. Showalter**, Oregon State University, and **Hong-Ming Yin**, Washington State University.

Regular Algebras and Noncommutative Projective Geometry (Code: SS 2A), **Brad Shelton**, University of Oregon, **Michaela Vanclicff**, University of Texas at Arlington, and **James J. Zhang**, University of Washington.

Representations of Groups and Algebras (Code: SS 5A), **Jonathan W. Brundan**, **Alexander S. Kleshchev**, and **Viktor Ostrik**, University of Oregon.

Resolutions (Code: SS 1A), **Christopher Alan Francisco**, University of Missouri, and **Irena Peeva**, Cornell University.

Wavelets, Frames, and Related Expansions (Code: SS 10A), **Marcin Bownik**, University of Oregon, and **Darrin M. Speegle**, St. Louis University.

Taichung, Taiwan

Tung-Hai University

December 14–18, 2005

Wednesday – Sunday

Meeting #1013

First Joint International Meeting between the AMS and the Taiwanese Mathematical Society.

Associate secretary: John L. Bryant

Announcement issue of *Notices*: June 2005

Program first available on AMS website: Not applicable

Program issue of electronic *Notices*: Not applicable

Issue of *Abstracts*: Not applicable

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

Watch the Official Website maintained by the local organizers at www.math.thu.edu.tw/2005ims/en/index.htm for additional program details and links to sites for hotels, tours, and other local information.

Organizers interested in proposing a Special Session should send the session name, subtopics, organizers, invited speakers, and any other relevant details to tms@math.ntu.edu.tw no later than June 30. The themes of newly proposed sessions should not overlap any sessions already approved.

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtg/internmtgs.html.

Invited Addresses

Ching-Shui Cheng, Institute of Statistical Science, Academia Sinica, *Title to be announced.*

Lawrence Ein, University of Illinois at Chicago, *Title to be announced.*

Chang-Shou Lin, National Chung Cheng University, *Title to be announced.*

Richard M. Schoen, Stanford University, *Title to be announced.*

Jing Yu, National Tsing Hua University, *Title to be announced.*

Jiu-Kang Yu, Purdue University, *Title to be announced.*

Special Sessions

Affine Algebraic Geometry, **Ming-Chang Kang**, National Taiwan University, and **Kwai-Man Fan**, National Chung Cheng University.

Algebraic Geometry, **Jung-Kai Chen**, National Taiwan University, **Chin-Lung Wang**, National Central University, and **Robert Lazarsfeld**, University of Michigan.

Differential Geometry, **Dong-Ho Tsai**, National Tsing Hua University, and **Bennett Chow**, University of California San Diego.

Discrete Mathematics (Graph Coloring), **Gerard J. Chang**, National Taiwan University, **Douglas B. West**, University of Illinois at Urbana-Champaign, and **Xuding Zhu**, National Sun Yat-sen University.

Dynamics and Differential Equations, **Song-Sun Lin**, National Chiao Tung University, and **Shui-Nee Chow**, Georgia Institute of Technology.

Lie Algebra and Representation Theory, **Shun-Jen Cheng**, National Taiwan University, and **Brian J. Parshall** and **Weiqliang Wang**, University of Virginia.

Number Theory (Arithmetic Geometry over Local and Global Fields), **Liang-Chung Hsia**, National Central University, and **William A. Cherry**, University of North Texas.

Operator Theory and Control, **Fang-Bo Yeh**, Tung-Hai University, and **Nicholas J. Young**, University of Newcastle.

Optimization and Applications, **Soon-Yi Wu**, National Cheng Kung University, and **Shu-Cherng Fang**, Industrial

Engineering and Operations Research, North Carolina State University.

Partial Differential Equations and Geometric Analysis, **Chiun-Chuan Chen** and **Yng-Ing Lee**, National Taiwan University, **Sun-Yung Alice Chang**, Princeton University, and **Robert J. Sibner**, Graduate College, City University of New York.

Probability, **Tai-Ho Wang**, National Chung Cheng University, **Ching-Tang Wu**, National Kaohsiung University, and **George Yin**, Wayne State University.

Scientific Computing, **Wei-Cheng Wang**, National Tsing-Hua University, and **Thomas Y. Hou**, California Institute of Technology.

Statistical Modeling and Applications, **Ming-Yen Cheng**, National Taiwan University, and **Jianqing Fan**, Princeton University.

Contributed Papers

There will be a session for contributed papers. The submission deadline is September 14, 2005; you will receive a reply regarding the acceptance of your abstract no later than November 1. Details will be provided under the "Submission of abstracts" section of the official conference website by the end of June.

Abstracts

Abstract submission procedures will be published on the official conference website by the end of June.

Accommodations

Hotel reservation procedures will be published on the official conference website by the end of June.

Restaurants/Food Service

A box lunch will be provided daily to all registered participants. On campus there are two dormitory cafeterias, a coffee shop, a food mall, and a restaurant. Details can be found at http://www.thu.edu.tw/english/swf/map_english/map_new.swf. There are also many restaurants and food stands within a 15-minute walking distance from campus.

Registration and Meeting Information

The meeting will take place at Tunghai University, 181 Taichung Harbor Road, Section 3 Taichung 40704, Taiwan. For more information about the campus see www.thu.edu.tw/english/enindex.htm.

Registration, plenary addresses, and Special Sessions will be held in the Humanities Building (floors B1, 1F, and 2F); see the floor plans at <http://www.math.thu.edu.tw/2005ims/place.htm>.

Registration fees paid by September 30 are US\$80/members, US\$100/nonmembers, and US\$20/students payable by credit card through the official website. Registration fees after September 30 are US\$100/members, US\$120/nonmembers, and US\$20/students. On-site registration fees

are NT3300, payable in Taiwan dollars only. As of 4/29/05, US\$1=NT31.450

Social Events

Tickets must be reserved in advance for these events.

All registered participants are invited to a Welcome Banquet on the evening of December 15 at the Howard Prince Hotel. There is no extra charge for registered participants. Guest tickets are US\$20.

A tour to Chitou Forest Recreational Area has been arranged especially for conference participants for the afternoon of December 16. See www.math.thu.edu.tw/2005ims/en/Chitou.htm. Giant trees, green bamboo, winding trails, chirping birds, croaking frogs, fog-enshrouded scenery, and fresh air characterize the Chitou Forest Recreation Area. Take a walk in the woods, relax in the tranquility, and recharge your mind. Scenic overlooks and abundant plant and bird life are hallmarks of this pleasant area. Don't miss the architecturally unique bamboo cottage located in the quiet Mong-Tsung bamboo forest. Also visit the Bamboo House, where the house and all the furnishings are made from this wonderfully versatile plant. The cost for the tour is US\$10 or NT300.

Travel and Maps

An excellent site for general information about traveling to Taiwan and the many wonderful things the country has to offer is found at <http://www.taiwan.net.tw/lan/cht/index/index.asp>.

The conference will be held at Taichung which is about 100 miles from Chiang Kai-Shek International Airport (<http://www1.cksairport.gov.tw/english/>). Participants are advised to use CKS airport. Airport taxis charge according to the meter plus a 50 percent surcharge (highway tolls not included), and provide transport to anywhere in Taiwan. Typical fare to Taichung is around NT\$3,200. Air-conditioned limousine buses (with space for luggage) leave for Taichung City every thirty minutes. The cost is around NT\$250 and the trip takes about two hours. It is suggested that you take a taxi to the hotels after getting off the bus at Chaoma station. The cost for a taxi from the station will be about NT\$150. Refer to <http://www.cksairport.gov.tw/english/transportation/taichung.htm> for further information.

Participants holding passports from these countries do not need to apply for a visa (see www.boca.gov.tw/~boca2000/en/exempte.htm for additional rules as well as procedures for some other countries): Australia, Austria, Belgium, Brunei Darussalam, Canada, Costa Rica, Denmark, Finland, France, Germany, Greece, Ireland, Iceland, Italy, Japan, Republic of Korea, Liechtenstein, Luxembourg, Malaysia, Malta, Monaco, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, U.K. and U.S.A.

For other foreign participants see the regulations and frequently asked questions from the Bureau of Consular Affairs at <http://www.boca.gov.tw/english/index.htm>. Here you will also find a visa application form

to download. Applications must be sent for processing to a ROC Embassy/Mission; a list is available through the bureau website.

Watch the official webpage of this conference cited in the first paragraph of this announcement for further details and up-to-date information.

San Antonio, Texas

Henry B. Gonzalez Convention Center

January 12–15, 2006

Thursday – Sunday

Meeting #1014

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), the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Matthew Miller

Announcement issue of *Notices*: October 2005

Program first available on AMS website: November 1, 2005

Program issue of electronic *Notices*: January 2006

Issue of *Abstracts*: Volume 27, Issue 1

Deadlines

For organizers: Expired

For consideration of contributed papers in Special Sessions:
August 3, 2005

For abstracts: September 28, 2005

AMS Invited Addresses

Herbert Edelsbrunner, Duke University, *Title to be announced.*

David Eisenbud, Mathematical Sciences Research Institute, *Title to be announced* (Retiring Presidential Address).

Charles L. Fefferman, Princeton University, *Title to be announced.*

Mikhail Kapranov, Yale University, *Title to be announced.*

Hendrik W. Lenstra Jr., Universiteit Leiden, *Title to be announced* (Colloquium Lectures).

Dusa McDuff, SUNY at Stony Brook, *Title to be announced.*

MAA Invited Addresses

Keith J. Devlin, Center for the Study of Language and Information, Stanford University, *Title to be announced.*

Naomi Fisher, University of Illinois at Chicago, *Title to be announced* (Retiring Presidential Address).

Robert E. Megginson, University of Michigan, Ann Arbor, *Title to be announced.*

Francis Edward Su, Harvey Mudd College, *Title to be announced.*

Call for MAA Contributed Papers

The MAA Committee on Contributed Paper Sessions solicits contributed papers pertinent to the sessions listed below. Contributed paper session organizers generally limit presentations to ten or fifteen minutes. Each session room contains an overhead projector and screen; blackboards will not be available. Speakers needing additional audio-visual equipment should contact, as soon as possible but prior to September 28, 2005, the session organizer whose name is followed by an asterisk (*). Organizers have been advised that the majority of speakers in a session must require the use of additional audio-visual equipment in order to justify the expenditure. Please note that the dates and times scheduled for these sessions remain tentative.

Philosophy of Mathematics (MAA CP A1), Thursday morning; **Roger Simons***, Rhode Island College (rsimons@ric.edu), and **Satish C. Bhatnagar**, University of Nevada. This session, sponsored by the SIGMAA for the Philosophy of Mathematics, 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, and the role of esthetics in the development of mathematics.

Mathlets for Teaching and Learning Mathematics (MAA CP B1), Thursday and Friday mornings; **David Strong***, Pepperdine University (david.strong@pepperdine.edu); **Thomas Leathrum**, Jacksonville State University; and **Joe Yanik**, Emporia State University. This session seeks to provide a forum in which presenters may demonstrate mathlets and related materials that they have created or further developed. Mathlets are small computer-based (but ideally platform-independent) interactive tools for teaching math, frequently developed as World Wide Web materials such as scripts or Java applets, but there may be many other innovative variations. Mathlets allow students to experiment with and visualize a variety of mathematical concepts, and they can be easily shared by mathematics instructors around the world.

Post-secondary Mathematics Assessment: Needs and Challenges (MAA CP C1), Thursday morning; **Gloria Dion***, Educational Testing Service (gdion@ets.org); **Daryl Ezzo**, Educational Testing Service; and **Luis Saldivia**, Educational Testing Service. We invite the submission of papers related to the mathematics assessment of college students. Topics of interest for this session include admissions testing, placement or proficiency testing, course assessments, outcomes testing, and exit exams. We are especially interested in innovative programs and experiences with integrating technology into assessment; performance or portfolio assessments; the uses and impact of national tests; assessing students with disabilities; placement testing for incoming students whose high school experience is in a standards-based curriculum; outcomes testing at critical junctures, e.g., following developmental courses; diagnostic and formative assessments; and other new

directions in assessment or research related to the mathematics assessment of college students.

Professional Development Programs for K-12 Teachers (MAA CP D1), Thursday morning; **Zsuzsanna Szaniszló***, Valparaiso University (zsuzsanna.szaniszl@valpo.edu); **Laurie Burton**, Western Oregon University; **Judith Covington**, LSU Shreveport; and **Patricia Hale**, California State Polytechnic University, Pomona. The mathematical community has long recognized the importance of teacher education. PMET (Preparing Mathematicians to Educate Teachers) is a prime example of projects that aim to help college mathematics faculty to train teachers. The next step in this endeavor is to include mathematicians in the professional development of in-service K-12 teachers. All over the country many small- and large-scale projects exist to provide a mutually beneficial opportunity for mathematicians to work with K-12 mathematics teachers. The directors of these projects will share their experiences developing and implementing the projects, including both mathematical and organizational issues. The session invites talks that showcase successful in-service training programs for K-12 mathematics teachers that utilize college and university mathematics faculty. The talks should reflect on every aspect of the program and include a description of the experiences of mathematicians. Programs that are easily replicable will be given priority. The submissions should include the grade levels of the participating teachers.

Number-Theoretic Applications (MAA CP E1), Thursday afternoon; **Thomas Koshy***, Framingham State College (tkoshy@frc.mass.edu), and **Thomas Moore**, Bridgewater State College. The advent of modern technology has brought a new dimension to the beauty and power of number theory. Once considered the purest of pure mathematics, it is increasingly used in the rapid development of technology in a number of areas. The various fascinating applications have confirmed that human ingenuity and creativity are boundless. Relevant and thought-provoking applications establish a strong and meaningful bridge between number theory and a number of other areas. Historical anecdotes, woven throughout a number theory course, give a meaningful, historical perspective to the development of the subject. They add a human face and touch on the development of the subject, and should provide a meaningful context for prospective and in-service teachers in mathematics. Attendees of the session should be able to take these anecdotes to their own classes to excite their students and share their enthusiasm with others. This contributed paper session focuses on interesting applications of and historical anecdotes in number theory and on the relevance of computers in the study of number theory. It is primarily aimed at number theory enthusiasts who enjoy teaching number theory for mathematics majors and in-service and preservice teachers.

Teaching Mathematics Courses Online (MAA CP F1), Thursday afternoon; **Kate McGivney***, Shippensburg University (kgmcki@ship.edu), and **Cheryl Olsen**, Shippensburg University. In recent years there has been an increasing trend for undergraduate institutions to offer

mathematics courses online. This session will focus both on presenting successful strategies for teaching such courses as well as describing shortcomings in delivering mathematics online. Consideration will be given to courses where at least fifty proposals that address issues including, but not limited to, designing effective means of communication between students and the instructor, managing group projects and assignments, incorporating various technologies into the course, and implementing successful assessment strategies are welcome. Papers that address how to design an online course that meets the same course goals as a traditionally taught course are of particular interest. Finally, data based on student experiences from learning in an online environment are welcome.

Teaching and Assessing Modeling and Problem Solving (MAA CP G1), Thursday afternoon; **Mike Huber***, United States Military Academy (michael.huber@usma.edu), and **Alex Heidenberg**, United States Military Academy. Developing problem-solving skills in the modeling sense is a central component in refocusing courses to emphasize process, conceptual understanding, and student growth. Universities and colleges are now writing institutional goals that address the capabilities of their graduates. How do we measure success in teaching our students to be effective problem solvers? This session invites presentations about courses that focus on the process of problem solving as a vehicle to learning mathematics at the precalculus/introductory calculus levels, with special emphasis on modeling. Of particular value will be presentations that offer assessment techniques in problem-solving courses. These presentations can include course philosophy, midterm examinations, attitude surveys, past projects, and other successful methods of assessment where students have become competent and confident problem solvers. Each presentation should address the specific goals in developing problem solvers as well as the assessment techniques used to measure attainment of those goals.

Getting Students to Discuss and to Write about Mathematics (MAA CP H1), Thursday and Friday afternoons; **Martha Ellen Murphy Waggoner***, Simpson College (waggoner@simpson.edu); **Charlotte Knotts-Zides**, Wofford College; and **Harrison W. Straley**, Wheaton College. 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/or 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.

Using History of Mathematics in Your Mathematics Courses (MAA CP I1), Friday morning; **Richard Jardine***, Keene State College (rjardine@keene.edu), and **Amy Shell-Gellasch**, Granfenwoer, Germany. This session solicits talks that describe ways to use or embed the history of mathematics in the collegiate mathematics curriculum. Talks should discuss ways to use history to enhance the teaching of mathematical subjects as opposed to ways to teach history of mathematics courses.

Innovative Teaching/Learning Ideas Using Technology in the Teaching of Courses before College Algebra (MAA CP J1), Friday morning; **Ed Laughbaum***, The Ohio State University (elaughba@math.ohio-state.edu), and **Mohammad H. Ahmadi**, University of Wisconsin-Whitewater. In this session we are looking for creative ideas that demonstrate how faculty are using handheld graphing or computer technology to enhance teaching and learning in remedial/developmental algebra courses. Examples might involve graphing calculator apps, the use of function as a central theme, teaching techniques that promote understanding, portable e-lessons, electronic class polling as formative assessment, etc.

Research and Other Mathematical Experiences for Students outside the Classroom (MAA CP K1), Friday morning; **Kay Somers***, Moravian College, (mekbs01@moravian.edu); **Susan Morey**, Texas State University; **Sivaram K. Narayan**, Central Michigan University; and **Jody Sorensen**, Grand Valley State University. Mathematics "happens" both inside and outside the classroom, and in fact many mathematics majors are drawn to the subject through a special event sponsored by a student chapter or math club or through special research projects and programs. This session seeks presentations by academic, industrial, business, and/or student mathematicians so that the audience will be encouraged to organize and run special events for their students. Descriptions of activities could include, but are not limited to, special lectures, workshops for students, math days/fairs, student conferences, recreational mathematics activities, problem-solving activities and contests, general community-building activities, and student consulting projects. We especially encourage information about student research projects and programs, including program logistics and project ideas. Information on how such activities are organized and carried out, what activities especially grab students' interests, how students are contacted and encouraged to participate, and how the events are funded will be especially helpful. This session is organized by the MAA Committee on Undergraduate Student Activities and Chapters and by the CUPM Subcommittee on Undergraduate Research.

Courses below Calculus: A Continuing Focus (MAA CP L1), Friday and Saturday mornings; **Mary Robinson***, University of New Mexico-Valencia Campus (maryrobn@unm.edu); **Florence S. Gordon**, New York Institute of Technology; **Laurette Foster**, Prairie View A&M University; **Arlene Kleinstein**, Farmingdale State University of New York; **Norma Agras**, Miami Dade Community College; and **Linda Martin**, Albuquerque T-VI. The MAA, AMATYC, and NCTM have been working together on a national initiative to refocus the courses below calculus to better serve the

majority of students taking these courses. The goal of the initiative has been and continues to be to encourage courses that place much greater emphasis on conceptual understanding and realistic applications of the mathematics compared to traditional courses that too often are designed to develop algebraic skills needed for calculus. In support of the emphasis placed on this topic by the MAA, AMATYC, and NCTM within their committees and executive boards, this session will address the courses below calculus, with particular emphasis on offerings in college algebra and precalculus. We seek presentations that present new visions for such courses, discuss implementation issues (such as faculty training, placement tests, introduction of alternative tracks for different groups of students, etc., related to offering such courses), present results of studies on student performance and tracking data in both traditional and new versions of these courses and in follow-up courses, and discuss the needs of other disciplines from courses at this level. This session is cosponsored by the CRAFTY, the Committee on Two Year Colleges, and the Committee on Service Courses.

Mathematics of Sports and Games (MAA CP M1), Friday afternoon; **Sean Forman***, Saint Joseph's University (sforman@sju.edu), and **Doug Drinen**, Sewanee: University of the South. When applied to the sporting arena, mathematics can provide both compelling classroom examples and interesting research problems. Baseball has long been mined for interesting statistics examples ranging from regression and probability to the game-theoretic aspects of in-game strategy (for example, Albert and Bennett's Curve Ball presents introductory statistics through baseball statistics). Recent books on jai alai, football, and a few other sports have likewise studied those sports through a mathematical lens. The economics of sports is now covered by its own journal, and the statistics publication *Chance* routinely discusses statistical examples in sports. Games have likewise taken on additional interest with the explosion of the professional poker circuit and interest in simulation and combinatorics relating to poker and other games of chance. The objectives of this session include the presentation of interesting classroom examples utilizing examples from sports and games and the discussion of research topics relating to sports and games.

Mathematical Connections in the Arts (MAA CP N1), Friday afternoon; **Douglas E. Norton***, Villanova University (douglas.norton@villanova.edu); **Reza Sarhangi**, Towson University; and **Nathaniel A. Friedman**, State University of New York, Albany. This session seeks interdisciplinary abstracts relating mathematics and one or more of the arts, considered in the broadest sense: architecture, dance, music, literature, theater, film, the visual arts, and others. Number, pattern, line, shape, and symmetry have long been mathematical tools at the disposal of the arts. Increasingly, the various expressions of artistic form have lent themselves to aesthetic presentations of mathematical topics and results. Mathematical concepts inform artistic presentation, while artistic presentation illuminates mathematics. In both directions, new technologies provide new possibilities. Altogether, the new approaches and new tools provide new opportunities for teaching

and for outreach to the general public about the perhaps unexpected place of mathematics in relation to the arts, culture, and society. Session objectives include: (i) explore old and new connections between math and the arts, from ancient Islamic tiles to contemporary folk arts, from perspective in paintings to Möbius sculptures; and (ii) demonstrate the use of new technologies and new looks at old technologies to illustrate connections between mathematics and the arts.

Research on the Teaching and Learning of Undergraduate Mathematics (MAA CP O1), Friday afternoon; **Bill Martin***, North Dakota State University (william.martin@ndsu.edu); **Barbara Edwards**, Oregon State University; and **Mike Oehrtman**, Arizona State University. Research papers that address issues concerning the teaching and learning of undergraduate mathematics are invited. Appropriate for this session are theoretical or empirical investigations conducted within clearly defined theoretical frameworks, using either qualitative or quantitative methodologies. Of highest priority are proposals that report on completed studies that further existing work in the field.

On Achieving Quantitative Literacy (MAA CP P1), Friday afternoon; **Aaron Montgomery***, Central Washington University (montgoaa@cwu.edu); **Stuart Boersma**, Central Washington University; and **Semra Kilic-Bahi**, Colby Sawyer College. The issue of quantitative literacy (QL) has become one of the challenging topics in the education community, as many schools are developing programs to improve their students' ability to use quantitative information in their lives. Many are faced with the difficulty of establishing the role of QL in the undergraduate mathematics curriculum as well as agreeing on necessary QL skills for students. The organizers of this session invite papers that will contribute to the ongoing discussion of quantitative literacy, quantitative reasoning, and/or numeracy. Papers contributed to this session should attempt to address topics such as: working definitions of QL; assessable QL standards; the development of a QL program; the development of QL-related courses and course material including modules, or units within a course; the assessment of the QL skills of students; and the assessment of a QL program.

Mathematics of Chemistry (MAA CP Q1), Saturday morning; **George Rublein***, College of William and Mary (gtrub1@math.wm.edu). Mathematics makes its appearance early on in college-level chemistry courses. Physical chemistry, which is heavily laced with mathematical models, has a reputation as the most difficult course in the undergraduate chemistry curriculum. The treatment of mathematics in chemistry textbooks often bears little resemblance to the approaches that students see in mathematics courses. This session solicits contributions that show examples of models drawn from chemistry that might comfortably appear in the calculus, differential equations of linear algebra courses in which chemistry students are commonly enrolled. Chemical thermodynamics, stoichiometry, and chemical kinetics are good sources for such models.

Mathematics Experiences in Business, Industry, and Government (MAA CP R1), Saturday morning; **Phil Gustafson***, Mesa State College (pgustafs@mesastate.edu), and **Michael Monticino**, University of North Texas. 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 SIG-MAA).

Countering "I Can't Do Math": Strategies for Teaching Underprepared, Math-Anxious Students (MAA CP S1), Saturday and Sunday mornings; **Bonnie Gold***, Monmouth University (bgold@monmouth.edu); **Suzanne Dorée**, Augsburg College; and **Richard Jardine**, Keene State College. How can we create a comfortable learning environment for underprepared or math-anxious students, and, in particular, how can we constructively assess student learning? What classroom practices are especially effective with such students, and how does research on student learning inform those practices? How might the recommendations of the 2004 CUPM Curriculum Guide influence our approach in teaching developmental or introductory courses to better reach these students? This session invites papers on all aspects of "what works" in teaching underprepared, math-anxious students.

Teaching Operations Research in the Undergraduate Classroom (MAA CP T1), Saturday morning; **Christopher J. Lacke***, Rowan University (lacke@rowan.edu), and **Paul E. Fishback**, Grand Valley State University. This session solicits papers highlighting innovative instructional strategies and assessment methods in the introductory undergraduate operations research sequence. Suggested topics include, but are not limited to, course projects, case studies, technology demonstrations, cooperative learning activities, and writing assignments. Papers may focus on original teaching materials or the creative use of previously existing ones, but all papers should provide specific learning objectives addressed by the use of such materials. Each submission must focus on operations research topics at the undergraduate level, including those in the introductory undergraduate operations research sequence or undergraduate courses in stochastic processes, queueing theory, network optimization, etc. In addition to the abstract sent to the AMS, the organizers request that they be sent a course syllabus relating to the submission.

My Favorite Demo: Innovative Strategies for Mathematics Instructors (MAA CP U1), Saturday morning and afternoon; **David R. Hill***, Temple University (hill@math.temple.edu), and **Lila F. Roberts**, Georgia College & State University. Mathematics instructors use a myriad of innovative techniques for teaching mathematical concepts. Technology readily available in colleges and universities has provided a means to boost creativity and flexibility in lesson design. Tools an instructor utilizes may include specialized computer applications, animations and other multimedia tools, Java applets, physical devices, games, etc. This contributed paper session will focus on novel demos that mathematics instructors have successfully used in their classrooms to facilitate learning. Mathematical content areas will include precalculus, calculus, elementary probability, and

selected postcalculus topics. This session invites (1) demos that introduce a topic, (2) demos that illustrate how concepts are applicable, (3) demos that tell a story or describe the development of a procedure, and (4) demos that lead to an activity that involves the class. 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. Proposals should describe how the demo fits into a course; the use of technology or technology requirements, if any; and the effect of the demo on student attitudes toward mathematics. Presenters should strive to include information regarding the effectiveness of the demo and assessment techniques employed.

Mathematics and Popular Culture (MAA CP V1), Saturday afternoon; **Sarah J. Greenwald***, Appalachian State University (greenwaldsj@appstate.edu), and **Christopher Goff**, University of the Pacific. One way that mathematics and popular culture interact is through Hollywood. Computer animators for blockbuster filmmakers like Pixar use mathematical algorithms in their work. In addition, television series such as *Numb3rs*, and movies like *A Beautiful Mind*, *Mean Girls*, and *Proof* (expected in 2005) offer varied portrayals of people with mathematical talent. These references to mathematics in popular culture can reveal, reflect, and even shape how society views mathematics. In the classroom, using popular culture can be a powerful technique for engaging diverse audiences. Capitalizing on student enjoyment of popular culture can alleviate math anxiety, energize shy and quiet students, and provide a creative introduction to an in-depth study of the related mathematics. This session invites presentations on all aspects related to mathematics and popular culture, including music, movies, television, artwork, and other media. Presentations could focus on how mathematics is changing Hollywood and movies or how popular culture can be used to understand the way society views mathematicians and their mathematics. Conversely, presentations could focus on how appearances of and references to mathematics in popular culture have been used creatively and effectively in mathematics courses to reduce math anxiety and motivate students to explore significant mathematics.

My Three Favorite Original Calculus Problems (MAA CP W1), Saturday afternoon; **J. D. Phillips***, Wabash College (philipj@wabash.edu), and **Tim Pennings**, Hope College. This session is for those who, while teaching single and multivariable calculus over the years, have thought of a couple of clever or novel problems with solid pedagogical value that they would like to share with others. In particular, we are looking for original problems suitable for homework assignments or challenging test questions. (We are not looking for extended modeling projects and open-ended problems, since good collections of these already exist.) We hope to organize these into a booklet for publication that could be used as a resource for calculus courses. Submissions may include from two to four problems. Participants should bring copies of their problems to the session for distribution. Each problem should begin on a new page. In addition to the abstract sent to the AMS, the organizers have requested that they

be sent: (i) a statement of the problem, (ii) a brief explanation of why it is interesting and pedagogically valuable, and (iii) a complete solution leading to an answer in closed form.

First Steps for Implementing the Recommendations of the Guidelines for Assessment and Instruction in Statistics Education (GAISE) College Report (MAA CP X1), Saturday afternoon; **Ginger Holmes Rowell***, Middle Tennessee State University (rowell1@mtsu.edu), and **Thomas L. Moore**, Grinnell College. The Guidelines for Assessment and Instruction in Statistics Education (GAISE) Project, funded by the American Statistical Association (ASA), has written a report that focuses on introductory college statistics courses. In addition to providing a historical overview of these courses and offering a list of goals for statistically literate students, this report updates the 1992 recommendations by George Cobb for teaching these courses. The report contains the following six recommendations: (1) emphasize statistical literacy and develop statistical thinking, (2) use real data, (3) stress conceptual understanding rather than mere knowledge of procedures, (4) foster active learning, (5) use technology to develop conceptual understanding and analyze data, and (6) use assessments to improve and evaluate learning. In a 2004 summary of the report, Robin Lock stated that putting these recommendations into practice may be an evolutionary process. For example, an instructor may take a first small step by finding or developing a case study of statistical interest. Instructors are invited to submit proposals describing successful first steps at implementing one or more of these recommendations. Innovative approaches for successful implementation are encouraged. Presenters in this session will be considered for the SIGMAA on Statistics Education's Best Contributed Paper Award.

Handheld Technology in Content and Methods Courses for Prospective Teachers with a Special Interest Strand Devoted to Teaching and Learning Geometry (MAA CP Y1), Saturday afternoon; **Charles Vonder Embse***, Central Michigan University (vonde1cb@cmich.edu); **Deborah A. Crocker**, Appalachian State University; **Gregory D. Foley**, The Liberal Arts and Science Academy of Austin at Lyndon B. Johnson High School; and **Stephen F. West**, SUNY Geneseo. Technology has significantly changed the way we teach and learn mathematics at both the school and collegiate levels. Various types of handheld technology are increasingly used in nearly all mathematics and mathematics education courses for prospective teachers of mathematics in both elementary- and secondary-level programs. In particular, interactive, dynamic geometry software for handheld graphing calculators has changed the basic way that mathematics is taught from a didactic, rigidly structured approach to an exploratory and investigative journey of discovery. State and national curriculum standards specify that geometry be an integral part of school mathematics programs from kindergarten through grade 12. As a result, geometry units and courses are a critical part of the mathematical development for preservice teachers. This session seeks papers on promising practices and research involving the use of handheld technology with prospective teachers of mathematics in grades K-12. A strand of the

session will be devoted to papers on handheld technology in geometry courses for preservice teachers. Papers may concern handheld technology use in mathematics content courses or mathematics methods courses.

Models That Work: Building Diversity in Advanced Mathematics (MAA CP Y3), Sunday morning; **Abbe H. Herzig***, University at Albany, SUNY (aherzig@albany.edu), and **Patricia Hale**, California State Polytechnic University, Pomona. The goal of this contributed paper session is to present to the mathematics community models of programs that have been successful at supporting diverse groups of people (women of all races and African Americans, Latinos and Chicanos, and Native Americans) in their pursuit of advanced mathematics study and careers. We believe that it is important to examine this question holistically, across the span of the educational pathway, since issues of diversity need to be addressed at every educational and professional juncture. Consequently, we seek proposals for presentations that will describe successful programs for postdoctoral (faculty), graduate, undergraduate, or precollege students. We interpret "success" broadly and are looking for ideas that should be shared with others in the mathematics community as models for promoting diversity across the educational spectrum. These might be academic or extracurricular programs that have targeted any group of people traditionally underrepresented in the mathematical sciences. Historical perspectives are also welcome. This session is jointly sponsored by the MAA Committee on the Participation of Women and the MAA Committee on the Participation of Minorities.

Strategies to Encourage Persistence in Mathematics (MAA CP Y5), Sunday morning; **David C. Carothers***, James Madison University (carothdc@jmu.edu); **Ahmed I. Zayed**, DePaul University; and **Keith E. Mellinger**, University of Mary Washington. Enrollments in advanced mathematics courses have declined in recent years, as shown by CBMS surveys. This has happened at a time when more than ever students majoring in many different disciplines would benefit from more mathematics. The CUPM curriculum guide also recognizes that mathematics departments should seek to enroll more students from the physical and life sciences, computer science, engineering, business, and many other disciplines in advanced mathematics courses while at the same time recruiting mathematics and statistics majors. This session will explore strategies to encourage students to persist in mathematics beyond introductory or required courses. Speakers are invited to present teaching and other strategies that have been successful in increasing the number of students who continue on to additional advanced courses after beginning calculus, statistics, or other introductory courses. This session is sponsored by the MAA Committee on the Teaching of Undergraduate Mathematics (CTUM).

Introductory Actuarial Science Programs (MAA CP Y7), Sunday morning; **Robert E. Buck***, Slippery Rock University (robert.buck@sru.edu). Multiple changes in the SOA/CAS exam structure over the past several years have impacted heavily on schools with actuarial science programs, particularly those institutions with small

introductory programs. With another exam restructuring in 2005, as well as increased interest in the field, it would be useful to share responses to the situation. This session invites papers outlining how departments have adjusted their programs to respond to these changes as well as papers detailing the type of programs offered. Of principal interest are papers discussing introductory undergraduate actuarial science programs, but papers describing advanced undergraduate actuarial science programs will also be considered. This session will be of special interest both to departments with existing actuarial programs and those considering such programs.

General Session (MAA CP Z1), Thursday, Friday, Saturday, Sunday mornings and afternoons; **Stephen Davis***, Davidson College (stdavis@davidson.edu), and **Eric Marland**, Appalachian State University. Papers may be presented on any mathematical topic. Papers that fit into one of the other sessions should be sent to that organizer, not to this session.

Submission Procedures for MAA Contributed Papers

Send your abstract directly to the AMS (abstracts should not be sent to the organizer(s)). Participants may speak in at most two MAA contributed paper sessions. If your paper cannot be accommodated in the session for which it was submitted, it will be automatically considered for the general session. Speakers in the general session will be limited to one talk because of time constraints. Abstracts must reach the AMS by Tuesday, September 28, 2005.

The AMS will publish abstracts for the talks in the MAA sessions. Abstracts must be submitted electronically to the AMS. No knowledge of \LaTeX is necessary; however, \LaTeX and $\text{\AMS-}\text{\LaTeX}$ are the only typesetting systems that can be used if mathematics is included. The abstracts submissions page is at <http://www.ams.org/cgi-bin/abstracts/abstract.pl>. Simply fill in each field as instructed. Submitters will be able to view their abstracts before final submission. Upon completion of your submission, your unique abstract number will immediately be sent to you. All questions concerning the submission of abstracts should be addressed to abs-coord@ams.org.

Miami, Florida

Florida International University

April 1–2, 2006

Saturday – Sunday

Meeting #1015

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: December 2005

Program first available on AMS website: February 16, 2006

Program issue of electronic *Notices*: April 2006

Issue of *Abstracts*: Volume 27, Issue 2

Deadlines

For organizers: September 1, 2005

For consideration of contributed papers in Special Sessions:
December 13, 2005

For abstracts: February 7, 2006

Notre Dame, Indiana

University of Notre Dame

April 8–9, 2006

Saturday – Sunday

Meeting #1016

Central Section

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: December 2005

Program first available on AMS website: February 23, 2006

Program issue of electronic *Notices*: April 2006

Issue of *Abstracts*: Volume 27, Issue 2

Deadlines

For organizers: September 9, 2005

For consideration of contributed papers in Special Sessions:
December 20, 2005

For abstracts: February 14, 2006

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions

Combinatorial Algebraic Geometry (Code: SS 2A), **Juan C. Migliore**, University of Notre Dame, and **Uwe R. Nagel**, University of Kentucky.

Commutative Algebra (Code: SS 1A), **Alberto Corso**, University of Kentucky, **Claudia Polini**, University of Notre Dame, and **Bernd Ulrich**, Purdue University.

Ergodic Theory (Code: SS 3A), **Nikos Frantzikinakis**, Pennsylvania State University, **Bryna R. Kra**, Northwestern University, and **Mate Wierdl**, University of Memphis.

Durham, New Hampshire

University of New Hampshire

April 22–23, 2006

Saturday – Sunday

Meeting #1017

Eastern Section

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: January 2006

Program first available on AMS website: March 9, 2006

Program issue of electronic *Notices*: April 2006
Issue of *Abstracts*: Volume 27, Issue 2

Deadlines

For organizers: September 22, 2005
For consideration of contributed papers in Special Sessions:
January 3, 2006
For abstracts: February 28, 2006

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Ailana M. Fraser, University of British Columbia, *Title to be announced.*

Dmitri Nikshych, University of New Hampshire, *Title to be announced.*

Florian Pop, University of Pennsylvania, *Title to be announced.*

Konstantina Trivisa, University of Maryland, College Park, *Title to be announced.*

Special Sessions

Discrete and Convex Geometry (Code: SS 1A), **Daniel A. Klain**, University of Massachusetts (Lowell), **Barry R. Monson**, University of New Brunswick, and **Egon Schulte**, Northeastern University.

San Francisco, California

San Francisco State University

April 29–30, 2006

Saturday – Sunday

Meeting #1018

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: January 2006
Program first available on AMS website: March 16, 2006
Program issue of electronic *Notices*: April 2006
Issue of *Abstracts*: Volume 27, Issue 2

Deadlines

For organizers: September 30, 2005
For consideration of contributed papers in Special Sessions:
January 10, 2006
For abstracts: March 7, 2006

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Lincoln Chayes, University of California Los Angeles, *Title to be announced.*

C. Robin Graham, University of Washington, *Title to be announced.*

Vadim Kaloshin, California Institute of Technology, *Title to be announced.*

Yuval Peres, University of California Berkeley, *Title to be announced.*

Special Sessions

History and Philosophy of Mathematics (Code: SS 1A), **Shawnee L. McMurrin**, California State University, San Bernardino, and **James J. Tattersall**, Providence College.

Salt Lake City, Utah

University of Utah

October 7–8, 2006

Saturday – Sunday

Meeting #1019

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: July 2006
Program first available on AMS website: August 24, 2006
Program issue of electronic *Notices*: October 2006
Issue of *Abstracts*: Volume 27, Issue 3

Deadlines

For organizers: March 7, 2006
For consideration of contributed papers in Special Sessions:
June 20, 2006
For abstracts: August 15, 2006

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

William Arveson, University of California Berkeley, *Title to be announced.*

Alexei Borodin, California Institute of Technology, *Title to be announced.*

Izabella Joanna Laba, University of British Columbia, *Title to be announced.*

Darren Long, University of California Santa Barbara, *Title to be announced.*

Special Sessions

Harmonic Analysis: Trends and Perspectives (Code: SS 1A), **Alex Iosevich**, University of Missouri, and **Michael T. Lacey**, Georgia Institute of Technology.

Cincinnati, Ohio

University of Cincinnati

October 21–22, 2006

Saturday – Sunday

Meeting #1020

Central Section

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: July 2006

Program first available on AMS website: September 7, 2006

Program issue of electronic *Notices*: October 2006

Issue of *Abstracts*: Volume 27, Issue 3

Deadlines

For organizers: March 21, 2006

For consideration of contributed papers in Special Sessions:
July 5, 2006

For abstracts: August 29, 2006

Storrs, Connecticut

University of Connecticut

October 28–29, 2006

Saturday – Sunday

Meeting #1021

Eastern Section

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: July 2006

Program first available on AMS website: September 14, 2006

Program issue of electronic *Notices*: October 2006

Issue of *Abstracts*: Volume 27, Issue 4

Deadlines

For organizers: March 28, 2006

For consideration of contributed papers in Special Sessions:
July 11, 2006

For abstracts: September 6, 2006

Fayetteville, Arkansas

University of Arkansas

November 3–4, 2006

Friday – Saturday

Meeting #1022

Southeastern Section

Associate secretary: Matthew Miller

Announcement issue of *Notices*: September 2006

Program first available on AMS website: September 21, 2006

Program issue of electronic *Notices*: November 2006

Issue of *Abstracts*: Volume 27, Issue 4

Deadlines

For organizers: April 3, 2006

For consideration of contributed papers in Special Sessions:
July 18, 2006

For abstracts: September 12, 2006

New Orleans, Louisiana

*New Orleans Marriott and Sheraton
New Orleans Hotel*

January 4–7, 2007

Thursday – Sunday

Meeting #1023

Joint Mathematics Meetings, including the 113th Annual Meeting of the AMS, 90th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Susan J. Friedlander

Announcement issue of *Notices*: October 2006

Program first available on AMS website: November 1, 2006

Program issue of electronic *Notices*: January 2007

Issue of *Abstracts*: Volume 28, Issue 1

Deadlines

For organizers: April 1, 2006

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

Davidson, North Carolina

Davidson College

March 3–4, 2007

Saturday – Sunday

Southeastern Section

Associate secretary: Matthew Miller

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, 2006

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

Oxford, Ohio

Miami University

March 16–17, 2007

Friday – Saturday

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: To be announced

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

San Diego, California

San Diego Convention Center

January 6–9, 2008

Sunday – Wednesday

Joint Mathematics Meetings, including the 114th Annual Meeting of the AMS, 91st Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).

Associate secretary: Michel L. Lapidus

Announcement issue of *Notices*: October 2007

Program first available on AMS website: November 1, 2007

Program issue of electronic *Notices*: January 2008

Issue of *Abstracts*: Volume 29, Issue 1

Deadlines

For organizers: April 1, 2007

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

Washington, District of Columbia

*Marriott Wardman Park Hotel
and Omni Shoreham Hotel*

January 7–10, 2009

Wednesday – Saturday

Joint Mathematics Meetings, including the 115th Annual Meeting of the AMS, 92nd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).

Associate secretary: Lesley M. Sibner

Announcement issue of *Notices*: October 2008

Program first available on AMS website: November 1, 2008

Program issue of electronic *Notices*: January 2009

Issue of *Abstracts*: Volume 30, Issue 1

Deadlines

For organizers: April 1, 2008

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

San Francisco, California

*Moscone Center West and the
San Francisco Marriott*

January 6–9, 2010

Wednesday – Saturday

Joint Mathematics Meetings, including the 116th Annual Meeting of the AMS, 93rd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association for Symbolic Logic (ASL).

Associate secretary: Matthew Miller

Announcement issue of *Notices*: October 2009

Program first available on AMS website: November 1, 2009

Program issue of electronic *Notices*: January 2010

Issue of *Abstracts*: Volume 31, Issue 1

Deadlines

For organizers: April 1, 2009

For consideration of contributed papers in Special Sessions:
To be announced

For abstracts: To be announced

New Orleans, Louisiana

*New Orleans Marriott and Sheraton
New Orleans Hotel*

January 5–8, 2011

Wednesday – Saturday

Joint Mathematics Meetings, including the 117th Annual Meeting of the AMS, 94th 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 2010

Program first available on AMS website: November 1, 2010

Program issue of electronic *Notices*: January 2011

Issue of *Abstracts*: Volume 32, Issue 1

Deadlines

For organizers: April 2, 2011

For consideration of contributed papers in Special Sessions:

To be announced

For abstracts: To be announced

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Sproul Hall, Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 951-827-5910.

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: Matthew Miller, Department of Mathematics, University of South Carolina, Columbia, SC 29208-0001, e-mail: miller@math.sc.edu; telephone: 803-777-3690.

The Meetings and Conferences section of the *Notices* gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. **Information in this issue may be dated. Up-to-date meeting and conference information can be found at www.ams.org/meetings/.**

Meetings:

2005

June 16-19	Mainz, Germany	p. 695
October 8-9	Annandale-on-Hudson, New York	p. 696
October 15-16	Johnson City, Tennessee	p. 697
October 21-23	Lincoln, Nebraska	p. 698
November 12-13	Eugene, Oregon	p. 699
December 14-18	Taiwan	p. 699

2006

January 12-15	San Antonio, Texas Annual Meeting	p. 701
April 1-2	Miami, Florida	p. 707
April 8-9	Notre Dame, Indiana	p. 707
April 22-23	Durham, New Hampshire	p. 707
April 29-30	San Francisco, California	p. 708
October 7-8	Salt Lake City, Utah	p. 708
October 21-22	Cincinnati, Ohio	p. 709
October 28-29	Storrs, Connecticut	p. 709
November 3-4	Fayetteville, Arkansas	p. 709

2007

January 4-7	New Orleans, Louisiana Annual Meeting	p. 709
March 3-4	Davidson, North Carolina	p. 709

March 16-17	Oxford, Ohio	p. 710
2008		
January 6-9	San Diego, California Annual Meeting	p. 710
2009		
January 7-10	Washington, DC Annual Meeting	p. 710
2010		
January 6-9	San Francisco, California Annual Meeting	p. 710
2011		
January 5-8	New Orleans, Louisiana Annual Meeting	p. 711

Important Information regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 100 in the January 2005 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts

Speakers should submit abstracts on the easy-to-use interactive Web form. No knowledge of \LaTeX is necessary to submit an electronic form, although those who use \LaTeX may submit abstracts with such coding, and all math displays and similarly coded material (such as accent marks in text) must be typeset in \LaTeX . Visit <http://www.ams.org/cgi-bin/abstracts/abstract.pl>.

Questions about abstracts and requests for paper forms may be sent to abs-info@ams.org.

Paper abstract forms must 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 5-July 21, 2005: Joint Summer Research Conferences in the Mathematical Sciences, Snowbird, Utah (see November 2004 *Notices*, page 1294).

July 25-August 12, 2005: Summer Research Institute on Algebraic Geometry, Seattle, Washington (see November 2004 *Notices*, page 1293).

Co-sponsored conference: June 2006: Fifth Conference on Poisson Geometry, Tokyo, Japan (watch <http://tmugs.math.metro-u.ac.jp/general.html> for future information).

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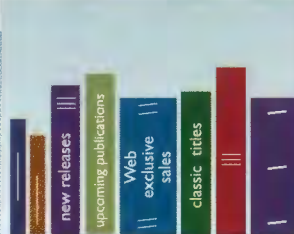
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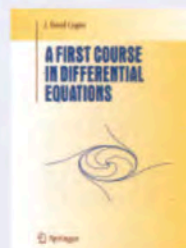
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J. David Logan,
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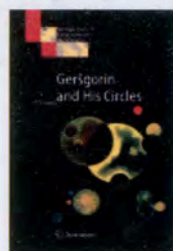
18 Unconventional Essays on the Nature of Mathematics

Reuben Hersh, University of New Mexico (Editor)

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— Sir Michael Atiyah,
University of Edinburgh

2005, Approx. 380 p., Softcover
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Richard S. Varga,
Kent State University

This book studies the original results, and their extensions, of the Russian mathematician, S.A.

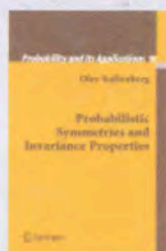
Geršgorin, who wrote a seminal paper in 1931, on how to easily obtain estimates of all n eigenvalues (characteristic values) of any given n -by- n complex matrix. Includes the latest research results.

2004, 226 p., (Springer Series in Computational Mathematics, Vol. 36) Hardcover
3-540-21100-4 ► **\$79.95**

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A.D. Alexandrov

2005, 539 p. 165 illus., (Springer Monographs in Mathematics) Hardcover
3-540-23158-7 ► **\$129.00**



Probabilistic Symmetries and Invariance Principles

Olav Kallenberg,
University of Auburn

This is the first

comprehensive treatment of the three basic symmetries of probability theory—contractability, exchangeability, and rotatability—defined as invariance in distribution under contractions, permutations, and rotations.

2005, Approx. 535 p., (Probability and its Applications) Hardcover 0-387-25115-4
► **\$89.95**

Dynamical Systems

Examples of Complex Behaviour

Jürgen Jost, Max Planck Institute for Mathematics in the Sciences, Germany

2005, 189 p., (Universitext) Softcover
3-540-22908-6 ► **\$49.95**

