Spring 2004

EMISSARY

Mathematical Sciences Research Institute

www.msri.org

Notes from the Director

David Eisenbud

MSRI at the JMM *(see page 5)*

A Cycle at MSRI

I came to MSRI as Director in the summer of 1997, nearly seven years ago. My first task was to write a five-year NSF proposal for the period starting in 2000 — a hard way to jump in! I'm about to start work on the next five-year proposal, so it's a good moment to look back and reflect on a few things that were part of this cycle.

Coming to MSRI, I was as excited about the adventure as I could be: the opportunity to lead such a well-established gem of the mathematics community, the incredibly rich flow of mathematics through the Institute, the thousands of mathematicians who felt such warmth about MSRI programs, the extraordinary people — Chern, Kaplansky, Thurston — who had led it before me, the collaboration with the stars on the Scientific Advisory Committee and the many other groups that inform the Institute's activities — all these things were highly attractive then, and the excitement and attraction haven't worn off! At the time my idea was to be Director for a single five-year term, partly because I thought I wouldn't be able to keep doing mathematics, and partly

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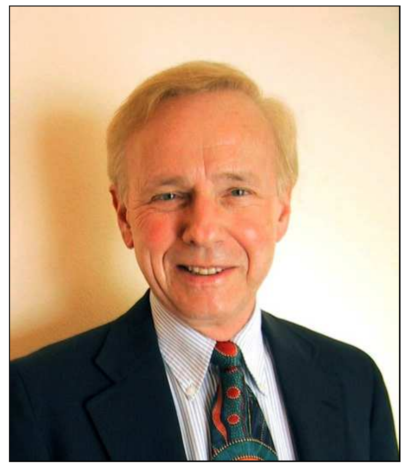
Lind to Head MSRI Planned Giving Effort

Douglas Lind, Professor at the University of Washington, will chair a new effort focused on planned giving for MSRI as announced by Robert Bryant, Chair of the Board, and David Eisenbud, Director.

Planned gifts are asset contributions that typically support an organization's endowment. They are often considered along with estate planning. Examples include gifts to MSRI through mention in Wills and Living Trusts, making MSRI the beneficiary of a retirement fund, and a Charitable Remainder Trust.



Doug Lind

"I feel strongly that the most effective way to support MSRI's long-term success is through building its general endowment," said Lind. "Through our efforts, we will create the flexible resources needed to enrich its programs and fund innovative ideas," he added.

Lind will soon be recruiting a committee to organize and implement the planned giving program. Individuals who make a planned gift to MSRI will be recognized in an organization likely to be called the Gauss Society, and will be invited to an Annual Dinner at the Institute. Lind, Bryant, and Eisenbud have joined through planned gifts that they have already committed.

In its last five-year recompetition, NSF directed MSRI to begin raising funds and establish an endowment to supplement funds from the Foundation. This Planned Giving effort will build upon the now completed $8.3 million capital campaign and the Archimedes Society, MSRI's annual support group.

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Notes from the Director

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because I thought I'd run out of new MSRI ideas and projects, and pass the torch to someone fresher. But here I am, well into my second term.

As for mathematics, I've certainly been frustrated on occasion — I give the pressing needs of administration priority, and that means missing a lot in this rich environment, as well as giving up a certain number of theorems and papers. But somehow I've been able to use moments around the periphery, and as I look back I feel that I've still kept quite active mathematically (if you like, you can get a glimpse on my website, www.msri.org/ de).

As for MSRI, though, I feel that there are more interesting ideas and activities bubbling around than ever. Our scientific programs are widely varied and earn great acclaim. Over 95% of the postdocs to whom we make offers accept them. The latest development in our encouraging minority participation — a mini-conference at a minority institution, in which leaders of next year's programs are the speakers — has been a great success. We'll soon host our first big conference in a series on Critical Issues in K–12 Education. The number of academic sponsors has risen from 32 when I came to over 75 today, a clear sign of our standing in the community.

One of the biggest changes at MSRI has been the diversification of the board of Trustees. This extraordinary group (see www.msri.org/people/governance/trustees.html) is deeply engaged with and supportive of the Institute. From personal gifts of time, treasure, and experience they have brought new resources to enhance the research at MSRI and to broaden its dreams and aspirations.

Of course this is far from being my doing alone! One of the great pleasures of working at MSRI has been the strength and quality of the deputy directors I've worked with: Hugo Rossi, Joe Buhler, Michael Singer, Bob Megginson, and now Hugo Rossi again. Each of them has added enormously to what goes on here, and has begun projects and ideas that continue. The rest of the staff does extraordinary work too, in matters as varied as the welfare of our 1700 mathematical visitors each year; the hosting of our governance committees; the cultivation of our library; the care and improvement of our computer networks for members, administration, and our web presence; our publications of books and videos; the search for resources; and the expert management of our finances. When I speak of what "I" have done at MSRI, it's really shorthand for our combined labors. And it isn't just the staff who look out for MSRI: many of the members who pass through have strong, even sometimes proprietary, feelings of what MSRI should do and how it should be done. I'm always grateful when one of them takes me aside to explain what could be better — and quite often I've been able to make a change or start something new in response. In the end, the involvement and enthusiasm of the math community is what makes the job worthwhile for me.

Fundraising Achieved

When I was hired at MSRI, the Trustees gave me an explicit mandate to get fundraising rolling. (This was something in which I had virtually *no* experience — both I and the trustees took quite a leap of faith!) The push came not only from within MSRI, but also from the NSF, whose argument was: "if you're doing so much for the community, they should be helping support you in a more direct way?" After long discussions with many people, I picked building expansion as the first serious fundraising target.

I feel that MSRI's building is the nicest place to work on the whole Berkeley campus, but the need for an expansion was clear from the moment the bulldozers left. In 1987 there were already plans for an addition to the construction, to be used "if the money was available" — which it was not. Each subsequent director, Kaplansky and then Thurston, felt this need. For the current plans, a building committee formed of Trustees and Academic Sponsor Representatives, and chaired by Doug Lind (Chair of the Committee of Academic Sponsors), took a very active role in specifying the building elements to be added. Bill Glass, the architect for the current structure, became the architect for the new project, and worked closely with the committee, listening to their ideas and demands, and making many drafts and changes. Based on this work, we set a fundraising target of $7,300,000.

As time went on, I began to learn about development, and the circle of our activity expanded. The crucial first step was an amazing $500,000 gift from the founding director, Shiing-Shen Chern, himself. By this time we were getting serious, and had hired a development director (the project couldn't have been completed without him!) Chern's gift helped inspire a $2,500,000 challenge grant from Jim Simons. Jim Simons and Roger Strauch became campaign co-chairs and formed a campaign cabinet including Elwyn Berlekamp, Robert Bryant, Gisela Fränken, David Hodges (Vice Chair), Julie Krevans, Doug Lind, Bob Megginson, Michael Singer, Jim Sotiros, Ron Stern, and myself.

Responding to our appeals, Will Hearst endowed the new library. Many others donated sums large and small. Because of the range of our individual support, almost every foundation we approached gave us money — a sure indication that we were on firm ground. In the end, we raised $8,300,000, a million dollars more than our original goal! We won't have any trouble spending the extra — the scope of our project has increased too. For example, our new Austine McDonell Hearst Library will have about three times as much space of the current library instead of two times as much. Other leading features of the new building: a beautiful lecture hall (the Simons Auditorium), two seminar rooms, a professional kitchen, a common room, and many improvements to the existing structure.

The success of this project is the result of the broad community support that MSRI enjoys among mathematicians, combined with an increasing awareness of the Institute and its importance by scientists outside mathematics and by the general public. Working to pull these strands together has been a great satisfaction for me. I think that the community will enjoy the result for many, many years.

My sincere thanks, on behalf of the whole community, go to each of you who have contributed your work, influence, or funds to the success of MSRI in this time.

Next Cycle, Please

To paraphrase E.M. Forster: Yes — oh, dear, yes — institutes need grants. (You can read the rest of the passage, at the beginning of chapter two in *Aspects of the Novel*, to see how I feel about that.) The contributions of the 75 Academic Sponsors, the many individuals, and the private foundations, crucial as they are for providing unrestricted and special purpose funds, will not run MSRI at anything like its current level. Our biggest grant, some 70% of our operating budget, comes from the Division of Mathematical Sciences at the NSF, a reliable and generous patron ever since MSRI was founded. We'll submit a proposal covering the years 2005–2010 this May.

What will go into the proposal? First and foremost, now as always, the quality of the research mathematics done at MSRI will star, and the needs of the research enterprise will be the central items. Adequate support for the researchers and postdocs who come to visit the Institute will be the top priority. Work for the diversity of the mathematical population at MSRI will remain important. Outreach to the public, which already played a role in the 2000 grant, will be built in again and elaborated further. We'll boast about our newest activities related to K–12 education, though funding for them will come from other sources.

Suggestions, anyone? Within this skeleton, there's plenty of room for elaboration and the development of new ideas. I'll be grateful for your suggestions! You can write to me, de@msri.org, with comments of any kind, as always.

Planned Giving

(continued from page 1)

If you would like to include MSRI in a planned gift and join the Society, please contact Jim Sotiros, Director of Development at jsotiros@msri.org or 510-643-6056.

Puzzles Column

Joe P. Buhler and Elwyn R. Berlekamp

Stan Wagon has contributed several problems to this page in the past, and has used several of the problems in his internet "problem-of-the-week" at Macalester college (widely circulated elsewhere also). He used the charming "ants-on-a-stick" problem from last time, but worried that it might be too easy (rumor has it that he pays a small sum to Macalester students who solve the problems) since the problem has appeared elsewhere in various guises. John Guilford solved this meta-problem by coming up with an amusing new variant of the puzzle; we continue the sharing between the columns by using this new version here.

1. 101 ants are placed randomly on a one-meter stick, except that one of them, Alice, is placed in the exact center. Each ant is placed facing a random direction. At a certain moment all of the ants start crawling in the direction they are facing, always traveling at one meter per minute. When an ant meets another ant or reaches the end of the stick, it immediately turns around and continues going in the other direction. What is the probability that after 1 minute Alice is again at the exact center of the stick?

Here is another chess problem, this time on an infinite chess board.

2. A white king and a white rook play chess against a black king on a quarter-infinite chessboard consisting of the first quadrant of the Cartesian plane. Initially, the White rook is at the lower left hand square (0,0), the White king is adjacent to it at the square (1,0) on the lower boundary, and the Black king is at (1,2). White moves first. On any move when he is not in check, Black can elect to end the game by cashing out, receiving a payment from White of $\$(x + y)$ if the Black king is on the square (x, y). Assuming correct play, how large a sum can Black earn?

Our last puzzle column had a difficult problem about read-only computer memory. Here is a classic, and much easier, problem in the same vein.

3. A read-only array (ROM) contains n integers. Find a linear-time algorithm that determines whether the array has a "majority element," and if so, returns that value. An integer x is a majority element in the array if it is in k locations, where $k > n/2$.

Finally, here is a much more difficult problem, not unrelated to last issue's puzzle, that seems to simultaneously generalize ROM problems and the infamous hat puzzles. We heard this from postdoc Julia Kempe at Berkeley, and suspect that the problem is making the rounds by now.

4. A team of n computer scientists meet and plot strategy in the following game. Your job of course is to devise a strategy for them that maximizes the probability that they will win.

Each member of the team is assigned a unique public number k from 1 to n.

When the contest begins, each contestant in placed in his own private room, with his own primitive computer. No further communications between team members are permitted.

The game show host creates a ROM with n locations. The k-th location has an entry $\pm\pi(k)$, where π is a random permutation of $\{1, \ldots, n\}$, and each of the n signs is chosen randomly.

Each contestant can program his or her computer to access this ROM. The program can examine up to $n/2$ locations the ROM, but no more. Each program is allowed only a small fixed number of scratch locations, but dynamic access to the ROM is allowed (i.e., the "next" location can depend on the values observed in earlier locations).

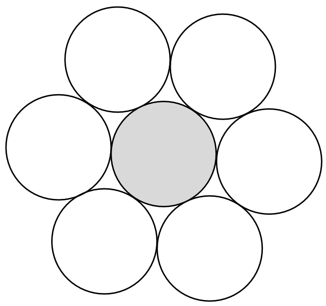
After examining $n/2$ locations of the ROM (or sooner, if his treasure hunt succeeds) the k-th contestant is required to guess the sign of k in whichever location it happens to occupy.

The team wins if and only if all n members of the team guess correctly. Find a strategy giving your team a significant chance of winning even when the number of players is very large.

Kissing numbers: Surprises in Dimension Four

Günter M. Ziegler, TU Berlin

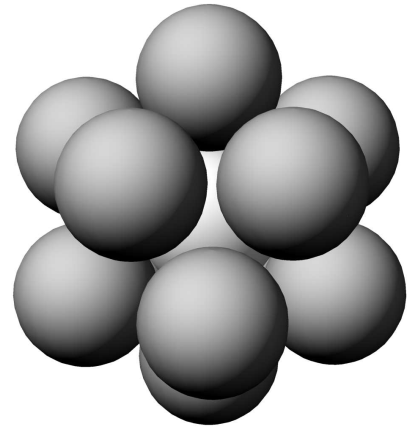
The "kissing number problem" is a basic geometric problem that got its name from billards: Two balls "kiss" if they touch. The kissing number problem asks how many other balls can touch one given ball at the same time. If you arrange the balls on a pool table, it is easy to see that the answer is exactly six: Six balls just perfectly surround a given ball.



If, however, you think about this as a three-dimensional problem, the question "how many balls can touch a given ball at the same time" becomes much more interesting — and quite complicated. In fact, The 17th century scientific genius Sir Isaac Newton and his colleague David Gregory had a controversy about this in 1694 — Newton said that 12 should be the correct answer, while Gregory thought that 13 balls could be fitted so that they would touch a given ball (all of them of the same size) simultaneously. One of the famous platonic solids, the icosahedron, in fact yields a configuration of 12 touching balls that has great beauty and symmetry — and leaves considerable gaps between the touching balls (top right). So perhaps if you move all of them to one side, would a 13th ball possibly fit in? The answer is no — 12 is the correct answer — but to *prove this* is a hard problem, which was finally solved by Schütte and van der Waerden in 1953.

Mathematicians worry about the same problem also for higher dimensional spheres, say for four-dimensional balls in four-dimensional space. Why should they? Well, one answer is that good sphere packings are closely related to good error-correcting codes, and thus the geometry of sphere packings in high dimensional spaces is important for the mathematical theory of error-correcting codes, and thus to one of the mathematical core technologies that play there perfect role in every day life (without us usually noticing that).

So the kissing number problem may be posed in n-dimensional space, and in fact the mathematical theory to describe sphere packings is just basic linear algebra, as one learns it in college. The mathematical theory that allows one to sometimes *solve* such problems is much more complicated: Philippe Delsarte (Phillips Research Labs) in 1973 described a "linear programming method" that does allow one to prove good bounds on the maximal number of balls that would kiss a given one in n-dimensional space. Spectacular breakthroughs on this problem occurred in the late seventies, when Andrew Odlyzko and Neil Sloane (at AT&T Bell Labs)



Graphic: Detlev Stalling, ZIB Berlin

and at the same time Vladimir I. Levenštein in Russia proved that the correct, exact maximal numbers for the kissing number problem are 240 in dimension 8, and 196560 in dimension 24. This is amazing, because these are also the only two dimensions where one knows a precise answer. It depends on the fact that mathematicians know very remarkable configurations in dimensions 8 and 24, which they call the E_8 *lattice* and the *Leech lattice*, respectively.

So the kissing number problem remained unsolved, in particular, for the case of dimension four. The so-called *24-cell*, a four-dimensional "platonic solid" of remarkable beauty (next page), yields a configuration of 24 balls that would touch a given one in four-dimensional space. But is 24 the answer? It was *proved* that with Delsarte's method the best upper bound one could get is 25. So it comes as a great surprise that now the Russian mathematician Oleg Musin, who lives in Los Angeles, has indeed found a method to modify Delsarte's method in a very beautiful and clever way, and thus improve the upper bound from 25 to 24.

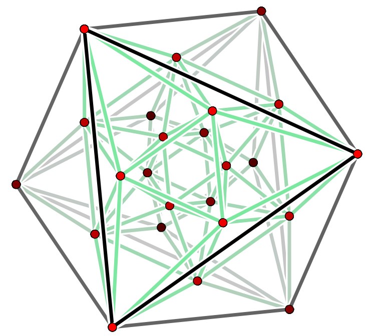
So indeed: 24 is the answer!

Oleg Musin

Surprisingly, this is not the only spectacular recent piece of progress related to the packing of spheres in high-dimensional space. Namely, by again extending and improving upon Delsarte's method, Henry Cohn (Microsoft Research) in joint works with Noam Elkies (Harvard University) and with Abhinav Kumar (a mathematics graduate student at Harvard) has obtained new upper bounds on the density of packings of balls of equal size in

n-dimensional space, that is, on the fraction of space that can be filled by packing balls of equal size. Indeed, for dimensions 8 and 24 they obtained upper bounds that are off by a fraction of one part in 10^{27} from the best known lattice sphere packings — which are given by the E_8 lattice and the Leech lattice. Both bounds are amazingly close, and there still is hope to prove that, indeed, the E_8 lattice and the Leech lattice are the optimal ways to pack billard balls in 8-dimensional respectively 24-dimensional space. This would be quite amazing: Just recall that the Kepler conjecture about the packing of equal balls in three-dimensional space was only recently resolved (by Thomas C. Hales), the proofs were very difficult and used a lot of computer calculations, there was lots of controversy, and still no proof is published! It seems that geometry in dimensions 4, 8 or 24 has many surprises — and may be easier and provide nicer answers than geometry in three-dimensional space (at least to some mathematicians).

Oleg Musin and Henry Cohn presented their work to an international audience of experts at the workshop "Combinatorial and Discrete Geometry" (November 17 to 21, 2003), at MSRI.



Graphic: Michael Joswig, TU Berlin

MSRI at the Joint Meetings

MSRI took part in the Joint Mathematical Meetings in Phoenix (January 7–10, 2004) with the presence of the Director and a Deputy Director, and a booth among the book and software vendors. In spite of general puzzlement over there being nothing to buy, the booth was very well-attended — it was next to the free coffee! — and many people picked up the Emissary, brochures about our initiatives, CDs of lecture compilations, and MSRI's introductory CD, *Invitation to Discover*.

There was even a raffle, where several MSRI T-shirts and hats were the prizes, together with copies of MSRI's most recent hit video productions: *Funny Numbers: An Evening with Steve Martin* (see the Spring/Fall 2003 Emissary or go to www.ams.org/bookstore), and *porridge pulleys and Pi: two mathematical journeys*, a new video by George Paul Csicsery that premiered last November at the Téléscience Festival in Montréal. Csicsery is an old hand at presenting our favorite subject to a wide public — he directed and produced *N is a Number*, about the life of Paul Erdős — and *porridge pulleys and Pi* does not disappoint. It focuses on two mathematicians who have had a vast influence on contemporary science: Fields medalist Vaughan Jones, one of the world's foremost knot theorists and an avid windsurfer, and Hendrik Lenstra, a number theorist with a passion for classical Greek. See page 7 for more information and an order form.

But the greatest attraction was the demonstration of MSRI's new video distribution system, Vmath (see next page). Garikai Campbell of Swarthmore College (seated in photo on page 1) was one of many mathematicians who listened to and watched lecture material delivered over Vmath, on one of the two 17-inch Mac laptops where we had downloaded about 20 such lectures to take to the meeting. Here is what Campbell has to say about it:

> *The clarity of the lectures presented with this system is outstanding. Other than not being able to ask questions of the speaker, viewing a lecture this way might even be better than seeing it live — it's like having TiVo for lectures! It clearly has terrific potential to allow those folks who can't make it to a particular program or workshop to still "take part" in some way. Vmath seems a wonderful way to broaden the reach of the activities and programs of MSRI!*

The MSRI booth was staffed by Anne Brooks Pfister, Assistant to the Director, and Max Bernstein (photo), our Network Administrator. Max and Anne, thanks for a very smooth operation!

math

Mathematical Sciences Research Institute

Video math: Free downloadable lectures by the world's best mathematicians.

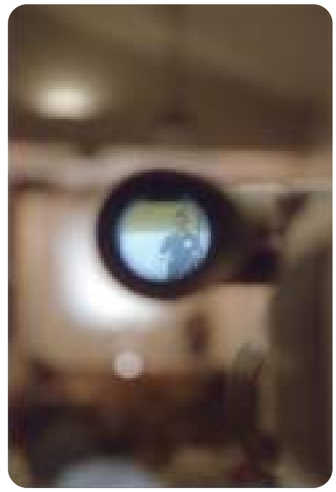
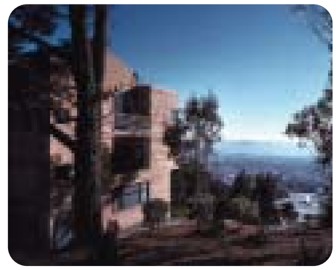


Photo: Ed Alcock



Vmath: MSRI Lectures on the Internet

The Mathematical Sciences Research Institute (MSRI) wants to make its premier collection of lecture video materials ubiquitous. Teaching a course in Quantum Computation? A seminar on Noncommutative Algebra? Curious about the latest progress in Differential Geometry? Want to find a great speaker on Random Matrices or the Genetics of Complex Diseases? Pick your favorite lectures from our website and enrich your offering with them! Our library is there for your free use, and vast improvements are being made in its accessibility and video quality.

MBONE to Streaming Video

Since 1982 when the Institute opened its doors, many of the world's great mathematical researchers have visited MSRI. We have dreamed of sharing the excitement here with the students and researchers who cannot attend.

To realize this dream, MSRI became a pioneer in distributing lectures over the Internet. Starting in 1996, the "MBONE Project" broadcast a small number of lectures to a small group of math sites. But few could watch: technical barriers were high, and the fact that lectures were broadcast at the time they were given was less an advantage (mathematical ideas are long-lived) and more of a problem (it might be night where you live) than expected.

MSRI responded with Streaming Video. Our imperatives were these:

1. To allow the lecturer to present the material in the most effective way, whether with blackboard, overhead slides, or PowerPoint.
2. Make the lectures available free on the web to the widest possible audience, using low bandwidth.
3. Host material produced elsewhere and offer assistance to other institutions.

Despite many problems, the system worked. Seminars are based on the materials on our site. Many, many lectures have been watched. MSRI has the largest mathematical video library in the world, nearly 3000 hours of lectures as of 2004, available for free at any hour of the day or night.

Vmath

Starting in 2004 a generous grant from William R. Hearst III, and technical contributions from the Internet Archive and Brewster Kahle, will enable MSRI to take the next steps. The best features of our old system will be kept: free access and the avoidance of anything that disturbs the presenter. But we will:

1. Improve the production values, lighting, and sharpness of the videos to nearly cinematic quality, and make use of available bandwidth.
2. Make lecture notes, and associated documents available as PDFs.
3. Encourage individuals and institutions to establish special collections of our videos, possibly annotated, for locally given courses and seminars.
4. Greatly improve the indexing and accessibility of the material on the videos
5. Make individual DVDs of any lecture available by mail on a low-cost basis.

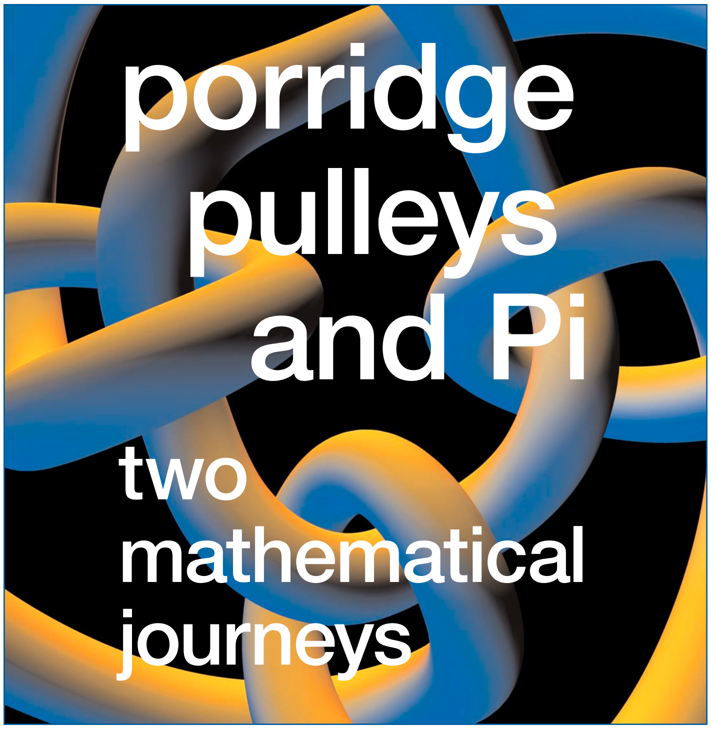
Visit **www.msri.org** to see Vmath for yourself!

MSRI

Mathematical Sciences Research Institute

MSRI *presents*

porridge pulleys and Pi:
two mathematical journeys
A video produced and directed by George Paul Csicsery



Available from
Mathematical Sciences Research Institute
17 Gauss Way
Berkeley, CA 94720-5070 USA www.msri.org
Phone: (510) 642-0143 Fax: (510) 642-8609

porridge pulleys and Pi:
two mathematical journeys
A video by George Paul Csicsery
(28:30 minutes) MSRI © 2004 ISBN 0-9639903-2-2

"I seem to have a special gift in seeing problems where other people don't see problems. Things are happening and you say, well that is something that asks for an explanation. And of all those problems that you see, you just pick out those where you see a possibility of getting your finger behind it." ***— Hendrik Lenstra***

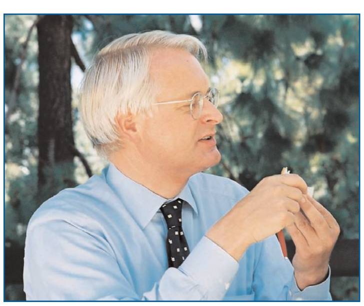
A portrait of two very different mathematicians, *porridge pulleys and Pi* features Fields medalist Vaughan Jones, one of the world's foremost knot theorists and an avid windsurfer, and Hendrik Lenstra, a number theorist with a passion for Homer and all things classical.

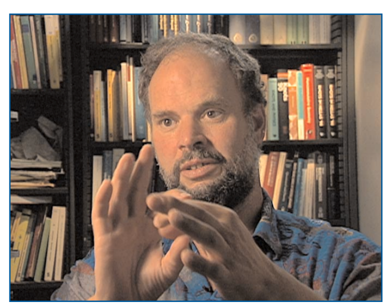
porridge pulleys and Pi poses the question: how do we get first-rate research mathematicians? Hendrik Lenstra and Vaughan Jones have had an extraordinary impact on mathematics; this charming documentary gives the viewer a taste of their personalities, mathematical and otherwise. A whirlwind tour of knots, genomics, cryptography, music, Homer, elliptic curves, art, and windsurfing, the video contains sections on the history of Pi, and a surprising discovery involving a cocoa tin and an Escher print.

The contrasting personalities and work styles of Jones and Lenstra show two men with very different backgrounds and approaches. The unifying theme: each finds that the work of doing mathematics makes him happy. Points at which their discoveries intersect with real-world problems and applications show how mathematics is harnessed to resolve questions in other areas.

Biographical sections, vignettes from their private lives, scenes from lectures and seminars, and interviews with colleagues, family members, and journalists, are interwoven in an exploration of how these two highly creative and original individuals think. The result delivers a glimpse of the mathematical achievements of two important contemporary figures.

"If I had an advantage in my career it was that I had really followed my own path. And I ended up having some ideas that no one else had. It was really an amazingly rapid trip from the most abstract realms of modern mathematics to putting DNA in test tubes and seeing what happens, and taking electron micrographs of things, and the fight against cancer and AIDS. It was extremely unlikely and very exhilarating." ***— Vaughan Jones***



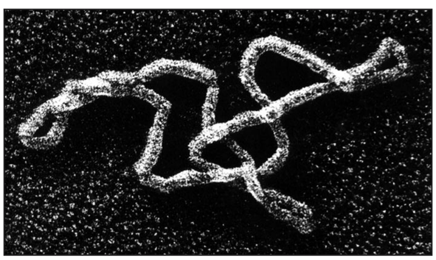


porridge pulleys and Pi:
two mathematical journeys

A video by George Paul Csicsery

"Two of the most likable mathematical personalities on planet earth come across as so different, honest, passionate, and wonderfully human… A path-breaking piece of work that will create interest in mathematics and its practitioners among many audiences. At the same time it dashes some of the less pleasant stereotypes of mathematicians."
— Donald J. Albers,
Associate Executive Director
Director of Publications,
The Mathematical Association of America

"This delightful film offers intriguing, intertwined glimpses of two mathematicians doing what they truly love. From hints of deep mathematics, involving numbers and knots, to images of windsurfing, swimming, singing, and other pastimes, it deftly illuminates the diverse elements of a rich mathematical life."
— Ivars Peterson, Science News



"One thing both have in common is that their work has found important real-life applications of some extremely abstract pure mathematics, the way DNA replicates in the case of Jones, and data encryption for Lenstra. Csicsery's film provides a much needed human face to modern mathematics."
— Keith Devlin, Executive Director, Center for the Study of Language and Information, Stanford University

Web Links

porridge pulleys and Pi
http://www.msri.org/events/ppp

Mathematical Sciences Research Institute
www.msri.org

Vaughan F. R. Jones
http://www.math.auckland.ac.nz/Careers/vaughan/vaughan.htm

Vaughan Frederick Randal Jones
http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Jones_Vaughan.html

The KnotPlot Site
http://www.cs.ubc.ca/nest/imager/contributions/scharein/KnotPlot.html

The International Guild of Knot Tyers
http://www.igkt.net

Nicholas R. Cozzarelli
http://mcb.berkeley.edu/faculty/BMB/cozzarellin.html

The Wisdom of Hendrik W. Lenstra, Jr.
http://www.matem.unam.mx/~magidin/lenstra.html

Hendrik W. Lenstra, Jr.
http://www.math.leidenuniv.nl/~hwl

Escher and the Droste Effect
http://escherdroste.math.leidenuniv.nl

Escher's Print Gallery at Stanford
http://math.stanford.edu/~henrys/printgallery

Ludolph Van Ceulen
http://www-history.mcs.st-and.ac.uk/Posters/1231.html

Pi in the Pieterskerk (in Dutch)
http://www.math.leidenuniv.nl/~naw/serie5/deel01/jun2000/pdf/pi-dag.pdf

Please return this form with your order.

porridge pulleys and Pi: two mathematical journeys

MSRI

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Summer Hoo-Hah*

Joe P. Buhler and Bill Casselman

Summer graduate programs usually cover a specific mathematical topic in depth. One of last summer's was unusual in that it covered a meta-topic — mathematical graphics — that is useful in almost all areas of mathematics. The program focused on the theory and practice of using graphics in mathematical exposition; the fundamental notion was that graduate students could quickly learn sophisticated techniques and apply them to illustrate ideas in their own areas of mathematics.

The program was held at Reed College in Portland, Oregon, in mid-July. Instruction was limited to two powerful tools: Postscript and Java. The organizers assumed that everyone would be able to learn to program in Postscript, but that serious use of Java would be mostly limited to those that had prior programming experience.

Introductory lectures on Postscript were given by Bill Casselman (University of British Columbia), lectures on Java were given by David Austin (Grand Valley State University, Michigan), and lectures on basic algorithms in graphics were given by Jim Fix (Reed College). Almost all of the lecture material can be found at http://www.math.ubc.ca/~cass/msri-summer-school/.

Most mornings were devoted to lectures, and all afternoons to computer labs. Reed College had several pleasant labs that facilitated circulation and interaction between the students, the lecturers, and the teaching assistant (David Maxwell, University of Washington). Students were required to produce projects, either in Postscript or Java, at the end of the two weeks. The projects were supposed to be suitable for presentation to their peers and also for posting on the Internet. The idea was to use graphics in an essential way in mathematical exposition, and if possible to use graphics alone to carry most of the burden of the explanation. A wide range of mathematical subject areas were chosen by the students, consistent with the breadth of their interests.

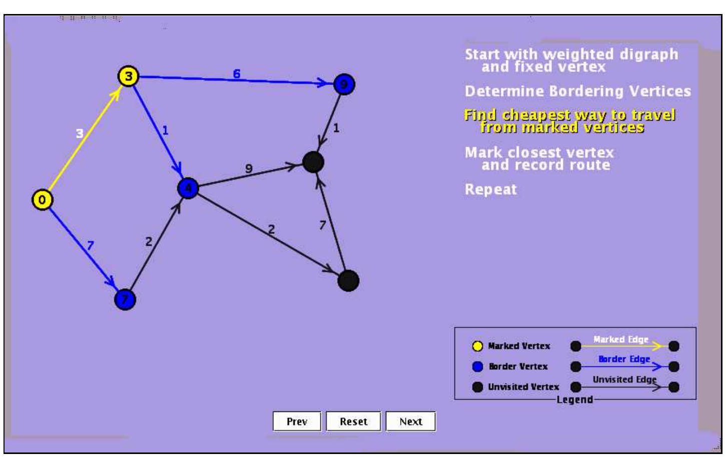
These projects rapidly became the focus of students' work, and by the end of the first week all non-lecture time was devoted to them. Some turned out remarkably well given the tight time frame and lack of prior background on the part of most of the students. All the projects can be found at http://merganser.math.gvsu.edu/david/reed03/projects/.

In addition to the lectures and projects, there were a number of special lectures associated with the program. Given its experimental nature, the program planners decided to err on the side of too many rather than too few. All were of high quality, but perhaps there were too many to be integrated into the rest of the program. One of the more unusual ones was that given by the well-known graphics expert Jim Blinn (Microsoft Research), who stopped by on his way to the SIGGRAPH conference and gave an amusing afternoon presentation on the films that he and Tom Apostol made several years ago with themes from mathematics and physics.

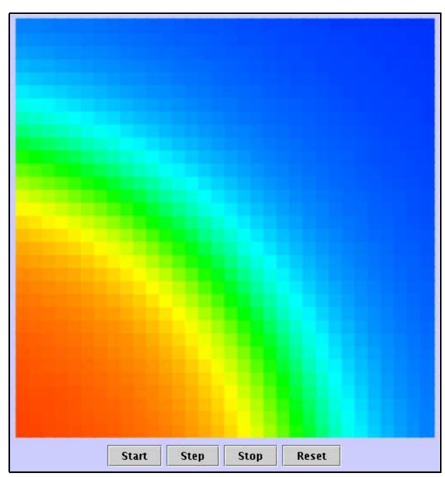
There were three evening lectures to which the general public was invited. The first was by Bart de Smit (Leiden University) on his work with Hendrik Lenstra (also at Leiden, formerly U. C. Berkeley) on their recent "completion" of M.C. Escher's *Print Gallery* lithograph. These fascinating ideas have received extensive publicity on the web, in major newspapers, and in various mathematical publications. De Smit's was unquestionably the best attended of the public lectures, perhaps due to a curious bit of advance publicity — the author of a "what's happening" column in *The Portland Mercury*, a hip local weekly, received a press release about the lecture from Reed and the MSRI team, and ran the following announcement in his column, nicely illustrating the perils and charms of popularizing mathematics:

> **SUPERNERDS** — *Tonight Bart de Smit reveals the secrets behind the recent "completion" of* **one of MC Escher's most mysterious works**, *"Print Gallery." Turns out the gorgeous, twisty painting needed an elaborate sequence of* **mathematical hoo-hah** *to be viewed correctly, and it took until now, decades after its appearance, for someone to figure it out. The results are baffling, and astounding. Learn how it all works tonight.*

The second public lecture was by John Sullivan (University of Illinois) on *Optimal Geometry*, and included a video about sphere

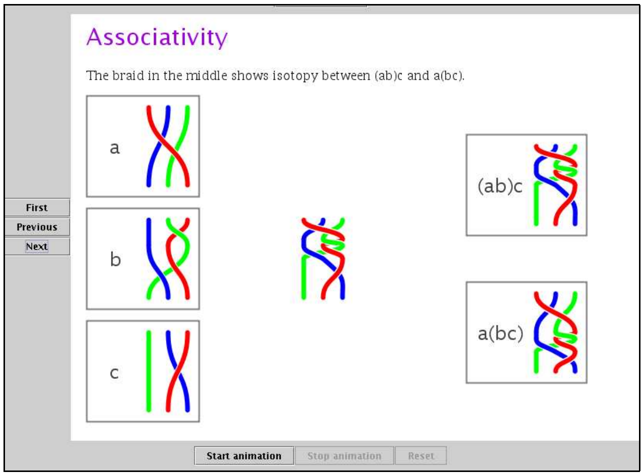


"Dijkstra's Algorithm" (Peter Dolan, University of Oregon).



"Adaptive Mesh Refinement" (Wenjun Ying, Duke University).

*Always glad to learn new words, the editor accepted this title much to the authors' surprise. Dictionary.com defines hoo-hah as "a fuss", but a google scan (especially one including the variant spelling hoohaw) will reveal that it can also be synonymous with "nonsense", "hullaballoo", "mayhem", and things unprintable. Take your pick.



"Braid Groups" (Maria Voloshina).

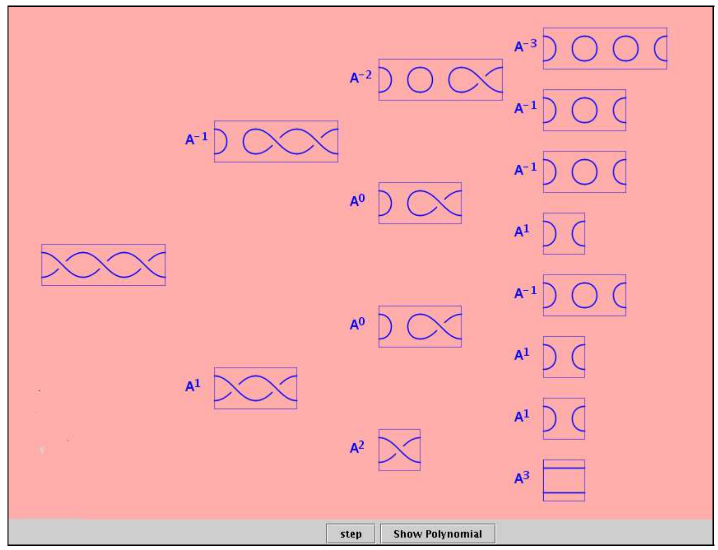
eversion. The third was by Yvan St. Aubin (University of Montreal) on mathematics and music, including some treatment of the technology of music reproduction. In addition St. Aubin gave a separate afternoon talk analyzing some of the graphics ideas used in his papers. Students particularly enjoyed his sophisticated critical discussion of his successes and failures, and some of the ideas were reflected in several of their final projects.

Reed College was perhaps an ideal place for the program. "Perfect ambiance", said one student evaluation. The only negative feedback were comments such as "hard beds, stiff sheets, otherwise great." The relative proximity of the dorms, food, lecture halls, and labs made socializing among the attendees and organizers easy and frequent. The generally pleasant environment of the labs and their ease of access, together with the secluded location of Reed, meant that students worked hard. It was easy to organize the two social outings, and on the second weekend the whole program took advantage of local scenery by taking a boat trip up the Columbia Gorge. These outings had a noticeable effect on the cohesiveness of the group.

Two aspects of the program were surprising to the organizers. First, while it was anticipated that only about two thirds of the population would fully appreciate Java and employ it in their projects, it turned out that animations in Java were deemed to be extremely powerful, and nearly all of the projects used Java in some way. Given the templates made available to students, and fairly narrow application range, even the most novice programmers were able to pick up on the language quickly and use it productively.

The other aspect was that almost all of the students felt the program to be intensely enjoyable, if exhausting. All worked from the morning until at least 9 PM, and some stayed through midnight and beyond in the labs From their feedback after the course, it was clear that many felt that the experience had a high value to their careers, and that they felt that many graduate students would profit from it. "Vital but stressful", "stressful at first, but forced us to accomplish something", "despite my lack of sleep, the pressure was positive" are some typical student comments.

This summer graduate program was definitely an experiment. Several things should have been done differently — questions of style and efficiency in using graphics should have been emphasized, projects should have been introduced even earlier, and outside lectures should have been fewer and more tightly tied to the rest of the program. Even so, a serendipitous combination of topic and of the commitment and enthusiasm of the students and organizers led to a memorable summer school that the organizers hope to replicate in the future.



"Jones Polynomials of Braids"
(Liam Watson, University of British Columbia).

Happy campers just back from the Columbia Gorge tour (photo by David Austin).

Combinatorics of a Successful Campaign

Jim Sotiros, MSRI's Development Director, has kindly provided detailed statistics on the Capital Campaign for the building addition and improvements. We thought they would be of interest to many readers.

Campaign Chairs: Jim Simons and Roger Strauch.

Campaign Cabinet: Elwyn Berlekamp, Robert Bryant, David Eisenbud, Gisela Fränken, David Hodges (Vice Chair), Julie Krevans, Doug Lind, Bob Megginson, Michael Singer, Jim Sotiros, and Ronald Stern.

Goal: $7,300,000

Total Raised: $8,299,224

Number of Gifts: 286

Smallest Gift: $10

Median Gift: $2,500

Largest Gift: $2,520,000

Mean Gift: $29,018

Gifts from Sponsoring Academic Institutions: 25

Gifts from Foundations: 6

Simons Challenge Grant: a $2,500,000 grant from Marilyn and Jim Simons, conditioned on our raising an equal amount from other donors.

Individual Gifts: 251 donors enabled us to meet the terms of the Simons Challenge Grant. 21 mathematicians contributed $5,000 and over, several of whom signed a letter asking friends to give $1,000 for naming a brick in the patio. 125 responded with a gift, and 50 pledged $1,000 for a patio brick.

Groundbreaking: Planned for June 2004

Completion of construction: Expected by September 2005

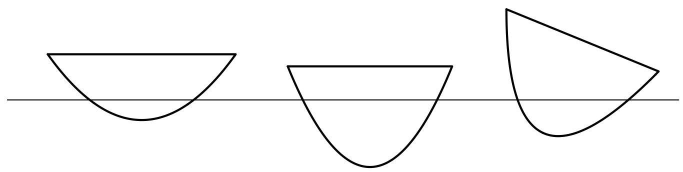
Rational Roots

Silvio Levy, *MSRI Editor*

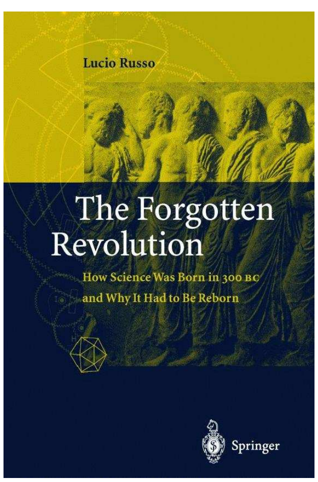
In 2002 and 2003 I had the pleasure and privilege of translating and editing a book that will be read by all mathematicians interested in the history of their discipline, and of science in general. It is Lucio Russo's *The Forgotten Revolution*, whose Italian original was extensively reviewed in the *Notices of the AMS* (http://www.ams.org/notices/199805/review-graffi.pdf).

The book deals with the birth of Science as we understand the term: not an accumulation of facts or philosophically based speculations, but an organized effort to model nature and apply such models, or *scientific theories*, to the solution of practical problems and to a growing understanding of nature. This happened in the third century BC, the time of Euclid, Archimedes, Eratosthenes, and many other scientists who are less familiar now but who, in the Renaissance, were quite well-known and whose rediscovery paved the way for the modern rebirth of Science. (Today few non-historians of science are aware that heliocentrism was introduced around 200 BC by Aristarchus of Samos, but this was universally known at the time of Copernicus and Galileo, whose writings referred to the Greek scientist and whose supporters and opponents called themselves pro- and anti-Aristarchus.)

The author carefully documents this "Forgotten Revolution", its often underestimated technological and social repercussions, and also its demise, all within the wider framework of ancient culture. He shows that, while classical Greece reached great perfection in art, in rhetoric, ans so on, it was in the subsequent *Hellenistic period*, from 300 to 100 BC, that we start seeing the conscious creation of new cultural forms, as attested by the appearance of not only new sciences (such as mechanics, hydraulics, optics, anatomy) but of many other disciplines as well: grammar, logic (going far beyond Aristotle, and not surpassed until the nineteenth century), literary criticism, urban planning, and even new art forms, such as the novel. Even the classical notion of a definition was abandoned in favor of a "modern" one, which regards a definition as an explicit convention and so allows the introduction of neologisms with a precise meaning — something that for us is essential and even obvious, but was not so from the end of Antiquity until the eighteenth or nineteenth centuries (depending on the subject). Likewise, Hellenistic scientific theories, unlike Aristotelian and medieval natural philosophy but like much of contemporary exact science, were explictly based on postulates and understood as models of a part of reality.



Archimedes' classification of the stability regime of a floating paraboloid of revolution as a function of its density and tallness gives an idea of the high level of Hellenistic science. Many works of Archimedes were lost because they were far too sophisticated to be understood in late Antiquity and the Middle Ages.



This wide-ranging book has now been published in English by Springer. A softcover edition will come out in February 2004, and you can preview the book at www.msri.org/~levy/files/russo-preview.

Forthcoming Workshops

Most of these workshops are offered under the auspices of one of the current programs (see Director's Notes starting on page 1). For more information about the programs and workshops, see http://www.msri.org/calendar.

March 15 to March 19, 2004: *Mathematical Neuroscience*, organized by Paul C. Bressloff, Jack D. Cowan (chair), G. Bard Ermentrout, Mary Pugh, and Terry J. Sejnowski.

March 22 to March 26, 2004: *Symplectic Geometry and Mathematical Physics*, organized by Denis Auroux, Dan Freed, Helmut Hofer, Francis Kirwan, and Gang Tian.

April 12 to April 16, 2004: *Algorithmic, Combinatorial and Applicable Real Algebraic Geometry*, organized by Lalo Gonzalez-Vega, Victoria Powers, and Frank Sottile.

May 23 to May 27, 2004: *Geometric Combinatorics*, organized by Francis Su.

June 14 to June 18, 2004: *Analysis of Algorithms*, organized by P. Flajolet, P. Jacquet, H. Prodinger, G. Seroussi, R. Sedgewick, W. Szpankowski, B. Vallée, and M. Weinberger.

June 22 to June 25, 2004: *Tenth Annual Conference for African American Researchers in the Mathematical Sciences*.

August 23 to August 27, 2004: *Introductory Workshop in Hyperplane Arrangements and Applications*, organized by Michael Falk, Peter Orlik (Chair), Alexander Suciu, Hiroaki Terao, and Sergey Yuzvinsky.

September 27 to October 1, 2004: *Recent Progress in Dynamics*, organized by Michael Brin, Boris Hasselblatt (chair), Gregory Margulis, Yakov Pesin, Peter Sarnak, Klaus Schmidt, Ralf Spatzier, Robert Zimmer.

October 4 to October 8, 2004: *Topology of Arrangements and Applications*, organized by Daniel C. Cohen, Michael Falk (chair), Peter Orlik, Alexandru Suciu, Hiroaki Terao, Sergey Yuzvinsky.

November 1 to November 5, 2004: *Combinatorial Aspects of Hyperplane Arrangements*, organized by Philip Hanlon, Peter Orlik, Sasha Varchenko.

January 10 to January 14, 2005: *Introductory Workshop in Probability, Algorithms and Statistical Physics*, organized by David Aldous, David Donoho, Yuval Peres.

Current and Recent Workshops

Most recent first. For information see http://www.msri.org/calendar.

February 23 to February 27, 2004: *Topology and Geometry of Real Algebraic Varieties*, organized by Viatcheslav Kharlamov, Boris Shapiro, and Oleg Viro.

February 9 to February 13, 2004: *Genetics of Complex Disease*, organized by Jun Liu, Mary Sara McPeek, Richard Olshen (chair), David O. Siegmund, and Wing Wong.

January 12 to January 16, 2004: *Introductory Workshop in Topological Aspects of Real Algebraic Geometry*, organized by Selman Akbulut, Grisha Mikhalkin, Victoria Powers, Boris Shapiro, Frank Sottile, and Oleg Viro.

December 1 to December 5, 2003: *Geometric Analysis*, organized by Ben Chow, Peter Li, Richard Schoen (chair), and Richard Wentworth.

November 17 to November 21, 2003: *Combinatorial and Discrete Geometry*, organized by Jesús A. De Loera, Jacob E. Goodman, János Pach and Günter M. Ziegler.

November 9 to November 13, 2003: *Floer homology for 3-manifolds*, organized by Yasha Eliashberg, Robion Kirby and Peter Kronheimer.

October 13 to October 17, 2003: *Mathematical Foundations of Geometric Algorithms*, organized by Pankaj Agarwal, Herbert Edelsbrunner, Micha Sharir, and Emo Welzl.

September 27 to September 28, 2003: *Texas Southern University/MSRI Workshop on Modern Mathematics: An Introduction to 2004–05 Programs at the Mathematical Sciences Research Institute*, organized by Nathaniel Dean and Robert Megginson.

August 20 to August 29, 2003: *Introductory Workshop in Discrete and Computational Geometry*, organized by Jesús A. De Loera, Herbert Edelsbrunner, Jacob E. Goodman, János Pach, Micha Sharir, Emo Welzl, and Günter M. Ziegler.

August 11 to August 20, 2003: *Von Neumann Symposium on Complex Geometry, Calibrations, and Special Holonomy*, organized by Robert Bryant (Co-chair), Simon Donaldson, H. Blaine Lawson, Richard Schoen, and Gang Tian (Co-chair).

MSRI Book Series

Hot off the press!

Modern Signal Processing, edited by Dan Rockmore and Dennis Healy Jr., vol. 46.

Several more books are scheduled to come out in 2004:

Algorithmic Number Theory, edited by Joe Buhler and Peter Stevenhagen, vol. 44.

Electromagnetic Theory and Computation: A Topological Approach, by Paul Gross and Robert Kotiuga, vol. 48.

Rankin L-series, edited by Henri Darmon and Shouwu Zhang, vol. 49.

Finsler Geometry, edited by D. Bao, R. Bryant, S.-S. Chern, and C. Shen, vol. 50.

Commutative Algebra, edited by Craig Huneke et al., vol. 51.

See http://www.msri.org/publications/books for details on published books and full text for many of them.

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Phone area code 510. Add *@msri.org* to email addresses.

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MSRI
Mathematical Sciences Research Institute

17 Gauss Way, Berkeley CA 94720-5070
510.642.0143 • FAX 510.642.8609 • www.msri.org
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