Fall 2004

EMISSARY

Mathematical Sciences Research Institute

www.msri.org

Notes from the Director

David Eisenbud

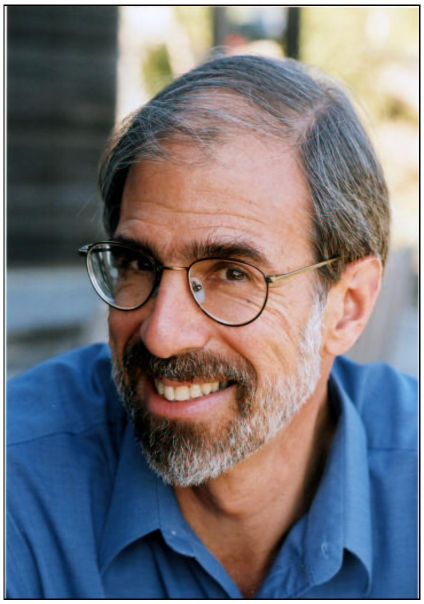

Photo courtesy of George Csicsery

Stability in Change

Danke, daß die Gunst der Musen
Unvergängliches verheißt,
Den Gehalt in deinem Busen
Und die Form in deinem Geist.

— from *Dauer und Wechsel*, by J. W. von Goethe

I keep thinking that there will come a semester at MSRI like the one before it, but this just doesn't happen. The programs, of course, are designed to vary over a broad spectrum of pure and applied mathematics, and this year, with *Hyperplane Arrangements and Applications* in the fall, *Mathematical, Computational and Statistical Aspects of Image Analysis* and *Probability, Algorithms and Statistical Physics* in the spring, is no exception. These, together with the research workshops (*Recent Progress in Dynamics*, a joint workshop with the Clay Mathematics Institute, and *Mathematical and Statistical Methods for Visualization and Analysis of High Dimensional Data* this semester), remain our primary activities, and each brings its own personality to MSRI: they're as different as one's children.

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MAA and MSRI Join Forces

The Mathematical Association of America and MSRI collaborated in a novel way this May by cosponsoring a workshop May 23–27 on Geometric Combinatorics through the MAA's Professional Enhancement Program (PREP). The PREP program is funded by the NSF and enables faculty in the mathematical sciences to respond to rapid and significant developments that can impact undergraduate mathematics.

The Geometric Combinatorics workshop, led by Francis Edward Su of Harvey Mudd College, was an outgrowth of the Fall 2003 MSRI program on Discrete and Computational Geometry in which Su was a member. The goal of the workshop was to introduce participants to some of the interesting mathematics in geometric combinatorics and discrete geometry, with a view towards bringing some of these ideas into the undergraduate curriculum and fostering research projects by participants and their students. For example, many of the ideas in the field could be used to enrich a wide variety of undergraduate courses, such as discrete mathematics, linear algebra, and geometry. Some of the material reflected recent research from the Fall 2003 program at MSRI.

Participants were given a set of "PREParatory problems" to think about before they arrived for the workshop. These were a list of problems which related to concepts that would be covered in the workshop. By doing (or at least attempting) these problems, participants would better appreciate the motivation for learning certain concepts in geometric combinatorics.

In this 5-day workshop, there were 24 faculty participants in the workshop from all types of institutions and at all stages in their careers. The workshop program involved a mixture of 15 lectures and group discussion time. In the lectures, Su introduced a selection of topics in geometric combinatorics, to give them a sense of the subject and equip them to do further reading. Topics included combinatorial convexity, set intersection theorems, triangulations, polytopes, Ehrhart polynomials, phylogenetic trees, tropical geometry, and combinatorial fixed point theorems. Su also pointed out several ideas that would find natural homes in certain courses in the undergraduate curriculum, and gave them suggestions for undergraduate projects.

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Notes from the Director

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Change can even restore the situation a few changes before. Hugo Rossi was Deputy Director in 1997–99, and returned in that role in 2003. Our Institute is a much richer place for projects like the Math Circles he's championed. Matt Miller has come on board as Associate Director for the Fall. It's a delight to work with them.

There are also more mundane developments, some rarely noticed by MSRI's scientific visitors, that make semesters unique and exciting. Here are a few current ones:

Telegraph Avenue

If you haven't visited MSRI recently, you might get a surprise: We're in temporary quarters, on the second and sixth floors at 2850 Telegraph Avenue, while our own building on top of the hill at 17 Gauss Way is renovated. (Addresses change more often than homes for us: 17 Gauss Way is the same place as 1000 Centennial Drive. When we got the opportunity to name our access road and give ourselves a number, we chose 17 Gauss Way in honor of the youthful Gauss's first major discovery, the constructibility of the regular 17-gon.) There are tradeoffs: our current space, like our usual home, has plenty of big windows (with a couple of pine trees that come right up to the sixth floor and beyond), and even views of the Golden Gate Bridge. Many offices are much larger... but office space has to be shared more ways. The main lecture hall is not as good as we were used to... but we have an additional seminar room that's quite nice. Most of the members and workshop visitors seem to find these temporary quarters a pleasant enough compromise, though there's no question we'll be glad to get home. On the other hand, there are some 20 interesting restaurants within a ten-minute walk; *that* will be hard to leave.

NSF Renewal and Overall Funding

We are now in the late stages of an NSF renewal review. We submitted our latest proposal last May, and the Site Visit has just occurred. The Division of Mathematical Sciences (DMS) has told us it will probably make funding recommendations this December, for action by the National Science Board soon afterwards.

These events are no surprise: With even moderate optimism, one could have foreseen them at the founding of MSRI, some 22 years ago. But one might not have foreseen (though it was discussed) the rest of the funding picture. At its founding, the Institute derived about 98% of its operating support from the DMS grant (the rest came from the Academic Sponsors). In constant dollars the current amount of the DMS grant is actually a little bit (but very little) less than in the beginning. However, the Institute has been able to find new sources of support for mathematics, public and private, so that in 2000 the proportion of support from the DMS was just 73%, and this year it reached 68%.

By the way, these numbers do not include MSRI's capital campaign for the new building. Including pledges, this totals about $10,000,000 so far, with a long list of donors, including lots of you, the readers of this newsletter — to you our heartfelt thanks!

World Digital Mathematics Library

Among the more speculative projects through which MSRI works to serve the mathematical sciences is a grant proposal to the Gordon and Betty Moore Foundation to digitize a broad swathe of the older mathematical journal literature and make it freely available as part of a nascent World Digital Mathematics Library. The International Mathematical Union's Committee on Electronic Information and Computing has laid much of the basis for such an effort, and there are several projects underway in the US and abroad (Euclid, Emani, NUMDAM are good search terms). If the proposal is successful, the MSRI project will add a great deal to these. MSRI's goal is to provide service to mathematicians by ensuring free access to records including high-quality JPEGs, optical character recognition for searchability, and high-quality bibliographic data for document linking, allowing users to click from paper to paper across the history of mathematics. Even for those sitting at one of the top five mathematical libraries, where all these papers might reside, the ability to search and browse in this way would be completely novel; I think it might bring as big a change, again, in the way we do research as the other internet services have... I'll tell you more about this in a future newsletter if it comes to fruition!

And More...

Many other novel things are starting or being planned: Puzzles On Wheels (see page 6) went live on half the buses in San Francisco on October 4; Deborah Loewenberg Ball, Herb Clemens, and Jim Lewis are working on a conference on Mathematical Knowledge for Teaching; new public events, including perhaps one with Matt Groening, creator of the Simpsons, are in preparation. And this is only part of the list...

The purpose that unites these disparate activities is benefit to the mathematical sciences community. As a byproduct, they make MSRI an interesting and challenging place to work!

MAA and MSRI Join Forces

(continued from page 1)

In the group discussion time, participants discussed ways in which they would incorporate the material into their coursework, as well as ideas that they may wish to pursue in their research or research with undergraduates. A highlight of the workshop was the participant presentations on Friday afternoon, in which they shared their ideas to the whole group. Several participants took seriously the challenge of solving some of the problems that were posed, while others had great ideas on how they would want to incorporate material into their courses.

All in all, participants had a great time in the workshop and left armed with some new mathematics and new ideas for their teaching and research. In the future, MSRI and MAA hope to team up to provide more such workshops related to current or future program themes at MSRI. For more information about PREP programs, including this workshop, see http://www.maa.org/prep/.

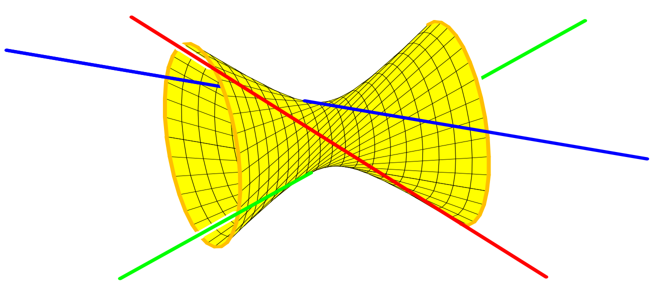
Tropical Interpolation

Frank Sottile, Texas A&M University

Everyone knows that two points determine a line, and many who have studied geometry know that five points on the plane determine a conic. In general, if you have m random points in the plane and you want to pass a rational curve of degree d through all of them, there may be no solution to this interpolation problem (if m is too big), or an infinite number of solutions (if m is too small), or a finite number of solutions (if m is just right). It turns out that "m just right" means $m = 3d-1$ ($m = 2$ for lines and $m = 5$ for conics).

A harder question is, if $m = 3d-1$, *how many* rational curves of degree d interpolate the points? Let's call this number N_d, so that $N_1 = 1$ and $N_2 = 1$ because the line and conic of the previous paragraph are unique. It has long been known that $N_3 = 12$, and in 1873 Zeuthen showed that $N_4 = 620$. That was where matters stood until about ten years ago, when Kontsevich and Manin used associativity in quantum cohomology to give an elegant recursion for this number.

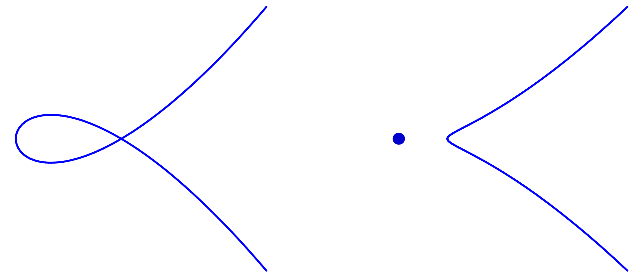
The research themes in the MSRI winter 2004 semester on Topological Aspects of Real Algebraic Geometry included enumerative real algebraic geometry, tropical geometry, real plane curves, and applications of real algebraic geometry. All are woven together in the unfolding story of this interpolation problem, a prototypical problem of *enumerative geometry*, which is the art of counting geometric figures determined by given incidence conditions. Here is another such problem: how many lines in space meet four given lines? To answer this, note that three lines lie on a unique doubly-ruled hyperboloid.



The three lines lie in one ruling, and the second ruling consists of the lines meeting the given three lines. Since the hyperboloid is defined by a quadratic equation, a fourth line will meet it in two points. Through each of these two points there is a line in the second ruling, and these are the two lines meeting our four given lines.

Enumerative geometry works best over the complex numbers, as the number of real figures depends subtly on the configuration of the figures giving the incidence conditions. For example, the fourth line may meet the hyperboloid in two real points, or in two complex conjugate points, so there are either two or no real lines meeting all four. Based on many examples, we have come to expect that any enumerative problem may have all of its solutions be real.

Another neat problem of enumerative geometry is the 12 rational curves interpolating 8 points in the plane. Most mathematicians are familiar with the nodal (rational) cubic shown on the left below. There is another type of real rational cubic, shown on the right.

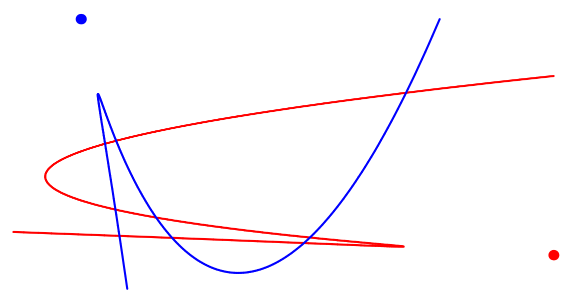


In the second curve, two complex conjugate branches meet at the isolated point. Kharlamov and Degtyarev showed that, if we let $N(\tau)$ be the number of real curves of type τ interpolating 8 given points,

$$N(\propto) - N(\cdot\!<) = 8\,.$$

Their elementary topological methods are described in my article at www.math.tamu.edu/~sottile/stories/real_cubics.html.

Since there are at most 12 such curves, $N(\propto) + N(\cdot\!<) \le 12$, and so there are 8, 10, or 12 real rational cubics interpolating 8 real points in the plane, depending upon the number (0, 1, or 2) of cubics with an isolated point. Thus there will be 12 real rational cubics interpolating any 8 of the 9 points of intersection of the two cubics below.



Welschinger, who was an MSRI postdoc last winter, developed this example into a theory. In general, the singularities of a real rational plane curve C are nodes or isolated points. The parity of the number of nodes is its *sign* $\sigma(C) \in \{\pm 1\}$. Given $3d-1$ real points in the plane, Welschinger considered the quantity

$$\left| \sum \sigma(C) \right| ,$$

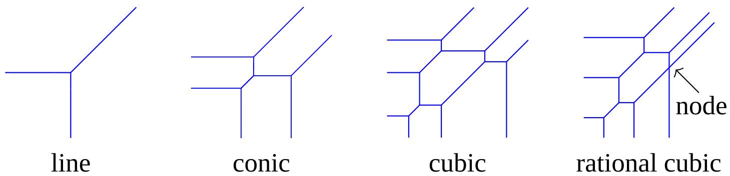
the sum over all real rational curves C of degree d that interpolate the points. He showed that this weighted sum does not depend upon the choice of points. Write W_d for this invariant of Welschinger. For example, we just saw that $W_3 = 8$.

This was a breakthrough, as W_d was (almost) the first truly nontrivial invariant in enumerative real algebraic geometry. Note that W_d is a lower bound for the number of real rational curves through $3d-1$ real points in the plane, and $W_d \le N_d$.

Mikhalkin, who was an organizer of the semester, provided the key to computing W_d using tropical algebraic geometry. This is the geometry of the tropical semiring, where the operations of max and $+$ on real numbers replace the usual operations of $+$ and $\cdot$. A tropical polynomial is a piecewise linear function of the form

$$T(x,y) \;=\; \max_{(i,j)\in\Delta} \{x\cdot i + y\cdot j + c_{i,j}\},$$

where $\Delta \subset \mathbb{Z}^2$ is the finite set of exponents of T and $c_{i,j} \in \mathbb{R}$ are its coefficients. A tropical polynomial T defines a tropical curve, which is the set of points (x,y) where $T(x,y)$ is not differentiable. Here are some tropical curves:



The degree of a tropical curve is the number of rays tending to infinity in either of the three directions West, South, or North East. A tropical curve is rational if it is a piecewise-linear immersion of a tree. Nodes have valence 4.

Mikhalkin showed there are only finitely many rational tropical curves of degree d interpolating $3d-1$ generic points. While the number of such curves does depend upon the choice of points, Mikhalkin attached positive multiplicities to each tropical curve so that the weighted sum does not, and is in fact equal to N_d. He also reduced these multiplicities and the enumeration of tropical curves to the combinatorics of lattice paths within a triangle of side length d.

Mikhalkin used a correspondence involving the map

$$\mathrm{Log} : (\mathbb{C}^*)^2 \longrightarrow \mathbb{R}^2$$

defined by $(x,y) \mapsto (\log|x|, \log|y|)$, and a certain 'large complex limit' of the complex structure on $(\mathbb{C}^*)^2$. Under this large complex limit, rational curves of degree d interpolating $3d-1$ points in $(\mathbb{C}^*)^2$ deform to 'complex tropical curves', whose images under Log are ordinary tropical curves interpolating the images of the points. The multiplicity of a tropical curve T is the number of complex tropical curves which project to T.

Following this correspondence, Mikhalkin attached a real multiplicity to each tropical curve and showed that if the tropical curves interpolating a given $3d-1$ points have total real multiplicity N, then there are $3d-1$ real points which are interpolated by N real rational curves of degree d. This real multiplicity is again expressed in terms of lattice paths.

What about Welschinger's invariant? In the same way, Mikhalkin attached a signed weight to each tropical curve (a tropical version of Welschinger's sign) and showed that the corresponding weighted sum equals Welschinger's invariant. As before, this tropical signed weight may be expressed in terms of lattice paths.

During the semester at MSRI, Itenberg, Kharlamov, and Shustin used Mikhalkin's results to estimate Welschinger's invariant. They showed that $W_d \geq \frac{1}{3}d!$, and also that

$$\log W_d = \log N_d + O(d),$$
$$\log N_d = 3d\log d + O(d).$$

Thus at least logarithmically, *most* rational curves of degree d interpolating $3d-1$ real points in the plane are real.

There are two other instances of this phenomenon of lower bounds, the first of which predates Welschinger's work. Suppose that d is even and let $W(s)$ be a real polynomial of degree $k(d-k+1)$. Then Eremenko and Gabrielov showed that there exist real polynomials $f_1(s), \ldots, f_k(s)$ of degree d whose Wronski determinant is $W(s)$. In fact, they proved a lower bound on the number of k-tuples of polynomials, up to an equivalence. Similarly, while at MSRI, Soprunova and I studied sparse polynomial systems associated to posets, showing that the number of real solutions is bounded below by the sign-imbalance of the poset. Such lower bounds to enumerative problems, which imply the existence of real solutions, are important for applications.

For example, this story was recounted over beer one evening at the MSRI Workshop on Geometric Modeling and Real Algebraic Geometry in April 2004. A participant, Schicho, realized that the result $W_3 = 8$ for cubics explained why a method he had developed always seemed to work. This was an algorithm to compute an approximate parametrization of an arc of a curve, via a real rational cubic interpolating 8 points on the arc. It remained to find conditions that guaranteed the existence of a solution which is close to the arc. This was just solved by Fiedler-Le Touzé, an MSRI postdoc who had studied cubics (not necessarily rational) interpolating 8 points to help classify real plane curves of degree 9.

The Mission at the Mission

On October 8th, MSRI visited classrooms at Mission High School in San Francisco to meet and work with students and teachers on mathematical puzzles now posted on city buses and on the MSRI website (see page 6). Deputy Director Hugo Rossi and Associate Director Matt Miller (photo, right) exchanged ideas and problem-solving strategies with the students in Angela Torres' class. "My students really enjoyed having visitors," remarked Torres afterward. "Anything to continue their excitement about math is wonderful!" Photo by Marianne Smith.

Groundbreaking Party

Jim Sotiros, MSRI

On June 10, over a hundred MSRI friends and supporters gathered to celebrate the success of MSRI's first capital campaign and the groundbreaking for the new building and renovation project. They were greeted by a huge THANK YOU! banner on the east side of the building, a party canopy, hundreds of balloons, delicious catered snacks and drinks, a special printed program, the sounds of the Brass West ensemble, and the remarkably talented juggler Jack Kalvan and his assistant. Indoors there were renderings of the new building and information on the campaign and construction.

David Eisenbud began the official program by welcoming everyone, thanking them for their support, and introducing the speakers. Campaign co-chairs Jim Simons and Roger Strauch, MSRI trustee Will Hearst, and Beth Burnside, UC Berkeley Vice-Chancellor for Research, each made brief comments. Simons, after whom the new auditorium will be named, told us how he decided to give the $2.5 million challenge grant that launched the campaign. Also seated under the canopy were Elwyn Berlekamp and Doug Lind, MSRI trustees; Ed Denton, UC Berkeley's Vice-Chancellor for Capital Projects; Cal Moore, co-founder of MSRI, Al Thaler, longtime NSF Program Officer; Bill Glass, the project architect, and Michele Wagner from the NSA. All donned special MSRI hard hats.

Joyce Lashof offered a reading of Edna St. Vincent Millay's poem *Euclid Alone Has Looked on Beauty Bare*.

Simons, Strauch, Hearst, Glass, Denton, Berlekamp and Eisenbud then dug in with engraved chrome shovels, and turned the first earth for the construction project. Many of the guests followed their example, breaking ground with the ceremonial shovels.

Guests received a souvenir bookmark celebrating the forthcoming Austine McDonnell Hearst Library. The new and expanded library is made possible by Will Hearst's generosity and is named after his mother. Donors to the capital campaign adjourned to the building for a Museion dinner, featuring a lecture by Richard C. Atkinson on *College Admissions and the SAT* and music by Pete Muller.

Many thanks to Joe Buhler and everyone else who worked to make the event a great success. Thanks to everyone who came, and to everyone who was there in spirit!

Capital Campaign Committee: James H. Simons, Co-Chairman; Roger Strauch, Co-Chairman; David A. Hodges, Vice Chairman; Elwyn R. Berlekamp; David Forney; Douglas Lind; Ronald J. Stern; Robert Bryant.

Building Committee (advisory for construction planning): Douglas Lind, Chairman; Richard Brualdi; Gisela Fränken; Silvio Levy; Dusa McDuff; Robert Megginson; Cal Moore; Carol Wood.

Building Oversight Committee (advisory for oversight of the construction): David A. Hodges, Chairman; Douglas Lind; Sandor Straus.

Photos by Sheila Newbery. More at www.sheilanewbery.com/msri-groundb/ and www.msri.org/groundbreaking/, the latter featuring photos by George Csicsery.

Puzzles Column

Elwyn R. Berlekamp and Joe P. Buhler

1. One of the charms of writing this column is corresponding with people who have comments or improvements on the puzzles that we present. Here is a second order version of this: a reader's variation of a puzzle that was itself a reader-proposed variation of an earlier puzzle.

To facilitate comparison (and provide implicit hints) we recall the first two versions before giving the new one. Last year we asked the following:

> 100 ants on a meter stick begin traveling to the right or left at one meter per minute. Colliding ants instantaneously reverse direction; when an ant reaches either end of the meter stick it falls off. What is the longest amount of time one must wait to be sure that no ants remain?

(The origin of this puzzle isn't clear; it can be found on several web sites.)

John Guilford (via Stan Wagon) proposed the following variation, which appeared here last spring:

> 100 ants are placed uniformly randomly on a one-meter stick, and an extra ant, Alice, is placed precisely at the center. Each ant begins moving right or left at 1 meter per minute (the direction being chosen randomly), and instantly reverses directions on a collision as in the earlier problem. But when an ant reaches one of the ends of the stick, it instantly reverses direction. What is the probability that after 1 minute Alice is again exactly at the center of the meter stick?

Finally, Matthew Hubbard writes as follows (we paraphrase):

> I enjoyed working on The Ant Problem in this quarter's Emissary from MSRI. I also solved a variant where Alice and the other ants are on a circle of circumference 1 meter; the question and conditions are otherwise the same. Is the solution to this problem well known? A lot of the thinking is similar to the solution of the stick problem, but the answer is slightly different.

2. Solve the following cryptogram:

```
   MAAAMS
+    SIAM
+ MEETING
=
       IN
+ ATLANTA
+      01
+      06
+    2005
```

A solution is of course a one-to-one mapping from the letters that occur to decimal digits such that the indicated equation is true. Leading zeroes are not allowed.

3. A set A of positive integers is said to have density d if the fraction of integers in $[1, n]$ that are in A approaches d as n goes to infinity, i.e.,

$$d = \lim_{n\to\infty} A(n)/n,$$

where $A(n)$ is the cardinality of the set of elements in A of size at most n.

Find two sets of density one-half whose intersection does not have a density, i.e., the relevant limit above does not exist.

4. For positive real x less than 1, define

$$f(x) = x - x^2 + x^4 - x^8 + x^{16} - \cdots$$

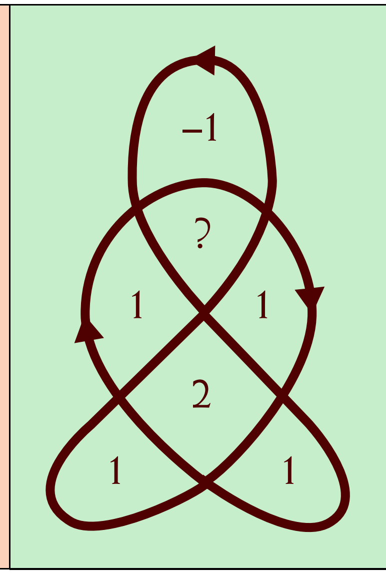
Does $f(x)$ have a limit as x approaches 1 from below? If so, what is the limit?

(We thank Noam Elkies for this question, which he posted to sci.math.research recently.)

Puzzles on Wheels

From October 2004 through February 2005, San Francisco bus riders will enjoy puzzling over a mathematical problem displayed among the ads for health insurance and instant rice. They — and anyone else who wants to participate — have a chance to win $100 by submitting the correct answer online.

This city-wide effort to bring fun and challenging mathematics to citizens of all ages, especially school-age children, is funded as a pilot project by the National Science Foundation. See www.msri.org/pow/ to look at the current problem! (The picture shown here is for the one that will go up in February.)



Forthcoming Workshops

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

December 9 to December 13, 2004: *Mathematical and Statistical Methods for Visualization and Analysis of High Dimensional Data*, organized by Gunnar Carlsson, Susan Holmes, Persi Diaconis.

December 16 to December 18, 2004: *Mathematical Circles and Olympiads*, organized by Hugo Rossi, Tatiana Shubin, Zvezdelina Stankova, Paul Zeitz (see below).

January 21 to January 22, 2005: *MSRI Workshop for Women in Mathematics: Introduction to Image Analysis*, organized by Ruzena Bajcsy, Jana Kopecka, Kathryn Leonard.

January 24 to January 28, 2005: *Introductory Workshop in Mathematical, Computational and Statistical Aspects of Image Analysis*.

January 31 to February 4, 2005: *Markov chains in algorithms and statistical physics*, organized by Fabio Martinelli, Alistair Sinclair, Eric Vigoda.

February 7 to February 11, 2005: *Emphasis Week on Neurobiological Vision*, organized by David Donoho and Bruno Olshausen.

February 21 to February 25, 2005: *Emphasis Week on Learning and Inference in Low and Mid Level Vision*, organized by Andrew Blake and Yair Weiss.

March 7 to March 11, 2005: *Phase Transitions in Computation and Reconstruction*, organized by Dimitris Achlioptas, Elchanan Mossel, Yuval Peres.

March 21 to March 25, 2005: *Pattern Classification, Learning Theory, and Object/Scene Recognition*, organized by Don Geman, Jitendra Malik, Pietro Perona, Cordelia Schmid.

April 18 to April 22, 2005: *Models of Real-World Random Networks*, organized by David Aldous, Claire Kenyon, Jon Kleinberg, Michael Mitzenmacher, Christos Papadimitriou, Prabhakar Raghavan.

Current and Recent Workshops

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

November 5 to November 6, 2004: *2004 Blackwell-Tapia Conference*, organized by Carlos Castillo-Chavez, Mark Green, William Massey, Herbert Medina, Robert Megginson, Richard Tapia, Stephen Wirkus.

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

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.

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.

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.

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

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.

New Awards Honor MSRI Founder, Associates

陈 省 身 A newly established and generous award in Mathematics, carrying a purse of roughly US$1,000,000, was awarded in 2004 to MSRI's founder and longtime UC Berkeley mathematician, Shiing-Shen Chern, who also founded and directed the Nankai Institute of Mathematics in Tianjin, China.

The Shaw Prize in Mathematics, administered by the Shaw Foundation in Hong Kong, is one of three awards established under the auspices of Mr. Run Run Shaw in November 2002. Prof. Chern received the award "for his initiation of the field of global differential geometry and his contribution to the development of mathematics in the last 60 years" (he is now 93).

BERKELEY MATH CIRCLE

Zvezdelina Stankova of Mills College (Oakland, CA) and Francis Edward Su of Harvey Mudd College (Claremont, CA) have won the Mathematical Association of America's first Henry L. Alder Award, which honors Ph.D. mathematicians of recent vintage who are also "extraordinarily successful teachers whose influence extends beyond the classroom".

Emissary readers remember Zvezdelina from her time as an MSRI postdoc and her key involvement with many math education initiatives, such as the Bay Area Math Olympiads (BAMO) and Circles, and the International Mathematical Olympiads. In December she will be leading, together with Hugo Rossi, Tatiana Shubin and Paul Zeitz, an MSRI workshop titled *Math Circles and Olympiads*, which will bring together dozens of educators involved in such activities and jump-start the creation of a nationwide network of Math Circles and of materials and resources for new Circles. For details see www.msri.org/calendar/workshops/WorkshopInfo/295/show_workshop.

Francis Su was an MSRI member and workshop organizer in the fall of 2003 and the spring of 2004 (see "MAA and MSRI Join Forces" on front page).

MSRI Staff Roster

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

Scientific Staff

David Eisenbud, Director, 642-6142, *de*
Hugo Rossi, Deputy Director, 643-6040, *rossi*
Matthew Miller, Associate Director, 643-6467, *miller*
Robert Osserman, Special Projects Director, 643-6019, *osserman*
Silvio Levy, Editor and Librarian, 643-1716, *levy*

Administrative Staff

Gisela Fränken, Chief Financial and Administrative Officer, 643-8321, *giselaf*

Michelle Antonio, Program/Administrative Assistant, 642-0144, *mya*
Max Bernstein, Network Engineer, 643-6070, *max*
Jackie Blue, Housing and Visa Officer, 643-6468, *jblue*
Marsha Borg, Facilities & Administrative Coordinator, 642-0143, *marsha*
Anca Maria Cunningham, Library Assistant, 643-1716, *anca*
Nathaniel Evans, Accounting Manager, 642-9238, *nate*
Arne Jensen, Network Engineer/Webmaster, 643-6049, *arne*
Chivly Krouch, Program Coordinator, 642-0555, *ck*
Larry Patague, Head of Computing, 643-6069, *larryp*
Anne Brooks Pfister, Assistant to the Director, 642-0448, *annepf*
James T. Sotiros, Director of Development, 643-6056, *jsotiros*
Sheng Zhu, Accounts Payable/Member Relations, 642-9798, *szhu*

Come to the Institutes' Open House at the January 2005 Joint Meetings in Atlanta!
Wed, January 5, 2004
Hyatt Regency
5:30pm to 8:00pm
Regency VII Room

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