MATH MATTERS

Department of Mathematics ♦ Cornell University ♦ Ithaca NY November 2002

Letter From The Chair, Kenneth S. Brown

"I thought you might like to open this one yourself," said my assistant, Linda Clasby, handing me a sealed envelope and a letter opener. The letter was from Bill Thurston, who wrote to accept our offer of a professorship. (See accompanying article.) Thurston, who is widely regarded as one of the greatest mathematicians of the 20th century, is the first Fields Medalist to ever hold a position at Cornell. He has inspired a generation of mathematicians, and we are thrilled to have him join our faculty.

I became department chair on July 1 when John Smillie stepped down after three years of service to the department. I thought the summer would be a quiet time when I could learn the mechanics of being chair in a leisurely way. In early August, however, after one month on the job, I received an e-mail from Thurston saying that he might be interested in coming to Cornell. He asked me what I could tell him about the future plans and prospects for the department. I'd like to devote the rest of this letter to telling you, the friends and alumni of the Cornell Mathematics Department, my current view of the future plans and prospects for the department.

First, we are very lucky to have three outstanding tenure-track assistant professors: Yuri Berest, Irena Peeva, and Ravi Ramakrishna. The future of this department depends on our ability to recruit and retain young mathematicians of this caliber. In September the tenured faculty met to consider the promotion of Ravi to associate professor with tenure, and we voted unanimously to do so. Ravi is a number theorist who has won awards both for his research and for his teaching. (See page 2). He contributes a tremendous amount to our department, and we are doing everything we can to keep him.

Three tenure-track assistant professors are not enough. We need more young people, and I will continually be on the lookout for promising young mathematicians who might be interested in coming here. I will also be vigilant for targets of opportunity of any age (such as Thurston). The two goals are quite compatible; indeed, having people like Thurston on the faculty can only help when we are recruiting young mathematicians.

Another goal is to maintain strength in those areas where we are already strong. The most obvious such area is probability, where we are arguably number one in the country. We were recently weakened when Harry Kesten, one of the leading probabilists in the world, retired on June 30 after 40 years at Cornell. Fortunately, we were able to hire Greg Lawler (who came here from Duke last year), and we remain strong.

We have been fortunate in all of our recruiting efforts to have strong support and encouragement from the dean and provost. Although we are about to get a new president and a new dean, I will work hard to maintain a cooperative relationship with the college and university administrations as we continue to try to strengthen the department.

The VIGRE program, coordinated by Rick Durrett, has been a shot in the arm for us. (See page 3.) I hope the interdisciplinary aspect of it will help us increase cooperative activities with other departments and colleges. For example, I expect to have joint projects with the newly formed Department of Biological Statistics and Computational Biology (of which Rick Durrett and John Guckenheimer from Mathematics are members). We are also beginning to have some interaction with the Office of Computing and Information Science. In fact, Thurston will have a joint appointment in CIS, thanks to Dean Bob Constable.

Finally, let me say a few words about our teaching program. Although everything mentioned above has an impact on teaching, I would like to emphasize that we are full supporters of the provost's stated goal of making Cornell number one in undergraduate teaching among research universities. Director of Undergraduate Studies Birgit Speh is leading the effort to improve our undergraduate curriculum. We are creating new courses, revising old ones, and rethinking how we teach. In addition, we are responding to the national teacher crisis by strengthening Cornell's program in mathematics teacher education. We hope to create a program that will attract more of our strong mathematics majors into the teaching profession.

In closing, let me thank all of you for your past support and ask for your continued support as we work toward our goals.

Bill Thurston Joins Cornell Faculty

We are pleased to announce that William P. Thurston has accepted an offer of a professorship in the Mathematics Department, with a joint appointment in the Faculty of Computing and Information Science, starting in the fall of 2003.

Thurston has received many honors and awards during his career, the most important of which is the Fields Medal. This prestigious international prize was awarded to Thurston by the International Mathematical Union in 1982. It is the highest honor that a mathematician can receive. (There is no Nobel Prize in mathematics.)

According to Cornell Mathematics Professor John Hubbard, who is just completing a book about some of Thurston's work, Thurston is a fantastic geometer who completely transformed how a whole generation thinks about geometry and topology in low dimensions. He discovered links between topology, hyperbolic geometry, and complex analysis that none had suspected, and in the process invented a world of new techniques that still leave the mathematical community awestruck.

Thurston comes to us from the University of California at Davis, where he has been since 1996. Prior to that he held positions at UC Berkeley, Princeton, MIT, and the Institute for Advanced Study. He received his Ph.D. from UC Berkeley in 1972. Thurston served as Director of the Mathematical Sciences Research Institute in Berkeley from 1992-1997.

For further information, see www.math.cornell.edu/News/news.html.

Ravi Ramakrishna Wins Three Awards

Assistant Professor Ravi Ramakrishna has been honored with three awards in the past year. In December 2001, Ravi was presented with our new Junior Faculty Teaching Award in recognition of the profound impact he has had on the lives of undergraduates through his teaching and advising. Then on May 1, 2002, he received the College of Arts & Sciences' Stephen and Margery Russell Distinguished Teaching Award for his devotion to teaching.

Ravi was also the recipient of an American Mathematical Society Centennial Research Fellowship in May 2002, which is given annually to outstanding mathematicians to help further their research careers.

For more information about the department, please visit us www.math.cornell.edu.

Cornell Conference on Analysis and Probability on Fractals

Analysis and probability on fractals is an exciting new area of mathematical research that studies basic analytic operators and stochastic processes when the underlying space is fractal. The books *Diffusions on Fractals* by M. Barlow (Lecture Notes 1690, Springer, 1998) and *Analysis on Fractals* by Jun Kigami (Cambridge University Press, 2001) and the expository article *Analysis on fractals* by R. Strichartz (Notices AMS **46** (1999), 1199-1208) give an indication of the accomplishments in this area in the recent past. Research in this area is closely related to work in analysis and probability when the underlying space is manifold or a graph.

The purpose of this conference, held June 16-20, 2002, was to bring together mathematicians who are already working in this area and also graduate students and researchers from related areas who wanted to learn more about it. Toward this end, the conference included a mini-course intended to bring neophytes up to speed on the subject, starting with basic definitions and examples, and reaching to the frontiers of research.

Martin Barlow, Jun Kigami, Robert Strichartz, and Alexander Teplyaev were the organizing committee members.

Invited speakers were: Martin Barlow, University of British Columbia; Richard Bass, University of Connecticut; Rostislav Grigorchuk, Steklov Institute of Mathematics; Ben Hambly, Oxford University; Alf Jonsson, University of Umea; Jun Kigami, Kyoto University; Takashi Kumagai, Kyoto University; Michel Lapidus, University of California at Riverside; Volker Metz, Bielefeld University; Hirofumi Osada, Nagoya University; Christophe Sabot, University of Paris; Robert Strichartz, Cornell University; Alexander Teplyaev, University of California at Riverside. There were about 50 outside attendees.

Math Explorers Club

by Robert Strichartz

The Math Explorers Club began three years ago with Saturday meetings open to all high school students at no charge. The goal of the club is two-fold: to stimulate an interest in mathematics by exposing students to material not usually encountered in the high school curriculum, and to provide a peer group of students who share an interest in mathematics.

The club ran for two 6-week cycles this fall. Each cycle featured a one-hour module (mini-course) taught by faculty, after which participants chose between computer lab activities and problem-solving sessions led by graduate students Mercedes Franco, Sharad Goel, Todd Kemp, Maria Sloughter, and Tiberiu Tomita.

The module on Tilings was taught by Robert Strichartz and visitors Judy Palagallo and Tom Price. The students learned about Penrose tilings by manipulating plastic tiles and self-similar fractal tiles by maneuvering transparency images. They solved a jigsaw puzzle relating the Heighway dragon and the twin dragon (an unpublished discovery of Sze-Man Ngai, a former Cornell visitor). They also learned about the badge-and-hydrant tiles and other tiles with complicated interiors that were discovered recently by Cornell undergraduates Shawn Drenning and Matt Maloney while working on a research project with Strichartz, Palagallo, and Price.

The second module, on Relativity, is currently being taught by Brian Smith, a VIGRE Assistant Professor whose research interest is in that area.

The program is funded by the VIGRE grant, which provides stipends for the graduate students and pays for supplies and refreshments. This is a great opportunity for the graduate students to interact with faculty in an informal setting and to gain valuable experience in education and outreach that will help them in future job searches. The high school students enjoy learning about cool, and in some cases very new, mathematics presented on a level they can understand.

Badge-and-Hydrant Tile

VIGRE Program

by Rick Durrett

This is the third year of our VIGRE grant, an award from the National Science Foundation that supports postdocs, graduate students, undergraduate research, an outreach program, and an interdisciplinary colloquium.

VIGRE Postdoctoral Associates must be U.S. citizens, nationals, or permanent residents, and we provide faculty mentors to help them untangle the mysteries of their jobs. As part of this process, the department held its first ever professional development workshop for postdocs on May 7, 2002, at the Rose Inn, a bed and breakfast about 10 miles north of Ithaca. Six VIGRE postdocs and two NSF postdocs and eight Cornell faculty members discussed various aspects of teaching, research, and other professional duties in four 80-minute discussions. Feedback from the postdocs indicated that they found the experience useful so it will become an annual event. Three new VIGRE Postdocs arrived in the fall: Tara Brendle (Columbia University), Alexander Meadows (Stanford University), and Brian Smith, (University of Alabama Birmingham). This increased the number of VIGRE Postdocs to nine.

Graduate recruiting, which is as unpredictable as the Ithaca weather, brought in six new VIGRE fellows: David Biddle (Binghamton University), Andrew Cameron (University of Virginia), Benjamin Chan (University of Rochester), Heather Heston (Millersville University), Michael O'Connor (University of Massachusetts Amherst), and Jay Schweig (George Mason University). In addition, Jessica Zuniga will be a VIGRE fellow for three years following one year of support from the Graduate School. Sarah Koch, who transferred here after a year at Berkeley, will receive a small supplement to her National Physical Sciences fellowship, raising her support to the level of a VIGRE fellow.

At the undergraduate level, VIGRE provided support for two Cornell undergraduates to participate in the Cornell Research Experiences for Undergraduates Program: Brian Lukoff and Asher Walkover, and for four students to do summer research:

- Sami Can, working with Ravi Ramakrishna, studied elliptic curves.
- Ben Cooper, working with Allen Hatcher and Jim West, studied knot invariants.
- Joey Palin, working with Konstantin Rybnikov, studied properties of polytopes.
- Oded Yacobi, working with Ed Swartz, studied homology groups of simplicial complexes.

The VIGRE Interdisciplinary Colloquium resumed this fall with a series of lectures on Mathematical Problems Arising from Molecular Biology. Eric Siggia, a Cornell physicist, who in recent years switched to biology and to Rockefeller University, started the series with a talk about gene regulation that was attended by 100 people. In subsequent colloquiums, David Shalloway (another former physicist), Andy Clark (a new hire in Molecular Biology and Genetics from Pennsylvania State), and Chip Aquadro (a Cornell Drosophila geneticist) have exposed participants to a diverse collection of mathematical questions. The final talk of the semester will be given by Carlos Bustamante, a new hire in the newly formed Department of Biological Statistics and Computational Biology.

The NSF is conducting the third-year review of our VIGRE grant. We will receive funding for years four and five if they are convinced we have done a good job in the first three years. In the first stage of the process, we supplied data about the program and responded to eight essay questions designed to gauge the extent to which our activities were meeting the goals of the VIGRE program: broadening education at all levels, integrating research and education, promoting recruitment into the mathematical sciences, and improving the instructional training and communication skills of students and postdocs. The answers filled eighteen single-spaced pages. The grant has involved many people; in addition to the nine postdocs already mentioned, twenty-three faculty participated in various ways, thirteen graduate students have been VIGRE fellows, another twelve have had VIGRE semesters free from teaching, six Cornell undergraduates have participated in our REU program and another ten have done research on their own in the three summers since the beginning of the grant. It is too early to tell if the VIGRE program will have a significant impact on the time to degree of supported graduate students, but the grant has already had an impact on the department. The mandatory curriculum review associated with the VIGRE grant has led to changes in the graduate and undergraduate course offerings. In addition, the availability of summer research support has helped increase the number of seniors writing honors theses.

The second stage of the review process was a site visit on October 17 from three people from NSF: Richard Millman, newly hired to manage the VIGRE Program, Roger Lewis, an NSF program officer from last year's VIGRE management team, and Steve Nash, a computational scientist who is a Dean at George Mason University. They quizzed our VIGRE coordinating committee for an hour and a half and then met in closed-door sessions with Arts & Sciences Associate Dean Jonathan Culler, our postdocs, graduate students, and undergraduates. The exit interview at the end of the day was generally positive, so we are cautiously optimistic that when the third-year review is completed in mid-January 2003, our program will be approved to continue for an additional two years.

Research Experiences for Undergraduates

by Robert Strichartz

The Mathematics Department has been running an NSF-supported summer REU Program since 1994 under my direction. Cornell's program is one of the most successful in terms of the quality of students it attracts and the research accomplishments of its participants. We were recently awarded a five-year renewal to support the program during the years 2002-2006. Additional support comes from the department's VIGRE grant. In our renewal application, we listed 19 publications for 1997-2001 in such journals as Transactions of the AMS, Indiana University Mathematics Journal, Mathematical Proceedings of the Cambridge Philosophical Society, Experimental Mathematics, Discrete and Computational Geometry, and Constructive Approximation. Many of these papers have already impacted on their areas of research.

Each year faculty members direct three project areas with the support of visitors and graduate students.

Students work individually or in small groups on problems that have been carefully chosen to be accessible to undergraduates, but still of interest to the general mathematical community. Often these problems involve computer experimentation. At the end of the program, the students give public lectures on their results at an Undergraduate Research Forum at Cornell. Many go on to give talks at various conferences. Students hone their lecturing skills at weekly jam sessions where they discuss their work with other participants, and they attend a lecture series, the Smorgasbord Seminar in which members of the department dish out small tastes of what research is like in many different areas of mathematics. Here is a description of work done in summer 2002:

Analysis on Fractals, directed by Robert Strichartz with the assistance of visitors Jun Kigami and Alexander Teplyaev and graduate student Alan Demlow. This theory goes far beyond what is generally thought of as fractal geometry and makes contact with many classical areas such as partial differential equations, harmonic analysis, analysis on manifolds, and numerical analysis. The students carry out computer experiments to explore new problems. This summer, Jonathan Needleman (Oberlin College) and Po-Lam Yung (Chinese University of Hong Kong) developed a theory of power series and analytic functions on the Sierpinski gasket (SG): Carto Wong (Chinese University of Hong Kong) studied a nonlinear p-Laplacian operator on SG; Kealey Dias (SUNY Stony Brook) and Kevin Coletta (RPI) developed numerical analysis techniques involving Fourier series and finite element methods to study Schrodinger equations, wave equations, and Gibbs' phenomenon on SG. In addition, Matthew Hirn (Cornell) worked with Strichartz and Matthew Fickus (VIGRE Postdoc) on an unrelated fractal problem involving Fourier series with respect to the Cantor measure.

Dynamical Systems, directed by John Guckenheimer with the assistance of visitor Warren Weckesser, postdoc Ricardo Oliva, and graduate student Radu Haiduc. This project was devoted to understanding the dynamics of the forced van der Pol equation. This system of equations has solutions that exhibit two time scales, a fast and a slow scale, whose ratio is controlled by a parameter e. A typical solution has a trajectory that follows a slow flow most of the time, but occasionally jumps and follows a fast flow before resuming the slow flow. When $e = 0$ one obtains a "reduced" system whose behavior is easier to understand. However, the full system also exhibits a different kind of trajectory called a "Canard" that crosses from the stable sheet of the critical manifold to the unstable sheet without immediately jumping. This project developed methods for representing the Canard solutions in the reduced system and analyzing the resulting flows. Five students were involved in this work: Katherine Bold (University of Texas), Chantal Edwards (University of Maryland-BaltimoreCounty), Sabyasashi Guharay (Princeton University), Judith Hubbard (Caltech), and Christopher Lipa (North Carolina State). A paper based on this work has already been completed, and more information may be found at the web site www.mathlab.cornell.edu/~weck/.

Visualizing Dynamics in 4-Space, directed by John Hubbard with the assistance of visitor William Dunbar and graduate student Roland Roeder. The dynamics of polynomials in one complex variable are captured in the geometry of Julia sets, which are easily visualized as subsets of the plane. The situation becomes dramatically more complicated when one passes to polynomial mappings in two complex variables. An important family of such mappings that have been intensively studied are the Hénon mappings. It is possible to define the analog of the Julia set, but now it is a subset of 4-space. How do you visualize that? The approach taken by students Kyle Bradley (Caltech) and Brian Lukoff (Cornell) was to approximate the Julia sets by a family of 2-manifolds depending on a parameter t, with the limit as t approaches 0 giving the Julia set. These 2-manifolds live in 4-space, but by choosing appropriate projections into 3-space they were able to make "movies" of these manifolds as they evolve from a simple torus to a manifold of genus 2.

Another problem arising from the study of Hénon mappings led to a very interesting detour into the theory of Diophantine approximation. A great deal is known about the approximation of a single irrational number by rational numbers, thanks to the theory of continued fractions. There is an

(REU continued)

analogous procedure, called the Farey triangle, for a pair of irrational numbers, but how well does it work? Justin Grosslight (Stanford University) and Asher Walkover (Cornell University) explored this problem. First they gathered experimental evidence that it does not work well at all, in that a certain sequence of triangles that must converge to a point for the method to be effective, actually converges to a line. By the end of the summer, Asher Walkover had a proof that this happens with probability one. As often happens in mathematical research, someone else was onto the same result. It turns out that Nogeira had published a 30-page paper in 1995 proving this result. But Walkover's proof is better, shorter, and more direct, and it will be submitted for publication.

In summer 2003, the project areas will be Analysis on Fractals (Robert Strichartz), Complex Dynamics (Rodrigo Perez), and Mathematical Biology (Rick Durrett).

Math in Moscow

by Paul Young

I am one of ten students from the US and Canada participating in the Math in Moscow program at the Independent University of Moscow this semester. Small mathematics classes provide an intimate and interactive environment for learning. The program offers more than quality academic training. We have visited museums, churches, and historical sites, as well as attended concerts in their numerous theatres. Life in Moscow has also been a learning experience. I have honed my language skills and learned more about the Russian culture.

Anyone interested in learning about the program should visit the Math in Moscow web site www.mccme.ru/mathinmoscow/. You could also contact me to answer any questions about my experience at pky3@cornell.edu.

Graduate Student Activities

Core Courses Preparation

In order to prepare the incoming first-year graduate students for their fall courses, Jim Belk, Chris Francisco, and Todd Kemp gave a series of lectures during the week before classes began. The topics were Real Analysis (Todd), Algebra (Chris), Linear Algebra (Jim), and Point-Set Topology (Jim). Each speaker gave three one-hour lectures, designed to cover all the undergraduate topics the incoming students are expected to know. The short courses were well received by the new students, who found the lectures quite useful. We hope these courses will continue to run in the future.

Expanding your horizons

On April 27, 2002, Cornell graduate students once again participated in a day of hands-on workshops in mathematics for seventh and eighth grade girls. The department sponsored a workshop on game theory. In the workshop *The Secret of Nim*, graduate students Cynthia Bowers Francisco, Leah Gold, Melanie Pivarski, Mohan Rajagopalan, and Maria Sloughter worked with the girls using M&Ms and pretzels to study the game of Nim. See what the girls learned by visiting www.math.cornell.edu/Community/horizons.html.

Graduate Students In Canada

Graduate Students Spencer Hamblen and Henri Johnston attended the Canadian Number Theory Association meeting in Montreal, May 19-25, 2002. In addition, Spencer attended the MSRI Summer Graduate Program, Excursions in Computational Number Theory: "Polynomials with Integer Coefficients," held in Vancouver, June 17-28, 2002.

Ithaca High School Senior Seminar

Cornell mathematics graduate students—Kristin Camenga, Todd Kemp, and Jeff Mermin—are running a seminar for a group of Ithaca High School juniors and seniors this year. The class meets three times a week for one class period at the high school. The goal of the seminar is to introduce the students to subject matter they would not normally see in mainstream undergraduate courses. Todd taught the first module, "Random Walks on Graphs and Electric Networks," Jeff will teach a module on Cryptology, and Kristin will teach a module on Graph Theory and Geometry. Students will do guided research in the last three months of the year. We hope this seminar will continue in years to come!

2002 Commencement & Beyond

Math Majors Jason Flannick and Han Pin Goh (both triple majors), served as Marshalls for the College of Arts & Sciences in the May 2002 Commencement ceremonies. The Marshalls are students with the highest GPA in the graduating class.

Over half of the class of 2002 are pursuing advanced degrees in a variety of areas (engineering, applied mathematics, computer science, operations research, physics, and economics) at Cornell and other institutions. Several enrolled in Law School. The math majors who are attending graduate school in mathematics are listed below:

- Scott Bailey, Northwestern University
- Debbie Grier, Columbia University
- Supap Kirtsaeng, University of Southern California
- Daniel Ramras, Stanford University
- S. Alex Smith, UCLA
- Raciel Valle, Ohio State University

Mind/Life Conference

by Avery Solomon

Every year or two since 1987, top western scientists meet with His Holiness the Dalai Lama, other Buddhist Lamas, and observers to have a dialogue between Buddhism and Science. Transcripts of previous dialogues have been published as books, starting with *Gentle Bridges* in 1992. This year, the focus topic was the nature and origin of life. Monks from the Science/Math for Monks Program with whom I have been working were invited to the conference in Dharamsala, India, Sept. 30-Oct. 4, 2002. By good fortune, I was able to attend.

We met every day for five days in the quarters of His Holiness the Dalai Lama. There were about 20 Buddhist monks and lamas, translators, people from the math/science program, and others. The purpose of the conference was twofold: to share knowledge on various topics related to the universe and individual human beings and to interact on issues of ethics and life of concern to both science and humanity as a whole.

Each morning, scientists presented the cutting edge of science on the theme of what is life, how does it evolve, and where does it come from. Each afternoon there was a dialogue on questions raised in the morning or directed to His Holiness for response. The head of the MIT genome lab, in the forefront of the world genome-sequencing project, two world-famous biologist/geneticists, and a Nobel physicist were among the presenters. Also participating were three translator lamas, all holding western Ph.D.'s in physics or molecular biology, and a well-known philosopher of science.

Luigi Luisi presented the nature of the cell as the basic building block of life. What makes something "alive" and sentient? What is the origin of life? How could it emerge from non-life 3.5 billion years ago? What is the relation of life, consciousness, and matter? That afternoon there was a magical interaction on the notion of life: the Buddhist view that life can only come from life is distinct from the scientific view that somehow life is an "emergent" property of matter.

Molecular biologist Ursula Goodenough presented a molecular view of life on the second day. She described the genetic code that contains instructions for molecules of protein to be produced, as well as the switches that tell the instructions to be read. Through the process of random mutation and selection of most adaptable, fittest, etc., there is a natural evolution of forms of life. But why and how does this happen? Ursula also presented the evolutionary "tree" with three basic forms of life and when these separated at different time frames. How and why does evolution happen?

Eric Lander, professor and head of the MIT genome lab, presented the story of the genetic sequencing on the third day. He used fascinating analogies to the Tibetan Buddhist Bible, which helped the lamas understand the scale: the genetic book of code is about six times as large.

His Holiness and the lamas addressed many ethical issues of stem cell research, genetic engineering, and so on in the afternoon. At what point in the embryo development can we definitely say the embryo will be human? Science is neutral, but how we make use of it and why we are doing it is important.

Steven Chu, Nobel Prize physicist, gave a view of the atomic basis for life on Thursday. What is it possible for science to know? How much information can we really know about how the millions of molecules move around the cell? What is the power of mathematics in exploring science?

There was a brief presentation of the Buddhist view of emotions and ethics in the afternoon. Research on the effects of meditative states using brain scan and EEG was mentioned.

On the last day, Arthur Zajonc presented some views of dynamical systems, exploring how to model the way complex forms could come from simple processes repeated over and over. Translator/scientist Alan Wallace and Western lama Mathieu Richard presented powerful views of Buddhism that afternoon. Science explores the nature of the world in order to understand the world and what is happening in it. Buddhism explores the world in order to understand the nature of the world-appearance.

Many inspiring conversations and new friendships were formed during the meals. Some germinal ideas floated around about a venture to interrelate mathematics and Buddhism, studying foundational ideas about proof and understanding in Buddhism, science and mathematics, and some possibilities to turn video footage of the presentations into curriculum for the monks and others. Centuries-old Buddhist tradition met centuries-old scientific tradition, and there was real listening and dialogue.

The entire article is found on our web site www.math.cornell.edu.

Avery Solomon (left); Dalai Lama (right)

Cornellians In Brazil

by Nelia Charalambous

In the summer of 2002, Professor José Escobar and his four graduate students—Nelia Charalambous, Jean Cortissoz, Fernando Coda Marques, and Fernando Schwartz—had the opportunity to visit the Institute of Pure and Applied Mathematics (IMPA) in Rio de Janeiro, Brazil.

IMPA is South America's most renowned research institute in mathematics. It is both an academic and a research institution with many well-established mathematicians, such as Jacob Palis (director of IMPA, current president of the International Mathematics Union, and former president of the last International Congress of Mathematics) and the Geometer Emeritus Professor Manfredo do Carmo. Professors and postdocs regularly visit IMPA from universities around the world as well as from Brazil. The institute has excellent resources including a vast library and multiple computer labs. It was recently moved to the outskirts of the Tijuca forest, away from the busy parts of the city, with a beautiful view of the city below.

Those of us who were there for the first time were extremely impressed by the academic atmosphere of the institute. Students and professors alike work with enthusiasm, and there is a strong sense of community. We presented a series of lectures at the Differential Geometry Seminar and received a lot of positive feedback on our work, even an inspiration to keep up our efforts. Professors and students of IMPA, as well as many visitors, attended the talks.

Rio is an amazing city. We visited the Corcovado Christ, the Pao de Azucar, Rio's center, and watched the World Cup final on the beach of Copacabana, celebrating with thousands of ecstatic soccer fans. A conglomeration of green hills and seashore, rich and poor neighborhoods, Rio casts its spell on you in an instant.

At the end of the three weeks, we traveled to the city of Goiania in the western part of the country to attend the School in Differential Geometry at the Goiás Federal University (UFG). The main speakers were some of the most distinguished researchers in the area from around the world, and many Brazilian professors presented their latest research. We aided our advisor, Professor Escobar, with teaching a mini-course titled "Topics in Partial Differential Equations and Differential Geometry." It was intended mainly for advanced students, and it received many positive comments from attendees. We met up with Henrique Araujo, a former Cornell Mathematics graduate student and student of Professor Escobar, who is now a professor in the Federal University of Pernambuco (UFP) in Recife.

Overall the trip was a wonderful experience. Establishing contacts with a large group of mathematicians, and in particular with acknowledged researchers from around the world, was invaluable. The director of IMPA, Professor Palis, welcomed us personally and reiterated his wish that we remain in close contact and consider IMPA as a possibility for postgraduate studies at the end of our Ph.D. program.

We are deeply thankful to the NSF, the Maria Einaudi Center, IMPA, and the committee of the Brazilian School of Geometry for providing the resources to make this trip possible.

Group Theory Riddle Cracked

by Robert Strichartz

A collaboration between Professor Keith Dennis and undergraduate Paul Young has led to the final solution of a problem in finite group theory posed in 1974 by W. Scharlau. The so-called Scharlau invariant of a finite group is a natural number associated with the group that encodes important information about the representations of the group. Although a great deal of work had previously been done to compute the invariant for all groups, the last holdouts were the groups $SL_2(p)$ of 2×2 matrices with integer entries mod p of determinant one, when p is a Fermat prime. Recall that Fermat primes are numbers of the form $1 + 2^{2^n}$ that are also prime. So far, only n = 1,2,3,4 are known to produce Fermat primes. By creating a computer program to study the Scharlau invariant for $SL_2(17)$, Dennis and Young were able to find a simple pattern that led to the proof for all Fermat primes.

Young, who was president of the Math Club last spring, is currently spending the fall semester in Moscow, participating in the Math in Moscow program. (See page 5.) When he returns this spring, he will work with Dennis in developing a computational component for the undergraduate abstract algebra course, Math 434. His work was supported by a VIGRE summer grant. (See VIGRE Program, page 3.) These grants enable undergraduate students to work on research projects under faculty supervision.

Got news?
mathnews@cornell.edu

Math Matters is published through the combined efforts of members of the department. Many thanks to the contributers of articles, as well as to the following people for their assistance:

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Mathematics Department Endowments

The department is grateful to alumni, friends, and family who support the department endowments. Without their generosity, we would be unable to provide many of the offerings that make our department unique.

The **Cornell University Department of Mathematics Award** is presented annually to an Ithaca High School student who has excelled in mathematics and who has demonstrated originality and innovative power in mathematics.

We instituted new departmental teaching awards for graduate students and faculty in 2001. We would like to endow the **Teaching Award for Graduate Students** so that a generous prize can accompany it.

The **Colloquium Endowment Fund** was instituted to invite distinguished scientists to speak at the Oliver Club seminars. The Oliver Club was founded (as the Mathematical Club of Cornell University) in January 1891 by James E. Oliver. (See www.math.cornell.edu/~oliver/.)

The **Eleanor Norton York Endowment** was established in honor of Eleanor Norton York, with the intent of recognizing outstanding graduate students in both Astronomy and Mathematics. The income from this endowment is used to provide annual prizes to a continuing graduate student.

The **Faculty Book Endowment** is dedicated to the goal of providing the Cornell community with immediate access to one of the world's finest collections of mathematics books and publications.

The **Israel Berstein Memorial Fund** was established in honor of Israel Berstein, who was a professor in this department 1962-1991. The memorial fund has as its central purpose helping young mathematicians in the field of topology.

The **Logic Endowment** was established as the direct result of a very generous gift from a former Cornell undergraduate. This endowment seeks to actively support promising logic students.

The **Robert John Battig Endowment** was established in December 1997 to honor a former graduate student in mathematics. Founded by Battig's parents after his untimely death, the fund provides an annual prize to an outstanding continuing graduate student in mathematics at Cornell.

If you would like to contribute to any of these endowments, please make your check payable to Cornell University, indicate the specific endowment on the check, and send it to:

The Mathematics Department Endowments
310 Malott Hall
Cornell University
Ithaca, NY 14853-4201

Department of Mathematics
310 Malott Hall
Cornell University
Ithaca, NY 14853-4201