Cornell University Department of Mathematics

Annual Report 2004–2005

Surfaces can be described using the notion of curvature — a flat plane has zero curvature, a sphere has constant positive curvature, but a hyperbolic plane is a surface with constant *negative* curvature. In the 1970s William Thurston came up with the idea of how to make a model of a hyperbolic plane out of paper. In 1997 Daina Taimina (pictured left) saw such a model for the first time and decided to make a set for her geometry class using crochet. Recently her work has been of interest in the art world. The model pictured on the cover is made of wool and is one of the models of her display in the art show *NOT THE KNITTING YOU KNOW*, on display June 13–September 10, 2005, Washington D.C.

Cornell University
Department of Mathematics

Annual Report 2004-2005

The Department of Mathematics at Cornell University is known throughout the world for its distinguished faculty and stimulating mathematical atmosphere. There are close to 40 tenured and tenure-track faculty — representing a broad spectrum of current mathematical research — a lively group of postdoctoral fellows and frequent research and teaching visitors. The graduate program includes over 70 graduate students from many different countries. The undergraduate program includes several math major programs, and the department offers a wide selection of courses for all types of users of mathematics.

The Cornell Mathematics Department is part of the College of Arts and Sciences, one of the endowed (or private) units of Cornell, which includes 50 departments and programs in the humanities, social sciences, and the physical and natural sciences. There are approximately 19,500 students at Cornell, of which nearly 14,000 are undergraduates.

Cornell University is situated on a hill between two spectacular gorges that run down to Cayuga Lake in the beautiful Finger Lakes region of New York state. After 110 years in White Hall, the department moved to newly renovated Malott Hall, in the center of the Cornell campus. Renovation of Malott Hall was completed in 1999 to the specifications of the department. Its amenities include a spacious Mathematics Library, which houses one of the most extensive mathematics collections in the country, seminar rooms, classrooms and lecture rooms of all sizes, state-of-the-art computer facilities, and a large lounge with comfortable furniture and wall-to-wall blackboards.

Department Chair:	Prof. Kenneth Brown
Director of Undergraduate Studies (DUS):	Prof. Allen Hatcher
Director of Graduate Studies (DGS):	Prof. Michael Stillman
Director of Teaching Assistant Programs:	Dr. Maria Terrell
Administrative Manager:	Colette Walls

Department of Mathematics, 310 Malott Hall, Cornell University, Ithaca, NY 14853-4201
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August 2, 2005

Dear friends and colleagues,

Cornell's faculty is its most important resource. We are very fortunate to have a distinguished faculty in the Mathematics Department (see the list of recent awards on p. 1), and my highest priority as department chair is to do whatever I can to keep it that way. For this reason, the main thing I want to talk about in this letter is the state of our faculty, especially our hiring efforts.

In last year's annual report, I mentioned the tragic death of José (Chepe) Escobar in January 2004, at the age of 49. This was a great personal loss to those who were close to him. In addition, the loss of Chepe left a big hole in our department. Chepe's area of research was geometric analysis, in which methods of calculus are applied to geometric problems. This area has become quite prominent recently because of the announced solution by Grigory Perelman of the celebrated Poincaré conjecture, using methods of geometric analysis.

We tried very hard this year to hire a replacement for Chepe. We had an outstanding candidate, and we had the support of administrators at the highest level. Unfortunately, she ultimately turned down our offer. We will try again during the coming year.

On the other hand, we were successful in recruiting a distinguished young logician, Greg Hjorth, who will be joining our faculty on January 1, 2006. Greg got his Ph.D. at Berkeley in 1993. He won the Sacks prize in 1994 for the best thesis in logic worldwide. After a postdoc at Caltech, Greg moved to UCLA, where he rose quickly, becoming a full professor in 2001. He won a Sloan Fellowship in 1997, was an invited speaker at the International Congress of Mathematicians in 1998 and, with his coauthor Alexander Kechris, won the Karp Prize in 2003. The Karp Prize is given every five years and is the major award in logic. We are delighted that Greg is joining our department.

Our other hiring this year also went very well. We hired several new postdocs (non-tenure-track assistant professors), and we hired a new tenure-track assistant professor, Tara Holm. Tara's area of research is symplectic geometry, and I expect her to interact with many of our existing faculty members. Her appointment started July 1, 2005, but she will take her first year on leave at the University of Connecticut. We look forward to having her here in Ithaca for the 2006–2007 academic year.

In addition, we have a new associate professor, Yuri Berest, who was promoted on July 1, 2005. Yuri works in noncommutative algebraic geometry, an emerging area with close ties to mathematical physics. It is a pleasure to welcome Yuri to the tenured faculty.

Cliff Earle retired on December 31, 2004, after 39 years in the department, including three as department chair. Cliff has had a distinguished career working in complex analysis, in which he has published over 70 papers so far. I suspect that retirement for him just means that he will be able to spend even more time on his research. Indeed, during the past 7 years when he's been officially half time (on phased retirement), his research output has been better than ever. I wish him the best of luck in this new phase of his career, as professor emeritus. Eugene Dynkin is also entering a new phase of his long and distinguished career. As of July 1, 2005, he is tapering off to a half-time appointment. Again, we all wish him the best of luck.

I also want to send best wishes to Administrative Manager Colette Walls, who is moving to the Department of Romance Studies (see p. 5). Colette has been invaluable to me during my three years as chair. I will miss her sound judgment and her mastery at managing the finances of this complicated department. Colette has been the leader of an outstanding staff; they play a vital role in helping the faculty carry out the teaching, research, and service missions of the department.

Colette is being replaced by Bill Gilligan. Bill has been at Cornell since 1986 in various jobs related to finance and budget, and he has served as director of finance and budget for the Arts College for the past 5 years. Having worked closely with managers in departments across campus, Bill has a clear idea of the issues facing a large, complex department like ours. I look forward to working with him.

I have to report some very sad news about an alumnus, Raju Chelluri, who graduated in 1999 and died tragically in August 2004 at the age of 26. My heart goes out to his family and friends. I would like to thank them on behalf of the department for generously endowing the Chelluri Lecture Series in Raju's honor (see p. 6). We expect the first Chelluri Lecture to take place in spring 2006.

I initially signed on for a three-year term as department chair. I have found the job very rewarding, and I am grateful that my colleagues are giving me the opportunity to serve a fourth year. Dan Barbasch will take over as chair in July 2006. As far as I know, this is the first time we have ever had a "chair elect" a year in advance. Dan and I will work together in the coming year to ensure a smooth transition.

I could not do this job without help from a large number of people. I've already mentioned the staff support. Many faculty members have also made enormous efforts on behalf of the department. I'd like to single out a few in particular:

- Maria Terrell, senior lecturer and director of teaching assistant programs, is a constant source of new ideas. Some of her experimental teaching innovations are described on pp. 16–17. This year her efforts on behalf of our teaching program were recognized by the Arts College, which gave her a Russell Distinguished Teaching Award (p. 16).

- Rick Durrett has completed his fifth year as VIGRE director. He worked extremely hard on our unsuccessful attempt to get a new 5-year VIGRE grant (see p. 7). He also ran the Math Explorer's Club (p. 46), which he revitalized last year. Rick will continue to lead the way as we apply again for a new VIGRE grant this fall.

- Allen Hatcher has completed his first year as director of undergraduate studies. He brings new ideas and energy to the job, and it has been a pleasure to work with him.

- Mike Stillman has completed his third year as director of graduate studies. Mike works hard on behalf of our graduate program, and I am very happy to say that he has agreed to serve a fourth year.

Finally, I would like to wish former Cornell President Jeff Lehman the best of luck in whatever comes next for him. Jeff is an alumnus of the department, having graduated as a math major in 1977. I was as shocked as everyone else when he announced his resignation on June 11, after only two years as president. I had high hopes for his presidency, and I appreciated his accessibility to the faculty. Whatever his disagreements with the Board of Trustees might have been, this loss of a president after two years is a sad situation for Cornell.

Sincerely yours,

Ken Brown

Table of Contents

AWARDS AND HONORS 1

MATHEMATICS DEPARTMENT DIRECTORY 2004–2005 2

FACULTY, STAFF, AND GRADUATE STUDENT CHANGES FOR 2005-2006 4

GIFTS AND ENDOWMENTS 6

FACULTY RESEARCH AND PROFESSIONAL ACTIVITIES 7

Grants • VIGRE • The Jahrbuch Project • Faculty Editorships • 2004–2005 Faculty Publications

TEACHING PROGRAM 13

Visiting Program • Summer Session 2004 Course Enrollment Statistics • Academic Year Course Enrollment Statistics • Teaching Awards • Writing Prize • Curriculum Changes • Instructional Technology Support • Mathematics Support Center • Learning Strategies Center

GRADUATE PROGRAM 20

Graduate Student Recruitment • Graduate Student Awards • Outreach Activities • Department Colloquia • Preparing Future Professors • Other Graduate Student Activities • Graduate Student Publications • Doctoral Degrees • Master of Science Degree • Master of Science Special Degrees

UNDERGRADUATE PROGRAM 28

Events and Receptions • Undergraduate Mathematics Club • Mathematics Major Requirements • Undergraduate Awards and Honors • Study Abroad • Student Research and Activities • Putnam Competition • Mathematical Contest in Modeling • Senior Theses • Bachelor of Arts Degrees

DEPARTMENT CONFERENCES AND SEMINARS 34

Seminar on Stochastic Processes • Cornell Topology Festival • 2nd Conference on Analysis and Probability on Fractals • Analysis Seminar • Computational and Commutative Algebra Seminar • Discrete Geometry & Combinatorics Seminar • Dynamical Systems Seminar • Educational Mathematics Seminar • Lie Groups Seminar • Logic Seminar • Number Theory and Algebraic Geometry Seminar • Oliver Club • Olivetti Club • Probability Seminar • Teaching Seminar • Topology and Geometric Group Theory Seminar

RESEARCH EXPERIENCES FOR UNDERGRADUATES PROGRAM 44

COMMUNITY OUTREACH 46

Math Explorer's Club • Ithaca High School Senior Seminar • Saturday Workshops for Teachers • K–8 Professional Development: New York State Math Standards • Curriculum Development for Robert Moses' Algebra Project • A Digital Library of Printable Machines: Models for Collection Building and Educational Outreach • CU Math/Science Professional Development Day • Mathematics Awareness Week at Area Schools • Freshman Math Prize Exam • Expanding Your Horizons • Mathematics Awareness Month Public Lecture • Michael D. Morley Ithaca High School Senior Prize in Mathematics

MATHEMATICS LIBRARY 50

FACULTY RESEARCH AREAS IN THE FIELD OF MATHEMATICS 52

FACULTY PROFILES 54

Awards and Honors

Professor William P. Thurston received the *2005 AMS Book Prize* on January 6th at the Joint Mathematics Meetings in Atlanta for his book Three-dimensional Geometry and Topology, edited by Silvio Levy. The book presents Thurston's "Geometrization Program," one of the big events of modern mathematics. The Book Prize recognizes an outstanding research book that makes a seminal contribution to the research literature, reflects the highest standards of research exposition, and promises to have a deep and long-term impact in its area.

In January 2005, math major **Peter Maceli '06** was among those awarded a prize for outstanding work in the Undergraduate Student Poster Session at the Joint Meetings in Atlanta for his poster *Analysis of 3-Dimensional Fractal Tree Canopies*. The poster was based on work done last summer in the REU program at Ithaca College with Cornell Ph.D. David Brown.

The French Government named **Yulij Ilyashenko** *Chevalier dans l'Ordre des Palmes Academiques* for service provided to the French culture. The Diploma was signed by the Minister of Youth, National Education and Research and presented by the French Ambassador to Moscow on January 24, 2005 at the Independent University of Moscow. The honor was established by Napoleon in 1808. As president of the Independent University of Moscow, Yulij collaborated with the National Center of Scientific Research (CNRS) to establish a mutual scientific laboratory.

Camil Muscalu was one of five Cornell faculty to receive a *Sloan Foundation Research Fellowship* this year. Sloan fellows are engaged in research at the frontiers of physics, chemistry, computer science, mathematics, neuroscience, and economics. The fellowships provide teaching relief, leaving fellows free to pursue whatever research is of most interest to them. Camil's research is in harmonic analysis, particularly the "modern theory" of multilinear singular integrals, which includes objects whose complexity goes well beyond the complexity of the famous Carleson operator, related to the pointwise convergence of Fourier series. Previous Sloan Fellows include: Yuri Berest (2001), Richard Durrett (1981), David Henderson (1968), Gregory Lawler (1986), Irena Peeva (1999), Reyer Sjamaar (1996), John Smillie (1985), Birgit Speh (1983), & William Thurston (1974).

On April 26, 2005, the American Academy of Arts & Sciences announced the election of 196 new Fellows, including our own **Gregory Lawler**. The Academy will welcome this year's new Fellows and Foreign Honorary Members at its annual induction ceremony in October at the Academy's headquarters in Cambridge, MA. The Academy was founded during the American Revolution by John Adams, James Bowdoin, John Hancock, and other leaders who contributed prominently to the establishment of the new nation, its government, and its Constitution. Now in its third century, the Academy continues to mobilize the intellectual resources needed to anticipate, examine, and confront the critical challenges facing our society. Leonard Gross (2004), Richard Durrett (2002), Harry Kesten (1999), Eugene Dynkin (1978), and William Thurston (1978) are also members.

One faculty member and three undergraduate majors were recognized with Cornell honors this year. **Maria Terrell** was awarded a *Stephen & Margery Russell Distinguished Teaching Award.* (See page 16.) **Saúl Blanco Rodríguez '05** received the *J.G. White Prize for Excellence in English*. **Andrew Marks '05** and **Elizabeth Smoot '07** each won third prize in the *Cornell University Library Council Book Collection Contest*. (See pp. 28–29.)

Department Prizes and Awards

Department Teaching Awards

Senior Faculty Award:	Leonard Gross
Junior Faculty Award:	Tara Brendle
	Kasso Okoudjou
Graduate Student Award:	Heather Armstrong

Graduate Student Awards

Battig Graduate Prize:	Antonio Montalban
	Roland Roeder
Hutchinson Fellowships:	Drew Armstrong
	Treven Wall
York Award:	Jeffrey Mermin
	Jagadheep Pandian (Astro.)

Harry S. Kieval Prize in Mathematics

Vorrapan Chandee	Shawn Drenning
Timothy DeVries	Michael Jennings

Freshman Math Prize Exam

1st–3rd place (tied):	Andrew Owen Costello
	Michael Davis
	Hyun Kyu Kim
4th place:	Yunming Gong
5th place:	Eric Phillip Frackleton

Michael D. Morley Ithaca High School Prize in Mathematics

Yan Wang

Mathematics Department Directory 2004–2005

Professors

Dan Barbasch
Louis Billera
Kenneth Brown, chair
Stephen Chase
Robert Connelly
R. Keith Dennis
Richard Durrett
Eugene Dynkin
Clifford Earle (fall)
Leonard Gross
John Guckenheimer
Allen Hatcher
David Henderson
John Hubbard
J. T. Gene Hwang
Yulij Ilyashenko
Peter Kahn
Gregory Lawler
Anil Nerode
Michael Nussbaum
Laurent Saloff-Coste
Alfred Schatz
Shankar Sen
Richard Shore
John Smillie
Birgit Speh
Michael Stillman
Robert Strichartz
William Thurston
Karen Vogtmann
Lars Wahlbin
James West

Associate Professors

Irena Peeva
Ravi Ramakrishna
Reyer Sjamaar

Assistant Professors

Yuri Berest
Camil Muscalu
Edward Swartz
Alexander Vladimirsky

2004–2005 Faculty Leaves

Louis Billera	sabbatical leave, spring 2005
Indira Chatterji	leave, spring 2005
Etienne Rassart	leave, academic year

Professors Emeritus

James Bramble
Marshall Cohen
Clifford Earle (spring)
Roger Farrell
Harry Kesten
G. Roger Livesay
Michael Morley
Lawrence Payne
Alex Rosenberg
Moss Sweedler

H.C. Wang Assistant Professors

Nathan Broaddus
Kariane Calta
Indira Chatterji
Barbara Csima
Martin Kassabov
Kasso Okoudjou
Alessandra Pantano
Rodrigo Perez
Etienne Rassart
Luke Rogers
Kevin Wortman
Dan Zaffran

VIGRE Assistant Professors

Tara Brendle
Hsiao-Bing Cheng
Sarah Day
Paul Jung
Alexander Meadows
Brian Smith

Postdoctoral Associate

Robert Clewley

Senior Lecturers

Allen Back
David Bock
Avery Solomon (fall)
Maria Terrell
Robert Terrell

Lecturer

Patricia Alessi

Senior Research Associate

Daina Taimina

Field Members

Timothy Healey	(T&AM)
Dexter Kozen	(Computer Science)
Philip Protter	(OR&IE)
Richard Rand	(T&AM)
James Renegar	(OR&IE)
Steven Strogatz	(T&AM)

Visiting Faculty

Vesselin Gasharov
Andrzej Hulanicki (spring)
Gregory Kuperberg
Dmitriy Leykekhman (fall)
Gerhard Michler
Dmitry Novikov
Brendan Owens

Visiting Program Participants

James Belk
Nelia Charalambous
William Harris
Sunethra Weerakoon

Visiting Scholars

Sylvain Bonnot (spring)
Dong-Shang Chang
Edward Waymire
Warren Weckesser (fall)

Teaching Associates

Sylvain Bonnot (spring)
Richard Furnas

Graduate Students

Bryant Adams
Drew Armstrong
Heather Armstrong
Owen Baker
Maria Belk
Nathanael Berestycki
David Biddle
Jason Bode
Joshua Bowman
Kristin Camenga
Andrew Cameron
Edoardo Carta

Raymond Cassella
Benjamin Chan
Guan-Yu Chen
Nikolai Dimitrov
Alimjon Eshmatov
Farkhod Eshmatov
Jennifer Fawcett
Bradley Forrest
Laure Fumex (nondegree)
Christophe Garban (nondegree)
Lee Gibson
Timothy Goldberg
William Gryc
Pavel Gyrya
Radu Haiduc
Spencer Hamblen
Christopher Hardin
Noam Horwitz
Henri Johnston
Todd Kemp
Evgueni Klebanov
Sarah Koch
Hway Kiong Lim
Chris Alan Lipa
Jason Martin
Francesco Matucci (nondegree)
Andrei Maxim
Jeffrey Mermin
Robyn Miller
Mia Minnes
Vadims Moldavskis
Antonio Montalban
Steven Morris
Gregory Muller
Philip Mummert (nondegree)
Radu Murgescu
Jonathan Needleman
Matthew Noonan
Michael O'Connor
Melanie Pivarski
Artem Pulemyotov
Roland Roeder
Franco Saliola
Hasanjan Sayit
Fernando Schwartz
Jay Schweig
Ingvar Sigurjonsson
Achilleas Sinefakopoulos
Steven Sinnott
Sergey Slavnov
Aaron Solo
John Thacker
José Antonio Trujillo Ferreras
Mauricio Velasco
Anael Verdugo
Brigitta Vermesi
Treven Wall
Biao Wang
Gwyneth Whieldon
Russell Woodroofe
John Workman
James Worthington
Yan Zeng
Zhigen Zhao
Jessica Zuniga

Administrative Support Staff

Linda Clasby
Arletta Havlik
Joy Jones
Michelle Klinger
Gayle Lippincott
Donna Smith
Catherine Stevens
Colette Walls, manager

Computer Consultants

Douglas Alfors
Steven Gaarder

Instructional Technology Lab

Lee Gibson

Mathematics Support Center

Douglas Alfors, director
Richard Furnas

Mathematics Library Staff

Steven Rockey, librarian
Natalie Sheridan

This year's Women in Math potluck dinner was organized by Melanie Pivarski and hosted by Daina Taimina. The potluck is an annual event that provides an opportunity to get to know new graduate students and visiting faculty, to discuss job searches and mathematics, and to enjoy each others' culinary skills. Starting at the left and proceeding clockwise around the table are Sunethra Weerakoon, Daina Taimina, Robyn Miller, Barbara Csima, Kristin Camenga, Melanie Pivarski, Maria Belk, Brigitta Vermesi, and Tara Brendle.

Faculty, Staff, and Graduate Student Changes for 2005–2006

Faculty and Graduate Student Departures

Faculty Who Have Left Cornell

(Includes location of next position)

Tara Brendle	Louisiana State University
Indira Chatterji	Ohio State University
Barbara Csima	University of Waterloo (Canada)
Alexander Meadows	St. Mary's College of Maryland
Rodrigo Perez	University of Toronto (Canada)
Brian Smith	N/A
Kevin Wortman	Yale University
Dan Zaffran	Academia Sinica (Taiwan)

Ph.D. Recipients

(Includes location of first position; details on pp. 22–27)

James Belk	Cornell University
Nelia Charalambous	Cornell University
Dan Ciubotaru	MIT
Jean Cortissoz	University of Toledo
Christopher Francisco	University of Missouri
Yuval Gabay	Ben-Gurion University of the Negev (Israel)
Noam Greenberg	University of Notre Dame
JaEun Ku	Purdue University
Dmitry Leykekhman	Rice University (spring)
Yi Lin	University of Illinois at Urbana-Champaign
Fernando Schwartz	Duke University
Harrison Huibin Zhou	Yale University

M.S. Recipient

(Includes location of first position; details on page 27)

Everilis Santana-Vega	Escuela Especializada de Bellas Artes, Humacao, PR

Graduate Students

Jason Anema	Purdue University
Marisa Belk	SUNY, Binghamton
Jennifer Biermann	Lawrence University
Saúl Blanco Rodríguez	Cornell University
Daniel Erb	Rensselaer Polytechnic Institute
Victor Kostyuk	Rochester Inst. of Technology
Bastian Laubner	University of Bremen (Germany)
Jiamou Liu*	University of Auckland (New Zealand)
Peter Luthy	Connecticut College
Francesco Matucci*	University of Firenze (Italy)
Sergio Andrés Pulido Niño	Los Andes National University (Colombia)
Peter Samuelson	California Inst. of Technology
Pavel Semukhin*	University of Auckland (New Zealand)
Paul Shafer	Cornell University
Denise Terry	University of Redlands
Russ Thompson	University of North Carolina, Chapel Hill

**Non-degree students*

New Faculty and Graduate Students

(Includes institution of highest degree held.)

Tenure-Track Assistant Professor

Tara Holm	MIT

Non-Tenure-Track Assistant Professors

Todd Kemp	Cornell University
Alvaro Lozano-Robledo	Boston University
Carla Martin	Cornell University
Steve Morris (spring)	Cornell University
Timothy Riley	Oxford University

Short-Term Faculty

(Includes Ph.D. institution for postdoctoral associates and home institution for others, unless otherwise indicated.)

Postdoctoral Associates

Robert Clewley	University of Bristol (UK)
Michael LaMar	University of Texas, Austin
Joan Lind	University of Washington
Lea Popovic	University of Minnesota
Raazesh Sainudiin	Cornell University
David White	University of Washington

Visiting Scholars

Dong-Shang Chang	National Central University (Taiwin)
Kazumasa Kuwada	Kyoto University (Japan)
Changhao Lin	South China Normal Univ.

Teaching Visitors

Marat Arslanov	Kazan State University (Russia)
Cilanne Boulet	MIT (new Ph.D.)
Eknath Ghate	Tata Institute of Fundamental Research (India)
Bakhadyr Khoussainov	University of Auckland (New Zealand)

Wook Kim	Purdue University (new Ph.D.)
Gerhard Michler	Essen University (Germany)
Damiano Testa	MIT (new Ph.D.)
George Wilson	Oxford University (UK)

Visiting Program Faculty

Craig Johnson	Marywood University
Thomas Stiadle	Wells College

Faculty Changes

- Clifford Earle and Avery Solomon have retired, effective December 31, 2004.
- Yuri Berest was promoted to associate professor with tenure, effective July 1, 2005.
- John Guckenheimer has been appointed associate dean of Computing and Information Science, starting August 1, 2005. (See www.math.cornell.edu/News for details.)

Faculty Leaves

Robert Connelly	Sabbatical leave, 2005–2006
Richard Durrett	Sabbatical leave, fall 2005
Tara Holm	Leave, 2005–2006
Anil Nerode	Sabbatical leave, fall 2005
Michael Nussbaum	Sabbatical leave, spring 2006
Ravi Ramakrishna	Sabbatical leave, spring 2006

Staff Changes

New Network Administrator

In May 2005, the department hired Steve Gaarder to replace Allen Back as the department's network administrator. With this hire, the position became 100% full-time equivalent for the first time. Steve has extensive experience in a broad spectrum of computing technologies with an emphasis on Linux/Unix and networking. He came to us from a local biotechnology company, Gene Network Sciences (GNS), where he administered the network, servers, and desktops running Linux and Windows 2000 and XP. In a previous position at Moldflow Corporation (formerly C-Mold), Steve managed a complex, heterogeneous network, including systems from every major Unix vendor, Linux, Windows NT, and Macintosh. Steve is an effective administrator. His intelligence, skill, creativity, and unflappable good will are greatly appreciated.

Stimson Instructional Computing Lab Closed

Doug Alfors, Todd Cullen, Steve Gaarder, and Colette Walls worked closely with Maria Terrell and Ken Brown to review usage and implement the closing of the department's Instructional Computing Lab in Stimson Hall during summer 2004. This was a long process that required months of careful planning and creative problem solving. In the process, the lab director Todd Cullen was laid off, and management of the lab was turned over to CIT on a one-year trial basis.

The process of reviewing the department's instructional technology needs and reallocating existing funds to other instructional computing initiatives in the department proved to be a worthy effort. Usage of the lab had diminished over the years, and the only regular user (MATH 171) could easily be accommodated using existing computer labs in other areas of campus. We were able to reallocate existing funding and received an extra teaching assistant stipend/tuition package as a result of our endeavor to find better ways to meet the instructional computing needs of the department. Space was carved out of the MSC for a new initiative, and a graduate student, Lee Gibson, was hired by Maria Terrell to run the new Instructional Technology Office in 258 Malott Hall. (See pp. 18–19 for additional information about the IT Office and the many services it offers.)

The college decided to close the CIT-run lab in Stimson and turn that space into a large seminar room that will benefit many of the departments in the college. They have asked us to work with the Sociology Department to move our MATH 171 usage to the Uris Hall G90 lab. Steve Gaarder is consulting with the lab director about statistical software needs, and MATH 171 classes will meet in the Uris Hall lab starting in fall 2005. Michelle Klinger will coordinate requests for time in the Uris Lab with the Sociology Department.

Administrative Manager

Quite unexpectedly, Colette Walls announced in late May that she had accepted a position as administrative manager of the Department of Romance Studies. Colette's tenure with the department started in September 1996, when she was hired by then-chair Bob Connelly. She has made many contributions to the department, but her oversight of the organization and implementation of the department's move from White Hall to Malott Hall in June 1999 stands out as the most significant of her accomplishments. In the end, the move brought a lot of positive changes to members of the department, and it even turned out to be fun for the staff. While no one can to *replace* Colette, Bill Gilligan will be taking over as administrative manager. Bill comes to us from the Arts College Dean's Office, where he was director of finance and budget. He will be full time starting August 15, 2005.

Gifts and Endowments

As always, we appreciate the kindness and generosity of alumni and other friends of mathematics. During the 2004–2005 academic year, designated donor gifts increased the principal of various department endowments. In addition, the department received some unrestricted gift donations, which are used to supplement departmental activities for the mathematics community at Cornell. In many cases, contributions were received in response to the department newsletter, *Math Matters*. By distributing this newsletter, we hope to keep our many friends current on department activities. If you would like to be added to the newsletter mailing list, please contact Catherine Stevens at cls15@cornell.edu.

2004–2005 Contributors

Vorrapan Chandee
Saraswathi Chelluri
Robert G. Chipkin
Sean Cleary
R. Keith Dennis
Shawn Luke Drenning
Abdel-Aziz Farrag
L. Scott Feiler
Peter Fillmore
Jill E. Fisch
Joshua I. Goldberg
Louis J. Gross
Harvey J. Iglarsh
Andrew S. Joskow
Ira G. Kastrinsky
Alison S. Klugherz Kideckel
John T. Lemley
Howard A. Levine
Charlotte R. Lin
Andrew John McCabe
Shirley S. McGrath
Jean-Pierre G. Meyer
Nagavarapu Mohan
Gerald J. Porter
Heydar Radjavi
John W. Rosenthal
C. C. A. Sastri
Ch. V. Sastry
Henry K. Schenck
Michael P. Schumacher
G. V. R. K. Sharma
Soo Tang Tan
David N. Wall
Beverly J. Williams

Endowments

The department is thankful 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 Department of Mathematics instituted departmental teaching awards for graduate students and faculty in 2001. The **Graduate Student Teaching Award** endowment was created to fund a generous prize to accompany this annual award in recognition of excellent teaching.

The **Chelluri Lecture Endowment** was established in 2004 with support from family and friends of Thyagaraju (Raju) Chelluri. Funds from this endowment will be used for an annual lecture series in memory of Raju, who graduated magna cum laude from Cornell with a Bachelor's degree in mathematics in 1999. Raju died in 2004, shortly after completing all requirements for the Ph.D. in Mathematics at Rutgers University, where he was awarded a Ph.D. posthumously. Each year, a distinguished mathematician will be invited to give the Chelluri Lecture.

The **Colloquium Endowment Fund** was instituted to invite distinguished scientists to speak at the Oliver Club seminars. James E. Oliver founded the Oliver Club in January 1891 as the Mathematical Club of Cornell University. (Oliver Club talks are announced at 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 continuing graduate students.

The **Faculty Book Endowment** is dedicated to 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 from 1962 through 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 by his parents after his untimely death. Robert was awarded a January 1998 Ph.D. in mathematics. The fund provides an annual prize to an outstanding continuing graduate student in mathematics at Cornell.

The **Michael D. Morley Senior Prize in Mathematics** is presented to an Ithaca High School student who has excelled in mathematics and who has demonstrated originality and innovative power in mathematics.

Faculty Research and Professional Activities

Grant and contract expenditures for the fiscal year 2004–2005 totaled $3,066,726. This included 44 grants and contracts from federal, state and private agencies awarded to 30 faculty members. Faculty submitted 14 new grant proposals, 7 of which (shown below) have been funded to date.

Agency	P.I.	Amount	Duration	Title of Grant
NSF	Tara Brendle	$97,301	7/1/05–6/30/08	Subgroups of Mapping Class Groups
NSF	Robert Connelly	$280,000	7/1/05–6/30/08	Theoretical & Applied Discrete Geometry
NSF	Eugene Dynkin	$138,076	7/1/05–6/30/08	Superdiffusions & Partial Differential Equations
NSF	Gregory Lawler	$11,250	3/1/05–2/28/06	Seminar on Stochastic Processes 2005
Sloan	Camil Muscalu	$45,000	9/1/05–8/31/07	Sloan Research Fellowship
NSF	Reyer Sjamaar	$150,996	5/1/05–4/30/08	Lie Group Actions on Symplectic Manifolds
NSF	William Thurston	$367,698	7/1/05–6/30/08	Low-Dimensional Geometry & Topology

VIGRE

The 2004–2005 academic year was the fifth year of the Mathematics Department's 5-year NSF VIGRE grant, which provided $500,000 a year to support postdocs, graduate students, undergraduate research, and our outreach activities to high school students. We applied for a new 5-year VIGRE grant this year, but our proposal was turned down. We were quite disappointed, even though we knew in advance that it was a long shot; there were about two dozen proposals submitted and only three or four expected to be funded. We will try again in the coming year.

The Jahrbuch Project Award

The first reviewing publication in mathematics, the Jahrbuch über die Fortschritte der Mathematik was published from 1869 until 1943 and reviewed more than 200,000 items in its 68 volumes. Its coverage of the mathematical literature was thorough, and it remains an important research tool today.

In the late 1990s the Deutsche Forschungsgemeinschaft (DFG) funded the conversion of the JFM into an enhanced electronic database with the goal of using it to guide the digitization of the important mathematics of that period. The project was carried out at the Niedersächsische Staats- und Universitätsbibliothek Göttingen (SUB Göttingen) and involved more than 150 mathematicians along with librarians. Today the ERAM (Electronic Research Archive for Mathematics), also known as the Jahrbuch Project, has been completed and is now an integral part of the research tools of the discipline.

The Physics, Astronomy and Mathematics Division of Special Libraries Association recognized this great achievement by awarding the Jahrbuch Project the PAM Division Award for 2005. The project editors were Prof. Dr. Bernd Wegner (TU Berlin), long-time editor-in-chief of Zentralblatt für Mathematik, and **Professor Keith Dennis**, former editor-in-chief of Mathematical Reviews.

The PAM Division Award reads: "The award should be given for a significant contribution to the literature of physics, mathematics or astronomy or to honor work that demonstrably improves the exchange of information in physics, mathematics or astronomy. The contribution should also significantly benefit libraries or enhance the ability of librarians to provide service. It should be special — above and beyond the normal job requirements of the individual(s) or group concerned.

"The ERAM or Jahrbuch Project is perfectly suited for this award. Mathematics librarians and researchers around the world depend daily on this enhancement to our research tools. Dr. Wegner and Dr. Dennis, we thank you for the creation of this unique, freely accessible database and archive of mathematics literature. And we applaud you and your colleagues for your foresight, determination, and high standards. Congratulations on this award."

Faculty Editorships

Dan Barbasch, editor of *Proceedings of the AMS*
Yuri Berest, editor of the *Journal of Nonlinear Mathematical Physics* (Sweden)
Louis Billera, member of the editorial boards of *Discrete and Computational Geometry* and *Journal of Algebraic Combinatorics*

Robert Connelly, editor of *Beiträge zur Algebra und Geometrie*

Richard Durrett, associate editor of *Journal of Theoretical Probability, Stochastic Processes and their Applications* and *Notices of the American Mathematical Society*

Eugene Dynkin, member of the advisory boards of the *Journal of Stochastic Analysis and Applications* and *Mathematics in Operations Research, Probability Theory and its Applications*

Leonard Gross, member of the editorial boards of *Journal of Functional Analysis*, *Reviews of Mathematical Physics*, *Potential Analysis*, *Soochow Journal of Mathematics*, *Revista Colombiana de Matemàticas* and advisory board of *Methods of Functional Analysis and Topology*

John Guckenheimer, editor of the *Journal of Experimental Mathematics*, the *SIAM Journal of Applied Dynamical Systems*, and the *International Journal of Bifurcation and Chaos*

Yulij Ilyashenko, member of the editorial boards of *Dynamical and Control Systems*, *Proceedings of the Moscow Mathematical Society* and *Mathematical Enlightenment*; member of the advisory boards of *Functional Analysis and its Applications* and *Ergodic Theory and Dynamical Systems;* and editor-in-chief of *Moscow Mathematical Journal*

Gregory Lawler, associate editor of C*ombinatorics, Probability and Computing* and the *Electronic Journal and Electronic Communications in Probability*

Anil Nerode, member of the editorial boards of the *Annals of Mathematics and Artificial Intelligence*, *Documenta Mathematicae,* the *Journal of Pure and Applied Algebra*, the *International Journal of Hybrid Systems* and *Computer Modeling and Simulation*.

Michael Nussbaum, associate editor of *Annales de l'Institut Henri Poincaré* and *Statistics and Decisions*

Laurent Saloff-Coste, editor of *Mathematische Zeitschrift*; associate editor of *Probability Theory and Related Fields*, S*tochastic Processes and their Applications*, *ESAIM: Probability and Statistics*, and the *Journal of Theoretical Probability*

Shankar Sen, member of the editorial board of the *Journal of the Ramanujan Mathematical Society*

Richard Shore, editor of *Studies in Logic and the Foundations of Mathematics* (North-Holland book series)

Reyer Sjamaar, managing editor of *Transformation Groups* (Birkhäuser)

Birgit Speh, editor of the *New York Journal of Mathematics* and the *Journal of Representation Theory*

Michael Stillman, algebraic geometry editor for the *Proceedings of the American Mathematical Society*

Robert Strichartz, executive editor of *Journal of Fourier Analysis and Applications*

Lars Wahlbin, editor of *Mathematics of Computation*

James West, associate editor of *Fundamenta Mathematicae*

2004-2005 Faculty Publications

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Kenneth Brown, *The homology of Richard Thompson's group F;* in Proceedings of the Special Session on Topological Group Theory (Nashville 2004), to appear.

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Vidar Thomée and **Lars Wahlbin,** *Maximum-norm estimates for finite element methods for a strongly damped wave equation*, BIT **44** (2004), 165–179.

Teaching Program

During the 2004–2005 academic year, the Mathematics Department offered 127 courses in 218 lectures and 151 recitations to 5,754 students, generating 22,513 credit hours. While students were drawn from every college at Cornell, the majority came from the College of Agriculture & Life Sciences (13%), Arts & Sciences (32%), Engineering (43%), and the Graduate School (9%). (See pp. 14–15 for a complete list of courses with enrollments and credit hours.)

The Department of Theoretical & Applied Mechanics (T&AM) supported instructors for 12 lectures of the engineering calculus sequence. The remaining 206 lectures were supported by the Mathematics Department. The following faculty from T&AM and other scientific departments at Cornell contributed to the success of our teaching program in 2004–2005 by teaching lectures of engineering mathematics: from T&AM, K. Bingham Cady, Chung-Yuen Hui, Luigi La Ragione, Ulrich Miller, Subrata Mukherjee, S. Leigh Phoenix, Steven Strogatz, and Alan Zehnder; from Electrical Engineering, Hsiao-Dong Chiang; from Mechanical Engineering, P. C. Tobias de Boer; and from Chemical Engineering, T. Michael Duncan. Since T&AM shares the teaching of engineering calculus, they are accredited with 50% of the credit hours for MATH 190/191 in the fall and MATH 293-294 for the year, amounting to 3,790 credits for 2004–2005.

The 2004–2005 teaching program was supported by 104 teaching assistants and associates, who served as TA instructors for 33 lectures of MATH 105, 111, 112, 171, and 191, as instructors for 2 freshman writing seminars (MATH 189), as recitation TAs for our freshman- and sophomore-level courses, and as graders for our upper-level undergraduate and first-year graduate courses. The department received support for 8 full-time TAs from T&AM, 2 full-time TAs from the Center for Applied Mathematics (CAM), 1.5 full-time TAs from the Knight Writing Program for MATH 189 and our Writing-in-the-Major (WIM) course MATH 451, and 1.3 full-time TAs from the Computer Science Department for MATH 335/COM S 480. The majority of our teaching assistants are mathematics graduate students, but in the 2004–2005 academic year 17 TAs were from T&AM, 10 from CAM, 4 from Statistics, 2 from Computer Science, 2 from Economics, 1 from Civil and Environmental Engineering, 1 from Education, 1 from Electrical Engineering, and 1 from Physics.

During summer session 2004, the Mathematics Department offered 10 courses to 169 students, generating 648 credit hours. (Enrollments and credit hours are displayed in the table below.) The following short-term visitors taught during summer 2004: Thomas Barr (Rhodes College), Gary Cochell (Culver-Stockton College), Thomas Pfaff (Ithaca College), and V. Lee Turner (Southern Nazarene University).

Visiting Program

Each year, the Visiting Program attracts mathematics professors on leave from small colleges around the country. Program participants are appointed half time to teach two (usually identical) courses each semester. While at Cornell, participants are free to attend classes, participate in seminars, conduct research and interact with Cornell faculty and students. James Belk (new Cornell Ph.D.), Nelia Charalambous (new Cornell Ph.D.), William Harris (Georgetown College), and Sunethra Weerakoon (University of Sri Jayewardenepura, Sri Lanka) participated in this year's visiting program. We appreciate their efforts.

Summer Session 2004 Course Enrollment Statistics

Course	and Title	Format	Instructor(s)	Enroll	Cr Hrs	Session
103	Mathematical Explorations	Lecture	M. Terrell	11	33	3-week
103	Mathematical Explorations	Lecture	Barr	5	15	6-week
109	Precalculus Mathematics	Lecture	Alfors	12	36	6-week
111	Calculus I	Lecture	Belk, Hardin	31	124	6-week
171	Statistical Theory and Applications	Lecture	Back	16	64	6-week
191	Calculus For Engineers	Lecture	Pfaff	19	76	6-week
192	Calculus For Engineers	Lecture	Leykekhman	13	52	6-week
293	Engineering Mathematics	Lecture	Gomes (T&AM)	23	92	8-week
294	Engineering Mathematics	Lecture	Turner	34	136	8-week
332	Algebra and Number Theory	Lecture	Cochell	5	20	6-week

Academic Year Course Enrollment Statistics

Course and Title		Format	Instructor(s)	Enroll	Cr Hrs	Term
103	Mathematical Explorations	Lecture	Solomon, Speh	52	156	Fall 2004
103	Mathematical Explorations	Lecture	Charalambous, Smillie	51	153	Spring 2005
105	Finite Mathematics for the Life and Social Sciences	Lecture	Saloff-Coste	98	294	Fall 2004
106	Calculus for the Life and Social Sciences	Lec/Sec	R. Terrell	148	444	Spring 2005
111	Calculus I	Lecture	Harris, Henderson, M. Terrell (czar)	385	1,540	Fall 2004
111	Calculus I	Lecture	Harris	118	472	Spring 2005
112	Calculus II	Lecture	Barbasch (czar), Charalambous, Weerakoon	151	604	Fall 2004
112	Calculus II	Lecture	Gross, Weerakoon	187	748	Spring 2005
122	Honors Calculus II	Lec/Sec	Strichartz	31	124	Fall 2004
122	Honors Calculus II	Lec/Sec	Pantano	13	52	Spring 2005
135	The Art of Secret Writing	Lecture	J. Belk	22	66	Fall 2004
135	The Art of Secret Writing	Lecture	J. Belk	29	87	Spring 2005
171	Statistical Theory & Application in the Real World	Lec/Sec	Hwang, Nussbaum, Stillman, Vogtmann	96	384	Fall 2004
171	Statistical Theory & Application in the Real World	Lec/Sec	Bock, Goel, Hwang, Nussbaum	112	448	Spring 2005
189	FWS: Pictures in 1000 Words or Less	Seminar	(TA)	17	51	Fall 2004
189	FWS: To Infinity and Beyond	Seminar	(TA)	17	51	Spring 2005
190	Calculus for Engineers	Lec/Sec	Schatz	46	184	Fall 2004
191	Calculus for Engineers	Lec/Sec	Cady (czar; T&AM)*, Calta, Csima, U. Miller (T&AM)*, Owens, Rogers	376	1,504	Fall 2004
191	Calculus for Engineers	Lec/Sec	Owens	20	80	Spring 2005
192	Calculus for Engineers	Lec/Sec	Chatterji, Cheng, de Boer (M&AE)*, Duncan (ChemE)*, Gasharov (czar), La Ragione (T&AM)*, Mukherjee (T&AM)*, Novikov, Pantano	374	1,496	Fall 2004
192	Calculus For Engineers	Lec/Sec	Cheng, Ramakrishna	412	1,648	Spring 2005
213	Calculus III	Lec/Sec	Kassabov	23	92	Fall 2004
213	Calculus III	Lec/Sec	Calta	31	124	Spring 2005
221	Linear Algebra and Differential Equations	Lec/Sec	Brendle, Hatcher, Lawler, Meadows, Novikov, Ramakrishna	140	560	Fall 2004
221	Linear Algebra and Differential Equations	Lec/Sec	Kassabov, Peeva, Swartz	49	196	Spring 2005
222	Multivariable Calculus	Lec/Sec	Back, B. Smith	46	184	Fall 2004
222	Multivariable Calculus	Lec/Sec	Back, Hulanicki, Muscalu, Zaffran	85	340	Spring 2005
223	Theoretical Linear Algebra and Calculus	Lec/Sec	Hubbard	31	124	Fall 2004
224	Theoretical Linear Algebra and Calculus	Lec/Sec	Vladimirsky	25	100	Spring 2005
231	Linear Algebra with Applications	Lecture	Sen	26	78	Spring 2005
275	Living in a Random World	Lecture	Durrett	14	42	Spring 2005
293	Engineering Mathematics	Lec/Sec	Jung, Phoenix (T&AM)*, Strogatz (T&AM)*	363	1,452	Fall 2004
293	Engineering Mathematics	Lec/Sec	Okoudjou, Wahlbin, Zehnder (T&AM)*	355	1,420	Spring 2005
294	Engineering Mathematics	Lec/Sec	Meadows, R. Terrell	382	1,528	Fall 2004
294	Engineering Mathematics	Lec/Sec	Hui (T&AM)*	373	1,492	Spring 2005
304	Prove It!	Lecture	Kahn	20	80	Spring 2005
311	Introduction to Analysis	Lecture	Guckenheimer	13	52	Fall 2004
311	Introduction to Analysis	Lecture	Rogers	21	84	Spring 2005
321	Manifolds and Differential Forms	Lec/Sec	Sjamaar	13	52	Fall 2004
323	Introduction to Differential Equations	Lecture	Wahlbin	20	80	Fall 2004
332	Algebra and Number Theory	Lecture	Chase	18	72	Fall 2004
335	Introduction to Cryptology (also COM S 480)	Lecture	Connelly	18	54	Fall 2004
335	Introduction to Cryptology (also COM S 480)	Lecture	Swartz	21	63	Spring 2005
336	Applicable Algebra	Lecture	Berest	31	124	Spring 2005
356	Groups and Geometry	Lecture	J. West	6	24	Spring 2005
401	Honors Seminar: Topics in Modern Mathematics	Lecture	Michler	4	16	Spring 2005
403	History of Mathematics	Lecture	Strichartz	14	56	Spring 2005
408	Mathematics In Perspective	Lecture	Vogtmann	8	32	Spring 2005
413	Honors Introduction to Analysis I	Lecture	Ilyashenko, Muscalu	47	188	Fall 2004
413	Honors Introduction to Analysis I	Lecture	Hulanicki	24	96	Spring 2005
414	Honors Introduction to Analysis II	Lecture	Sjamaar	19	76	Spring 2005
418	Theory of Functions of One Complex Variable	Lecture	Speh	13	52	Spring 2005
420	Differential Equations and Dynamical Systems	Lec/Sec	Day	18	72	Fall 2004
420	Differential Equations and Dynamical Systems	Lec/Sec	Day	21	84	Spring 2005
422	Applied Complex Analysis	Lec/Sec	Novikov	17	68	Spring 2005
424	Wavelets and Fourier Series	Lecture	Okoudjou	13	52	Spring 2005
425	Numerical Analysis and Differential Equations	Lecture	Vladimirsky	8	32	Fall 2004
428	Introduction to Partial Differential Equations	Lecture	Schatz	11	44	Spring 2005
431	Linear Algebra	Lecture	Zaffran	48	192	Fall 2004
432	Introduction to Algebra	Lecture	Wortman	34	136	Spring 2005
433	Honors Linear Algebra	Lecture	Dennis, Michler	22	88	Fall 2004
434	Honors Introduction to Algebra	Lecture	Michler	13	52	Spring 2005

Course and Title		Format	Instructor	Auditors	Enroll	Cr Hrs	Term
441	Introduction to Combinatorics I	Lecture	Connelly		10	40	Fall 2004
451	Euclidean and Spherical Geometry	Lecture	Henderson		16	64	Fall 2004
452	Classical Geometries	Lecture	J. West		4	16	Spring 2005
453	Introduction to Topology	Lecture	Brendle		22	88	Fall 2004
454	Introduction to Differential Geometry	Lecture	Henderson		24	96	Spring 2005
455	Applicable Geometry	Lecture	Swartz		6	24	Fall 2004
471	Basic Probability	Lecture	Saloff-Coste		21	84	Fall 2004
472	Statistics	Lecture	Hwang		14	56	Spring 2005
481	Mathematical Logic (also PHIL 431)	Lecture	Nerode		13	52	Spring 2005
490	Supervised Reading and Research	Ind Stud	varies		8	27	Fall 2004
490	Supervised Reading and Research	Ind Stud	varies		7	26	Spring 2005
508	Mathematics for Secondary School Teachers	Lecture	Bock		5	5	Fall 2004
508	Mathematics for Secondary School Teachers	Lecture	Bock		5	14	Spring 2005
611	Real Analysis	Lecture	Dynkin		16	64	Fall 2004
612	Complex Analysis	Lecture	Hubbard		12	48	Spring 2005
613	Topics in Analysis	Lecture	Vladimirsky		11	44	Fall 2004
613	Topics in Analysis	Lecture	Kuperberg	15	4	16	Spring 2005
614	Topics in Analysis	Lecture	Saloff-Coste		9	36	Spring 2005
615	Mathematical Methods in Physics	Lecture	Gross	3	9	36	Fall 2004
617	Dynamical Systems	Lecture	Smillie		6	24	Fall 2004
618	Smooth Ergodic Theory	Lecture	Guckenheimer	4	10	40	Spring 2005
621	Measure Theory and Lebesgue Integration	Lecture	Okoudjou	3	9	36	Fall 2004
622	Applied Functional Analysis	Lecture	Wahlbin	3	7	28	Spring 2005
631	Algebra	Lecture	Dennis	5	10	40	Fall 2004
632	Algebra	Lecture	Sen		5	20	Spring 2005
633	Noncommutative Algebra	Lecture	Dennis	2	2	8	Spring 2005
649	Lie Algebras	Lecture	Speh		5	20	Spring 2005
651	Introductory Algebraic Topology	Lecture	Hatcher	2	11	44	Spring 2005
652	Differentiable Manifolds I	Lecture	Sjamaar	5	19	76	Fall 2004
662	Riemannian Geometry	Lecture	Owens	5	10	40	Spring 2005
671	Probability Theory I	Lecture	Lawler	7	11	44	Fall 2004
672	Probability Theory II	Lecture	Lawler	4	18	72	Spring 2005
674	Introduction to Mathematical Statistics	Lecture	Nussbaum		15	60	Spring 2005
681	Logic	Lecture	Csima	2	5	20	Spring 2005
711	Seminar in Analysis	Seminar	Earle	9	4	16	Fall 2004
712	Seminar in Analysis	Seminar	Hubbard		7	28	Fall 2004
712	Seminar in Analysis	Seminar	Dynkin	1	10	40	Spring 2005
713	Functional Analysis	Lecture	Novikov	1	2	8	Spring 2005
715	Fourier Analysis	Lecture	Muscalu	2	2	8	Spring 2005
722	Topics in Complex Analysis	Lecture	Hubbard		9	36	Spring 2005
731	Seminar in Algebra	Seminar	Berest		3	12	Fall 2004
732	Seminar in Algebra	Seminar	Ramakrishna	2	6	24	Spring 2005
735	Topics in Algebra	Lecture	Michler	4	3	12	Fall 2004
737	Algebraic Number Theory	Lecture	Sen		5	20	Fall 2004
739	Topics in Algebra	Lecture	Peeva		4	16	Spring 2005
751	Seminar in Topology	Seminar	Wortman	9	4	16	Fall 2004
752	Seminar in Topology	Seminar	Vogtmann	3	4	16	Spring 2005
753	Algebraic Topology	Lecture	Kahn	4	6	24	Fall 2004
755	Topology and Geometric Group Theory Seminar	Seminar	N/A		0	0	Fall 2004
756	Topology and Geometric Group Theory Seminar	Seminar	N/A		1	4	Spring 2005
757	Topics in Topology	Lecture	Broaddus	6	3	12	Fall 2004
758	Topics in Topology	Lecture	Thurston		1	4	Spring 2005
761	Seminar in Geometry	Seminar	Thurston		1	4	Fall 2004
762	Seminar in Geometry	Seminar	Connelly	1	1	4	Spring 2005
767	Algebraic Geometry	Lecture	Stillman		10	40	Fall 2004
771	Seminar in Probability and Statistics	Seminar	N/A		2	8	Fall 2004
772	Seminar in Probability and Statistics	Seminar	N/A		2	8	Spring 2005
777	Stochastic Processes	Lecture	Durrett	10	20	80	Fall 2004
778	Stochastic Processes	Lecture	Jung	4	6	24	Spring 2005
781	Seminar in Logic	Seminar	Shore	8	4	16	Fall 2004
782	Seminar in Logic	Seminar	Nerode		4	16	Spring 2005
784	Recursion Theory	Lecture	Shore		7	28	Fall 2004
787	Set Theory	Lecture	Shore	1	6	24	Spring 2005
790	Supervised Reading and Research	Ind Stud	varies		22	124	Fall 2004
790	Supervised Reading and Research	Ind Stud	varies		19	94	Spring 2005

* The Department of Theoretical and Applied Mechanics shares in the teaching of engineering calculus and is accredited with 50% of the credit hours for MATH 190/191 in the fall and MATH 293 and 294 for the year; the remainder is accredited to Mathematics.

TOTALS	Courses	Enroll	Dept* Cr Hrs	Total Cr Hrs
Fall Semester	58	3,142	10,027	12,361
Spring Semester	69	2,612	8,696	10,152
Academic Year	127	5,754	18,723	22,513

Teaching Awards

Dr. Maria Terrell was presented a Stephen & Margery Russell Distinguished Teaching Award at a College of Arts & Sciences faculty meeting on Wednesday, May 4, 2005. Selected by a committee composed of former Russell Award winners and Dean G. Peter LePage, Maria has consistently demonstrated her devotion to teaching not only in the classroom but also through development of new methods of student instruction. Most recently, she created the GoodQuestions project, introduced homework study group sessions to MATH 111-112, pioneered the use of MapleTA to conduct pre-class questions, and was involved in the creation of an Instructional Technology Support TA. Maria also conducts the department's annual Teaching Assistant Training Program. Two other department faculty members have won Arts & Sciences teaching awards. They are Ravi Ramakrishna, who won a Russell Award in 2002, and Ken Brown, who won a Clark Award in 1987.

Recipients of three Department Teaching Awards were announced at the department's annual holiday party. The *Senior Faculty Teaching Award* was given to **Leonard Gross** in recognition of consistent excellence in teaching a wide variety of undergraduate and graduate courses. As one of his students said, he attains "what every teacher's aim should be… He is able to make you love the subject and really understand it." The *Junior Faculty Teaching Award* was given to **Tara Brendle** in recognition of the infectious enthusiasm for mathematics that she has shared with students in a range of courses and to **Kasso Okoudjou** in appreciation of his sensitive and perceptive teaching skills, continually challenging his students while ensuring each one has a solid understanding of the material. The *Graduate Student Teaching Award* was given to **Heather Armstrong** for outstanding dedication in helping her students succeed in learning calculus through clear and lively presentations.

Writing Prize

William J. Polacheck, a freshman in the College of Agriculture & Life Sciences, was awarded the James E. Rice, Jr. '30 Honorable Mention for his essay Dimensions for Dummies, written for Kristin Camenga's Freshman Writing Seminar MATH 189: Pictures in 100 Words or Less. Created in spring 1999, MATH 189 is a very popular first-year seminar, and we have been able to offer it in both fall and spring with support from the John S. Knight Institute for Writing in the Disciplines.

Curriculum Changes

Reorganization of Introductory Calculus

During the spring 2005 semester, the department piloted a new structure for teaching introductory calculus (MATH 111-112) with two major modifications:

(1) three 50-minute lectures per week instead of four;
(2) weekly Homework Study Group Sessions (HSGS) facilitated by undergraduate course assistants (CAs).

The motivation for the change came from a desire to address the scheduling and staffing difficulties that the four-day-per-week format has always presented for students, instructors, and staff.

The four-day format was adopted nearly 30 years ago when the department changed MATH 111 and 112 from a large lecture/recitation format (three hours of lecture, one hour of recitation) to small classes taught by individual instructors. These changes were dramatic and highly successful in meeting students' needs for closer interaction with their instructor and resulted in higher student satisfaction.

Maria Terrell, Birgit Speh, and Allen Hatcher collaborated on a proposal for reorganizing MATH 111-112 that would keep class sizes small but reduce the number of lectures per week to three by adding an optional weekly evening study group. In the process of rethinking the courses, they sought to develop a plan that would address the staffing and scheduling concerns, offer opportunities to use innovative tools and approaches to teaching, and help undergraduates explore interests in teaching. The proposal grew out of an effort to take advantage of two kinds of opportunities now available to improve instruction: the instructional technology software Maple TA and a growing cadre of undergraduates interested in learning about teaching mathematics. At the same time, the proposal builds more out-of-class informal "study group" and homework support group opportunities for students in the course.

The department approved implementation of the new course structure in MATH 111 this spring as a trial to determine whether it is possible to teach the same amount of material with one fewer lecture every week. The same syllabus was used as in previous semesters.

Daniel Kim, a teaching assistant from the Department of Education, conducted and analyzed responses to surveys of instructors, students and undergraduate course assistants as part of an independent study project. Results of the surveys, conducted during weeks 5 and 14, revealed that overall instructors were in favor of the change from four lectures a week to three. To quote one of them: "Students' time is far better spent working on homework problems in small groups than sitting in class for an extra hour each week listening to me. Working on calculus problems with one's peers is considerably more valuable and enjoyable than working on them alone."

Over 37% of the students in MATH 111 attended Homework Study Groups Sessions at some point in the term, many of them attending multiple times. Student comments revealed that

- HSGS helped them to "wrestle" with the material instead of struggling alone and getting nowhere;
- the presence of CAs in the room provided comfort and on the spot help;
- CAs helped students to understand key concepts;
- students found working with fellow students to be more enjoyable than working alone;
- CAs effectively provided both general and specific help to individuals and groups.

Although most students did not attend the HSGS this semester, it is interesting to note that 62% indicated they would like to see HSGS offered in other math courses that they might take. The most common reason students chose not to attend HSGS this semester is that they were able to do their homework on their own.

This semester's course assistants were a wonderful group of seven undergraduate mathematics majors who helped lay out the foundations of this newly created position. Not only did they help implement the new structure with their on-going energy and innovative ideas, but they themselves benefited tremendously. All seven CAs reported that they enjoyed serving as CAs rather than as graders. To quote one of the CAs, they were "forced to absorb the material better, since the role of CA requires far more than just solution manual knowledge." While helping students, the CAs gained insights as to which homework problems and concepts most students have difficulties with and in what ways, thus enabling the CAs to offer more helpful feedback when it came to grading.

The spring experiment showed that MATH 111 could be successfully taught in the new format, and the department decided to expand the pilot to MATH 111 and MATH 112 in fall 2005 and spring 2006.

New Syllabi in Engineering Calculus

The department began phasing in the new syllabi of MATH 191, 192, and 293 this year. MATH 191 is now a standard second-semester calculus course, with MATH 192 the standard sequel on multivariable calculus, while MATH 293 is an introduction to differential equations. Those students who have not had a good first-semester calculus sequence are required to take such a course in the summer, before taking MATH 191. The changes complete a revision cycle begun a decade ago, reflecting the increasing level of math preparation of incoming engineering students. A major advantage of the new arrangement is that each course now covers a separate package of topics, with no spillover between semesters. The courses now fit in better with calculus courses that students take before arriving at Cornell, or that they take at other institutions for transfer credit. In addition, the new MATH 293 is now a full semester of differential equations, giving a more thorough introduction to this important topic.

NEW — MATH 304: Prove It!

In spring 2005, the department introduced a new course on mathematical proof methodology, entitled *Prove It!*, developed and taught by Peter Kahn. Mathematical proof is the backbone or skeleton of mathematics, giving it a level of reliability and conceptual integrity that is unmatched in other intellectual endeavors. Whether one thinks of mathematics as a tool to be used in science or engineering or as a discipline of intrinsic beauty or value, mathematical proofs play a fundamental validating role.

In MATH 304, twenty students were introduced to the basic techniques and strategies of mathematical proof, both in understanding and analyzing already completed proofs and in attacking and working out proof-problems for themselves. They learned the fundamentals of mathematical logic, which is an indispensible tool for "parsing" complex mathematical assertions, and saw illustrations of the methods they have learned by working through an extended development of a basic item of mathematical knowledge: the logical construction of the real numbers. This served not only to impart that knowledge but also to show how complex, large-scale mathematical structures are built via definition and proof from elementary foundations.

MATH 304 will be offered again in spring 2006.

In Development for 2005-2006

The department plans to offer two new courses in the coming year. In fall 2005, Sarah Day will teach a cross-level course on computational homology as a one-time offering to both undergraduates and graduate students. In spring 2006, Allen Hatcher will teach a new course called *Invitation to Higher Math*, which is intended to provide an alternative to calculus as a point of entry into advanced mathematics courses.

Instructional Technology Support

As computing software, hardware, and Internet technology evolves, so do approaches to incorporating computing technology into undergraduate mathematics instruction. During the 1980s and 1990s our approach to using computer technology to enhance undergraduate mathematics courses was focused on the use of software to support powerful classroom demonstrations and to engage students in mathematical exploration and applications that emerging mathematical software could support. The department responded to this need by opening an instructional computing lab in Stimson Hall the early 1990s. In recent years there has been a dramatic change in the availability and power of personal computers and innovative uses of Internet-based instructional support. Fewer courses used the services of the Stimson Lab, and a decision was made to close the lab during summer 2004. Although this decision resulted in the loss of a half-time support staff position (Todd Cullen), the department was able to continue using existing resources for instructional technology support. Happily, we also received an additional teaching assistant "package" as a result of the transition. As a result of these efforts to "re-deploy" and maximize our resources, we have been able to support a much larger component of the department in the area of instructional technology.

We established the Instructional Technology Office in 258 Malott Hall in September 2004, in a space carved out of the Mathematics Support Center. A graduate student (under the direction of Maria Terrell) will be hired each year to manage the lab and train and supervise undergraduates hired to assist in accomplishing the goals of the Instructional Technology Office. Lee Gibson held this position in 2004–05. He did a great job of establishing policies and procedures and setting standards of excellence for future directors.

There are four areas in which the Instructional Technology Office can support undergraduate mathematics instruction at Cornell:

Instructional Computing

Mathematical software such as Maple, MatLab, DataDesk, Minitab, Mathematica, and emerging mathematical software enhance classroom instruction and student exploration and application of mathematical concepts. The IT office helps graduate teaching assistants, instructors, and faculty get started using MapleTA for their courses and provides problem-solving services to instructors. During the spring semester, a major MapleTA sample question bank and tutorial project took place. Soon it will be possible for the instructional staff to create MapleTA questions of their own very simply using this tutorial and sample LaTeX file. These files will be made available on the IT office web page www.math.cornell.edu/~inst_tech/. In the future, the IT office will begin training members of the Mathematics Support Center to create mastery-style assignments for MapleTA to add to their current library of self-testing assignments.

Instructional Design and Pedagogy

The IT Office has two laptops available for use in providing a technology component to seminars or class presentations. These laptops were used to enable Marita Hyman to make a full multi-media presentation concerning mathematics development in aboriginal people in Australia for the Educational Mathematics Seminar, and assisted Joshua Bowman in preparing a presentation for MATH 223 on aspects of three-dimensional graphing.

In the first year of operation, the IT undergraduate assistants helped instructors with the development of technology-oriented course materials for ongoing use — chiefly the question bank creation process in MapleTA — and provided support to the MATH 111 undergraduate course assistants who worked with MapleTA and Blackboard. The use of emerging and innovative software such as MapleTA can support timely and frequent assessment of student learning and enhance how class time is spent. MapleTA allows instructors to expand their interaction with students outside the classroom by allowing them to pose mathematical questions to students through the web that can be automatically graded, and thereby give both faculty and students feedback on student learning outside of class time.

Another project of the IT Office has been the study of possible uses of the HiTT (HyperInteractive Teaching Technology) software to find better, more flexible ways for it to be used by instructional staff. (The result of this project may be found under the appropriate heading on the IT web site.) HiTT polling systems are currently used in MATH 111 to help instructors engage students in lively discussion and debate of mathematical concepts. In-class polling systems are gaining increasing use in a wide range of disciplines. Following up on this project, IT is supporting the expansion of the Good Questions for Calculus project into other math courses, including MATH 106 and MATH 112.

Course Management Tools

Existing software and tools offered through CIT, such as CourseInfo and Blackboard support both course communication and record keeping for large, multi-section courses. CIT offers powerful tools for instructors to develop sophisticated course websites that can be used to post information about the course and allow instructors to communicate with each other and their students, while serving as a secure central repository of student grades and progress in the course that is accessible via the web to instructors and students. After a substantial amount of communication with departmental instructional staff, Blackboard course management administrative staff at CIT, and MapleTA developers and marketing personnel, it was determined that the product was appropriate for our department. At that time the department moved to purchase the MapleTA Blackboard interface. IT office staff tested it and brought it into production in conjunction with the CIT Blackboard staff in time for the Spring 2005 semester.

Mathematics Support Center

An academic support wing of the Mathematics Department, the Mathematics Support Center (MSC) provides free one-on-one and small-group tutoring, workshops and review sessions on topics of common concern in mathematics, approximately fifty brief printed capsules on various mathematical topics, and advice, encouragement, and referrals for students. Although the center focuses on support of introductory courses, it employs both undergraduates and postgraduates (about eight each year) of diverse backgrounds and provides some limited tutoring even in upper-level courses.

During the 2004–2005 academic year, in addition to paid tutors, two volunteers donated their time and expertise: Professor Emeritus Roger Farrell and Harry Bowman. Douglas S. Alfors directed the operations of the MSC and coordinated its efforts with the instructors of the introductory calculus sequence.

The MSC is located on a main thoroughfare of Malott Hall and is consequently quite visible and accessible to students. It has several tutoring areas that are sufficiently separated from one another to address privacy and noise issues, the reception area can adequately accommodate students who are waiting for their turn to be tutored, and there are a couple of sites that work nicely for small groups. Tutors and tutees can easily access the small library of texts that are maintained by the MSC, and mathematics computer programs provide additional support when needed. In the coming year, the MSC anticipates developing a more visible web presence and replacing some antiquated computer equipment. The MSC maintains weekday hours of service (10:00 AM –5:00 PM), as well as Sunday hours (1:30-5:30 PM).

Learning Strategies Center

The Learning Strategies Center (LSC) provides academic support in a variety of subjects across campus, including biology, chemistry, physics, genetics, economics, writing, study skills, mathematics and statistics. The mission of the LSC is to provide academic assistance to students during their transition from high school students to accomplished Cornell students. Studies have shown that students who successfully complete their freshman year generally go on to graduate from Cornell. Therefore, most of the LSC's efforts are directed to supporting large, primarily freshmen, courses.

In the 2004–2005 academic year, the LSC provided academic support for MATH 105, 106, 111, and 112. Support included respective supplemental courses MATH 005, 006, 011, and 012. Each supplemental course consisted of a ninety-minute weekly lecture, held on either Sunday, Monday or Wednesday evening, which reviewed material covered in the parent course, with an emphasis on problem solving and prelim preparation. In addition, the supplemental course instructors and their assistants provided extensive tutoring hours.

Under the direction of Patricia Alessi, the LSC Statistics Lab in the Center for Learning and Teaching provided support for MATH 171 and other undergraduate statistics courses. The tutor-staffed lab was open four evenings per week, equipped with statistical software and problem sets for the courses supported. During the 2004–2005 academic year, support will continue to be provided as described above for MATH 105, 106, 111, 112, and 171.

Graduate Program

Cornell's Graduate Program in Mathematics has been ranked as one of the top ten in the country for many years. The Ph.D. program included 77 graduate students during the 2004–2005 academic year, including four non-degree students. Class representatives were **Russ Woodroofe** (sixth and seventh year), **Franco Saliola** (fifth year), **Henri Johnston** (fourth year), **Bradley Forrest** (third year), **Jonathan Needleman** (second year), and **Ingvar Sigurjonsson** (first year). **Treven Wall** served as the graduate and professional student representative.

Graduate students play an essential role in all aspects of the department: teaching, research, mentoring of undergraduates, and community outreach programs.

Graduate Student Recruitment

This year the Mathematics Department was fortunate to receive six one-year fellowships from the Graduate School. These fellowships will be offered to top-ranking applicants for their first year of study. We will continue to work with the Graduate School to increase the number of fellowships that can be offered to our students. Our goal is to offer all of our students at least two years free of teaching duties. Support could come from fellowships or graduate research assistantships. This would make our Ph.D. program more competitive with peer institutions.

Joshua Bowman, Heather Heston, Sarah Koch, Mia Minnes, Gregory Muller, Jay Schweig, Gwyneth Whieldon, and **John Workman** planned and executed a very successful Prospective Graduate Student Weekend March 4–6, 2005. Twelve prospective students attended the weekend activities, which included meetings with faculty and students, and attending classes, lectures and many special events. Everyone agrees that it is well worth the effort and resources. Eight of the twelve visiting students will join the Ph.D. program next year.

The entering class this fall will consist of thirteen new Ph.D. students, so we will have 72 graduate students in the program. Six students are entering with a one-year Graduate School fellowship: **Daniel Erb,** RPI; **Victor Kostyuk,** RIT; **Bastian Laubner,** University of Bremen; **Sergio Pulido Niño,** Unversity of the Andes; **Peter Samuelson**, CIT; **Denise Terry**, University of Redlands. And the following seven students will be supported as teaching assistants: **Jason Anema**, Purdue University; **Marisa Belk**, University of Binghamton; **Jennifer Biermann**, Lawrence University; **Saúl Blanco Rodríguez**, Cornell University; **Peter Luthy**, Connecticut College; **Paul Shafer**, Cornell University; and **Russ Thompson**, UNC Chapel Hill.

The department will host three non-degree students in 2005–2006: **Jiamou Liu** and **Pavel Semukhin**, from the University of Auckland, will be at Cornell for the fall semester working with Visiting Professor Bakhadyr Khoussainov. **Francesco Matucci** will stay one more year to work with Ken Brown. He will be supported as a teaching assistant.

Graduate Student Awards

The *Robert John Battig Graduate Prize* was awarded to **Antonio Montalban** and **Roland Roeder**. Recipients of the Battig Prize are graduate students in mathematics at Cornell who have passed the A exam (typically in their second year of study). Any such graduate student is eligible regardless of social or financial background. Antonio is a student of Richard Shore. Roland works with John Hubbard. Antonio and Roland will graduate in August 2005; they are outstanding researchers and have been excellent students.

Hutchinson Fellowships were awarded to **Drew Armstrong** and **Treven Wall**, providing one semester of relief from teaching to allow them to work on their thesis problems. Established in 1947 by Genevra Barrett Hutchinson to honor her husband John Irwin Hutchinson and his long teaching career in the Mathematics Department, Hutchinson fellowships are awarded annually to mathematics graduate students who have done outstanding work as teaching assistants or as students in the graduate program. Accordingly, it is given to students who have completed three years of study and are not in their final year. Drew is working with Louis Billera and Treven with Len Gross. Both students are outstanding researchers and instructors.

The *Eleanor Norton York Award* was awarded to **Jagadheep Panbian** in Astronomy and **Jeffery Mermin** in Mathematics. The York Award was established by friends of Eleanor York, who died of cancer in 1993. Each year a student in the Mathematics Department and a student in the Astronomy Department, in which Eleanor was employed, are selected to receive this award. Recipients are chosen from those in the middle of their graduate education on the basis of their achievements to date to encourage them to have even more success in the future. Jeff is a fifth year student with Michael Stillman.

The *Graduate Student Teaching Award* was presented to **Heather Armstrong** at the Mathematics Department's annual holiday party. Heather is a third year student working with Karen Vogtmann. (For more information, see page 16.)

Outreach Activities

Graduate students play a key role in the department's outreach activities. Expanding Your Horizons was organized and run by the following team of graduate students: **Maria Belk, David Biddle, Evgueni Klebanov,** and **Melanie Pivarski.** They worked with a group of 7th, 8th, and 9th grade girls and approximately seven gallons of bubble solution in order to study minimal surfaces. **Mia Minnes, Jonathan Needleman,** and **Treven Wall** also participated in the planning.

Jeffrey Mermin and **Jason Martin**, along with CAM graduate student Deena Schmidt, organized the Ithaca High School Senior Seminar under the direction of Rick Durrett. The three graduate students led workshops on the elementary properties of continued fractions, ciphers, and probability theory.

Bryant Adams, Antonio Montalbán, Chris Lipa, and **Radu Murgescu** participated in Math Explorer's Club. Bryant led a module on fractals, Antonio and Yannet Interian-Fernandez (CAM) focused on puzzles, Chris led activities on dynamical systems and chaos, and Radu introduced students to number theory. More on these outreach activities can be found in Community Outreach, pp. 46–49.

Department Colloquia

Devoted to expository talks on current research areas, the Olivetti Club is organized entirely by graduate students, and most of the speakers are graduate students. **Todd Kemp** and **Matthew Noonan** served as organizers in the fall and **Robyn Miller** and **Roland Roeder** organized talks in the spring. In addition, **Jeffrey Mermin** organized the Number Theory and Algebraic Geometry Seminar, and **Mia Minnes** and **Kristin Camenga** conducted the Teaching Seminar. In all, 36 graduate students gave 96 talks in department seminars this year. (See Department Conferences and Seminars for a list of talks, pp. 34–43.)

Preparing Future Professors

The Preparing Future Professors program continues to prepare graduate students for the professorate while attracting attention from outside administrative agencies. The College of Arts and Sciences Dean's Office provided funding for the program this year, and Dr. Maria Terrell served as director.

Cornell graduate students gave talks to mixed audiences of faculty and students at nearby colleges and universities, an experience that afforded participants the opportunity to talk about their work in ways that anticipate both professional meetings and job searches, while providing understandable and enjoyable colloquia for undergraduates in our region. The graduate student speakers were also able to see firsthand how faculty roles and student expectations at other campuses can vary widely from those here at Cornell. Graduate students **Eduardo Carta** and **Sarah Koch** coordinated the following talks:

Ben Chan: *Branching processes in biology* (Ithaca College)
Spencer Hamblen: *Perfect numbers* (Wells College); *Congruent numbers* (Hobart & William Smith College)
Evgueni Klebanov: *Living in the N3/2 dimensions* (Hamilton College)

Other Graduate Student Activities

Graduate students were active in attending conferences and giving off-campus research presentations at meetings and specialized conferences. A small sampling of these activities follows:

Drew Armstrong attended the Summer Session in Geometric Combinatorics at the Institute for Advanced Study/Park City Mathematics Institute, Park City, Utah, summer 2004, and the American Institute of Mathematics workshop on braid groups, clusters, and free probability in Palo Alto, California, January 2005. He was selected to prepare an article on the open problems discussed at the workshop.

Nathanael Berestycki spoke at the 6th Bernoulli world conference in a session on Random Walks, July 2004.

Kristin Camenga spoke at the Mathematics colloquium at St. Olaf College and presented her research on the use of writing in mathematics instruction to middle and high school teachers, participants of the Teacher Professional Development Day at Cornell.

Todd Kemp was invited to lecture and collaborate on research at Queen's University with Roland Speicher.

Antonio Montalban gave the following talks at conferences: *Logic, computability and randomness*, Cordoba, Argentina, Septermber 2004; *Up to* *equimorphism, hyperarithmetic is recursive*, AMS Central Section Meeting, Evanston, IL, October 2004; *On Frass's conjecture and some equivalent statements*, Joint Mathematics meetings, Atlanta, January 2005; *On the proof-theoretic strength of Jullien's results,* ASL annual meeting, Stanford, CA, March 2005; *A minimal pair of K-degrees*, seminar talks at the University of Notre Dame, the University of Wisconsin-Madison, the University of Chicago, and the University of Connecticut.

Melanie Pivarski gave a talk, *Bounds and boundaries: relationships between Sobolev and isoperimetric inequalities,* at the MAA Seaway Section meeting at Canisus College. She also attended the Joint AMS meeting in Atlanta.

Artem Pulemyotov gave an invited talk at the Welsh Probability Seminar at the University of Wales, Swansea.

Fernando Schwartz gave a talk, *The zero scalar curvature Yamabe problem on noncompact manifolds with boundary,* at Communication at the XIII School of Diff. G. USP, Sao Paulo, Brazil, July 2004.

José Trujillo Ferreras gave an invited talk, *Stochastic Loewner evolution*, at the Second Conference on self-similarity and applications, Toulouse, France, June 2005.

Graduate Student Publications

Richard Durrett and **Nathanael Berestycki,** *A phase transition in the random transposition random walk*, Probab. Theor. Rel. Fields, submitted. Available on the arXiv as math.PR/043259.

Christopher Hardin, *How the location of * influences complexity in Kleene algebra with tests*; in Proceedings of the 11th Int. Conf. Logic for Programming, Artificial Intelligence, and Reasoning (F. Baader and A. Voronkov, eds.), Lecture Notes in Artificial Intelligence 3452, Springer-Verlag, 2005, pp. 224–239.

Todd Kemp, *Hypercontractivity in non-commutative holomorphic spaces*. Comm. Math. Phys. (to appear).

Yurij Berezansky and **Artem Pulemyotov**, *The spectral theory and the Wiener-Ito decomposition for the image of a Jacobi field*, submitted.

Roland K. W. Roeder, John H. Hubbard, and William D. Dunbar, *Andreev's theorem on hyperbolic polyhedra,* Les Annales de l'Institut Fourier, submitted.

Roland K. W. Roeder, *Compact hyperbolic tetrahedra with non-obtuse dihedral angles,* Publicacions Matematiques, submitted.

T. E. Evans, **Roland K. W. Roeder**, J.A. Carter et al, *Experimental signatures of homoclinic tangles in poloidally diverted tokamaks,* Journal of Physics: Conference Series 7 (2005), 174–190.

Fernando Schwartz*, The zero scalar curvature Yamabe problem on noncompact manifolds with boundary*, Indiana Univ. Math. J. (to appear).

Robert Connelly and **Maria Sloughter**. *Realizability of graphs*, Discrete and Comp. Geom., submitted.

Maria Sloughter, *Realizability of graphs in three dimension*, Discrete and Comp. Geom., submitted.

Gregory F. Lawler and **José Antonio Trujillo Ferreras,** *Random walk loop soup,* Trans. AMS (to appear).

Doctoral Degrees

August 2004

James Belk
Thompson's Group F

M.S. Special (2002), Cornell University
M.S. (1999), SUNY Binghamton
B.S. (1999), SUNY Binghamton
Committee: Brown, Cohen, Vogtmann, Saloff-Coste
First Position: Visiting assistant professor at Cornell University

Abstract: We introduce two new types of diagrams that aid in understanding elements of Thompson's group *F*. The first is the *two-way forest diagram*, which represents an element of *F* as a pair of infinite, bounded binary forests together with an order-preserving bijection of the leaves. These diagrams have the same relationship to a certain action of *F* on the real line that the standard tree diagrams have to the action of *F* on the unit interval. Using two-way forest diagrams, we derive a simple length formula for elements of *F* with respect to the finite generating set $\{x_0, x_1\}$.

We then discuss several applications of two-way forest diagrams and the length formula to the geometry of *F*. These include a simplification of a result by S. Cleary and J. Taback that *F* has dead ends but no deep pockets; a precise calculation of the growth function of the positive submonoid with respect to the $\{x_0, x_1\}$ generating set; a new upper bound on the isoperimetric constant (a.k.a. Cheeger constant) of *F*; and a proof that *F* is not minimally almost convex.

Next, we introduce *strand diagrams* for elements of *F*. These are similar to tree diagrams, but they can be concatenated like braids. Motivated by the fact that configuration spaces are classifying spaces for braid groups, we present a classifying space for *F* that is the "configuration space" of finitely many points on a line, with the points allowed to split and merge in pairs.

In addition to the new results, we present a thorough exposition of the basic theory of the group F. Highlights include a simplified proof that the commutator subgroup of F is simple, a discussion of open problems (with a focus on amenability), and a simplified derivation of the standard presentation for F and the normal form for elements using *one-way forest diagrams*.

Nelia Charalambous

On the L^p Independence of the Hodge Laplacian and Logarithmic Sobolev Inequalities on Non-compact Manifolds

M.S. Special (2001), Cornell University
B.S. (1998), University of North Carolina at Chapel Hill
Committee: Escobar, Gross, Strichartz, Saloff-Coste
First Position: Visiting assistant professor at Cornell University

Abstract: The central aim of this thesis is the study of the spectrum and Heat kernel bounds for the Hodge Laplacian on differential forms of any order k in the Banach Space L^p. The underlying space is a C^∞-smooth open manifold M^N, not necessarily compact, on which Ricci curvature is bounded below, and has uniformly subexponential volume growth. It will be demonstrated that on such a space the L^p spectrum of the Hodge Laplacian on differential k-forms is independent of p for $1 \le p \le \infty$, when the Weitzenböck tensor on k-forms has a lower bound as well. It follows as a corollary that the isolated eigenvalues of finite multiplicity are also L^p independent. By considering the L^p spectra of the Hodge Laplacian on the hyperbolic space H^{N+1} we conclude that the subexponential volume growth condition is necessary in the case of one-forms.

The proof of the L^p independence result, relies on finding a Gaussian type upper bound for the heat kernel of the Hodge Laplacian. For obtaining the Gaussian bound we will use Kato's inequality. It will be shown that similar bounds can be also obtained via logarithmic Sobolev inequalities by assuming a uniform lower bound on the volume of balls of radius one instead of a uniform subexponential volume growth.

Finally, as an application, we will show that the spectrum of the Laplacian on one-forms has no gaps on manifolds with a pole and on manifolds that are in a warped product form. This will be done under weaker curvature restrictions than what have been used previously; it will be achieved by finding the L^1 spectrum of the Laplacian.

Dan Ciubotaru

Unitary Representations of Exceptional p-adic Groups

B.S. (1998), Babes-Bolyai University (Romania)
Committee: Barbasch, Speh, Brown
First Position: CLE Moore Instructor at MIT

Abstract: One of the fundamental problems in representation theory is the classification of the irreducible unitary representations (*the unitary dual*) of reductive groups defined over local fields. In the case of groups over p-adic fields, an important piece of the unitary dual is formed by the *Iwahori-spherical* representations, which are representations with nontrivial fixed vectors under the action of a particular subgroup of G, the Iwahori subgroup.

The main focus of my thesis is the description of the Iwahori-spherical unitary representations for a split reductive p-adic group G of type F_4. From the work of D. Barbasch and A. Moy, this is equivalent to the determination of the unitary representations with real infinitesimal character of the corresponding affine graded Hecke algebra $\mathbf{H}$. Using the classification of simple Hecke algebra modules, the unitary dual is partitioned into subsets parametrized by nilpotent orbits in the dual Lie algebra. Most of the techniques involved are similar to those used by Barbasch-Moy and Barbasch in the classification of the spherical unitary spectrum for classical groups.

Jean Cortissoz

On the Ricci Flow in Rotationally Symmetric Manifolds with Boundary

B.Sc. (1998), Universidad de los Andes (Colombia)
Committee: Escobar, Gross, Wahlbin, Strichartz
First Position: Visiting assistant professor at Toledo University
Abstract: N/A

Christopher Francisco

Hilbert Functions and Graded Free Resolutions

M.S. Special (2002), Cornell University, Mathematics
B.S. (1999), University of Illinois at Urbana-Champaign
Committee: Stillman, Billera, Brown
First Position: Postdoctoral fellow at the University of Missouri

Abstract: This thesis discusses the connection between Hilbert functions and graded free resolutions. One can

compute the Hilbert function of a module from its graded free resolution. However, there may be modules with the same Hilbert function but different graded Betti numbers. We investigate what graded free resolutions actually occur for a given Hilbert function. We provide a quick review of background material in the first chapter.

In Chapter 2, we consider the simplest case of this question: For what Hilbert functions is there only one possible set of graded Betti numbers? We characterize these Hilbert functions for ideals in $k[x, y]$. In more variables, the question is more difficult, and we give examples of some families of Hilbert functions for which there is a unique set of attainable graded Betti numbers.

The third chapter focuses on stable ideals. Fix a Hilbert function H. We ask if there exists a stable ideal I with Hilbert function H such that the graded Betti numbers of any other stable ideal J with the same Hilbert function are at least as large as those of I. We answer the question affirmatively for ideals in $k[x_1, x_2, x_3]$ but provide a counterexample in four or more variables.

In the fourth and fifth chapters, we investigate the Lex-Plus-Powers Conjecture on graded Betti numbers and the EGH Conjecture on Hilbert functions. We devote Chapter 4 to introducing versions of the conjectures and the relationships among them. In Chapter 5, we prove that the graded Betti numbers of a lex-plus-powers almost complete intersection are an upper bound for the graded Betti numbers of any ideal with the same Hilbert function and regular sequence in the same degrees. In addition, we give some related results on Hilbert functions.

We conclude in Chapter 6 by investigating a conjecture of Huneke and Srinivasan on the multiplicity of an ideal. They conjecture bounds for the multiplicity in terms of the graded free resolution. We prove some special cases of the conjecture for ideals with generators in high degrees relative to their regularity, survey some computational work, and discuss some reductions of the conjecture.

Yuval Gabay
Double Jump Inversions and Strong Minimal Covers in the Turing Degrees

B.Sc. (1998), Hebrew University of Jerusalem
Committee: Shore, Nerode, Kozen
First Position: Postdoctoral research position at Ben-Gurion University of the Negev

Abstract: Decidability problems for (fragments of) the theory of the structure D of Turing degrees, form a wide and interesting class, much of which is yet unsolved. Lachlan showed in 1968 that the first order theory of D with the Turing reducibility relation is undecidable. Later results concerned the decidability (or undecidability) of fragments of this theory, and of other theories obtained by extending the language (e.g. with **0** or with the Turing jump operator). Proofs of these results often hinge on the ability to embed certain classes of structures (lattices, jump-hierarchies, etc.) in certain ways, into the structure of Turing degrees. The first part of the dissertation presents two results which concern embeddings onto initial segments of D with known double jumps, in other words a double jump inversion of certain degree structures onto initial segments. These results may prove to be useful tools in uncovering decidability results for (fragments of) the theory of the Turing degrees in languages containing the double jump operator.

The second part of the dissertation relates to the problem of characterizing the Turing degrees which have a strong minimal cover, an issue first raised by Spector in 1956. Ishmukhametov solved the problem for the recursively enumerable degrees, by showing that those which have a strong minimal cover are exactly the r.e. weakly recursive degrees. Here we show that this characterization fails outside the r.e. degrees, and also construct a degree below $\mathbf{0}'$ which is not weakly recursive, thereby answering a question from Ishmukhametov's paper.

Noam Greenberg
The Role of True Finiteness in the Admissibility of Recursively Enumerable Degrees

B.Sc. (1998), Hebrew University
Committee: Shore, Nerode, Morley
First Position: Postdoctoral position at the University of Notre Dame

Abstract: When attempting to generalize recursion theory to admissible ordinals, it may seem as if all classical priority constructions can be lifted to any admissible ordinal satisfying a sufficiently strong fragment of the replacement scheme. We show, however, that this is not always the case. In fact, there are some constructions which make an essential use of the notion of finiteness which cannot be replaced by the generalized notion of α-finiteness. As examples we discuss both codings of models of arithmetic into the recursively enumerable degrees, and non-distributive lattice embeddings into these degrees. We show that if an admissible ordinal α is effectively close to ω (where

this closeness can be measured by size or by cofinality) then such constructions may be performed in the α-r.e. degrees, but otherwise they fail. The results of these constructions can be expressed in the first-order language of partially ordered sets, and so these results also show that there are natural elementary differences between the structures of α-r.e. degrees for various classes of admissible ordinals aα. Together with coding work which shows that for some α, the theory of the α-r.e. degrees is complicated, we get that for every admissible ordinal α, the α-r.e. degrees and the classical r.e. degrees are not elementarily equivalent.

JaEun Ku
Least-Squares Methods for Second-Order Elliptic Partial Differential Equations

B.S. (1995), Pohang University
Committee: Wahlbin, Schatz, Vavasis (Comp. Sci.)
First Position: Visiting assistant professor at Purdue University

Abstract: We study least-squares finite element methods for second-order elliptic partial differential equations.

Bramble, Lazarov and Pasciak [5] proposed a least-squares method which could be thought of as a stabilized Galerkin method. We modify their method by weakening the strength of the stabilization terms and present various error estimates. The modified method has all the desirable properties of the original method. At the same time, our numerical experiments show an improvement of the method due to the modification.

We also study a first-order least-squares method proposed by Cai, Lazarov, Manteuffel and McCormick [12]. The method does not require the $\inf - \sup$ condition. We bound the error in the primary function u and the flux $\underline{\mathbf{p}}$ separately and obtain various error estimates with different approximating spaces.

Dmitriy Leykekhman
Pointwise Weighted Error Estimates for Parabolic Finite Element Equations

B.A. (1998), New York University
Committee: Wahlbin, Schatz, Vavasis (Comp. Sci.)
First Position: Lecturer, Cornell University

Abstract: n this thesis we consider the standard Galerkin finite element approximation to the solution of a parabolic partial differential equation given on a bounded domain $\Omega \subset \mathbf{R}^n$.

The error between the exact solution and the approximate solution naturally splits into two parts. The first part is the so-called semidiscrete error and the second part is the error between approximate solution and semidiscrete approximation. A big part of the material of this thesis is devoted to obtaining pointwise weighted estimates for the semidiscrete error. These results extend those obtained by A. Schatz in 1998, in the case of stationery elliptic problems.

Then we will give an example, which shows that the localization does not always hold for time discretization.

The analysis of the fully discrete error is very different and requires a completely different technique. In all known results, in order to show an optimal order estimate in terms of data, it is necessary to make some artificial assumptions. In the last chapter, we show that, using a certain "trick," those artificial assumptions are not necessary.

Yi Lin
Equivariant Symplectic Hodge Theory and Strong Lefschetz Manifolds

M.S. Special (2000), Cornell University
M.S. (2000), Sichuan University
B.S. (1994), Sichuan University
Committee: Sjamaar, Stillman, Kahn
First Position: Visiting assistant professor at the University of Illinois at Urbana-Champaign

Abstract: Consider a Hamiltonian action of a compact Lie group on a symplectic manifold which has the strong Lefschetz property. We establish an equivariant version of the Merkulov-Guillemin $d\delta$-lemma, namely the d_G, δ-lemma, and an improved version of the Kirwan-Ginzburg equivariant formality theorem, which says that every cohomology class has a *canonical* equivariant extension.

We then proceed to examine the equivariant cohomology of a compact strong Lefschetz Hamiltonian manifold (M, ω) with generalized coefficients and establish a version of the d_G, δ-lemma for equivariant differential forms with generalized coefficients.

Consider a compact Hamiltonian circle manifold with the strong Lefschetz property. We constructed a family of 6 dimensional compact Hamiltonian S^1 manifold each of which satisfies the strong Lefschetz property itself but has a non-Lefschetz symplectic quotient. As an aside we showed an interesting compact Hamiltonian circle

manifold constructed by Karshon has the strong Lefschetz property.

Harrison Huibin Zhou
Minimax Estimation with Thresholding and Asymptotic Equivalence for Gaussian Variance Regression

M.S. (1998), Beijing University
B.S. (1995), Central China Normal University
Committee: Hwang, Nussbaum, Wells, Strichartz
First Position: Assistant professor at Yale University

Abstract: Part I: Many statistical practices involve choosing between a full model and reduced models where some coefficients are reduced to zero. Data were used to select a model with estimated coefficients. Is it possible to do so and still come up with an estimator always better than the traditional estimator based on the full model? The James-Stein estimator is such an estimator, having a property called minimaxity. However, the estimator considers only one reduced model, namely the origin. Hence it reduces no coefficient estimator to zero or every coefficient estimator to zero. In many applications including wavelet analysis, what should be more desirable is to reduce to zero only the estimators smaller than a threshold.

We construct such minimax estimators which perform thresholding. We apply our recommended estimator to the wavelet analysis and show that it performs the best among the well-known estimator aiming simultaneously at estimation and model selection. Some of our estimators are also shown to be asymptotically optimal. This part is a joint work with J.T. Gene Hwang, which is to appear in the Annals of Statistics.

Part II: One of the most important statistical contributions of Lucien Le Cam is the asymptotic equivalence theory. A basic principle of asymptotic equivalence theory is to approximate general statistical models by simple ones. A breakthrough of this theory was obtained by Nussbaum (1996) following the work of Brown and Low (1996). Nussbaum (1996) established the global asymptotic equivalence of the white-noise problem to the nonparametric density problem. The significance of asymptotic equivalence is that all asymptotically optimal statistical procedures can be carried over from one problem to the other when the loss function is bounded.

In this paper we established the asymptotic equvalence between the Gaussian variance regression problem and the Gaussian white noise problem under the Besov smoothness constraints. A multiresolution coupling methodology for the likelihood ratios (similar to the Hungarian construction) is used to establish asymptotic equivalence. For each resolution, our coupling approach is more elegant than the traditional quantile coupling methods; essentially we use quantile couplings between independent Beta's and independent normals. For the quantile coupling between a Beta random variable and a normal random variable, we establish a bound which improves the classical bound in KMT paper with a rate, which is of independent interest.

This is a joint work with Michael Nussbaum.

May 2005

Fernando Schwartz
Scalar Curvature Problems on Manifolds with Boundary

M.S. (1999), University of Chile
B.S. (1998), University of Chile
Committee: Gross, Strichartz, Saloff-Coste, Schoen*
First Position: visiting assistant professor at Duke University

Abstract: Let (M^n, g), $n \geq 3$ be a complete, noncompact *positive* Riemannian manifold with compact boundary and finitely many ends, all of them large. Let f be a smooth function on the boundary of M. We prove that there exists a conformally related metric $\bar{g}$ on M so that $(M, \bar{g})$ is complete, has large ends, is scalar flat and has mean curvature exactly f on the boundary.

Let M_1, M_2 be compact n-manifolds with boundary and with $n \geq 3$. We show that the Yamabe invariant of the connected sum of M_1 and M_2 over the boundary, $M_1 \# M_2$, satisfies:

$$Y(M_1 \# M_2) \geq \begin{cases} \min\{Y(M_1), Y(M_2)\} & \text{if } Y(M_i) > 0 \text{ for some } i, \\ -\left(|Y(M_1)|^{\alpha} + |Y(M_2)|^{\alpha}\right)^{1/\alpha} & \text{otherwise,} \end{cases}$$

where $\alpha = \pi / 2$ for the relative-Yamabe invariant, and $\alpha = n - 1$ for the boundary-Yamabe invariant.

*Richard Schoen, Stanford University

Master of Science Degree

August 2004

Everilis Santana-Vega
The Impact of the GoodQuestions Project on Students' Understanding of Calculus Concepts

B.S. (2000), University of Puerto Rico, Humacao
Committee: Henderson, Billera
First Position: High school teacher at Escuela Especializada de Bellas Artes, Humacao, Puerto Rico

Abstract: In this study, I assess the impact of new teaching methods on students' understandings of calculus concepts. In particular, I investigate possible relationships between students' performance in the course examinations and the use of "good questions" and peer discussion methodology. Students' reactions to the new methods are also investigated. Surveys were used to gather information about how the new methods were implemented in each section, as well as students' responses to the methods. The analysis was done using ANOVA procedures with statistical software.

The results obtained revealed an association between students' high scores in examinations and frequent use of "good questions" with peer discussion. The statistical results were partially significant for preliminary examinations and highly significant for the final examination. The results also suggest that use of "good questions" without peer discussion does not benefit students. In addition, the study shows that the use of "deep questions," the most difficult of the "good questions," even in a sporadic way, is associated with higher scores. Results were similar for conceptual and total scores, suggesting that use of classroom time for discussion about calculus concepts does not affect negatively students' performance in computational exercises.

Students' answers to surveys show they were participating actively in peer discussions about the "good questions". They also revealed that most students think such activities help them to understand calculus concepts. Moreover, students who thought the new methods were helping them, got higher scores in examinations than their counterparts. Results in the study show that when classroom time is used to engage students in deep thinking about mathematical concepts students improve their mathematical understanding. The results should encourage calculus teachers to use cooperative methods in the classroom.

Master of Science Special Degrees

(No Thesis Required)

January 2005

Drew Armstrong, Mathematics
B.S. (2002), Queen's University
Committee: Billera, Brown, Vogtmann

Jason Bode, Mathematics
B.S. (2001), Calvin College
Committee: Brown, Saloff-Coste, Henderson

Christopher Hardin, Computer Science
B.A. (1998), Amherst College
Committee: Kozen, Shore, Nerode

Vadims Moldavskis, Mathematics
M.S. (2001), Moscow State University
Committee: Ilyashenko, West, Stillman

Jay Schweig, Mathematics
B.S. (2001), George Mason University
Committee: Swartz, Billera, Connelly

John Thacker, Mathematics
B.S. (2001), Duke University
Committee: Lawler, Saloff-Coste, Durrett

Mauricio Velasco, Mathematics
B.A. (2002), Universidad de los Andes
Committee: Stillman, Peeva, Nussbaum

May 2005

Heather Armstrong, Mathematics
B.S. (2002), Millersville University
Committee: Vogtmann, Hatcher, Brown

Sarah Koch, Mathematics
B.S. (2001), Rensselaer Polytechnic Institute
Committee: Hubbard, Smillie, Guckenheimer, Earle

Undergraduate Program

The Cornell undergraduate program in mathematics accepted 53 new majors in the academic year 2004–2005 and conditionally accepted 8 students, increasing the program slightly to 134 majors and 8 provisional majors just prior to commencement. Among these students are 66 double majors, 5 triple majors, and 1 dual degree student from the Engineering College.

Events and Receptions

The mathematics major committee organized two receptions this year. The fall reception was a fairly big event. John Hubbard gave brief "inspirational" presentations aimed at showing students that math is a vibrant field that is very much alive. Bob Strichartz discussed REU opportunities. Yulij Ilyashenko discussed the Math in Moscow program, and Ravi Ramakrishna spoke about the Budapest Semesters in Math program. Alex Vladimirsky spoke about the Math Modeling contest, while Dave Bock spoke about opportunities in education. Math Club president Mike Nute talked to students about the club. Following these formal presentations, students had the opportunity to chat informally with professors about courses next term. The spring reception was a smaller affair that focused more on courses and mingling. The receptions are likely useful as recruiting tools and may have played some positive role in the recent increase of our majors.

In the fall, Director of Graduate Studies Michael Stillman conducted a meeting concerning applications for graduate school in mathematics, and Robert Strichartz, Tara Brendle, and Martin Kassabov gave a presentation about research opportunities for undergraduates at Cornell and elsewhere in January.

Undergraduate Mathematics Club

The undergraduate Mathematics Club, under the leadership of president Michael Nute, organized a series of talks by Cornell faculty. Attendance for the talks ranged from 10 to 40 people, primarily undergraduates but also faculty and graduate students.

John Hubbard, *KAM Theorem*

Ravi Ramakrishna, *Fermat's last theorem, a history*

Alexander Meadows, *Brower, a beautiful mind, and the birthday bash*

Gregory Lawler, *Choosing at random from very large sets*

Edward Swartz, *How many are there?*

Tara Brendle, *Braids and cryptography*

To wrap up the academic year, a pizza and games night was held during study week in May, involving undergraduates, graduate students, and faculty. Participants enjoyed pizza and played games, such as chess, checkers, bridge, and more.

Mathematics Major Requirements

Upon reviewing the requirements for the major this fall, the mathematics major committee recommended the following changes:

- Expand the eligible concentration courses to include: for mathematical biology, BTRY 408 and 409 (no credit with MATH 471 and 472); for economics, ECON 327, 476, 477, 676, 677, 748, and 749; for operations research, OR&IE 483; for physics, PHYS 314, 323, 445, 451, 481, 456, and 457.
- Remove the mathematical modeling requirement for students who have fulfilled an outside concentration.
- Cap the number of econometrics courses (320, 325, 327, 748, 749) used for the economics concentration at two (suggested by Economics DUS Tom Lyons).
- Rather than allowing *any* course in computer science above 300 for the computer science concentration, allow COM S 321, 322, 381, 400, 411, 421, 426, 427, 428, one of 465 or 467, 468, 474, 478, 480, 481, 482, 483, and 486 (as recommended by Computer Science DUS Keshav Pingali).
- Count 2-credit courses as half courses.
- Establish a policy that 500-level MATH courses do not count toward the major, except in rare cases.

The department approved these recommendations on October 27, 2004. The first two items, which loosen requirements, were implemented immediately, while the new restrictions will apply to students graduating in May 2007 or later.

Undergraduate Awards and Honors

The *Harry S. Kieval Prize in Mathematics* for 2005 was awarded to **Vorrapan Chandee, Timothy DeVries, Shawn Drenning,** and **Michael Jennings.** Harry S. Kieval '36 established the Kieval Prize in 1983 to provide an annual award for outstanding graduating senior mathematics majors. Dr. Kieval was a generous man who fervently believed in undergraduate education. Upon his death in 1994, he left an endowment to support the continuation of the Kieval Prize. The department's honors committee chooses the recipients on the basis of academic performance, the quality and variety of mathematics courses taken, and faculty recommendations.

Vorrapan Chandee is a student of John Hubbard. She co-wrote a senior thesis entitled *Counting Kneading Sequences* under the direction of Rodrigo Perez. Vorrapan was the degree marshal for the College of Arts and Sciences in this year's commencement procession because she had the highest GPA in the college. She will attend graduate school at Stanford Univeristy in mathematics.

Tim DeVries is a student of Laurent Saloff-Coste. He wrote a senior thesis entitled *The Weak Order and Flag h-Vector Inequalities* under the direction of Ed Swartz and spent two summers doing REU at University of Washington, Seattle and Cal Poly San Luis Obispo. Tim was the symbol-banner bearer for the College of Arts and Sciences in this year's commencement procession because he had the third highest GPA in the college. He will attend graduate school in mathematics at the University of Pennsylvania.

Shawn Drenning is a student of Gregory Lawler. Shawn's participation in Cornell's REU has yielded a paper to be published in Experimental Math. Under the direction of Bob Strichartz, he wrote a senior thesis entitled *Fractal Analysis: Extending the Domain*, which will be the basis for another paper. Shawn will attend graduate school at the University of Chicago in mathematics.

Michael Jennings is a student of Karen Vogtmann. Michael participated in Cornell's REU program last summer, under the direction of Bob Strichartz, with whom he is currently collaborating on a paper. He has also done research with Prof. Sirer in computer science on ad hoc networking protocols. Mike graduates with a double major in computer science and will enter the Ph.D. program at MIT's Computer Science and Artificial Intelligence Lab.

In January 2005, **Peter Maceli '06** was among those awarded a prize for outstanding work in the Undergraduate Student Poster Session at the Joint Meetings in Atlanta for his poster *Analysis of 3-Dimensional Fractal Tree Canopies*. The poster was based on work done last summer in the REU program at Ithaca College with Cornell Ph.D. David Brown.

Andrew Marks '05 and **Elizabeth Smoot '07** each won third prize in the *Cornell University Library Council Book Collection Contest* for their collections "Jewish Law Through the Ages" (Andrew) and "Mathmania" (Elizabeth). The contest is an annual competition for Cornell undergraduates interested in books and book collecting. Introduced in 2003, the Book Collection Contest provides Cornell students the opportunity to articulate their interest in books and to display their aptitude in assembling and organizing book collections. A panel of judges, consisting of Cornell faculty, librarians, and members of the Library Council, selects six finalists from all entries.

Tulika Kumar '05 wrote the best final project for MATH 403, which was presented for consideration for the Knight Prize. Although she did not win an award, she was acknowledged as an author of good independent research about Vedic mathematics. **Saúl Blanco Rodríguez '05** received the J. G. White Prize for Excellence in English.

Study Abroad

Seven of our juniors took advantage of Cornell's Study Abroad program this year. **Daniel Carlton** spent his spring semester at the University of Melbourne studying mathematics, econmics, and psychology. **William Cross** and **Mark Keremedjiev** spent the academic year studying at the University of St. Andrews in Scotland. Bill studied mathematics and history, while Mark took courses in mathematics, astronomy, and physics. **Jay Lu** and **Patrick Mutch** studied abroad at the University College London. Jay focused on economics and biology, and Patrick studied mathematics and economics. **Jessica Nadel** studied mathematics, biology, history, and environmental law this spring in Sydney, Australia.

Kelly Bowen participated in the *Budapest Semesters in Math* program in the spring, studying under the tutelage of eminent Hungarian scholar-teachers. Instructors are members of Eötvös University and the Mathematical Institute of the Hungarian Academy of Sciences, two institutions known for having educated more than half of Hungary's highly acclaimed mathematicians. In keeping with Hungarian tradition, teachers closely monitor each student's progress. Considerable time is devoted to problem solving and encouraging student creativity. Emphasis is on depth of understanding rather than on the quantity of material. Kelly reports that she has taken some really great math courses with about 60 math majors from all over the country and is even attempting to learn Hungarian!

Thomas Church '06 has been awarded a *Math in Moscow* scholarship to study at the Independent University of Moscow (IUM) in fall 2005. IUM is a small, elite institution of higher learning focusing primarily on mathematics. Discovering mathematics under the guidance of an experienced teacher is the central principle of the Math in Moscow program, which emphasizes in-depth understanding of carefully selected material rather than broad surveys of large quantities of material. The program provides a fifteen-week-long research experience for students (in the spirit of an REU, but with broader representation from the international community), with other mathematically talented and highly motivated undergraduates as well as some of the world's leading mathematicians.

Student Research and Activities

Last summer, **Saúl Blanco Rodriguez '05** participated in the Karyn Kupcinet International Science School for Overseas Students at the Weizmann Institute of Science in Israel. Saúl worked with Aviezri Fraenkel on combinatorial game theory, particularly variations of the game of Domineering. He continued this research during the academic year under the direction of Michael Morley. Saúl submitted his results as a senior thesis.

Tim DeVries '05 spent last summer at California Polytechnic in San Luis Obispo, California, working under Dr. Borzellino in the REU program. Tim worked in a group with two other students studying closed geodesics on cone-manifolds of revolution. The group was able to prove that on such objects one has either exactly one closed geodesic or infinitely many geometrically distinct closed geodesics. During the academic year, Tim studied a partial ordering known as the weak order on various permuation groups, in the hopes of proving certain inequalities related to flag h-vectors of specific simplicial complexes. This involved writing a lot of code in Python searching for injections that would reveal the desired inequalities. Tim submitted his results as a senior thesis.

Michael Jennings '05 worked this year with Prof. Gun Sirer in Computer Science on simulating ad-hoc networking protocols and measuring/characterizing the properties of these protocols based on the simulations. Mike also participated in the Cornell REU last summer with Bob Strichartz and Mariya Bessonov (a student from North Carolina State). They studied some of the properties of fractal graphs and are working on a publication. Mike will be working at Oracle this summer.

For the past two summers, **Anne Jorstad '05** held an internship at Boeing Mathematics and Engineering Analysis research group in Seattle, developing and expanding geometry analysis software. These tools are being developed in conjunction with physics (mostly fluid flow) analysis programs, to limit the number of vehicle models that must be built in order to reach an optimal design.

Hannah Seidel '05 did some research in biology using mathematical models to understand photosynthesis.

Under the supervision of Yuri Berest, **Junping Shao '06** studied in the fall some basics of algebra and algebraic geometry with a view toward concrete problems in mathematical physics. By the end of the semester, he was working on a problem related to factorization of ordinary differential operators (Darboux transformations).

Wai Wai Liu '06, under the supervision of Laurent Saloff-Coste, is working on the exact computation of the logarithmic constant of small finite graphs. This is a remarkably difficult elementary calculus problem that has a long history in the department: In a seminal 1975 paper that introduced logarithmic Sobolev inequalities, Len Gross solved the smallest case where the graph has two points attached by an edge. The late Oscar Rothaus also worked on such a problem for a while as Persi Diaconis and Laurent did later on. Liu is doing very well and making some progress.

Noah Spies '06 has been doing bioinformatics research in Steve Zinder's microbiology lab. His computer program takes large amounts of data from DNA samples, cleans up the data and standardizes them, then spits out basic statistical information and graphs with an option to put the data in pivot table format so that the biologists can use more advanced statistical software to analyze it. The data helps identify which methane-producing bacteria are present in different conditions in two model peat bogs being studied. This project is particularly interesting in the real world, as methane is one of the major sources of global warming.

During last summer, **Tulika Kumar '05** participated in the Summer Program for Women in Mathematics (SPWM) at George Washington University, fully funded by the National Security Agency. SPWM is a five-week intensive program for mathematically talented undergraduate women who are completing their junior year and may be contemplating graduate study in the mathematical sciences. Goals of the program are to communicate an enthusiasm for mathematics, to develop research skills, to cultivate mathematical self-confidence and independence, and to promote success in graduate school. During the program, time is devoted to getting acquainted with some basic tools of mathematics, including instruction in modern mathematical software and library research skills, and discussions and analyses of mathematical writing and proof techniques. Over the course of the program, participants are brought into contact with successful women mathematicians in academia, industry, and government.

Gregory Leib '05 was on staff full-time at Cornell for the spring term working on a salary increase program (SIP) tool and two other software tools for the College of Agriculture and Life Sciences, while taking his last two courses to complete a triple major in mathematics, computer science, and philosophy. Greg wrote the SIP system that is used to analyze salaries for the college and to aide in the allocation of merit/equity increases, in accordance with provost guidelines and what is known of current market conditions. The process is complex for CALS because of mixed sources of funds and a need to bound increases on as many as six different sources separately for one employee. The SIP program is also being used by the College of Human Ecology. Greg submitted his solution to BOOM.

BOOM (Bits On Our Minds) is a fair that showcases student efforts and creativity in digital technology and applications, organized by the faculty of Computing and Information Science. Two other math majors participated in BOOM 2005. **Rafael Frongillo '07** and teammates Sachit Butail (MEng) and Kevin Canini (Eng. '06) wrote a program called the A.I. Puzzler that teaches itself to solve the Rubik's cube using cased-based search. Their work is ongoing work to expand the Puzzler to solve other puzzles and to minimize the help given in the form of hard-coded heuristics. Their goal is for the Puzzler to eventually start with no more knowledge about the puzzles than their basic mechanics. To achieve this goal, Rafael and his collaborators are studying a variety of other puzzles similar to the Rubik's Cube in depth. The A.I. Puzzler will attempt to learn algorithms for a number of group-based (highly symmetric) puzzles, as well as a few non-group-based (asymmetric) puzzles.

The Genetic MusicComposer was a Java-based creation of **Yash Parghi '06** and Andrew Dailey (A&S '06), which brings together computer science and music by intelligently composing short tunes. Using a genetic algorithm, the program generates random tunes and scores them based on such criteria as harmony and rhythm. In the next stage, the most promising tunes are selected and recombined to make better tunes. This process is repeated until a worthy tune emerges. The program creates new tunes within seconds.

Putnam Competition

The William Lowell Putnam Mathematics Competition is a North American math contest for college students. Each year on the first Saturday in December, over 2000 students spend 6 hours (in two sittings) trying to solve 12 problems, such as this one:

> An m x n checkerboard is colored randomly: each square is independently assigned red or black with probability 1/2. We say that two squares, p and q, are in the same connected monochromatic component if there is a sequence of squares, all of the same color, starting at p and ending at q, in which successive squares in the sequence share a common side. Show that the expected number of connected monochromatic regions is greater than $mn/8$.

The 65th Putnam exam was held on December 4, 2004. A total of 3733 students from 515 colleges and universities in Canada and the United States participated. Four Cornell students placed among the top 200 individuals (about 5%):

Hyun Kyu Kim	49 points
Kon-Hyomg Kim	49 points
Anand Bhaskar	40 points
Vorrapan Chandee	39.5 points

The three top scorers are freshmen. Eight more Cornell students were among the top 467 individual scorers, including three more freshmen. These results suggest an opportunity to form very competitive teams in the coming years. Cornell's team was ranked 25th out of 411 teams this year.

Mathematical Contest in Modeling

The Mathematical Contest in Modeling (MCM) is an international team competition, in which each team of three undergraduates chooses one of two open-ended ("real-world") problems, builds a mathematical model, obtains a solution based on it, and writes a detailed paper proving the feasibility of the team's model and solution, all in less than four days. This year MCM attracted 664 submissions from 10 countries. The solution of our first team (Eric Angle, Ian Duke, and **Philip Owrutsky '05**) to the Tollbooths problem was designated Meritorious (top 15% of the participants). A second team, composed of first-year students Chiun Lin Lim, Jon San Ng, Benjamin Zhong Xian Tang, also participated and submitted a solution to the Flood Planning problem. More information about Cornell's participation in MCM is available at www.math.cornell.edu/~mcm. This year's problems are described at www.comap.com/undergraduate/contests/mcm/contests/2005/problems/.

Senior Theses

Four graduating majors submitted senior theses this year. They will be added to the Mathematics Library's collection of senior theses.

Saúl A. Blanco Rodríguez
Some Results on Combinatorial Game Theory
Supervisor: Michael Morley
Abstract: This thesis is divided into two parts. In the first part we discuss some theoretical results of combinatorial games theory. Such discussion focuses mostly on theoretical results such as the construction of the surreal numbers and the Universal Embedding Theorem. We particularly spend some time on two different definitions of surreal numbers and the equivalence of such definitions.

In the second part, we discuss and solve particular examples of combinatorial games. Concretely, using elementary ideas from number theory, we determine the winner of Triomineering, Tridomineering, and Lemineering, which are variations of the game of Domineering, for some boards of the form $m \times n$, for general n and $m = 2, 3, 4, 5$.

Some of the results presented in the first part are new, although not difficult to prove. Most of the results presented in the second part are new, particularly everything done in Chapter 6.

Vorrapan Chandee (with Tian Tian Grace Qiu)
Counting Kneading Sequences
Supervisor: Rodrigo Perez
Abstract: Unavailable.

Timothy D. DeVries
The Weak Order and Flag h-Vector Inequalities
Supervisor: Edward Swartz
Abstract: The following paper examines properties of the weak order on the groups S_{r+1} and B_{r+1} as motivated by the search for a combinatorial proof of known *h*-vector inequalities. Several general results are developed with respect to descent set domination, and an explanation of the computer programs used to generate a number of these results is presented. While this paper primarily focuses on *h*- and flag *h*-vector inequalities of the order complex of geometric lattices, such inequalities for the order complexes of distributive and supersolvable lattices are also explored. Finally, several courses of action for further study are considered.

Shawn Drenning
Fractal Analysis: Extending the Domain
Supervisor: Robert Strichartz
Abstract: We give a complete description of the Dirichlet and Neumann spectra of the Laplacian on a class of homogeneous hierarchical fractals introduced by Hambly. These fractals are finitely ramified but not self-similar. We use the method of spectral decimation. As applications we show that these spectra always have infinitely many large spectral gaps, allowing for nice convergence results for eigenfunction expansions, and under certain restrictions we give a computer-assisted proof that the set of ratios of eigenvalues has gaps, implying the existence of quasielliptic PDE's on the product of two such fractals

Bachelor of Arts Degrees

Bachelors' degrees in mathematics were awarded to 51 students this year, including two in August and four in January. This graduating class was outstanding. We had four Kieval winners this year. Honors were awarded to 19 students: Vorrapan Chandee, Timothy DeVries, Shawn Drenning, and Michael Jennings graduated summa cum laude. Saúl Blanco Rodríguez and Mushfeq Khan graduated magna cum laude. Daniel Campbell, Saifon Chaturantabut, Nan Gu, Daanish Hasan, Avishek Hazrachoudhury, Seung Won Lee, Andrew Marks, Scott McCalla, Philip Rant, Hannah Seidel, David Siegel, Tomohiko Tanabe, and Haichen Wang graduated cum laude. At least 19 of our graduates are going on to graduate school in mathematics, physics, biology, operations research, computer science, economics, and statistics at Yale, Stanford, Chicago, Princeton, Berkeley, MIT, Penn, Cornell, and other top schools. Following is a complete list of students awarded a Bachelor of Arts in mathematics at Cornell this year.

August 2004

Mushfeq Ahmed Khan,† *Magna Cum Laude in Mathematics*
Joseph Gustave Munari†

January 2005

Avishek Hazrachoudhury,† *Cum Laude in Mathematics and Physics*
Matthew Ryan Maloney†
Philip Douglas Rant,† *Cum Laude in Mathematics*
Benjamin H Rosen

May 2005

William Charles Barksdale
Saúl Antonio Blanco Rodríguez,† *Magna Cum Laude in Mathematics*

Daniel John Campbell,† *Cum Laude in Mathematics*
Vorrapan Chandee,† *Summa Cum Laude in Mathematics*
Saifon Chaturantabut,† *Cum Laude in Mathematics*
Timothy Dampman DeVries,† *Summa Cum Laude in Mathematics*
Forrest David Dillaway
Shawn Luebke Drenning,† *Summa Cum Laude in Mathematics*
Daniel Goldin
Andrew Wesley Greene, *Magna Cum Laude in Comparative Literature*
Nan Gu,† *Cum Laude in Mathematics and Summa Cum Laude in Physics*
Daanish Hasan,† *Cum Laude in Mathematics*
Michael Andrew Insler†
Michael Vincent Jennings,† *Summa Cum Laude in Mathematics and Computer Science*
Anne Alison Jorstad
Dmitriy Komin
Tulika Kumar
Rishabh Kundalia
Sae-kyoung Lee
Seung Won Lee,† *Cum Laude in Mathematics*
Gregory Edward Leib†
Eric Thomas Litton
Andrew Jonathan Marks, *Cum Laude in Mathematics*
Jacob George Mathew
Scott Gregory McCalla, *Cum Laude in Mathematics*
Aaron James Miller
Michael Gordon Nute
Lorraine Nicole Pace
Min-Hyong Park
Alexander Darwin Reeve
Brendan Matera Rehon
Martin Rios
Scott Thomas Roche
Jason Michael Schoengold†
Joshua Reid Schwartzstein,† *Summa Cum Laude in College Scholar*
Hannah Snow Seidel,† *Cum Laude in Mathematics*
David Alan Siegel,† *Cum Laude in Mathematics and Magna Cum Laude in Physics*
Young Jin Song
Chris Brian Sosa
Tomohiko Tanabe,† *Cum Laude in Mathematics and Summa Cum Laude in Physics*
Jordan Matthew Tucker, *Cum Laude in Physics*
Randy Sunwin Uang, *Cum Laude in Spanish*
David Reinier van der Keyl
Haichen Wang,† *Cum Laude in Mathematics*
Noah Takeru Whitman

† **Distinction in all subjects**

The department chair and mathematics major director pose with this year's Kieval prize winners. From left to right: Kenneth Brown, Michael Jennings, Timothy DeVries, Vorrapan Chandee, Shawn Drenning, and Ravi Ramakrishna.

Department Conferences and Seminars

Seminar on Stochastic Processes

March 24-26, 2005

For the past twenty years, the Seminar on Stochastic Processes has been an annual spring conference in probability, but this is the first time that it was held at Cornell.

The format of the conference is five invited lectures plus a number of informal sessions for short contributions and open problems. The invited lectures were:

Alison Etheridge, Oxford University: *Genetic hitchhiking*;
Nina Gantert, Munich: *Deviations of random walks in random scenery*;
Alexander Holroyd, University of British Columbia: *Extra heads and stable marriage*;
Jeremy Quastel, University of Toronto: *Hydrodynamic limits for models of interacting random walks*; and
Ofer Zeitouni, University of Minnesota: *Diffusive behavior for motion in random media.*

The seminar was supported both by the NSF grant to the probability group and a special NSF grant for the meeting. The latter provided funds for young researchers and underrepresented minorities. About 100 mathematicians attended the conference.

Cornell Topology Festival

May 6-9, 2005

The topology/geometry group of the Mathematics Department hosted the forty-third annual Cornell Topology Festival on May 6–9 this year. Now an internationally known tradition, the Festival was founded in part by Paul Olum in 1963 as a small regional conference that celebrated the return of spring and reviewed the outstanding results in topology during the preceding year. In the current era of highly specialized conferences, the Cornell Topology Festival is noteworthy in that — representing the interests of the current faculty — it presents a broad spectrum of current mathematics, usually featuring topics in geometric and algebraic topology, geometric group theory, and geometry.

This year saw a continuation of changes in the scope and format of the Festival begun during the last two years with the aid of a three-year NSF grant. The Festival is now a four-day conference, making special outreach efforts to minorities, women, and younger mathematicians, including graduate students. A total of 27 participants from such groups received support from the Festival. The overall number of participants this year was about 80, less than last year's record number, but similar to that of the preceding year, which, in turn, was a significant increase over that of recent years.

This year, just as last year, the Festival featured eleven one-hour research lectures interspersed with breaks for discussion of results, conjectures and new theorems. As has been the tradition, the talks ranged over a wide area of topology and geometry. However, this year about half of the talks focused on the special area of symplectic geometry/topology. We plan to have similar areas of emphasis in future Festivals. In addition to the eleven talks, two introductory workshops and a forward-looking panel discussion were featured. The workshops and panel discussion again drew widespread praise from the participants. Other activities included an opening reception, a "family-style" banquet, two working luncheons, and a picnic. This format is traditional at the Festival and encourages a lively and open exchange of ideas and promotes mathematical collaboration.

This year's featured speakers and their talk titles were:

Denis Auroux, Massacusetts Institute of Technology: *Symplectic 4-manifolds, mappings class groups, and fiber sums*;
Augustin Banyaga, Pennsylvania State University: *Some invariants of transversally oriented foliations*;
Paul Biran, Tel Aviv University: *Algebraic families and Lagrangian cycles*;
Thomas Delzant, IRMA Strasbourg: *Fundamental groups of Kaehler manifolds*;
Yakov Eliashberg, Stanford University: *Geometry of contact transformations: orderability vs. squeezing*;
Etienne Ghys, ENS-Lyon: *Minimal sets of holomorphic functions on the complex projective plane: a survey*;
Yael Karshon, University of Toronto: *Tori in symplectomorphism groups*;
John Morgan, Columbia University: *Ricci flow and the topology of 3-manifolds*;
Shahar Mozes, Hebrew University: *Lattices in products of trees*;
Yann Ollivier, ENS-Lyon: *A panorama of random groups*;
Brendan Owens, Cornell University: *Unknotting information from Heegaard-Floer theory.*

Yakov Eliashberg conducted a workshop on the *h*-principle in symplectic and contact geometry, whereas Reyer Sjamaar conducted one on continuous symmetries in symplectic geometry.

The forty-fourth Cornell Topology Festival is planned for early May 2006. (Next year's schedule will be posted at www.math.cornell.edu/~festival/.)

2nd Conference on Analysis and Probability on Fractals

May 31–June 4, 2005

Following up on the first conference held here three years ago, the second Conference on Analysis and Probability on Fractals had 65 participants, more than 50 from outside Cornell, including undergraduates, graduate students, postdocs, and senior faculty from all over the world. It was an opportunity for experts in the field to discuss the latest results, and for beginners to learn about the field. There were two elementary short courses, more than a dozen invited addresses, almost 30 short talks, and a session on open problems. The organizing committee consisted of Martin Barlow (University of British Columbia), Jun Kigami (Kyoto University), Robert Strichartz (Cornell University), and Alexander Teplyaev (University of Connecticut). The conference was supported by the Cornell Mathematics Department using funding from the Provost to support research.

The area of analysis and probability on fractals began in the 1980s and has been rapidly evolving. It seeks to extend basic concepts such as Laplacian, energy, and Brownian motion from smooth analysis to the context where the underlying space is fractal. Two separate points of view, starting with probability or starting with analysis, compete and interact in the development of this area. As became clear during the conference, both points of view are essential, and their interactions are very fruitful. The conference also highlighted the great progress that has been made in the area in the past three years, and the challenges that lie ahead.

Cornell has been at the center of much of the research in this area. Prof. Strichartz, with his undergraduate collaborators in the REU program since 1996, has been involved in developing the analytic approach using computer experiments. (Five of the 2005 REU students attended this conference.) In connection with the conference, he wrote an informal introductory textbook, *Differential Equations on Fractals: A Tutorial* that will be published by Princeton University Press in 2006. One of the essential monographs in the subject, *Analysis on Fractals* by Jun Kigami, was written when Kigami was a visiting professor at Cornell. Alexander Teplyaev is a 1998 Ph.D. from Cornell.

Analysis Seminar

August 2004

Camil Muscalu, Cornell University: *Paraproducts on the bidisc*

September 2004

Alexander Meadows, Cornell University: *Tornados and continuity for semilinear elliptic equations*

Artem Pulemyotov, Cornell University: *Commutative Jacobi fields*

Armel Kelome, University of Massachusetts at Amherst: *Viscosity solution approach to a class of Dirichlet boundary value problem in infinite dimensions*

Chris Heil, Georgia Tech: *Redundancy in infinite dimensions*

October 2004

Xiaochun Li, Institute for Advanced Study: *Hilbert transforms along vector fields*

Hans Lindblad, University of California, San Diego: *The weak null condition and global existence for Einstein's equation*

Silvius Klein, UCLA: *Spectral theory for discrete quasi-periodic Schroedinger operators*

November 2004

Neshan Wickramasekera, MIT: *Regularity and compactness of immersed stable minimal hypersurfaces*

Joachim Krieger, Harvard University: *Global regularity of solutions for the Yang-Mills equations on high dimensional Minkowski space*

Mao-Pei Tsui, Columbia University: *Mean curvature flows and isotopy of maps between spheres*

Laurent Veron, Université de Tours: *Capacity estimates of semilinear parabolic equations*

Dmitry Novikov, Cornell University: *Maxwell problem on the number of equilibrium points of an electrostatic potential of a finite number of charges*

December 2004

Yulij Ilyashenko, Cornell University: *Simultaneous uniformization and persistence of topological features in polynomial dynamical systems*

January 2005

Robert Strichartz, Cornell University: *Welcome to the world of fractals, where Fourier series converge*

Andrzej Hulanicki, Wroclaw University and Cornell University: *Asymptotic for invariant measures for diffusion processes on groups NA/A*

February 2005

Claus Koestler, Queen's University: *Non-commutative continuous Bernoulli shifts*

John Hubbard, Cornell University: *Chirka's proof of Slodkowski's theorem and applications to Teichmüller theory*
Kasso Okoudjou, Cornell University: *On some Fourier multipliers for modulation spaces*

March 2005
Raanan Schul, Yale University: *Subsets of rectifiable curves in Hilbert space and the analyst's TSP*
Sunhi Choi, MIT: *The regularity and speed of the Hele-Shaw flow*
Gregory Lawler, Cornell University: *Loewner evolution in multiply-connected domains*

April 2005
Irina Nenciu, California Institute of Technology: *Lax pairs for the Ablowitz-Ladik system via orthogonal polynomials on the unit circle*
Todd Kemp, Cornell University: *Strong ultracontractivity*
Justin Holmer, University of California at Berkeley: *On multilinear oscillatory integrals*
Alfred Schatz, Cornell University: *Local error estimates in the finite element method*

May 2005
Sudeb Mitra, Queens College CUNY: *Quasiconformal trivializations of holomorphic motions*

Computational and Commutative Algebra Seminar

September 2004
Achilleas Sinefakopoulos, Cornell University: *LCM lattices of Borel ideals*
Mauricio Velasco, Cornell University: *Introduction to algebraic statistics*
Graham Leuschke, Syracuse University: *Factoring the adjoint and maximal Cohen-Macaulay modules*
Jeffrey Mermin, Cornell University: *Lexifying ideals*
Sara Faridi, University of Ottawa (Canada): *Sequentially Cohen-Macauley rings* (joint meeting with the Workshop on Resolutions)

October 2004
Yuri Berest, Cornell University: *A-infinity modules and deformation of resolutions*
Steven Sinnott, Cornell University: *Algebraic statistics: the maximum likelihood equation and Markov ideals associated to Bayesian networks*
Paul Monsky, Brandeis University: *Hilbert-Kunz theory for hypersurfaces*

November 2004
MSRI video presentations
Mauricio Velasco, Cornell University: *Generic initial ideals and deformations*
Claudia Miller, Syracuse University: *Extremal algebras*

February 2005
Mauricio Velasco, Cornell University: *Algorithms for primary decomposition*
Steven Sinnott, Cornell University: *Algorithms for primary decomposition II*

March 2005
Achilleas Sinefakopoulos, Cornell University: *Direct methods for primary decomposition III*
Jeffrey Mermin, Cornell University: *A short proof of Macaulay's theorem*
Franco Saliola, Cornell University: *Noncommutative Koszul algebras*

April 2005
Franco Saliola, Cornell University: *(Co)homology construction on posets*
Jeffrey Mermin, Cornell University: *Monomial regular sequences*

Discrete Geometry & Combinatorics Seminar

September 2004
Joseph Zaks, Haifa, Israel: *On the rational case of the Beckman-Quarles theorem and on the rational dimension of rationalizable sets*
Robert Connelly, Cornell University: *The 4-color theorem and rigidity*
Maria Sloughter, Cornell University: *Realizability of graphs in 3-space: the hard cases*
Edward Swartz, Cornell University: *Geometric lattices, supersolvable lattices, and spherical buildings*
Greg Kuperberg, University of California at Davis and Cornell University: *Numerical cubature from geometry and coding theory*

October 2004
Benjamin Howard, University of Maryland: *Duality of coxeter matroids*
Jay Schweig, Cornell University: *The h-vector of supersolvable lattice*

November 2004
Balazs Csikos, Eötvös University: *On a problem set of M. Kneser*
Aladar Heppes, Eötvös University: *Helly theorems with line transversals*

Patricia Hersh, MSRI and Indiana University at Bloomington: *A $GL_n(F_q)$ analogue of the partition lattice and discrete Morse theory for poset order complexes*
William Schmitt, George Washington University: *The free product of matroids*

December 2004
Ricky Pollack, New York University: *A new methodology in geometric transversal theory*

February 2005
Rena Zieve, University of California at Davis and Cornell University: *Packing fractions and stability angles in granular heaps*
Tom Zaslavsky, SUNY Binghamton: *The associative law in multary quasigroups*
Franco Saliola, Cornell University: *Face algebras of hyperplane arrangements, lattice cohomology and quivers*
Edward Swartz, Cornell University: *Face count on manifolds*

March 2005
Russ Woodroofe, Cornell University: *Groups, posets, and shellings*
Rigoberto Florez, SUNY Binghamton: *A conjecture of Lindstrom on a class of algebraically non-representable matroids*
David Forge, Orsay and SUNY Binghamton: *Orlik-Solomon algebras and other algebras of hyperplane arrangements*

April 2005
Drew Armstrong, Cornell University: *Catalan combinatorics of finite Coxeter groups*
Kristin Camenga, Cornell University: *Angle sums on polytopal complexes*
Wlodek Kuperberg, Auburn University: *Cylindrical partitions of complex bodies*
Aleksandar Donev, Princeton University: *Jammed packings of hard ellipsoids*

May 2005
Marcelo Aguiar, Texas A&M University: *Factorization of Hopf algebra characters*

Dynamical Systems Seminar

September 2004
Sarah Day, Cornell University: *Rigorous numerics based on the Conley index: infinite-dimensional maps*
Kariane Calta, Cornell University: *Veech surfaces and complete periodicity in genus 2*
John Hubbard, Cornell University: *A degenerate case of Newton's method in two variables*
John Guckenheimer, Cornell University: *Hénon-like maps from relaxation oscillations*

October 2004
Roland Roeder, Cornell University: *Homoclinic tangles in tokamaks (nuclear fusion reactors) and heat spirals on the tokamak wall*
Konstantin Mischaikow, Georgia Tech: *Topological analysis of time dependent patterns*
Tatyana Firsova, Moscow State University: *Topology of phase curves of generic analytic vector fields; Kupka-Smale property*

November 2004
John Smillie, Cornell University: *Some conjectures of John Hubbard about the complex Hénon family*
Tatiana Kutuzova, Moscow State University: *Nonexistence of time averages and nonuniqueness of limit measures*
Suzanne Hruska, Indiana University: *The dynamics of polynomial skew products of C^2*
Greg Buzzard, Purdue University: *Holomorphic motions and structural stability for Hénon maps*
Sylvain Bonnot, Université de Provence and Cornell University: *A global topological model for a class of complex Hénon mappings*

December 2004
John Robertson, Wichita State University: *The critical locus of Hénon maps*

January 2005
Robert Clewley, Cornell University: *A computational tool for the reduction of nonlinear ODE systems possessing multiple scales*

February 2005
Roland Roeder, Cornell University: *Bumpy tubes and tori — linking in the basins of attraction for Newton's method*

March 2005
Robert Ghrist, University of Illinois at Urbana-Champaign: *Braids and parabolic PDEs*
Kevin Lin, New York University: *Entrainment and chaos in the pulse-driven Hodgkin-Huxley oscillator*
Philip Mummert, Cornell University: *Anti-integrable limits, Biham-Wenzel's algorithm, and symbolic dynamics of Hénon maps*

April 2005
Stanislaus Maier-Paape, RWTH Aachen: *Structure of the attractor of the Cahn-Hilliard equation*
Bill Kalies, Florida Atlantic University: *Computational Conley index theory*

Jan Bouwe van den Berg, Vrije Universiteit, Amsterdam: *Fourth-order differential equations and braids*

Educational Mathematics Seminar

August 2004

David Henderson and Daina Taimina, Cornell University: *A new view of the history of geometry and how it can be used to clarify misconceptions*

September 2004

David Henderson, Cornell University: *APOS theory: preparing for Dubinsky's visit*

Ed Dubinsky, Kent State University: *APOS theory and the issue of encapsulation*

Prema Junius, Mansfield University: *Development of students' understanding of straight lines on plane and sphere*

Maria Terrell, Cornell University: *Good questions for deeper learning of mathematics*

October 2004

Florence Fassanelli, AAAS: *The relation between the history of art and history of mathematics for pedagogical purposes*

Kristin Camenga, Cornell University: *Variation in writing assignments in mathematics classes*

Marita Hyman, Cornell University: *Mathematics and the aboriginal imagination: convergences and conflicts in northeastern Arnhem Land*

November 2004

Susan Piliero, Cornell University: *Discussion of Schoenfeld's paper on the "Math Wars"*

Sarah Manning, NYC: *Math difficulties: what we know, what we do not know, and what we can do*

David Henderson, Cornell University: *Culturally responsive mathematics curricula — report from the NSF conference*

February 2005

David Biddle, Cornell University: *An example of using writing and language to describe the 3-dimensional sphere as the union of two solid tori: experiences from teaching a Freshman Writing Seminar in mathematics*

Daina Taimina, Cornell University: *Mathematical way of thinking — When is it creative?*

Deborah Ball and Hyman Bass, University of Michigan: *Teaching mathematical reasoning*

March 2005

David Bock, Cornell University: *The new NYS K-8 mathematics curriculum guidelines*

April 2005

Will Harris, Georgetown University and Cornell University: *Computer software and constructivism in the teaching of abstract algebra*

Sunethra Weerakoon, University of Sri Jayewardenepura and Cornell University: *How my teaching evolved over the years and what I want to do next*

May 2005

Sal Restivo, Rensselaer Polytechnic Institute, Nottingham University and Harvey Mudd College: *Where does mathematics come from? Reflections on God, Einstein's brain, and social construction*

Neil Davidson, University of Maryland: *Twelve step recovery program for teachers addicted to lecturing*

Lie Groups Seminar

September 2004

Alessandra Pantano, Cornell University: *Signatures of intertwining operators and Weyl group representations* (in two parts)

October 2004

Kevin Wortman, Cornell University: *Finiteness properties of arithmetic groups over function fields*

Peter Trapa, University of Utah: *Two bases of Weyl group representations*

Arvind Nair, Tata Institute and University of Michigan: *A Lefschetz property for arithmetic ball quotients*

Leticia Barchini, Oklahoma State University: *Stein extensions of real symmetric spaces*

November 2004

Toby Stafford, University of Michigan, Ann Arbor: *Cherednik algebras and Hilbert schemes of points*

Farkhod Eshmatov, Cornell University: *An example of an A-infinity functor*

David Vogan, MIT: *Comparing intertwining operators for different groups*

December 2004

Dragan Milicic, University of Utah: *Variations on a theme of Casselman-Osborne*

January 2005

Serguei Arkhipov, Yale University: *Towards representation theory of algebraic groups over a 2-dimensional local field*

February 2005

Martin Kassabov, Cornell University: *On the automorphism tower of free nilpotent groups*

Dan Zaffran, Cornell University: *Families of compact complex manifolds related to Mumford's geometric invariant theory*

March 2005

Lesley Saper, Duke University: *L^2-harmonic forms on locally symmetric spaces*

April 2005

Etienne Rassart, Institute for Advanced Study: *Polynomiality properties of type A weight and tensor product multiplicities*

Henrique Bursztyn, University of Toronto: *Fusion of quasi-Hamiltonian spaces*

Xuhua He, MIT: *The G-stable pieces and parabolic character sheaves of the wonderful group compactification*

Reyer Sjamaar, Cornell University: *Varieties invariant under a Borel subgroup*

May 2005

Michel Duflo, University of Paris VI: *Associated varieties for representations of Lie superalgebras*

Logic Seminar

August 2004

Denis Hirschfeldt, University of Chicago: *Degrees of infinite homogeneous sets for computable stable colorings of pairs* (in two parts)

September 2004

Denis Hirschfeldt, University of Chicago: *The wonderful world of K-triviality* (in two parts)

Michael O'Connor, Cornell University: *The geometry of strongly minimal sets* (in three parts)

Christopher Hardin, Cornell University: *Pi-1-1 comprehension* (in three parts)

October 2004

Barbara Csima, Cornell University: *Bounding homogeneous models* (in two parts)

Antonio Montalban, Cornell University: *The minimum beta-model of Pi-1-1 CA*

Antonio Montalban, Cornell University: *Countable coded beta-models*

Antonio Montalban, Cornell University: *Symmetric beta-models*

Christopher Hardin, Cornell University: *Proof systems for Kleene algebra* (in two parts)

Antonio Montalban, Cornell University: *beta-model reflection*

November 2004

Michael O'Connor, Cornell University: *omega-models* (in three parts)

Carl Jockusch, Jr., University of Illinois, Urbana: *Computable Ramsey theory and reverse mathematics*

Richard Shore, Cornell University: *Combinatorial principles weaker than Ramsey's theorem* (in two parts)

Valentina Harizanov, George Washington University: *Intrinsically Σ^0_α relations on computable structures*

December 2004

Valentina Harizanov, George Washington University: *Inductive inference of classes of computably enumerable vector spaces*

January 2005

Rebecca Weber, Pennsylvania State University: *Orbits and invariance in E_Π and E^**

Rebecca Weber, Pennsylvania State University: *Lattices of effectively closed sets*

February 2005

Greg Hjorth, UCLA: *Borel reducibility*

Joseph Miller, Indiana University: *The initial segment complexity of random reals* (in two parts)

Barbara Csima, Cornell University: *Computability results used in differential geometry*

Barbara Csima, Cornell University: *The NW ordering in c.e. sets*

Christopher Hardin, Cornell University: *Eliminating r = 0 in Kleene algebra* (in two parts)

March 2005

Mia Minnes, Cornell University: *Non-omega models: conservativity for WKL_0 over RCA_0*

Mia Minnes, Cornell University: *Non-omega models: conservativity for WKL_0 over PRA* (in two parts)

Bjorn Kjos-Hansen, University of Connecticut at Storrs: *Almost everywhere domination*

Bjorn Kjos-Hansen, University of Connecticut at Storrs: *Weak recursive degrees*

Antonio Montalban, Cornell University: *A minimal pair of K-degrees*

Michael O'Connor, Cornell University: *Spectra of computable models* (in two parts)

Anil Nerode, Cornell University: *Hybrid systems and the differential geometry of optimal control*

April 2005

Anil Nerode, Cornell University: *Finsler geometry of optimal control*

Robert Milnikel, Kenyon College: *The logic of proofs*

Robert Milnikel, Kenyon College: *Computational complexity of the logic of proofs*

Mia Minnes, Cornell University: *Automata techniques for deciding Presburger arithmetic* (in three parts)

Bryant Adams, Cornell University: *Automata recognizable versions of Konig's lemma* (in two parts)
Antonio Montalban, Cornell University: *Beyond the arithmetic*

Number Theory and Algebraic Geometry Seminar

All speakers are from Cornell University unless otherwise indicated.

June 2004

Jeffrey Mermin: *Ideals, varieties, and topology*

July 2004

Jason Martin: *Kummer theory* (in three parts)
Steven Sinnott: *Morphisms*
Problem session on morphisms
Henri Johnston: *The normal integral basis problem*
Steven Sinnott: *Tangent spaces*
Spencer Hamblen: *Deformation theory* (in three parts)

August 2004

Jeffrey Mermin: *Fibre theory* (in two parts)

September 2004

Jason Martin: *Normal forms: some linear algebra you may not have seen before*
Jeffrey Mermin: *Toric varieties I*
Jason Martin: *Lattice reduction and the LLL algorithm*
Steven Sinnott: *Toric varieties II & III*
Jason Martin: *An explicit implementation of the LLL algorithm*
Adrian Diaconu: *Moments of quadratic Dirichlet L-functions*

October 2004

Henri Johnston: *Failure of normal integral bases*
Gregory Muller: *Toric varieties IV*
Steve Sinnott: *Algebraic geometry of Bayesian networks*
Jeff Mermin: *Toric varieties V*

November 2004

Henri Johnston: *Some problems from research*
Steven Sinnott: *Toric varieties VI*
Jeffrey Mermin: *Toric varieties VII*
Jason Martin: *Schemes for number theorists*
Steven Sinnott: *Toric varieties VIII*
Jeffrey Mermin: *Toric varieties IX*

December 2004

Spencer Hamblen: *Congruent numbers*
Steven Sinnott: *Limit points of toric varieties*

February 2005

Jason Martin: *Using MAGMA* (in five parts)
Mauricio Velasco: *Algorithms for primary decomposition I*
Steven Sinnott: *Algorithms for primary decomposition II*

March 2005

Jeffrey Mermin: *Introduction to Hilbert functions*
Achilleas Sinefakopoulos: *Direct methods for primary decomposition III*
Jeffrey Mermin: *A short proof of Macaulay's theorem*

April 2005

Henri Johnston: *Dirchlet characters and explicit class field theory over Q*
Jeffrey Mermin: *Monomial regular sequences*

Oliver Club

September 2004

Yuri Berest, Cornell University: *Rings of differential operators*
Yulij Ilyashenko, Cornell University: *Restricted versions of the Hilbert 16th problem*
Ed Dubinsky, Kent State University: *Some remarks on understanding the concept of infinity*
Laura deMarco, University of Chicago: *Iteration at the boundary*
Wendelin Werner, Université Paris-Sud: *Schramm-Loewner evolution (SLE), Brownian loop soups, and universality*

October 2004

Dirk van Dalen, Universiteit Utrecht: *The problems and principles of the basic intuitionistic notions*
Anton Gorodetski, California Institute of Technology: *What is the probability of the Newhouse phenomena?*
Arvind Nair, Tata Institute and University of Michigan: *Intersection cohomology, locally symmetric varieties, and modular forms*
Eugene Mukhin, Indiana University-Purdue University: *Bethe Ansatz, Fuchsian operators and Schubert calculus*

November 2004

Toby Stafford, University of Michigan, Ann Arbor: *Noncommutative projective geometry*
Rodrigo Perez, Cornell University: *An algebraic invariant of Thurston maps*
Jeff Viaclovsky, MIT: *Moduli spaces of critical Riemannian metrics in dimension four*

December 2004

Martin Scharlemann, University of California, Santa Barbara: *Indecision and its uses*

January 2005

Todd Kemp, Cornell University: *Hypercontractivity and the central limit theorem*

Matvei Libine, University of Massachusetts: *Localization formulas for integrals of equivariant forms*

Serguei Arkhipov, Yale University: *Towards representation theory of algebraic groups over a 2-dimensional local field*

Elena Mantovan, University of California at Berkeley: *The role of the geometry of Shimura varieties in the Langlands program*

February 2005

Gregory Hjorth, University of California at Los Angeles: *An isolation theorem for groups of isometries*

Tara Holm, University of California at Berkeley: *Morse theory in real symplectic geometry*

Dylan Thurston, Harvard University: *How efficiently do 3-manifolds bound 4-manifolds?*

Greg Kuperberg, University of California at Davis and Cornell University: *What are perturbative quantum 3-manifold invariants?*

Herbert Abels, University of Bielefeld: *Geometry of linear groups*

Deborah Ball and Hyman Bass, University of Michigan: *Knowing mathematics for teaching*

March 2005

Roland Speicher, Queen's University: *Free probability theory and random matrices*

Kate Okikiolu, University of California at San Diego: *Spectral zeta functions and Riemannian geometry*

April 2005

Gerhard Michler, Cornell University: *Structure of abstract finite simple groups*

Alessandra Pantano, Cornell University: *A combinatorial description of the nilpotent curve*

Krystyna Kuperberg, Auburn University: *Wild arcs in dynamics*

Sarah Day, Cornell University: *Computer-assisted proofs for dynamical systems*

May 2005

Etienne Ghys, Ecoloe Normale Superieure de Lyon: *Minimal sets of holomorphic foliations on the complex projective plane: a survey*

Olivetti Club

August 2004

Todd Kemp, Cornell University: *Fock spaces and duality: an introduction to infinite dimensional analysis*

September 2004

Sarah Koch, Cornell University: S*plashing around in the basins: visualizing the dynamics of Newton's method in two complex variables*

Artem Pulemyotov, Cornell University: *Hilbert riggings and generalized eigenvectors*

Michael O'Connor, Cornell University: *Playing games on the real line*

October 2004

Gregory Muller, Cornell University: *Penrose tilings and other aperiodic tilings*

Ron Maimon, Gene Network Sciences: *Biological combinatorics*

James Belk, Cornell University: *Groups acting on trees*

November 2004

Jonathan Needleman, Cornell University: *Cantor set for president*

Treven Wall, Cornell University: *Have we really solved Laplace's equation?*

Matthew Noonan, Cornell University: *The geometry of electromagnetism*

Hasanjan Sayit, Cornell University: *Simple predictible processes and the no arbitrage property*

Roland Roeder, Cornell University: *On Poincaré's compactification of polynomial vector fields in the plane*

January 2005

Todd Kemp, Cornell University: *Hypercontractivity and the central limit theorem*

February 2005

Gregory Hjorth, University of California at Los Angeles: *An isolation theorem for groups of isometries*

Spencer Hamblen, Cornell University: *Lifting Galois representations: variations on a conjecture of Serre*

Sarah Koch, Michael O'Connor, Jonathan Needleman, et. al, Cornell University: *A potpourri of fun mathematical proofs*

Benjamin Chan, Cornell University: *A model for sexual reproduction*

March 2005

Matthew Noonan, Cornell University: *1 + 2 + 3 + … = –1/12, no forest has more than 6 trees, and other abstract nonsense*

Kristen Camenga, Cornell University: *Faces and angles of polytopes*

Drew Armstrong, Cornell University: *The mystery of the Catalan numbers*

Joshua Bowman, Cornell University: *Royden's theorem on isometries of Teichmüller space*

April 2005

Michael O'Connor, Cornell University: *The recreational mathematics of hats and lightbulbs*

Treven Wall, Cornell University: *Using one fish to feed 5,000*

Gwyneth Whieldon, Cornell University: *Climbing trees and counting solutions*

David Biddle, Cornell University: *What do determinants and Euler characteristics have in common?*

May 2005

Todd Kemp, Cornell University: *Fun with Fourier!*

Probability Seminar

September 2004

Gregory Lawler, Cornell University: *Two-sided $SLE_{8/3}$ and self-avoiding polygons in the plane*

Laurent Saloff-Coste, Cornell University: *Cut-off phenomena*

Robert Bauer, University of Illinois: *Radial stochastic Loewner evolution in multiply connected domains*

Wendelin Werner, Orsay: *Loop-soups and conformal field theory*

October 2004

Paul Jung, Cornell University: *Adding edges to the contact process*

Harry Kesten, Cornell University: *A problem in one-dimensional diffusion limited aggregation and positive recurrence of Markov chains*

Anja Sturm, University of Delaware: *The coalescent for a model with mutation and selection*

November 2004

Edward Waymire, Oregon State University and Cornell University: *Branching random walk and incompressible Navier-Stokes equations*

Federico Camia, EURANDOM: *The full scaling limit of 2D critical percolation*

Sunder Sethuraman, Iowa State University: *Diffusive estimates for a tagged particle in asymmetric zero-range systems*

Lee Gibson, Cornell University: *Survival among traps on an infinite graph*

January 2005

Edward Waymire, Oregon State University and Cornell University: *Heterogeneous dispersion and skew diffusion*

February 2005

Gregory Lawler, Cornell University: *The lambda-SAW walk*

Sharad Goel, Cornell University: *Mixing times for top to bottom shuffles*

Eugene Dynkin, Cornell University: *A class of harmonic functions on the space of measures associated with a superdiffusion*

David Aldous, University of California at Berkeley: *A tractable complex network model*

March 2005

Gennady Samorodnitsky, Cornell University: *Ergodicity of stable processes*

Toufic Suidan, New York University: *A GUE central limit theorem and universality of last passage percolation fluctuations in thin rectangles*

Julien Berestycki, University of Paris VI: *Small time behavior for beta-coalescents*

April 2005

Stas Volkov, University of Bristol: *A polling system with 3 queues and 1 server is a.s. periodic when transient: dynamical and stochastic systems, and chaos*

Dan Stroock, MIT: *Much ado about a simple PDE*

Haya Kaspi, Technion: *Splitting and coalescence associated with skew Brownian motion*

Richard Durrett, Cornell University: *Life in a small world*

May 2005

Henrik Hult, Royal Institute of Technology (Sweden): *Extremal behavior of stochastic integrals driven by multivariate regularly varying Levy processes*

Teaching Seminar

September 2004

Reflection as a part of teaching

Henri Johnston, Cornell University: *MATH 105 and prelim grading*

October 2004

William Harris, Cornell University: *Teaching colleges and teaching statements*

Treven Wall, Cornell University: *Encouraging academic integrity*

November 2004

Jonathan Needleman, Cornell University: *Encouraging students to communicate mathematics*

Lee Gibson, Cornell University: *Instructional technology: where we are, where we are going*

December 2004

Melanie Pivarski, Cornell University: *Outreach: what's appropriate, useful, and possible*

February 2005

Joshua Bowman, Cornell University: *Enlivening the classroom: reducing teachers' and students' stress with humor*

Kristin Camenga, David Biddle, and Sharad Goel, Cornell University: *Ideas for teaching a freshman writing seminar in math*

March 2005

Ernie Danforth, Corning Community College: *Writing in the mathematics classroom: What do students know? What do students believe?*

Lee Gibson, Cornell University: *Teaching upper level math courses - a panel discussion*

Maria Terrell, Cornell University: *A calculus concepts inventory*

April 2005

James Belk, Cornell University: *Technology for prelims*

Joshua Bowman and Jonathan Needleman, Cornell University: *Project calculus: incorporating long-term projects in your calculus classroom*

Topology and Geometric Group Theory Seminar

September 2004

Brendan Owens, Cornell University: *A generalization of a theorem of Elkies*

Martin Kassabov, Cornell University: *Computing Kazhdan constants*

Dan Margalit, University of Utah: *Weil-Petersson isometries are mapping classes*

Jason Behrstock, Columbia University: *Asymptotic geometry of the mapping class group and Teichmüller space*

October 2004

Tara Brendle, Cornell University: *Commensurations of the Johnson kernel*

Christophe Pittet, Université de Marseille: *Random walks on compactly generated groups*

Azer Akhmedov, University of California, Santa Barbara: *Quasi-isometric rigidity in group varieties*

Martin Bridson, Imperial College, London: *On the geometry and complexity of balanced presentations of groups*

November 2004

Nathalie Wahl, University of Aarhus (Denmark): *Mapping class groups and automorphisms of free groups*

Indira Chatterji, Cornell University: *On a characterization of hyperbolic spaces*

Aaron Heap, University of Rochester: *Bordism invariants of the mapping class group*

Walter Neumann, Columbia University: *Three-manifolds of splice type*

David Rosenthal, St. John's University: *On the algebraic K- and L-theory of word hyperbolic groups*

December 2004

Martin Scharlemann, University of California, Santa Barbara: *Proximity in the curve complex: boundary reduction and bicompressible surfaces*

February 2005

Dylan Thurston, Harvard University: *How efficiently do 3-manifolds bound 4-manifolds?*

Martin Kassabov, Cornell University: *New examples of groups with property tau*

Kevin Wortman, Cornell University: *An infinite solvable group with small quasi-isometry group*

March 2005

Joe Coffey, New York University: *Failure of parametric H-principle for maps with prescribed Jacobian*

Alireza Salehi-Golsefidy, Yale University: *Lattices of minimum covolume in classical Chevalley groups over* $F_q(1/t)$

Tim Riley, Yale University: *Intrinsic versus extrinsic diameter in finitely presented groups*

Martin Kassabov, Cornell University: *Symmetric groups and expanders*

April 2005

Joseph Masters, SUNY at Buffalo: *Quasi-Fuchsian surfaces in hyperbolic knot manifolds*

Gregory Bell, Pennsylvania State University: *Asymptotic dimension of groups*

Angela Barnhill, Ohio State University: *Global fixed points for actions of Coxeter groups on CAT(0) spaces*

James Belk, Cornell University: *The Grigorchuk group*

Mark Sapir, Vanderbilt: *Hilbert space compression*

May 2005

Dan Margalit, University of Utah: *Finiteness properties of the Torelli group for* $Out(F_3)$

Research Experiences for Undergraduates Program

The Cornell Mathematics Department has offered a Research Experiences for Undergraduates (REU) Program, sponsored by the National Science Foundation, every summer since 1994. This program brings talented undergraduates from Cornell and colleges across the country to work on research projects directed by Cornell faculty.

The projects in summer 2004 were

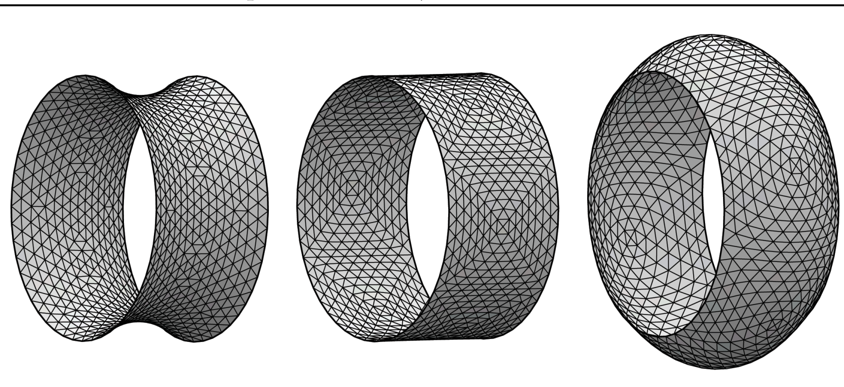
- *Analysis on Fractals*, directed by **Robert Strichartz**;
- *Dynamic Models of Excitable Cells*, directed by **John Guckenheimer** and **Warren Weckesser** (visiting prof.);
- *Differential Equations Arising in Geometry*, directed by **Alex Meadows**.

Cornell graduate students Joshua Bowman, Matthew Noonan, and Erik Sherwood assisted with the projects. In addition to their research work, students attended a Smorgasbord Seminar where the Cornell faculty give talks about different areas of mathematics. The students gave presentations on their work to each other in a weekly Jam Session and also to the whole Cornell Mathematics community at the final Undergraduate Research Forum. Several papers based on the research are in preparation.

Analysis on Fractals

Analysis on Fractals has been an area of research for REU students since 1996, and the cumulative results have had a considerable impact on the field. The approach is experimental: Students write and run computer programs to explore possibilities, generate and test hypotheses, and identify fruitful questions for further research. Proofs of experimental conjectures sometimes come quickly, but often are years in the making. This summer's work centered on the theme of the spectrum of the Laplacian on fractals and fractal graphs.

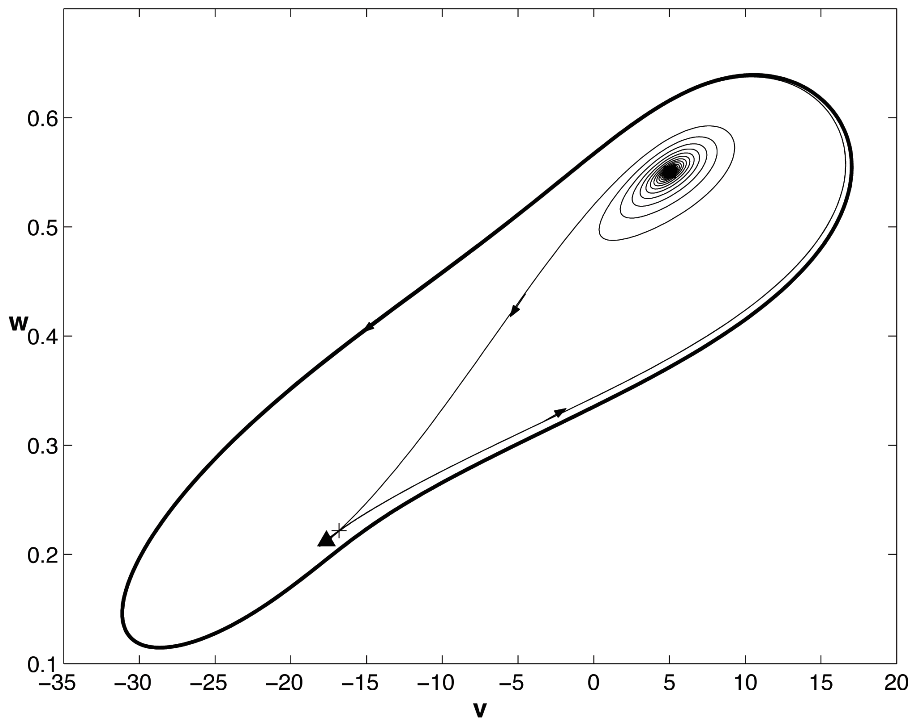
Shawn Drenning (Cornell) studied the spectrum for a class of fractals constructed by iterations chosen between two different construction schemes, so the resulting fractal is not self-similar, using the method of spectral decimation. Shawn is also a Cornell Presidential Research Scholar and has continued his work during the academic year, supported by that program. He wrote a senior thesis based on this work, which is available in the Mathematics Library and the department web site. **Adam Allan** (Clarkson University) studied spectral operators on the Sierpinski gasket. In particular, he was able to extend observations of a new kind of periodicity in the behavior of the heat kernel that first appeared in the work of Nitsan Ben-Gal in Summer 2003. **Mariya Bessonov** (North Carolina State) and **Michael Jennings** (Cornell) obtained experimental evidence for spectral gaps and a new phenomenon of eigenvalue clustering for a variety of different Laplacians on the Sierpinski gasket in the "lattice case." It will be quite a challenge to explain these observations theoretically! They also ran a series of experiments to exhibit the degradation of the spectrum of a Sierpinski graph as it undergoes random perturbations and becomes more like a random 4-regular graph. Certain features of the spectrum degrade very rapidly, while other features linger long after half the original edges have been changed. This work was inspired by the "small world networks" work of Watts and Strogatz who looked at other, nonspectral, features of graphs under perturbation, and found sudden "phase transitions." In the fractal/spectral work, no such phase transitions were found.



Differential Equations Arising in Geometry: Soap film surfaces spinning around a horizontal axis with increasing speed. Images calculated with *Surface Evolver.*

Dynamic Models of Excitable Cells

Students in the Dynamic Models of Excitable Cells project — **Justin Brockman** (North Carolina State), **David Cesa** (Northwestern), **David LeRay** (Worcester Polytechnic Institute), and **Ben Robinson** (Washington University, St. Louis) — studied the dynamics of the Morris-Lecar model of excitable cells. The Morris-Lecar model is a system of differential equations that is a prototype for describing how action



Solutions of the Morris-Lecar model, a system of differential equations of the membrane potential of a muscle cell. In the Dynamic Models of Excitable Cells group, we investigated the mathematical properties of this system, using techniques from dynamical systems theory. The heavy dark curve is a periodic orbit that corresponds to regular oscillations of the potential. The triangle is a stable equilibrium: there is a small region of solutions near the triangle that do not approach the periodic orbit in increasing time.

potentials arise from ionic currents flowing through membrane channels. Dynamical systems theory can be used to study the solutions to these equations, showing how they depend upon initial conditions and upon parameters in the model. Much of the focus of this project was in investigating bifurcations, qualitative changes in the solutions that occur as parameters are varied. This is a formidable task because the model is nonlinear and has a large number (thirteen) of parameters.

For systems of two differential equations like the Morris-Lecar model, there is an excellent characterization of the types of solutions and a classification of the simplest types of bifurcations. In this project, the students implemented algorithms to compute bifurcations in the Morris-Lecar model. As two parameters are varied simultaneously, bifurcations occur along curves that delimit regions within which the phase portrait of the model remains qualitatively unchanged. While computations of this type have been done previously, this project was perhaps the most systematic effort to investigate these phenomena to date.

Differential Equations Arising in Geometry

The Differential Equations Arising in Geometry group worked on three distinct projects. A group of students — **Frances Hammock** (UC Berkeley), **Peter Luthy** (Connecticut College), and **Phillip Whitman** (University of Texas, Austin) — studied the question of the existence of "tornado sequences" of solutions to some particular nonlinear elliptic problems. They were very successful in proving nonexistence in certain situations. Phillip presented results at the Mathfest in Providence and at the YMC Conference at Ohio State.

Zhuan Pei (Carleton College) studied the geometrical variational problem and associated differential equations concerning the following soap film problem: Consider a cylindrical soap film surface suspended between two coaxial circles of wire. Suppose it has some surface density and rotate it at some rate around the axis. Taking centrifugal forces into account, what is the equilibrium position of the surface? Zhuan had some success generating computer models and analyzing solutions to a simplified differential equation.

Thomas Peters (Rutgers) worked on generating one-parameter families of constant mean curvature surfaces, using recent ideas of Ferus, Leschke, Pedit, and Pinkall. The Mathematica code turned out some expected and some unexpected results and led to many interesting quandaries. Graduate student Matt Noonan worked with Thomas on this project.

The REU Program will continue in summer 2005 with projects in Analysis on Fractals (Robert Strichartz), Mapping class groups and the topology of surfaces (Tara Brendle), and Expander graphs and groups (Martin Kassabov).

Community Outreach

Math Explorer's Club

The Math Explorer's Club is an after school club at Ithaca High School that meets for 45 minutes at the end of the school day. The club was supported this year by the VIGRE grant and the Gowin line for mathematics education activities.

In the fall, Rick Durrett and Sharad Goel (CAM graduate student) explored games and probability for the first five weeks, focusing on games of strategy: Connect Four, Othello, a game based on percolation, and the ancient board game Go, which proved to be very popular with the students. For the next six weeks, Bryant Adams led a module on fractals, using three Dell laptops, and the program Fractint to explore the Mandelbrot set, Julia sets, etc.

In the spring, Antonio Montalbán and Yannet Interian-Fernandez (CAM graduate student) kicked things off with six weeks of puzzles: liars and truth-tellers puzzles, Rubik's cube, knots and graphs, and arithmetic and geometry. Chris Lipa then led six weeks of activities on dynamical systems and chaos, using the laptops to run a number of Java applets and games from Bob Devaney's homepage <math.bu.edu/people/bob/>. In the last six-week session, Radu Murgescu introduced the students to number theory, using puzzles and challenging the students to produce proofs of elementary facts about modulo arithmetic.

Ithaca High School Senior Seminar

Funded by the department's VIGRE grant, the Senior Mathematics Seminar is an advanced mathematics option that covers topics not normally found in high school or even in most mainstream undergraduate courses. During the 2004–2005 academic year, Cornell graduate students Jeffrey Mermin, Jason Martin, and Deena Schmidt organized the seminar, which met for three periods a week during school hours at the high school. A core group of seven IHS students attended meetings.

The organizers each led a module. Jeff Mermin focused on elementary properties of continued fractions: how they provide "best" rational approximations to real numbers, distinguish quadratic irrationals, and are closely related to the Euclidean algorithm. A series of diversions led to coverage of the definition of limits, the definition of real and p-adic numbers, and infinite cardinals.

Jason Martin began with basic substitution ciphers, then moved to poly-alphabetic substitution ciphers. From there the group investigated linear feedback shift registers, stream ciphers, and finally block ciphers.

Deena Schmidt focused on applications of probability theory ranging from gambling to genetics. Topics included the Monte Hall problem, birthday pairings, counting principles, conditional probability and

Pictured here is one of the K-MODDL collection's Cycloid Rolling Models, a series of models designed to illustrate the space curves generated by the rolling of cones on cones. In this model, one of the "cones" is a circular plate whose conical angle is 180 degrees. The space curves are represented by bronze wire. A point on the rolling plate generates one path, while a point normal to the plate (indicated in the model with an arrow) generates the other space path. This model can be seen in motion as a QuickTime animation at kmoddl.library.cornell.edu.

independence, Bayes Rule, random variables and their distributions, Gambler's Ruin problem, random walks, and Markov chains. Concepts were introduced with lots of examples, and students worked though challenging problems in class.

With help from the organizers, students concluded the year by researching and presenting topics of their choice. Some of the projects included differential cryptanalysis, the ENIGMA machine, group theory, the P vs. NP problem, and an extension of continued fractions to provide better approximations. At least one student independently produced existing results. Two students wrote a computer program to play poker that was entirely original and quite impressive.

Saturday Workshops for Teachers

This series of full-day workshops continues the tradition of the Cornell/Schools Mathematics Resource Program begun in 1985 and facilitated by David Henderson and Avery Solomon.

This year's workshops were planned and led by David Bock, the department's K–12 Education and Outreach Coordinator. Participants explored advanced mathematics related to the topics they teach, discussed pedagogy, and reviewed curriculum in light of the newly mandated New York State Learning Standards. About 25 teachers attended each of the four full-day sessions, collectively involving over 40 different teachers from 22 schools in central New York.

These sessions were greatly enhanced by the participation of faculty members John Guckenheimer, David Henderson, Irena Peeva, Robert Strichartz, and Sunethra Weerakoon, as well as graduate students David Biddle and Jeffrey Mermin, and undergraduate math major Jeffrey Zhang.

K-8 Professional Development: New York State Math Standards

Dave Bock led a series of Tompkins-Seneca-Tioga BOCES staff development workshops to help K–8 teachers understand and implement the newly adopted New York State Learning Standards for K–8 mathematics. These sessions involved both curriculum work and content support for over 100 teachers from the Candor, Dryden, Groton, Ithaca, Lansing, Newfield, South Seneca, and Trumansburg school districts.

Curriculum Development for Robert Moses' Algebra Project

David Henderson has recently become a member of the high school curriculum development team for Robert Moses' *Algebra Project*. Robert Moses, the well-known 1960's civil-rights leader, has been working for twenty years on what he calls the new civil-rights goal of educating under-served students to *want* to learn mathematics and to educate them to be successful in mathematics in terms of passing state exams and entering college without taking remedial courses. His project is the only long-term national project that is consistently successful. His key pedagogic idea is that mathematical meanings come from human experiences and then reflect on those experiences.

A Digital Library of Printable Machines: Models for Collection Building and Educational Outreach

The Institute for Museum and Library Services (IMLS) has awarded Cornell University Library a 2004 National Leadership Grant for Libraries. The $499,710 award funds an 18-month collaborative library-museum research project titled *A Digital Library of Printable Machines: Models for Collection Building and Educational Outreach*.

Cornell Library, in partnership with Cornell's College of Engineering and the Museum of Science in Boston, is researching and developing the use of stereolithographic ("3D printing") technology to create working physical replicas of mechanical artifacts that can be exchanged electronically between the project partners and manipulated by museum visitors, students, and other users of the collection. The *Printable Machines* project builds on CUL's Kinematic Models for Design Digital Library (K-MODDL), an open-access resource for teaching and learning about the history and theory of machines.

Project research will investigate the use of mechanical artifacts and their digital representations in two distinct learning environments (middle school classroom and museum), as well as the management of digital representations of physical objects in a library context.

Senior Research Associate Daina Taimina has been conducting workshops for teachers and participating in the project with five Watkins Glen Middle School technology classes. They hope to design a separate webpage-corner for school kids to get them more interested in mathematics and engineering. A significant part of Daina's work on this grant has been to describe the mathematics behind these models for students.

CU Math/Science Professional Development Day

On March 24, 2005, several hundred secondary mathematics and science teachers attended outreach workshops at Cornell during a conference day coordinated with several regional school districts. The Mathematics Department presented a total of 13 sessions. Presenters included current and former faculty members David Bock, Tara Brendle, Nathan Broaddus, David Henderson, Anil Nerode, Irena Peeva, Robert Strichartz, Daina Taimina, and Maria Terrell; graduate students James Belk, Kristin Camenga, and Jeffrey Mermin; engineering professor Timothy Healey; and Ithaca College professors Eric and Margaret Robinson. This was the first year the university sponsored such an ambitious outreach effort. Based on the success of this program, it is likely to become an annual event.

Mathematics Awareness Week At Area Schools

The Cornell Mathematics Department again participated in the American Mathematical Society and Mathematical Association of America's annual Mathematics Awareness Month. David Henderson and Melanie Pivarski gave well-received talks at Ithaca High School and Lansing High School, respectively. Cornell sponsored its annual T-shirt design contest, won this year by Yan Wang, a student at Ithaca High School. (Yan's winning design is pictured on the following page.) The departments of mathematics at Cornell University and Ithaca High School underwrote the cost of producing 100 shirts. Most were given to Ithaca High students as prizes for solving daily math problems; shirts were also available to the school's math teachers as well as Cornell staff and students.

Freshman Math Prize Exam

The sixth annual Freshman Math Prize Exam was held on March 2, 2005, organized by professors Allen Back, Alex Meadows, and Rodrigo Perez. This is a challenging prize exam open to all freshmen at Cornell. Although the problems do not require any mathematics beyond elementary calculus, they do require intuition, ingenuity and persistence. Here is a sample question:

> A potato P is floating in 3-dimensional space. P has the following property: For any 3 points a, b, c on the skin of P, the circle that passes through a, b, and c is completely contained in P. Prove that P is a spherical potato.

Five students were declared winners this year. Andrew Owen Costello, Michael J. Davis, and Hyun Kyu Kim shared first–third place. Yunming Gong took fourth place, and Eric Frackleton fifth place.

Expanding Your Horizons

Created in 1976, Expanding Your Horizons in Science and Mathematics is a national program aimed at encouraging middle-school girls' interest in math and science and motivating them to continue taking math and science courses throughout high school. Organized and run by women in mathematics and science, it is held in over 100 locations nationwide. The Math/Science Network — a non-profit membership organization of educators, scientists, mathematicians, parents, community leaders, and government and corporate representatives — licenses and coordinates this network of EYH conferences (www.expandingyourhorizons.org). M/SN's mission is to promote the continuing advancement in mathematics and science education of all people, with a particular emphasis on the needs of women and girls. It initiates local EYH sites and provides them with technical assistance and conference and planning materials, as well as support services such as coordinated publicity and public relations posters and buttons. The Network also provides a "networking" link between sites.

On April 23, 2005, members of the Cornell Mathematics Department participated in a day of hands-on workshops in mathematics for 7th, 8th, and 9th grade girls. In addition to the girls who attended, some math teachers who were looking for new classroom activities observed. The Mathematics Department featured a workshop on bubbles and minimal surfaces, run and planned by several members of the department. Graduate students Maria Belk, David Biddle, Evgueni Klebanov, and Melanie Pivarski worked with a group of girls and approximately seven gallons of bubble solution in order to study minimal surfaces. This year we were especially grateful for the additional help of Dr. Alex Meadows, our "bubble expert," who was not only involved in planning and running the workshop, but also brought along his personal supply of bubble making gadgets. We also benefited much in the planning from the help of Mia Minnes, Jonathan Needleman, and Treven Wall.

We began by having the girls bend wire into different shapes and seeing what surfaces formed when they were dipped into bubble solution. The bubble solution wants to find a way to connect the wire using the smallest amount of solution possible. The girls made interesting shapes, including circles, hearts, and spirals. We then used this idea, along with transparent pieces of plastic held together with wooden pegs, to find out how to connect three points in space (the pegs) using the smallest amount of material. The students guessed at the best way to connect them, measured their prediction with rulers, and then experimented by dipping the plastic into the bubble solution and shaking off the excess. The connections that the bubbles made showed the shortest pathway. After experimenting a couple of times with different arrangements of pegs, their predictions became quite accurate. Some even found experimental error in their measurements to account for the slight differences! All in all, a lot of good clean fun was had by everyone!

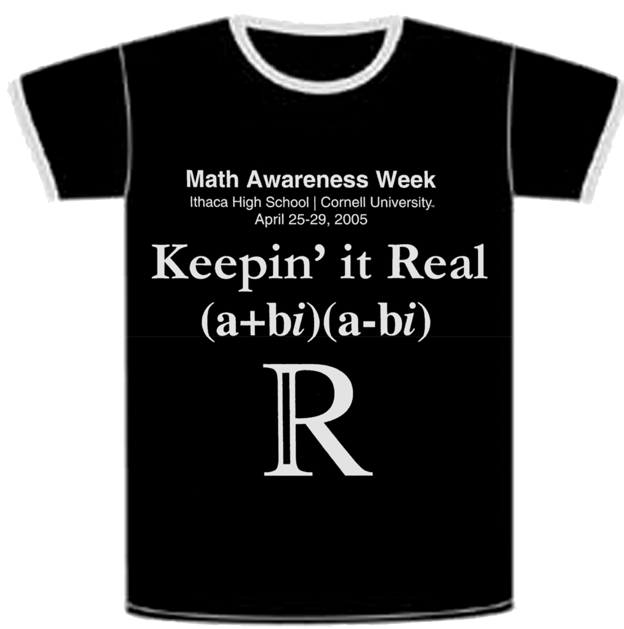
Mathematics Awareness Month Public Lecture

On April 27th, Prof. John Hubbard gave the 2005 Mathematics Awareness Month lecture. The crowd numbered over 100, including Cornell staff and students, as well as teachers and students from Ithaca High School and other schools as far away as Elmira.

In keeping with this year's theme, *Mathematics and the Cosmos,* Professor Hubbard's address explored *Order and Chaos in the Solar System*. He began with a look at the history of our understanding of the solar system, marveling at the work of Kepler and Newton before posing the troubling question of whether the orbits of the planets are stable. He entertained the audience with a computer simulation of several planetary systems that appeared stable for a while, before cataclysmic events sent planets careening through space. Hubbard concluded his address with remarks about the work of Kolmogorov, who showed that our solar system *might* be stable, offering comfort to some.

Michael D. Morley Ithaca High School Prize in Mathematics

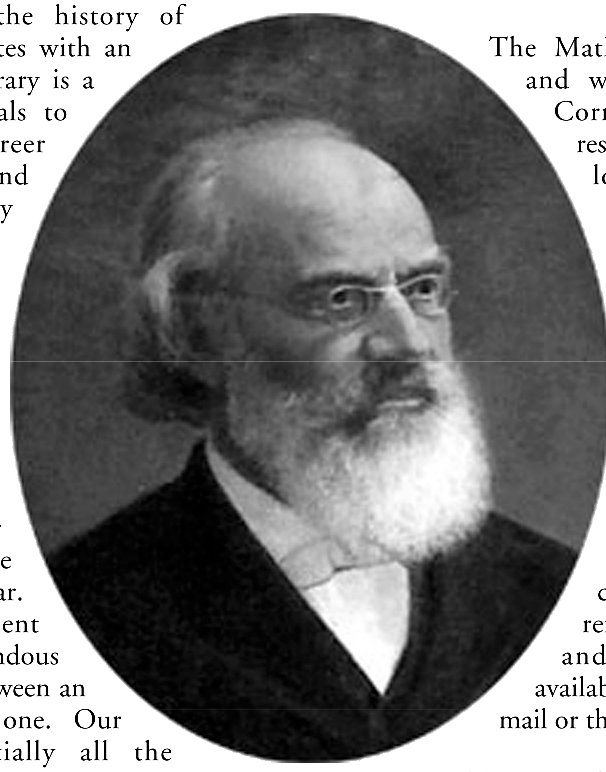
Todd Kemp presented the Michael D. Morley Ithaca High School Prize in Mathematics to Prabhas Pokharel, a senior at Ithaca High School who, through formal coursework and independent explorations, demonstrated substantial insight and wide-ranging interests in mathematics. Michael Morley, Graeme Bailey, and Todd Kemp interviewed three finalists chosen by the faculty at Ithaca High School, selecting Prabhas for his cleverness and ability to "think like a mathematician" when confronted by thought-provoking mathematical problems. The prize, formerly known as the Ithaca High School Senior Prize, is funded largely by faculty contributions.



Mathematics Library

The Mathematics Library continues to have a high level of use that often finds most of the library computers and many seats full. While scholarly journals are moving online, books remain in the paper world and the total use of the print collection continues to grow. Paintings and items of interest are on display in the library. Most notable is a collection of oil paintings of early faculty of the Mathematics Department, including a large portrait of James Edward Oliver (pictured here), who started the department colloquium series in 1891.

The Mathematics Library collection at Cornell is one of the finest in the nation and supports research and instruction in mathematics and statistics for the Cornell community. The research collection consists of works on mathematics, statistics, applied mathematics, mathematics education and the history of mathematics. For undergraduates with an interest in mathematics, the library is a wonderful resource for materials to support instructional and career needs as well as expository and recreational reading. The library collection has great historic depth and breadth and includes materials from around the world in many languages.



Gifts to the library endowment have made endowment income the primary source of funds for the purchase of books. Thanks to the generous gifts of our donors, endowment principle grew significantly in the last year. An anticipated larger endowment payout next year will be a tremendous help. Gifts are the difference between an excellent library and a mediocre one. Our endowments purchase essentially all the monographs we order individually.

The university appropriated budget for the library continues to grow, but not fast enough to keep pace with the cost of journals from a few large commercial publishers. In stark contrast, independent, society, university press, and not-for-profit journals are *not* increasing prices at an unsustainable rate. The majority of our appropriated budget is consumed by relatively few titles from a few large commercial publishers.

The library subscribes to about 600 journals. Half of the journals in the library collection are now available both on paper in the library and online to all Cornell users. Over 100 journals are now available only online where the University Library has negotiated site license contracts that make the online-only option financially favorable and provide archival reliability. In the coming year we will see many more titles go online only. At this time about 280 journals continue to be available only in paper. Online journals are important but they are not less expensive than the printed resources they will eventually replace. A crisis in scholarly communications is looming, largely because commercial publishers are pushing up the prices of their journals at a rate that is not sustainable. For more information on this subject, go to www.library.cornell.edu/scholarlycomm/.

The Mathematics Library encourages and welcomes all patrons in the Cornell community to use its resources. Reciprocal interlibrary loan agreements with other institutions open the world to Cornell researchers and make Cornell's resources available throughout the world. The need for quantification, analysis and more mathematical sophistication in the social, biological and engineering sciences attracts a spectrum of patrons from across the campus and generates frequent use of the collection. A full range of reference, circulation, printing, and photocopy services are available in person and via phone, e-mail or the web.

The library staff consists of Steven Rockey, director of the library, Natalie Sheridan, branch manager, and approximately a dozen part-time undergraduate student employees. The veteran professional staff and the competent student employees are always ready to serve the public and they welcome feedback. A primary goal is to make the library experience for the staff and patrons interesting, productive, and enriching in a small and personal environment.

The Mathematics Library's home page has been redesigned and relocated: www.library.cornell.edu/math/. It has information about the Mathematics Library, including services, hours of operation, pointers to bibliographic indexes such as MathSciNet and our locally created bibliography of "collected works'' of mathematicians, links to other mathematical science resources, etc. Library personnel are always adding new and relevant links to this home page. Visit our library, our home page, or contact us electronically or by telephone to find out how the Mathematics Library can serve you.

Cornell is involved in a number of digitization projects relating to mathematics. An overview of worldwide mathematics digitization efforts is available at: www.library.cornell.edu/math/digitalization.php. Here are some project highlights.

Project Euclid

projecteuclid.org

Project Euclid is Cornell University Library's electronic publishing initiative in mathematics that is now fully functional and has grown to 40 titles. Project Euclid is a user-centered initiative to create an environment for the effective and affordable distribution of serial literature in mathematics and statistics. The journal publishers join forces and participate in an online presence with advanced functionality, without sacrificing their intellectual or economic independence or commitment to low subscription prices. Full-text searching, reference linking, interoperability through the Open Archives Initiative, and long-term retention of data are all-important components of the project.

Cornell Historical Math Monographs Collection

historical.library.cornell.edu/math/

This is a collection of 576 digitized books that were scanned from originals held by the Mathematics Library. The titles can be viewed electronically, and the Mathematics Library also does a brisk business selling bound paper facsimiles to libraries and individuals. The Math Books collection is mostly composed of old books that are out of copyright but still mathematically relevant.

Digital Mathematics Library (DML)

www.ceic.math.ca/WDML/index.shtml

The successful Cornell-coordinated planning of the DML has resulted in the ongoing World DML project coordinated under the auspices of the International Mathematical Union. See www.mathematik.uni-bielefeld.de/~rehmann/DML/dml_links.html for a current list of retrodigitized mathematics

Electronic Mathematics Archives Initiative (EMANI)

www.emani.org

This is a collaborative effort between the German scientific publisher Springer and the libraries at Cornell, Göttingen, Tsinghua (Beijing), and NUMDAM (Grenoble). EMANI will focus on the archiving of digital mathematics literature, and also addresses repository and dissemination issues. Springer wishes to establish its reputation as a leader in digital archiving in a public-spirited fashion and hopes to benefit from the good will this can generate. Springer also hopes that a systematic and collaborative approach to digital archiving will speed their transition to electronic-only publishing. EMANI is expected to be an important component in the broader Digital Math Library initiative if Springer can in fact offer a model for other publishers of an open and collaborative approach to issues of archiving and access provision.

Faculty Research Areas in the Field of Mathematics

Dan M. Barbasch, Professor; Ph.D. (1976) University of Illinois; Representation theory of reductive Lie groups

Yuri Berest, Assistant Professor; Ph.D. (1997) Université de Montreal (Canada); Mathematical physics and algebraic geometry

Louis Billera, Professor; Ph.D. (1968) City University of New York; Geometric and algebraic combinatorics

Kenneth S. Brown, Professor and Chair; Ph.D. (1971) Massachusetts Institute of Technology; Algebra, topology, group theory

Stephen U. Chase, Professor; Ph.D. (1960) University of Chicago; Non-commutative algebra, homological algebra, Hopf algebras, group theory

Robert Connelly, Professor; Ph.D. (1969) University of Michigan; Discrete geometry, computational geometry and the rigidity of discrete structures

R. Keith Dennis, Professor; Ph.D. (1970) Rice University; Commutative and non-commutative algebra, algebraic K-theory, group theory, mathematical bibliography

Richard Durrett, Professor; Ph.D. (1976) Stanford University; Problems in probability theory that arise from ecology and genetics

Eugene B. Dynkin, A. R. Bullis Chair and Professor; Ph.D. (1948), Dr. of Science (1951) Moscow University; Probability theory, Lie groups

Clifford J. Earle, Professor; Ph.D. (1962) Harvard University; Complex variables, Teichmüller spaces

Leonard Gross, Professor; Ph.D. (1958) University of Chicago; Functional analysis, constructive quantum field theory

John M. Guckenheimer, Professor; Ph.D. (1970) University of California at Berkeley; Dynamical systems

Allen Hatcher, Professor; Ph.D. (1971) Stanford University; Geometric topology

Timothy Healey, Professor and Chair of Theoretical and Applied Mechanics; Ph.D. (1985) University of Illinois; Nonlinear elasticity, nonlinear analysis, partial differential equations

David W. Henderson, Professor; Ph.D. (1964) University of Wisconsin; Educational mathematics, geometry

John H. Hubbard, Professor; Doctorat d'Etat (1973) Université de Paris Sud; Analysis, differential equations, differential geometry

J.T. Gene Hwang, Professor; Ph.D. (1979) Purdue University; Statistics, confidence set theory

Yulij Ilyashenko, Professor; Ph.D. (1969) Moscow State University; Dynamical systems

Peter J. Kahn, Professor; Ph.D. (1964) Princeton University; Symplectic topology/geometry

Dexter Kozen, Professor of Computer Science; Ph.D. (1977) Cornell University; Computational theory, computational algebra and logic, logics and semantics of programming languages

Gregory Lawler, Professor; Ph.D. (1979) Princeton University; Probability, statistical physics

Camil Muscalu, Assistant Professor; Ph.D. (2000) Brown University; Harmonic analysis and partial differential equations

Anil Nerode, Goldwin Smith Professor; Ph.D. (1956) University of Chicago; Mathematical logic, computability theory, computer science, mathematics of AI, control engineering

Michael Nussbaum, Professor; Ph.D. (1979) Academy of Sciences Berlin (Germany); Mathematical statistics

Irena Peeva, Assistant Professor; Ph.D. (1995) Brandeis University; Commutative algebra and algebraic geometry

Philip Protter, Professor of Operations Research and Industrial Engineering; Ph.D. (1975) Univ. of California at San Diego; Probability theory, stochastic calculus, stochastic differential equations, stochastic numerical methods, mathematical finance theory, credit risk

Ravi Ramakrishna, Associate Professor; Ph.D. (1992) Princeton University; Algebraic number theory

Richard Rand, Professor of Theoretical and Applied Mechanics; Sc.D. (1967) Columbia University; Nonlinear dynamics

James Renegar, Professor of Operations Research and Industrial Engineering; Ph.D. (1983) University of California at Berkeley; Optimization algorithms

Laurent Saloff-Coste, Professor; Ph.D. (1983) and Doctorat d'Etat (1989) Université Paris VI; Analysis, potential theory, stochastic processes

Alfred H. Schatz, Professor; Ph.D. (1964) New York University; Numerical solutions of partial differential equations

Shankar Sen, Professor; Ph.D. (1967) Harvard University; Algebraic number theory

Richard A. Shore, Professor; Ph.D. (1972) Massachusetts Institute of Technology; Mathematical logic, recursion theory, set theory

Reyer Sjamaar, Associate Professor; Ph.D. (1990) Rijksuniversiteit te Utrecht (RUU), the Netherlands; Symplectic geometry

John Smillie, Professor; Ph.D. (1977) University of Chicago; Dynamical systems

Birgit E. Speh, Professor; Ph.D. (1977) Massachusetts Institute of Technology; Lie groups, automorphic forms, representation theory

Michael E. Stillman, Professor; Ph.D. (1983) Harvard University; Algebraic geometry, computational algebra

Robert S. Strichartz, Professor; Ph.D. (1966) Princeton University; Harmonic analysis, partial differential equations, analysis on fractals

Steven H. Strogatz, Professor; Ph.D. (1986) Harvard University; Applied mathematics

Edward Swartz, Assistant Professor; Ph.D. (1999) University of Maryland at College Park; Combinatorics and discrete geometry

William Thurston, Professor; Ph.D. (1972) University of California at Berkeley; Topology

Alexander Vladimirsky, Assistant Professor; Ph.D. (2001) University of California at Berkeley; Numerical methods, dynamical systems, nonlinear PDEs, control theory

Karen Vogtmann, Professor; Ph.D. (1977) University of California at Berkeley; Topology, geometric group theory

Lars B. Wahlbin, Professor; Ph.D. (1971) University of Göteborg, Sweden; Numerical solutions of partial differential equations

James E. West, Professor; Ph.D. (1967) Louisiana State University; Geometric topology, infinite-dimensional topology

Faculty Profiles

Allen Back

Senior Lecturer of Mathematics

My original training was primarily in differential geometry and secondarily in topology. The most interesting portion of my earlier work was related to the role of compact Lie group actions in differential geometry, especially curvature realizability questions. I've been impressed by a variety of recent progress in this area (e.g. Einstein metrics and positive Ricci curvature on many cohomogeniety one manifolds) and have been working on what further directions may now be fruitful.

Besides equivariant differential geometry, other areas of past work and interest include transformation groups, homotopy theory, dynamical systems, some parts of mathematical physics, geometric modeling and robotics. My work as director of the Instructional Computing Lab meshed with a long-standing interest in the use of computers for mathematical enrichment.

Selected Publications

Rational Pontryagin classes and killing forms, J. Diff. Geom. **16** no. 2 (1981), 191–193.

Pontryagin forms on homogeneous spaces, Comment. Math. Helv. **57** no. 3 (1982), 349–355.

Equivariant geometry and Kervaire spheres (with Wu Yi Hsiang), Trans. AMS **304** no. 1 (1987), 207–227.

dstool: Computer assisted exploration of dynamical systems (with J. Guckenheimer, M. Myers, F.J. Wicklin and P. Worfolk), Notices AMS **39** (1992), 303–309.

Mathematics and tensegrity (with R. Connelly), American Scientist March-April (1998), 142–151.

Dan Barbasch

Professor of Mathematics

My research is in the field of representation theory of reductive Lie groups. I am particularly interested in the classification of the unitary dual for groups over local fields, and its relation to the orbit structure of the Lie algebra. Furthermore I am interested in the relation of these representations to problems arising from number theory, more precisely automorphic forms.

Selected Publications

Unitary spherical spectrum for split classical p-adic groups, Acta Applicandae Mathematicae **44** (1996).

Local character expansions (with A. Moy), Ann. Sci. de L'Ecole Norm. Sup. (1997).

The associated variety of an induced representation (with M. Bozicevic), Proc. AMS (1998).

The spherical dual for p-adic groups (with A. Moy), Proc. of Conf. in Cordoba, Argentina.

The associated variety of unipotent representations, preprint.

Yuri Berest

Associate Professor of Mathematics

My research interests include mathematical physics, algebraic geometry and noncommutative algebra. I am particularly interested in various interactions between these fields. Some of my recent work is related to the study of algebras of differential operators on singular algebraic varieties and representation theory of Cherednik algebras.

Selected Publications

Automorphisms and ideals of the Weyl algebra (with G. Wilson), Math. Ann. **318** no. 1 (2000), 127–147.

Ideal classes of the Weyl algebra and noncommutative projective geometry (with G. Wilson and M. van den Bergh), IMRN **26** (2002), 1347–1396.

Finite-dimensional representations of rational Cherednik algebras (with P. Etingof and V. Ginzburg), IMRN **19** (2003), 1053–1088.

Cherednik algebras and differential operators on quasi-invariants (with P. Etingof and V. Ginzburg), Duke Math. J. **118** no. 2 (2003), 279–337.

Morita equivalence of Cherednik algebras (with P. Etingof and V. Ginzburg), J. Reine Angew. Math. **568** (2004), 81–99.

Louis J. Billera

Professor of Mathematics

For some time, my research has centered on combinatorial properties of convex polytopes and their relations to algebraic and geometric questions. Some questions are related to the facial structure of polytopes, for example, enumeration of faces or identification of their lattice structure. Others have to do with subdivisions of polytopes, how they might depend on the geometry (as opposed to the combinatorics) of the underlying set, or how the algebraic properties of objects related to a given subdivision, for example the algebra of smooth piecewise polynomial functions (splines) defined on it, might depend on both combinatorial and geometric factors.

A common theme in much of this has been the construction of polytopes to given specifications: for example the construction with Carl Lee of polytopes satisfying the conditions of McMullen's *g*-conjecture, showing these conditions to be sufficient to describe the enumeration of faces of all simplicial convex polytopes; or the construction with Bernd Sturmfels of fiber polytopes, showing that certain sets of polyhedral subdivisions of polytopes themselves had the structure of convex polytopes; or the construction with A. Sarangarajan of faces of the traveling salesman polytope, showing this polytope to have every possible 0-1 polytope as a low-dimensional face. In addition, we have used some of these techniques to study interesting problems arising in biology involving the structure of phylogenetic trees.

More recently, I have been studying algebraic structures underlying the enumeration of faces and flags in polytopes. This has led to the study of connections with the theory quasisymmetric and symmetric functions.

Selected Publications

Generalized Dehn-Sommerville relations for polytopes, spheres, and Eulerian partially ordered sets (with M. M. Bayer), Inv. Math. **79** (1985), 143–157.

Homology of smooth splines: generic triangulations and a conjecture of Strang, Trans. Amer. Math. Soc. **310** (1988), 325–340.

Fiber polytopes (with B. Sturmfels), Annals of Math. **135** (1992), 527–549.

Geometry of the space of phylogenetic trees (with S. Holmes and K. Vogtmann), Advances in Applied Mathematics **27** (2001), 733–767.

Peak quasisymmetric functions and Eulerian enumeration (with S. K. Hsiao and S. van Willigenburg), Advances in Mathematics **176** (2003), 248–276.

David Bock

Senior Lecturer of Mathematics and K-12 Education and Outreach Coordinator

I am generally interested in the teaching and learning of mathematics. I coordinate Mathematics Department outreach efforts that bring department members together with K–12 students for enrichment activities and with teachers for professional development opportunities. I also lead workshops for current and pre-service teachers. Currently I am active in the development of pedagogical initiatives for undergraduate statistics and have co-authored three textbooks. My most recent presentations at the Annual NCTM Meeting (National Council of Teachers of Mathematics) and at the Advanced Placement National Conference addressed strategies for teaching statistical inference.

Selected Publications

How to Prepare for the AP Calculus Examination (with S. Hockett), Barron's, 2002 (7th ed.), 636 pages.

Is That an Assumption or a Condition?, paper posted by The College Board at their APCentral website.

Intro Stats (with R. DeVeaux and P. Velleman), Addison-Wesley, 2003, 567 pages.

Stats: Data and Models (with R. DeVeaux and P. Velleman), Addison-Wesley, 2004, 743 pages.

Stats: Modeling the World (with R. DeVeaux and P. Velleman), Prentice Hall, 2004, 582 pages.

James H. Bramble

Professor Emeritus of Mathematics

For the past 25 years I have been interested in the development of the theoretical foundation of finite-element methods for the approximation of solutions of elliptic and parabolic partial differential equations. Recently I have concentrated on questions concerning rapid solution of large-scale systems that result from such approximations. Such a question is: Among all the theoretically good approximations to a general class of problems, are there some that can be solved efficiently by taking advantage of modern computer architectures such as parallelism? Answers to questions like this one can bring many problems into the realm of practical feasibility. My current research interest is the design of approximations to solutions to problems in partial differential equations that adequately describe the problem and that can be efficiently solved using modern computing power. In particular, I have been most recently interested in Maxwell's Equations and acoustics, including scattering problems.

Selected Publications

A new approximation technique for div-curl systems (with J. E. Pasciak), Math. Comp. **73** (2004), 1739–1762.

Analysis of a finite PML approximation for the three dimensional time-harmonic Maxwell and acoustic scattering problems (with J. E. Pasciak), Math. Comp. (to appear).

The approximation of the Maxwell eigenvalue problem using a least squares method (with T. Kolev and J. E. Pasciak), Math. Comp. (to appear).

Tara Brendle

VIGRE Assistant Professor of Mathematics

My interests include all topics related to the mapping class group Mod(*S*) of surface *S*. Recently I have focused on two particular subgroups of Mod(*S*): the Torelli group, which is the normal subgroup of Mod(*S*) made up of maps acting trivially on the homology of the surface *S*, and the handlebody group, consisting of those elements of Mod(*S*) which extend to a handlebody whose boundary is *S*. Both subgroups of Mod(*S*) play an important role in many branches of topology and geometry, including the study of homology 3-spheres and Heegaard splittings of 3-manifolds.

Selected Publications

On the linearity problem for mapping class groups (with Hessam Hamidi-Tehrani), Algebraic and Geometric Topology **1** (2001), 445–468.

Every mapping class group is generated by 6 involutions (with B. Farb), Journal of Algebra (to appear).

Braids and knots (with J. Birman); in Handbook of Knot Theory (W. Menasco and M. Thistlethwaite, eds.), to appear.

Commensurations of the Johnson kernel (with D. Margalit).

Nathan Broaddus

H. C. Wang Assistant Professor of Mathematics

I am interested in the topology and geometry of 3-manifolds. In particular I am interested in algorithmic problems arising from 3-manifolds.

Selected Publications

Noncyclic covers of knot complements, Geometriae Dedicata (to appear).

Kenneth Brown

Professor and Chair of Mathematics

My main interests have been algebra and topology. I have especially enjoyed using topological methods to study infinite discrete groups. In some of my early work, for instance, I studied Euler characteristics of groups. I obtained formulas relating the Euler characteristic (a topological concept) to purely algebraic properties of groups. When applied in special cases, these formulas unexpectedly led to new results in algebraic number theory. Later, I found topological methods for studying two interesting families of groups: infinite simple groups, and groups that can be presented by means of a complete rewriting system.

My work has recently had unexpected applications to probability theory. I have used methods of algebra and topology to analyze an interesting family of random walks.

Selected Publications

Euler characteristics of discrete groups and G-spaces, Invent. Math. **27** (1974), 229–264.

Cohomology of Groups, Graduate Texts in Mathematics **87**, Springer-Verlag, New York, 1982.

Buildings, Springer-Verlag, New York, 1989.

Semigroups, rings and Markov chains, J. Theoret. Probab. **13** (2000), 871–938.

Forest diagrams for elements of Thompson's group F (with James Belk), Internat. J. Algebra Comput. (to appear).

Kariane Calta

H. C. Wang Assistant Professor of Mathematics

My research involves the dynamics of the geodesic flow on translation surfaces, i.e. 2-manifolds whose transition functions are translations. I am also interested in the orbit structures of these surfaces in the moduli space of abelian differentials. Some of my research has applications to the study of billiards.

Selected Publications

Veech surfaces and complete periodicity in genus two, JAMS **17** no. 4 (2004), 871–908.

Stephen U. Chase

Professor of Mathematics

With the exception of my early work on module theory, homological algebra, and abelian groups, the enduring theme of my mathematical interests and research has been the Galois theory of rings and fields, and variations of these theories in which the role of the classical Galois group is played by some related algebraic structure such as a restricted Lie algebra, group scheme, Hopf algebra, or groupoid. This work impinges upon and utilizes techniques from other areas in which I also have strong interests, such as category theory and homological algebra, group theory, group schemes and Hopf algebras, representation theory, algebraic *K*-theory, and algebraic number theory.

Following a period in my career in which the main focus of my research was the Galois module structure of algebraic integers, I have returned to investigations in pure algebra; these involve primarily Hopf algebras (especially quantum groups and Tannakian reconstruction) and, more recently, finite groups (especially the structure of p-groups).

Selected Publications

Galois theory and Galois cohomology of commutative rings (with D. K. Harrison and A. Rosenberg), Amer. Math. Soc. Memoir **52** (1965).
Hopf algebras and Galois theory (with M. E. Sweedler), Lecture Notes in Math **97**, Springer-Verlag, 1969.
Infinitesimal group scheme actions on finite field extensions, Amer. J. Math. **98** (1976), 441–480.
Ramification invariants and torsion Galois module structure in number fields, J. Algebra **91** (1984), 207–257.

Indira Chatterji

H. C. Wang Assistant Professor of Mathematics

I am interested in topics related to the idempotent conjecture, which is that the only idempotents in the group ring of a torsion-free group should be 0 and 1. This conjecture has a generalization to the rings $\ell^1(G)$ or $C^*_{r(G)}$, and can be solved in some geometric cases using methods from topology (Baum-Connes conjecture).

Selected Publications

Property (RD) for cocompact lattices in a finite product of rank one Lie groups with some rank two Lie groups, Geometriae Dedicata **96** (2003), 161–177.
From acyclic groups to the Bass conjecture for amenable groups (with J. Berrick and G. Mislin), Math. Annalen **329** no. 4 (2004), 597–621.
Atiyah's L^2-index theorem (with G. Mislin), Enseignement Mathematique (2) **49** no. 1-2 (2003), 85–93.
Some geometric groups with the rapid decay property (with K. Ruane), GAFA (to appear).
Connected Lie groups and property RD (with C. Pittet and L. Saloff-Coste), preprint 2004.

Hsiao-Bing Cheng

VIGRE Assistant Professor of Mathematics

I am primarily interested in the study of parabolic geometric flows, and in particular, the Ricci and Mean Curvature flows. Much like the heat flow, these flows often have a "smoothing" effect and can thus be used to help find "simple" or canonical geometries on a given space.

Parabolic flows are also used extensively for numerical computations which are geometric in nature.

Marshall M. Cohen

Professor Emeritus of Mathematics

I am a geometric topologist and a combinatorial group theorist. Much of my work has dealt with the introduction of combinatorial and algebraic themes into geometric problems or geometric themes into combinatorial and algebraic problems. Over the years this work has involved the intermingling of topological manifolds, combinatorial topology, the foundations of piecewise linear topology, simple-homotopy theory, automorphisms of free groups, spaces of length functions on groups and equations over groups. Currently the second best description of me is as a geometric group theorist.

The title I most covet is that of teacher. The writing of a research paper and the teaching of freshman calculus, and everything in between, falls under this rubric. Happy is the person who comes to understand something and then gets to explain it.

In addition to research and teaching I deeply enjoy my role as faculty advisor to undergraduates. These days research, teaching and advising are done in my position as Visiting Professor at Morgan State University, the Urban University of Maryland and one of the classic HBCU's (Historically Black Colleges and Universities).

Selected Publications

Simplicial structures and transverse cellularity, Annals of Math. (2) **85** (1967), 218–245.
A Course in Simple-Homotopy Theory, Graduate Texts in Mathematics **10**, Springer Verlag, 1973.
On the dynamics and the fixed subgroup of a free group automorphism (with Martin Lustig), Inv. Math. **96** (1989), 613–638.
Very small group actions on R-trees and Dehn twist automorphisms (with Martin Lustig), Topology **34** (1995), 575–617.
The surjectivity problem for one-generator, one-relator extensions of torsion-free groups (with Colin Rourke), Geometry and Topology **5** (2001), 127–142.
Ode to geometric group theory, American Mathematical Monthly (Aug/Sept 2005), to appear.

Robert Connelly

Professor of Mathematics

Discrete geometry, with emphasis on the geometry of rigid and flexible structures, is my main area of interest. A tensegrity is a structure composed of sticks held in mid-air with strings that, nevertheless, holds its shape.

This can be modeled very nicely as a configuration of points with upper and lower bounds on the distances between certain pairs of points. This in turn leads to interesting problems in, and applications to, distance geometry and the theory of packings and coverings of spheres as well as applications to robotics, protein folding, motion planning and percolation problems in physics and probability.

Another subject of interest is the theory of flexible surfaces. There are triangulated surfaces that flex, keeping their edges at a fixed length, and it has recently been shown that such surfaces maintain a fixed volume while they flex. There is no perfect mathematical bellows. This is also related to a polynomial that relates the volume of the surface to the lengths of its edges. This is at the intersection of discrete geometry, algebraic geometry and topology.

Selected Publications

Mathematics and tensegrity (with A. Back), American Scientist March-April (1998), 142–151.

Tensegrity structures: Why are they stable?; in Rigidity Theory and Applications (M. F. Thorpe and P. M. Duxbury, eds.), Kluwer Academic/Plenum, 1999, pp. 47–54.

The Kneser-Poulsen conjecture (with K. Bezdek), Crelle's Journal, J. reine angew. Math. **553** (2002), 221–236.

The Kneser-Poulsen conjecture for spherical polytopes (with K. Bezdek), submitted.

Straightening polygonal arcs and convexifying polygonal cycles (with E. Demaine and G. Rote), in preparation.

Barbara Csima

H. C. Wang Assistant Professor of Mathematics

My research falls into two main areas: computable model theory, and computability theory questions arising from differential geometry.

In computable model theory, we examine the complexity of theorems in model theory using tools from computability theory. I have been particularly interested in studying the Turing degrees of prime models of complete atomic decidable theories.

Recent results in differential geometry have shown a connection between the settling times of computably enumerable (c.e.) sets and the depth and distribution of local minima in the space of Riemannian metrics on a smooth compact manifold, modulo diffeomorphisms. I have been working on showing the existence of sequences of c.e. sets whose settling times behave in a way that has interpretations in differential geometry. I have also been examining properties of c.e. sets related to their settling times.

Selected Publications

Degree spectra of prime models, J. Symbolic Logic **69** no. 2 (2004), 430–442.

Bounding prime models (with D. R. Hirschfeldt, J. F. Knight, and R. I. Soare), J. Symbolic Logic, submitted.

Sarah Day

VIGRE Assistant Professor of Mathematics

I have been working mainly in the area of rigorous numerical techniques for dynamical systems. In particular, I am interested in methods based on an algebraic topological tool called the Conley index. These methods have been used with a number of systems to prove the existence of dynamical objects from fixed points to chaotic attractors. Currently, I am investigating extensions to a wider class of problems in dynamical systems, including bifurcation analysis as well as applications to the study of biological models.

Selected Publications

Towards a rigorous numerical study of the Kot-Schaffer model, Dynamic Systems and Applications **12** no. 1–2 (2003), 87–98.

A rigorous numerical method for the global analysis of infinite dimensional discrete dynamical systems (with O. Junge and K. Mischaikow), SIAM Journal on Applied Dynamical Systems **3** no. 2 (2004), 117–160.

Towards automated chaos verification (with O. Junge and K. Mischaikow), Proc. Equadiff 2003, World Scientific, Singapore, 2005, pp. 157–162.

Rigorous Numerics for Global Dynamics: a study of the Swift-Hohenberg equation (with Y. Hiraoka, K. Mischaikow, and T. Ogawa), SIAM Journal on Applied Dynamical Systems **4** no. 1 (2005), 1–31.

R. Keith Dennis

Professor of Mathematics

Most of my research has been in the field of algebraic *K*-theory. This field is, in some sense, a fancy generalization of linear algebra to arbitrary rings. As such, it has applications in many other areas of mathematics such as topology, algebraic geometry, and even the theory of Markov processes. I have been most interested in the computational aspects of the subject, in particular, the computation of quotients of rings of algebraic integers and in the computation of the Whitehead group for finite abelian groups.

Parts of this work have involved the use of computers to understand a number of examples before formulating and proving the general results. This work has led to the study of questions about group rings, number theory, and theory of finite groups. My current interest lies in studying a number of problems relating to commutators, structure, and invariants of finite groups which can be investigated by computer computations.

While I was executive editor of *Mathematical Reviews*, I became interested in problems dealing with mathematical communication, databases and mathematical bibliography, and how to convert the older mathematical literature into searchable electronic form. I have mainly been involved with these issues during the last several years.

Selected Publications

Recent developments in digital library technologies (with G. O. Michler, M. Suzuki and G. Schneider); in DIAR-03: Workshop on Document Image Analysis and Retrieval (to appear).

Computation of the Scharlau invariant (with Paul Young), in preparation.

Homogeneous functions and algebraic K-theory (with R. Laubenbacher), in preparation.

The number of groups of order n, in preparation.

Generic product decompositions of finite groups, in preparation.

Richard Durrett

Professor of Mathematics

My initiation to work at the interface between mathematics and biology came from a collaboration with Simon Levin that was begun in the late 80's and produced 10 pages on the use of stochastic spatial models in ecology.

In 1997 I began a collaboration with Chip Aquadro in Molecular Biology and Genetics at Cornell. Our first paper on the evolutionary dynamics of DNA repeat sequences (e.g., CA repeated 15 times in a row) was published in the Proceedings of the National Academy of Science. Subsequent work with two graduate students has shown that the dependence of mutation rates on length of repeat is not simple and selection acts to reduce the length of long repeats.

With Rasmus Nielsen in Biological Statistics and Computational Biology, I have developed stochastic methods for studying the evolution of genomes due to large-scale processes: inversions within chromosomes, translocations between chromosomes, chromosomal fissions and fusions, and gene duplication. This work has led to a surprising new result on the behavior of the distance from the origin for random walk on the transposition group.

Joint work with Ted Cox and Iljana Zahle has studied the influence of spatial structure on genealogies. With Jason Schweinsberg, we developed a simple approximation for the effect of fixation of advantageous mutations on the variability of nearby nucleotides. Gene duplication is another topic that I have considered in three papers that are joint work with REU student Rachel Ward, with Deena Schmidt, and with Jason Schweinsberg.

Recently I have become interested in random graphs. Notes from a course I taught in fall 2004 will end up as a short book or long paper on the subject. In addition, I have done research on this topic with REU student Jonah Balisak and with Paul Jung.

Selected Publications

Microsatellite models: Insights from a comparison of humans and chimpanzees (with R. Sainudiin, C. F. Aquadro, and R. Nielsen), Genetics **168** (2004), 383–395.

Bayesian estimation of genomic distance (with R. Nielsen and T. L. York), Genetics **166** (2004), 621–629.

Subfunctionalization: How often does it occur? How long does it take? (with R. Ward), Theor. Pop. Biol. **66** (2004), 93–100.

Adaptive evolution drives the diversification of zinc-finger binding domains (with D. Schmidt), Mol. Biol. Evol. **21** (2004), 2326–2339.

Approximating selective sweeps (with J. Schweinsberg), Theor. Pop. Biol. **66** (2004), 93–100; Ann. Appl. Probab. (to appear).

The stepping stone model, II. Genealogies and the infinite sites model (with I. Zahle and J. T. Cox), Ann. Appl. Probab. **15** (2005), 671–699.

A phase transition in the random transposition random walk (with N. Berestycki), Prob. Theory Rel. Fields (to appear).

Power laws for family sizes in a gene duplication model (with J. Schweinsberg), Ann. Prob. (to appear).

Random Oxford graphs (with J. Blasiak), Stochastic Process and their Applications (to appear).

Two phase transitions for the contact process on small worlds (with P. Jung), Ann. Appl. Probab. (to appear).

Eugene B. Dynkin

Professor of Mathematics and A. R. Bullis Chair

Lie groups were the main subject of my earlier research. Dynkin's Diagrams are widely used by mathematicians and physicists. After 1954, probability theory became the central field of my interests. Principal efforts were devoted to Markov processes and their connections with potential theory and partial differential equations. Other work includes research in mathematical statistics (sufficient statistics, exponential families), optimal control (optimal stopping, control with incomplete data) and mathematical economics (economic growth and economic equilibrium under uncertainty).

In the 80s I worked on the relationship between Markov processes and random fields that arise in statistical physics and quantum field theory. One of the results — an isomorphism theorem connecting Gaussian fields with local times for Markov processes — has a considerable impact on the work of a number of investigators. For the last decade, my main efforts are devoted to the theory of measure-valued branching processes. (The name *superprocesses* suggested by me for these processes is now standard in mathematical literature.) Connections between superdiffusions and a class of nonlinear partial differential equations were established that makes it possible to apply powerful analytic tools for investigating the path behavior of superdiffusions, and that provides a new probabilistic approach to problems of nonlinear PDEs. New directions — the description of all positive solutions of a certain class of nonlinear equations and the study of removable boundary singularities of such solutions — have been started in a series of joint papers of Dynkin and Kuznetsov. A theory developed by them and by a number of other investigators is presented in a systematic way in a monograph of Dynkin published in 2002.

The complete classification of positive solutions of nonlinear equations $\Delta u = u^{\alpha}$ with $1 < \alpha \leq 2$ in a bounded smooth domain resulted from a series of papers by Dynkin and by Dynkin and Kuznetsov written in 2003. A systematic presentation of these results is contained in a book of Dynkin published in 2004.

Selected Publications

An Introduction to Branching Measure-Valued Processes, CRM Monograph Series **6**, American Mathematical Society, Providence, RI, 1994.

Fine topology and fine trace on the boundary associated with a class of semilinear differential equations (with S. E. Kuznetsov), Comm. Pure and Appl. Math. **51** (1998), 897–936.

Selected Papers of E. B. Dynkin with Commentary, Amer. Math. Soc. and International Press, 2000.

Diffusions, Superdiffusions and Partial Differential Equations, AMS Colloquium Publications, Vol. 50, Providence, Rhode Island, 2002.

Superdiffusions and positive solutions of nonlinear partial differential equations, American Mathematical Society, University Lecture Series, Volume 34, 2004.

Clifford J. Earle

Professor Emeritus of Mathematics

Most of my research concerns invariants belonging to Riemann surfaces. I am especially interested in learning how these invariants change when the complex structure of the Riemann surface is modified. A useful technique is to consider a family of Riemann surfaces depending holomorphically on some parameters and to study how the invariants of the surface change as we move about in the parameter space. Quasiconformal maps and Kleinian groups have proved to be fundamental tools for the construction of good parameter spaces, so I have studied and used them extensively.

Selected Publications

A fibre bundle description of Teichmüller theory (with J. Eells, Jr.), J. Diff. Geom. **3** (1969), 19–43.

Families of Riemann surfaces and Jacobi varieties, Ann. Math. **107** (1978), 255–286.

Conformally natural extension of homeomorphisms of the circle (with A. Douady), Acta Math. **157** (1986), 23–48.

Holomorphic motions and Teichmüller spaces (with I. Kra and S. L. Krushkal), Trans. Amer. Math. Soc. **343** (1994), 927–948.

Geometric isomorphisms between infinite dimensional Teichmüller spaces (with F. P. Gardiner), Trans. Amer. Math. Soc. **348** (1996), 1163–1190.

Roger H. Farrell

Professor Emeritus of Mathematics

Retired as of July 1, 1999, I am still semi-active in the department and try to come in most days to audit classes and work some in the Math Support Center. I am not active in research.

My research concerned the application of decision theory methods to statistical problems to try and characterize completely good and bad methods of estimation and testing. Useful decision theory methods can involve development of inequalities, compactification of spaces, and study of the way sequences of measures converge.

Selected Publications

Proof of a necessary and sufficient condition for admissibility in discrete multivariate problems (with L. D. Brown), J. Mult. Annal. **24** (1988), 46–52.

All admissible linear estimators of the vector of gamma state parameters with application to random effects models (with W. Klonecki and S. Zontek), Ann. Statist. **17** (1989), 268–281.

A lower bound for the risk in estimating the value of a probability density (with L. D. Brown), JASA **85** (1990), 1147–1153.

Estimations of accuracy in testing (with J. T. G. Hwang, G. Casella, C. Robert and M. T. Wells), Ann. Statist. **20** (1992), 490–509.

Spitzer and Bohnenblust, revisited (1997), preprint.

Leonard Gross

Professor of Mathematics

My research could, for the most part, be described as analysis over infinite dimensional spaces. This has sometimes been motivated by problems of mathematical physics, specifically statistical mechanics and the problem of existence of quantum fields. There is usually a naturally arising probability measure on the infinite dimensional space of interest to me that links functional analytic questions to probability theory. In the early 1990s I studied properties of the Dirichlet form associated to pinned Brownian motion on loop groups. A long-range goal was proof of a Hodge-deRham theorem for these manifolds of maps. More recently, I have studied Dirichlet forms in holomorphic function spaces over a complex manifold and their link to a strong kind of hypercontractivity.

Selected Publications

Existence and uniqueness of physical ground states, J. Func. Anal. **10** (1972), 52–109.

Logarithmic Sobolev inequalities, American J. Math. **97** (1975), 1061–1083.

Uniqueness of ground states for Schrödinger operators over loop groups, J. Func. Anal. **112** (1993), 373–441.

Hypercontractivity over complex manifolds, Acta Math. **182** (1999), 159–206.

Holomorphic Dirichlet forms on complex manifolds (with Z. Qian), Math. Z. **246** (2004), 521–561.

John M. Guckenheimer

Professor of Mathematics

Dynamical systems theory studies long time behavior of systems governed by deterministic rules. Even the simplest nonlinear dynamical systems can generate phenomena of bewildering complexity. Formulas that describe the behavior of a system seldom exist. Computer simulation is the way to see how initial conditions evolve for particular systems. In carrying out simulations with many, many different systems, common patterns are observed repeatedly. One of the main goals of dynamical systems theory is to discover these patterns and characterize their properties. The theory can then be used as a basis for description and interpretation of the dynamics of specific systems. It can also be used as the foundation for numerical algorithms that seek to analyze system behavior in ways that go beyond simulation. Throughout the theory, dependence of dynamical behavior upon system parameters has been an important topic. Bifurcation theory is the part of dynamical systems theory that systematically studies how systems change with varying parameters.

My research is a blend of theoretical investigation, development of computer methods and studies of nonlinear systems that arise in diverse fields of science and engineering. Much of the emphasis is upon studying bifurcations. The computer package DsTool is a product of the research of former students and myself with additional contributions from postdoctoral associates. It provides an efficient interface for the simulation of dynamical models and incorporates several additional algorithms for the analysis of dynamical systems. The program is freely available, subject to copyright restrictions. My current work focuses upon the dynamics of systems with multiple time scales, algorithm development for problems involving periodic orbits and upon applications to the neurosciences, animal locomotion and control of nonlinear systems.

Selected Publications

Nonlinear Oscillations, Dynamical Systems and Bifurcation of Vector Fields (with P. Holmes), Springer-Verlag, 1983, 453 pp.

Phase portraits of planar vector fields: computer proofs, J. Experimental Mathematics **4** (1995), 153–164.

An improved parameter estimation method for Hodgkin-Huxley model (with A. R. Willms, D. J. Baro and R. M. Harris-Warrick), J. Comp. Neuroscience **6** (1999), 145–168.

Computing periodic orbits and their bifurcations with automatic differentiation (with B. Meloon), SIAM J. Sci. Stat. Comp. **22** (2000), 951–985.

The forced van der Pol equation I: the slow flow and its bifurcations (with K. Hoffman and W. Weckesser), SIAM J. App. Dyn. Sys. **2** (2002), 1–35.

Allen Hatcher

Professor of Mathematics and Director of Undergraduate Studies

A common thread through much of my research is the idea of studying the space of all topological objects of a certain kind, for example, the space of all finite polyhedra, the space of all diffeomorphisms of a manifold, or the space of all knots. Recently I have also been writing a couple of graduate-level textbooks in topology.

Selected Publications

Higher simple homotopy theory, Annals of Math. **102** (1975), 101–137.

A proof of the Smale conjecture, Annals of Math. **117** (1983), 553–607.

Algebraic Topology, Cambridge University Press, 2002. (This book is also available online at www.math.cornell.edu/~hatcher.)

Timothy J. Healey

Professor and Chair of Theoretical and Applied Mechanics

I work at the interface between nonlinear analysis of pde's — mostly elliptic systems — and the mechanics of elastic structures and solid continua. Nonlinear (finite) elasticity is the central model of continuum solid mechanics. It has a vast range of applications, including flexible engineering structures, biological structures — both macroscopic and molecular, and materials like elastomers and shape-memory alloys — everything from fighter jets to lingerie! Although the beginnings of the subject date back to Cauchy, the current state of existence theory is quite poor; properly formulated problems of the subject are often out of the range of present day mathematics. In other words there are many open problems.

My work ranges from the abstract — e.g., developing a generalized nonlinear Fredholm degree to obtain solutions "in the large" in 3-D nonlinear elasticity — to the more concrete — e.g., modeling the helical microstructure of DNA in elastic rod models. Most recently I have become quite interested in the analysis of elastic surfaces in models inspired by "biological membranes."

Selected Publications

Global continuation in nonlinear elasticity (with H. Simpson), Arch. Rat. Mech. Anal. **143** (1998), 1–28.

Global continuation in displacement problems of nonlinear elastostatics via the Leray-Schauder degree, Arch. Rat. Mech. Anal. **152** (2000), 273–282.

Global continuation via higher-gradient regularization and singular limits in forced one-dimensional phase transitions (with H. Kielhöfer), SIAM J. Math. Anal. **31** (2000), 1307.

Material symmetry and chirality in nonlinearly elastic rods, Math. Mech. Solids **7** (2002), 405–420.

Global bifurcation in nonlinear elasticity with an application to barrelling states of cylindrical columns (with E. Montes), J. Elasticity **71** (2003), 33–58.

David W. Henderson

Professor of Mathematics

There is a huge crisis in the teaching and learning of mathematics in the world — this crisis is affecting the future of mathematics. My work on mathematics is having an impact on this crisis by stressing that teachers (and thence their students) learn and experience ways of thinking that are as close as possible to the ways that mathematician's think, but yet simultaneously paying attention to the cognitive development of students and teachers and the underlying meanings and intuitions of the mathematics. Only mathematicians can do this work, thus the term "Educational Mathematics." My main thesis is that we should enliven our conception of what "proof" is and that proofs should be a central part of mathematics teaching at all levels, where my definition of "proof" is: *A convincing communication that answers — Why.*

In addition, I am currently involved in extensive curriculum innovation projects in undergraduate mathematics. My first book, *Experiencing Geometry on Plane and Sphere* (Prentice-Hall, 1996), has been requested by faculty in over 50 countries and has been translated into Portuguese. My second book is *Differential Geometry: A Geometric Introduction* (Prentice-Hall, 1998). My third book, *Experiencing Geometry: in Euclidean, Spherical and Hyperbolic Spaces* (with Daina Taimina; Prentice-Hall, 2001), is an extensive revision and expansion of my first book. My fourth book, *Experiencing Geometry: Euclidean and Non-Euclidean With History* (with Daina Taimina; Pearson Prentice-Hall, published 2004, copyright 2005) is a further expansion and revision. Other books are in process. In addition, I am now a member of the high school curriculum development team for Robert Moses' *Algebra Project*.

Selected Publications

Extended hyperbolic surfaces in R^3; in the Ludmilla Keldysh Memorial Volume, Proceedings of the Steklov Institute of Mathematics **247**, 2004, pp.1–13.

Non-Euclidean geometry (with Daina Taimina) and *Differential geometry,* signed articles in Encyclopedia Britannica, 2005.

Alive mathematical reasoning; a chapter in The Brown Festschrift (L. Copes and F. Rosamond, eds.), 2005, pp. 239–263.

How to use history to clarify common confusions in geometry (with Daina Taimina); Chapter 1 in Using Recent History in the Teaching of Mathematics (A. Shell and D. Jardine, eds.), MAA Notes, 2005.

Experiencing Meanings in Geometry (with Daina Taimina); Chapter 3 in Aesthetics and Mathematics (David Pimm and N. Sinclair, eds.), Springer-Verlag, 2005, pp. 58–83.

Experiencing Geometry: Euclidean and Non-Euclidean With History (with Daina Taimina), 3rd Edition, Pearson Prentice-Hall, 2005. (pp: xxx + 402)

Tara Holm

Assistant Professor of Mathematics

The focus of my research is symplectic geometry and its relationships with combinatorics, algebraic topology, and algebraic geometry. Recent projects include: (1) studying real loci of symplectic manifolds and the corresponding varieties in real algebraic geometry; and (2) investigating the topology of symplectic quotients that are orbifolds.

Selected Publications

The equivariant cohomology of Hamiltonian G-spaces from residual S^1 actions (with Rebecca Goldin) Math. Res. Letters **8** (2001), 67–78.

Distinguishing chambers of the moment polytope (with Rebecca Goldin and Lisa Jeffrey), J. Symp. Geom. **2** no. 1 (2003), 109–131.

The mod 2 equivariant cohomology of real loci (with Daniel Biss and Victor Guillemin), Adv. in Math. **185** (2004), 370–399.

Computation of generalized equivariant cohomologies of Kac-Moody flag varieties (with Megumi Harada and Andre Henriques), Adv. in Math. (to appear).

Conjugation spaces (with Jean-Claude Hausmann and Volker Puppe), preprint.

Orbifold cohomology of torus quotients (with Rebecca Goldin and Allen Knutson), preprint.

John H. Hubbard

Professor of Mathematics

Differential equations are the main way in which mathematical models of real systems are constructed, and understanding their behavior is the main contribution a mathematician can make to applications. I am interested in understanding the behavior of differential equations and their close relatives: iterative systems. In particular, I try to see how such systems behave in the complex domain, largely because complex analysis brings new and powerful techniques to bear on the problems.

The availability of powerful computers and computer graphics has changed the way this sort of research is done. In the course of investigations of even such simple iterative systems as quadratic polynomials, amazing pictures show up, rather as artifacts to be investigated than as man-made objects. I anticipate that this sort of experimental mathematics will become a major trend.

Most of my research over the last five years has been devoted to dynamics in several complex variables. I have co-authored four foundational papers in the field. I am also writing three books on a very advanced level, one giving a treatment of Teichmüller space and its applications in theorems of Bill Thurston, the second on dynamics of one complex variable, and the third on differential geometry.

Selected Publications

Differential Equations, A Dynamical Systems Approach Part I (with B. West), Texts in Applied Mathematics **5**, Springer-Verlag, NY, 1991.

Differential Equations, A Dynamical Systems Approach: Higher Dimensional Systems (with B. West), Texts in Applied Mathematics **18**, Springer-Verlag, NY, 1995.

Vector Calculus, Linear Algebra and Differential Forms, A Unified Approach (with Barbara Burke Hubbard), 2nd edition, Prentice Hall, 2002.

Student Solution Manual to Accompany Vector Calculus, Linear Algebra and Differential Forms, A Unified Approach; Matrix Editions (with Barbara Burke Hubbard), 2002.

J. T. Gene Hwang

Professor of Mathematics

Recently, I started to focus mainly on the theory of statistical intervals. Statistical intervals, such as confidence intervals, prediction intervals and tolerance intervals are one of the major areas in statistics. By providing intervals, statisticians demonstrate the possible range of the interested parameters or future observations.

Much of my research is stimulated by scientific and engineering applications. Although my primary interest is in theory, the solutions often can be used directly in application. My recent joint work with the National Institute of Standards and Technology is one example.

Selected Publications

Optimal confidence sets, bioequivalence and the limacon of Pascal (with L. D. Brown and G. Casella), JASA **90** (1995), 880–890.

Maximum likelihood estimation under order restricted parameters by the prior feedback method (with C. Robert), JASA **91** (1996), 167–172.

An unbiased test for the bioequivalence problem (with L. D. Brown and Axel Munk), Ann. Stat. **25** (1997), 2345–2367.

Prediction intervals in artificial neural network (with A. Adam Ding), JASA **92** (1997), 748–757.

Prediction intervals, factor analysis models and high-dimensional empirical linear prediction (HELP) (with A. Adam Ding), JASA, to appear.

Yulij Ilyashenko

Professor of Mathematics

Dynamical systems describe evolutionary processes in the world around us. The theory of these systems stimulated the development of different branches of mathematics like topology, Lie groups theory, theory of automorphic functions and so on. The modern theory of dynamical systems contains two parts: higher and lower dimensional systems. The first part is much larger than the second one. Its major goal, amidst others, is to understand the chaotic behavior of deterministic systems, and, in particular, to explain the hydrodynamical turbulence. One of the major problems in the lower dimensional theory, namely, in the theory of planar differential equations, is the Hilbert's 16th problem: *what may be said about number and location of limit cycles of a planar polynomial vector field with components of degree n?* This problem still stays unsolved, but motivated a lot of progress in the theory.

In multidimensional theory, together with my students, I try to find new properties of dynamical systems that persist under small perturbations. The study is based on the heuristic principle: *any effect that occurs in random dynamical systems may be found as well in deterministic ones.* This principle was discovered during the study of nonlocal bifurcations [5] and developed in [13], [7], [6]. New definitions of attractors were suggested in [4]; I study them now together with my students.

The main paradigm of my study of the Hilbert 16th problem is to apply methods of multidimensional complex analysis and theory of Riemann surfaces to the study of real polynomial differential equations. The survey of this approach is contained in [9]. A larger survey of the whole theory is presented in [14]. New methods in the study of complex dynamical systems were developed, in particular, in [12], [8], [3]. Complex dynamical systems gave rise to a new branch of complex analysis, namely, to the theory of *functional cochains and nonlinear Stokes Phenomena* [2]. These cochains were applied to the proof of a partial answer to Hilbert's question: *Any polynomial vector field has but a finite number of limit cycles* [1].

A list of problems that forms my present field of interests is presented in [11]. It was a subject of a minicourse taught in a summer school organized by Christiane Rousseau and myself in Montreal, 2002 [10]. Three lectures of this school: A. Glutsyuk, V. Kaloshin, and S. Yakovenko are my former students.

Selected Publications

1. *Finiteness Theorems for Limit Cycles*, AMS, Transl. **94**, 1991, 288 pp.
2. Editor of *Nonlinear Stokes Phenomena*, Advances in Soviet Mathematics **14**, AMS, 1993, 287 pp.
3. Editor (with Yakovenko) of *Concerning Hilbert's 16th Problem*, AMS, 1995, 219 pp.
4. *Minimal and strange attractors* (with Gorodetski), Int'l J. Bifurcation and Chaos **6** no. 6 (1996), 1177–1183.
5. *Nonlocal Bifurcations* (with Li Weigu), Mathematical Surveys and Monographs **66**, AMS, 1999.
6. *Some new robust properties of invariant sets and attractors of dynamical systems* (with Gorodetski), Funct. Anal. Appl. **33** no. 2 (1999), 16–32.
7. *Some properties of skew products over a horseshoe and solenoid* (with A. Gorodetski), Proceedings of the Steklov Institute **231** (2000), 96–118.
8. *Some upper estimates of the number of limit cycles of planar vector fields with applications to Lienard equation* (with A. Panov), Moscow Mathematical Journal **1** no. 4 (2001), 583–599.
9. *Centennial history of Hilbert's 16th problem*, Bull. AMS **39** no. 3 (2002), 301–354.
10. Editor (with C. Rousseau) of *Normal Forms, Bifurcations and Finiteness Problems in Differential Equations*, Proceedings of a NATO seminar, Montreal, 2002, Kluwer, 2004.

11. *Selected topics in differential equations with real and complex time*; in Normal Forms, Bifurcations and Finiteness Problems in Differential Equations, Kluwer, 2004, pp. 317–354.
12. *Kupka-Smale theorem for polynomial automorphisms of C^2 and persistence of heteroclinic intersections* (with G. Buzzard and S, Hruska), Invent. Math. (2004).
13. *Non-removable zero Lyapunov exponents* (with A. Gorodetski, V. Kleptsyn, M. Nalski), Functional Analysis and Appl. **39** no. 1 (2005).
14. *Lectures on analytic differential equations* (with S. Yakovenko), book in preparation.

Paul Jung

VIGRE Assistant Professor of Mathematics

My research area is the subdiscipline of stochastic processes called interacting particle systems. In particular I am interested in the ergodic or long-run behavior of these processes. Many of these issues are motivated by problems arising in statistical mechanics. Recently, I am interested in the application of these processes to ecology and biology.

Selected Publications

Extremal reversible measures for the exclusion process, Journal of Statistical Physics (July 2003).

Perturbations of the symmetric exclusion process, Markov Processes and Related Fields **10** no. 4 (2004).

The critical value of the contact process with added and removed edges, J. Theoretical Probability (to appear).

The noisy voter-exclusion process, Stochastic Processes and Applications (to appear).

Two phase transitions for the contact process on small worlds, submitted for publication.

Peter J. Kahn

Professor of Mathematics

For the past few years, I have been working in the area of symplectic topology. My current interests include various existence and classification questions concerning symplectic forms on the total spaces of symplectic fibrations.

Selected Publications

Pseudohomology and homology (Nov. 2001), 35 pp.

Symplectic torus bundles and group extensions (updated Jan. 2005), 20 pp.

Automorphisms of the discrete Heisenberg group (Feb. 2005), 7 pp.

Martin Kassabov

H. C. Wang Assistant Professor of Mathematics

My research interests fall into two main categories: (1) representation theory of discrete groups, mainly Kazhdan property and property tau; (2) combinatorial algebra — applications of different combinatorial methods in abstract algebra.

The main part of my research is related to properties T and tau. These properties arise from the representation theory, and they have many applications in combinatorics.

Another part of my research can be broadly described as combinatorial algebra. My research interests are concentrated in the following topics: automorphism groups, Golod-Shafarevich groups, group rings.

Selected Publications

Kazhdan constants for $SL_n(Z)$, International Journal of Algebra and Computation (to appear).

Symmetric groups and expanders (announcement), Electronic Research Announcements of AMS (to appear).

Diameters of Cayley graphs of $SL_n(Z/kZ)$ (with Tim Riley), preprint January 2005.

Universal lattices and property Tau (with N. Nikolov), preprint February 2005.

Universal lattices and unbounded rank expanders, preprint February 2005.

Symmetric groups and expanders, preprint May 2005.

Todd Kemp

Escobar Assistant Professor of Mathematics

The arena of classical (and most modern) analysis and probability theory consists of function spaces — spaces of measurable functions, L^p functions, holomorphic functions, and so forth. Nevertheless, many theorems (particularly functional inequalities) dealing with classical function spaces can be stated in such a way that the functions themselves are no longer important.

One typical generalization of functional inequalities (motivated by quantum mechanics and quantum field theory) replaces functions with operators on Hilbert space. Some important examples include quantum (i.e., non-commutative) versions of entropy and Sobolev inequalities, as well as semigroup contraction theorems like hypercontractivity. I am primarily interested in non-commutative functional inequalities of these sorts.

In my Ph.D. thesis, I introduced a new family of non-commutative spaces that capture the essence of holomorphic L^p spaces, and I proved a Segal-Bargmann isomorphism theorem and strong hypercontractivity theorem for them. Currently, I am thinking about extending these results, and also about other contraction properties like ultracontractivity. A long-range goal is to prove a hypercontractivity theorem for (non-trivial) C^*-bundles over spin manifolds.

Selected Publications

Hypercontractivity in non-commutative holomorphic spaces, Commun. Math. Phys. (to appear).

Harry Kesten

Professor Emeritus of Mathematics

I am a probabilist. My main research interests are percolation theory and random walks, and in general I like to dabble in models inspired by statistical mechanics.

One model I have recently worked on can be viewed as a model for the spread of a rumor. There are two kinds of particles, A-particles (corresponding to the people in the know) and B-particles (people who have not heard the rumor). The A-particles perform independent (continuous time) random walks on $\mathbf{Z}^d$ with distribution F_A and similarly the B-particles perform independent random walks with distribution F_B. The only interaction between all the particles is that when a B-particle meets an A-particle it turns into an A-particle and continues forever as an A-particle. We start with independent Poisson numbers of B-particles at the sites of $\mathbf{Z}^d$ and a single A-particle at the origin. How fast does the set of A-particles grow with time? In other words, what is the set of people who heard the rumor by time t, for large t? It is expected that this set grows linearly with t, but so far results are known only if $F_A = F_B$, or if the B-particles do not move at all.

Selected Publications

Products of random matrices (with H. Furstenberg), Ann. Math. Statist. **31** (1960), 457–469.

Hitting Probabilities of Single Points for Processes with Stationary Independent Increments, Memoir **93**, AMS (1969).

Percolation Theory for Mathematicians, Birkhäuser, Boston, 1982.

Aspects of first-passage percolation; in Ecole d'été de Probabilités de Saint-Flour XIV, (P. L. Hennequin, ed.), Lecture Notes in Math 1180, Springer-Verlag, 1986, pp. 125–264.

On the speed of convergence in first-passage percolation, Ann. Appl. Probab. **3** (1993), 296–338.

Dexter Kozen

Joseph Newton Pew, Jr., Professor in Engineering (Computer Science)

My research interests include the theory of computational complexity, especially complexity of decision problems in logic and algebra, and program logic and semantics. In the past I have worked on algorithms for type inference in programming languages; static analysis of programs; functional decomposition of polynomials and rational and algebraic functions; and algorithms for resolution of singularities. My most recent interests include the theory and applications of Kleene algebra and Kleene algebra with tests (Kleene/Boolean algebra) in programming language semantics and verification.

Selected Publications

Substructural logic and partial correctness (with J. Tiuryn), Trans. Comput. Logic **4** no. 3 (2003), 355–378.

KAT-ML: An interactive theorem prover for Kleene algebra with tests (with Kamal Aboul-Hosn); in Proc. 4th Int. Workshop on the Implementation of Logics (B. Konev and R. Schmidt, eds,), University of Manchester, 2003, pp. 2–12.

Automata on guarded strings and applications, Matematica Contemporanea **24** (2003), 117–139.

Computational inductive definability, Annals of Pure and Applied Logic [Special issue: Provinces of logic determined, Essays in the memory of Alfred Tarski, Parts I, II and III (Z. Adamowicz, S. Artemov, D. Niwinski, E. Orlowska, A. Romanowska, J. Wolenski, eds.)] **126** no. 1-3 (2004), 139–148.

Some results in dynamic model theory, Science of Computer Programming [Special issue: Mathematics of Program Construction (E. Boiten and B. Moller, eds.)] **51** no. 1-2 (2004), 3–22.

Gregory F. Lawler

Professor of Mathematics

Most of my research is on random walk and Brownian motion, especially questions arising from statistical physics. A number of questions are inspired by a desire to understand self-avoiding random walk and other random walks with constraints.

Oded Schramm, Wendelin Werner, and I investigated the limit of lattice models in two dimensions that possess certain conformal invariance properties in the continuum limit. This project produced a number of results, e.g., we have verified a conjecture of Mandelbrot that the

Hausdorff dimension of the outer boundary of planar Brownian motion is 4/3.

The big challenge for the future for these problems is understanding three dimensions.

Selected Publications

Intersections of Random Walks, Birkhäuser-Boston, 1991.

Values of Brownian intersection exponents I and II (with O. Schramm and W. Werner), Acta Mathematica **187** (2001), 237–273, 275–308.

Conformal restriction: the chordal case (with O. Schramm and W. Werner), JAMS **16** (2003), 917–955.

Brownian loop soup (with W. Werner), Probab. Theor. Rel. Fields **128** (2004), 565–588.

Conformally Invariant Processes in the Plane, AMS, 2005.

G. Roger Livesay

Professor Emeritus of Mathematics

My major area of research is in topology, 3-dimensional manifolds with finite cyclic fundamental groups.

Alvaro Lozano-Robledo

H. C. Wang Assistant Professor of Mathematics

I study algebraic number theory, in particular p-adic Galois representations and their deformations, and connections with elliptic units and class number divisibility problems. I am also very interested in elliptic surfaces of high rank and constructing elliptic curves of high rank.

Selected Publications

On the surjectivity of Galois representations attached to elliptic curves over number fields, Acta Arithmetica **117** no. 3 (2005), 283–291.

On elliptic units and p-adic Galois representations attached to elliptic curves, J. Number Theory (to appear), 29 pp.

Constructing elliptic curves over Q(t) with moderate rank (with S. Arms and S. Miller), 11 pages, submitted.

Buscando puntos racionales en curvas elipticas: Metodos explicitos, La Gaceta de la Real Sociedad Matemática Española (in Spanish, to appear), 22 pp.

Alexander Meadows

VIGRE Assistant Professor of Mathematics

I am interested in geometric variational problems and nonlinear elliptic partial differential equations. I have been studying the equation $\Delta u = f(u)$, and more specifically the equation $\Delta u = 1/u$. The main focus has been on establishing the existence of continuous singular solutions that are pointwise limits of smooth solutions. Most of the results are consequences of stability for the corresponding variational problem.

Selected Publications

Stable and singular solutions of $\Delta u = 1/u$, Indiana Univ. Math. J. (to appear).

Tornado solutions for semilinear elliptic equations I: regularity theory, preprint.

Tornado solutions for semilinear elliptic equations II: applications (with F. Hammock, P. Luthy, and P. Whitman), in preparation.

Michael D. Morley

Professor Emeritus of Mathematics

Professor Morley's primary interest and contribution to the department lies in his devotion to the students. His skill, wisdom, commitment and sensitivity in advising is very well known throughout the Arts College. Comments about Michael Morley speak to his devotion: "[Mike Morley] is exactly the sort of advisor that Cornell needs..."; "...has a creative and total commitment to taking care of students..."; "...has been available to everyone's advisees who wander in unhappy." These comments speak eloquently of Prof. Michael D. Morley.

Professor Morley's primary research interests lie in the areas of advanced mathematical logic and model theory.

Camil Muscalu

Assistant Professor of Mathematics

My research interests include topics from classical analysis and partial differential equations. In recent years I have been studying boundedness properties of certain multilinear singular integrals and their Carleson maximal analogs.

Selected Publications

Multi-linear operators given by singular multipliers (with T. Tao and C. Thiele), JAMS **15** (2002), 469–496.

A discrete model for the bi-Carleson operator (with T. Tao and C. Thiele), GAFA **12** (2002), 1324–1364.

L^p estimates for the biest I. The Walsh case (with T. Tao and C. Thiele), Math. Ann. **329** (2004), 401–426.

L^p estimates for the biest II. The Fourier case (with T. Tao and C. Thiele), Math. Ann. **329** (2004), 427–461.

Bi-parameter paraproducts (with J. Pipher, T. Tao, and C. Thiele), Acta Math. **193** (2004), 269–296.

Anil Nerode

Goldwin Smith Professor of Mathematics

My principal research at present is in theorems and algorithms for extracting controls for hybrid systems using differential geometry and logic based controllers. Tools include the relaxed calculus of variations and connections on Finsler manifolds. I also continue work on other problems in logic, including computable model theory of nonstandard logics, foundations of logic programming, and multiple agent systems.

My professional activities include:

Chair, International Advisory Board, Clearsight Corp., Bellevue, Washington.

International Advisory Board, Computer Science, NTT, Japan.

International Advisory Board, Centre for Discrete Mathematics and Theoretical Computer Science, University of Auckland, New Zealand.

Chair, Steering Committee, Logical Foundations of Computer Science Symposium, 2007.

Program Committee, IEEE-MASS-2005 Security and Survivability Symposium.

Selected Publications

Automata Theory and Its Applications (with Bakhadyr Khoussainov), Birkhauser, 2001, 430 pp.

Control in hybrid systems (with W. Kohn, V. Brayman, and P. Cholewinski), Int. J. Hybrid Systems **3** (2003).

Control synthesis in hybrid systems with Finsler dynamics (with Wolf Kohn and Vladimir Brayman), Houston Journal of Mathematics **28** no. 2 (2003), 353–375.

Constructive Logics and Lambda Calculi (with G. Odifreddi), 500 pp., book in preparation.

Agent Control, Enterprise Models and Supply Chain Systems (with W. Kohn), book in preparation.

Michael Nussbaum

Professor of Mathematics

My research program focuses on developing a better theoretical understanding of the asymptotic theory of statistical experiments, in connection with statistical smoothing and curve estimation and nonparametric inference for stochastic processes. Current topics include Gaussian and Poisson approximation of nonparametric experiments in the Le Cam sense, constructive realization of equivalence, asymptotic risk bounds for density estimation and nonparametric regression, nonparametric models for point processes, diffusion processes and autoregression, functional limit theorems for empirical processes, statistical treatment of inverse and ill-posed problems.

Selected Publications

Asymptotic equivalence of density estimation and Gaussian white noise, Ann. Stat. **24** (1996), 2399–2430.

Asymptotic equivalence for nonparametric generalized linear models (with I. Grama), Probability Theory and Related Fields **111** (1998), 167–214.

Diffusion limits for nonparametric autoregression (with G. Milstein), Probability Theory and Related Fields **112** (1998), 167–214.

The asymptotic minimax constant for sup-norm loss in nonparametric density estimation (with A. Korostelev), Bernoulli **5** (6) (1999), 1099–1118.

Minimax risk: Pinsker bound; in Encyclopedia of Statistical Sciences, Vol. 3 (S. Kotz, ed.), John Wiley, New York, 1999, pp. 451–460.

Kasso Okoudjou

H. C. Wang Assistant Professor of Mathematics

My research interests lie in harmonic analysis, specifically in time-frequency analysis and wavelet theory. My work to date has focused on studying finer properties of functions, e.g., time-frequency concentration, smoothness and decay using the theory of frames, in particular Gabor and wavelet frames. I am also interested in studying (multilinear) pseudodifferential operators using mainly a time-frequency approach.

Recently I have been working on analysis on pcf self-similar fractals. More precisely, I am interested in extending some "classical" results of analysis on Euclidean spaces to this fractal setting using the analytic tools defined by Jun Kigami on pcf fractals.

Selected Publications

Gabor analysis in weighted amalgam spaces (with K. Grochenig and C. Heil), Sampling Theory in Signal and Image Processing **1** no. 3 (2002), 225–260.

Embeddings of some classical Banach spaces into modulation spaces, PAMS **132** no. 6 (2004), 1639–1647.

Bilinear pseudodifferential operators on modulation spaces (with A. Benyi), Journal of Fourier Analysis and Applications **10** no. 3 (2004), 301–313.

Modulation spaces and a class of bounded multilinear pseudodifferential operators (with A. Benyi, K. Grochenig and C. Heil), J. Operator Theory (to appear).

Weak uncertainty principles on fractals (with R. S. Strichartz), Journal of Fourier Analysis and Applications (to appear).

Alessandra Pantano

H. C. Wang Assistant Professor of Mathematics

I am interested in the study of the non-unitarity of a (spherical) principal series of a real group. When the group is split, the signature of a Hermitian form on the isotypic of a "petite" K-type can be computed by means of Weyl group calculations. The result is a non-unitarity test for a spherical principal series for split groups, which is especially effective if a lot of "petite" K-types are known. My research focuses on the construction of petite K-types.

Lawrence E. Payne

Professor Emeritus of Mathematics

My research interests lie in several areas of partial differential equations: isoperimetric inequalities, ill-posed and non-standard problems, growth decay and/or blowup of solutions, and applications to various problems in solid and fluid mechanics.

Selected Publications

Spatial decay bounds in time dependent pipe flow of an incompressible fluid (with C. H. Lin), SIAM J. Appl. Math. **65** (2004), 458–474.

Energy and pointwise bounds in some non-standard parabolic problems (with K. A. Ames and P. W. Schaefer), Proc. Roy. Soc. Edinburgh **134** (2004), 1–9.

Decay bounds for second-order parabolic problems and their derivatives II, Math. Ineq. and Appl. **7** (2004), 575–591.

Some nonstandard problems in viscous flows (with P. W. Schaefer and J. C. Song), Math. Meth. in Appl. Sci. **27** (2004), 2045–2053.

Spatial decay bounds for a class of quasilinear parabolic initial-boundary value problems (with G. A. Philippin), International J. Nonlinear Mech. **40** (2005), 295–305.

Irena Peeva

Associate Professor of Mathematics

My research is broad and at the interface between the fields of commutative algebra, algebraic geometry, and combinatorics. I have worked on problems involving free resolutions, toric varieties, Hilbert schemes, complete intersections, subspace arrangements, monomial resolutions, Gröbner basis, Koszul algebras, shellings, and Castelnuovo-Mumford regularity.

Some of my research interests are focused on the structure of free resolutions and their applications. I study resolutions over polynomial rings and their quotients. In essence constructing a resolution over a ring R consists of repeatedly solving systems of R-linear equations. From another point of view, resolutions provide a homological method for describing the structure of modules (the idea to associate a resolution to a module was introduced in Hilbert's famous 1890, 1893-papers).

Selected Publications

Complete intersection dimension (with L. Avramov and V. Gasharov), Publications Mathematiques IHES **86** (1997), 67–114.

Generic lattice ideals (with B. Sturmfels), J. American Mathematical Society **11** (1998), 363–373.

Deformations of codimension 2 toric varieties (with V. Gasharov), Compositio Mathematica **123** (2000), 225–241.

Finite regularity and Koszul algebras (with L. Avramov), American J. Math. **123** (2001), 275–281.

Toric Hilbert schemes (with M. Stillman), Duke Math. J. **111** (2002), 419–449.

Rodrigo Perez

H. C. Wang Assistant Professor of Mathematics

I am interested in combinatorial aspects of complex dynamics and their relationship with other areas; for instance, number theory and the theory of partitions, dynamics of polynomial automorphisms in $\mathbf{C}^2$ and geometric group theory.

The concept of "fractal group" has recently opened a vast new area of research by bringing algebraic methods to bear on the geometry of fractal sets. The iterated monodromy group $\mathrm{IMG}(f)$ of a rational map $f:\overline{\mathbf{C}}\to\overline{\mathbf{C}}$ with postcritically finite orbits is a finitely generated, infinitely presented group that seems to encode a lot of information about the structure of the corresponding Julia set. In joint work with Kai-Uwe Bux, we have established that $\mathrm{IMG}(z^2+i)$ is a group of subexponential growth. Currently, we are extending this proof to iterated monodromy groups of more general rational maps. We are also computing invariants of $\mathrm{IMG}(z^2+i)$ to better understand its fine structure. These include L-presentations, the spectrum of the Laplace operator on the Cayley graph and the associated Ihara zeta function.

As usual, the transfer of ideas between different areas brings the promise of new results. I expect to bring back techniques from geometric group theory into complex dynamics to study in detail the geometry of postcritically finite Julia sets.

Selected Publications

A new partition identity coming from complex dynamics (with G. E. Andrews), submitted.

Quadratic polynomials and combinatorics of the principal nest, submitted.

Geometry of Q-recurrent maps, submitted.

On the growth of iterated monodromy groups (with K.-U. Bux), in preparation.

A count of renormalizations in Multibrot sets (with A. Bridy), in preparation.

Philip Protter

Professor of Operations Research and Industrial Engineering

Recent interests include numerical methods for solving stochastic differential equations, filtration expansions and shrinkage, liquidity risk in finance theory, and credit risk in finance theory. All of these topics are related to stochastic calculus and stochastic differential equations, although they bring in techniques from weak convergence, Markov processes, Monte Carlo methods, data analysis, viscosity solutions in stochastic control theory, and the Malliavin calculus.

Selected Publications

Stochastic Integration and Differential Equations, Second Edition, Version 2.1, Springer-Verlag, 2004.

Liquidity risk and arbitrage pricing theory (with R. Jarrow, U. Çetin), Finance & Stochastics **8** (2004), 311–341.

Modeling credit risk with partial information (with U. Çetin, R. Jarrow, and Y. Yildirim), Annals of Applied Probability **14** (2004), 1167–1178.

The approximate Euler method for Levy driven stochastic differential equations (with J. Jacod, T. Kurtz, and S. Meleard), Annales of the Institut Henri Poincaré, special issue dedicated to P. A. Meyer (to appear).

A short history of stochastic integration and mathematical finance: the early years, 1880–1970 (with R. Jarrow); in The Herman Rubin Festschrift, IMS Lecture Notes **45**, 2004, pp. 75–91.

Ravi Ramakrishna

Associate Professor of Mathematics

My research is in Galois theory. This is the branch of mathematics concerned with symmetries of solutions of equations. There is an object that encodes all symmetries of solutions to all equations, the absolute Galois group of the rational numbers. I study this object and its relations with number theory. The study of these symmetries has gained an increasingly important role in number theory in recent years. In particular, Galois theory played an important role in the solution of Fermat's Last Theorem.

Selected Publications

Lifting Galois representations, Invent. Math. **138** no. 3 (1999), 537–562.

Infinitely ramified Galois representations, Ann. Math. (2) **151** no. 2 (2000), 793–815.

Deforming Galois representations and the conjectures of Serre and Fontaine-Mazur, Ann. Math. (2) **156** no. 1 (2002), 115–154.

Deformations of certain reducible Galois representations, J. Ramanujan Math. Soc. **17** no. 1 (2002), 51–63.

Finitenss of Selmer groups and deformation rings, Invent. Math. **154** (2003), 179–198.

Richard H. Rand

Professor of Theoretical & Applied Mechanics

My research involves using perturbation methods and bifurcation theory to obtain approximate solutions to differential equations arising from nonlinear dynamics problems in engineering and biology.

Current projects involve quasiperiodic forcing in Mathieu's equation, dynamics of coupled oscillators, and coexistence phenomenon in autoparametric excitation. Applications include NEMS (nano electrical mechanical systems), effects of biorhythms on retinal dynamics, cardiac arrhythmias, and ecology of plant communities. These projects are conducted jointly with graduate students and with experts in the respective application area.

Selected Publications

Lecture Notes on Nonlinear Vibrations, version 45, 2003.

Slow passage through resonance in Mathieu's equation (with L. Ng and M. O'Neil), Journal of Vibration and Control **9** (2003), 685–707.

Nonlinear dynamics of a system of coupled oscillators with essential stiffness nonlinearities (with A. F. Vakakis), International Journal of Nonlinear Mechanics **39** (2003), 1079–1091.

Dynamics of two van der Pol oscillators coupled via a bath (with E.Wirkus and H. Howland), International J. Solids and Structures **41** (2004), 2133–2143.

Perturbation solution for secondary bifurcation in the quadratically-damped Mathieu equation (with D. V. Ramani and W. L. Keith), International Journal of Nonlinear Mechanics **39** (2004), 491–502.

Etienne Rassart

H. C. Wang Assistant Professor of Mathematics

The interplay between combinatorics, the representation theory of complex semisimple Lie algebras, symplectic geometry and convex geometry has been a rich source of mathematical developments in recent years. Most of my recent work has been in using tools from all these areas to explore combinatorial invariants of the irreducible representations of the classical complex semisimple Lie algebras (types A, B, C, D), particularly the weight multiplicities and Clebsch-Gordan coefficients. For type A, these appear in the combinatorial theory of symmetric functions in the form of the Kostka numbers and the Littlewood-Richardson coeffcients respectively. Efficiently computing the weight multiplicities and Clebsch-Gordan coefficients has been a long-standing problem. A variety of formulas and methods exist for them, some of which are efficient for certain ranges of the parameters, but no single approach seems to provide a fast way of computing these combinatorial invariants. The need for efficient algorithms is motivated by the fact that these numbers appear in quantum physical computations. My current research project ties into all these areas of mathematics, using tools from combinatorics, convex geometry and symplectic geometry to study the behavior of the Kostka numbers and Littlewood-Richardson coefficients.

Selected Publications

Enumeration of symmetry classes of convex polyominoes in the square lattice (with P. Leroux and A. Robitaille), Adv. Appl. Math. **21** no. 3 (1998), 343–380.

Path counting and random matrix theory (with Ioana Dumitriu), Electronic J. Comb. **10** no. 1 (2003), R43.

A vector partition function for the multiplicities of $sl_k(C)$ (with S. Billey and V. Guillemin), J. Algebra **278** no. 1 (2004), 251–293.

Signature quantization and representations of compact Lie groups (with Victor Guillemin), Proc. Nat'l Acad. Sci. (USA) **101** (2004), 10884–10889.

A polynomiality property for Littlewood-Richardson coefficients, J. Comb. Theory, Series A **107** no. 2 (2004), 161–179.

James Renegar

Professor of Operations Research and Industrial Engineering

I am currently devoting the majority of my research efforts to devising new algorithms for linear programming, i.e., for solving systems of linear inequalities. Unlike the situation for linear equations, surprisingly basic problems remain unresolved for linear inequalities. For example, it is unknown whether there exists an algorithm that can solve a general system of linear inequalities using a number of arithmetic operations that is bounded polynomially in the number of variables and the number of inequalities in the system. By contrast, elementary Gaussian elimination (i.e., high-school mathematics) solves a system of n linear equations in n unknowns in roughly n^3 operations.

I am also interested in devising algorithms for more general problems involving hyperbolic polynomials. (A hyperbolic polynomial p is a real multivariate polynomial for which there exists a vector v such that all univariate polynomials obtained by restricting p to lines in the direction v have only real roots.) These polynomials have played an especially important role in optimization in recent years.

Timothy Riley

H. C. Wang Assistant Professor of Mathematics

I work on problems pertaining to the geometry, topology and asymptotics of finitely generated groups. My specific research topics include filling functions, isoperimetric problems, the word problem, asymptotic cones, the geometry of Cayley graphs, normal forms, combings, almost convexity, special linear groups, quasi-isometry invariants, nilpotent groups, finiteness conditions, and algorithmic complexity.

Selected Publications

Higher connectedness of asymptotic cones, Topology **42** (2003), 1289–1352.

Isoperimetric inequalities for nilpotent groups (with Steve Gersten and Derek Holt), GAFA **13** (2003), 795–814.

Some duality conjectures for finite graphs and their group theoretic consequences (with Steve Gersten) Proc. Edin. Math. Soc. (to appear).

Navigating in the Cayley graphs of $SL_N(Z)$ and $SL_N(F_p)$, Geometriae Dedicata (to appear).

Diameters of Cayley graphs of $SL_n(Z/kZ)$ (with Martin Kassabov), 2005.

Luke Rogers

H. C. Wang Assistant Professor of Mathematics

My research interests lie broadly in the area of harmonic analysis and geometric function theory, with a particular focus on Sobolev and quasiconformal mappings. In my graduate work I developed a degree-independent extension theorem for Sobolev spaces on locally uniform domains, a result that has its roots in earlier work of

Stein and of Jones on this problem. The approach I found may also have application to related function spaces such as the Besov spaces.

At present I am thinking about various problems in the theory of Sobolev spaces on general metric spaces, especially some related to the work of Kigami and of Strichartz in developing an analysis on post-critically finite fractals. I am also interested in several questions about quasiconformal mappings, particularly those related to characterizing quasiconformal and Sobolev removable sets.

Laurent Saloff-Coste

Professor of Mathematics

I am an analyst who enjoys touching on other areas including probability theory and geometric group theory. I study different aspects of heat diffusion on manifolds from the point of view of both partial differential equations and stochastic processes. I am mainly interested in those properties that relate to the large-scale geometry of the underlying space. For instance, I have recently been trying to understand how heat diffusion is affected by the existence of more than one end on a manifold. Potential theory and functional analysis often provide the framework and tools to study these properties.

I also work on random walks on groups. A random walk is a Markov process (g_n) on a group G where g_n is obtained from g_{n-1} by left multiplication by a random element of a fixed finite generating set of G. For instance, card-shuffling methods can be modelized as random walks on the symmetric group S_{52}. In this example, G is finite but G can be infinite. What interests me most in this subject is relating the behavior of random walks to the algebraic structure of the group and to the geometry of its Cayley graphs.

Random walks on finite groups are special examples of finite Markov chains. In the past 10 years, I have worked on quantitative estimates for ergodic finite Markov chains. Some of the most interesting examples of such chains are connected to combinatorial problems that are not tractable by deterministic algorithms but for which a reasonable stochastic algorithm exists. These stochastic algorithms often involve a finite Markov chain as one of the main building blocks. In this context, obtaining quantitative estimates is essential.

Selected Publications

Hitting probabilities for Brownian motion on Riemannian manifolds (with A. Grigor'yan), Journal de Mathématiques Pures et Appliquées **81** (2002), 115–142.

Aspects of Sobolev Type Inequalities, London Mathematical Society Lecture Notes **289**, Cambridge University Press, 2002.

On the sample paths of Brownian motions on compact infinite dimensional groups (with A. Bendikov), Annals of Probability **31** (2003), 1464–1493.

Random walks on finite rank solvable groups (with C. Pittet), Journal of the European Mathematical Society **5** (2003), 313–342.

Random walks on finite groups; in Probability on Discrete Structures, Encyclopaedia Math. Sci. **110** (H. Kesten, ed.), Springer, Berlin, 2004, pp. 263–346.

Alfred H. Schatz

Professor of Mathematics

My field of research is numerical analysis. I have been principally involved in the analysis and construction of finite element methods for the approximate solution of partial differential equations. In particular I have been investigating both the local behavior of such matters and another phenomena associated with them called superconvergence. Many physical problems have solutions that are smooth in some places and are nonsmooth (having singularities) in others. In the numerical solution of these problems, the singular part of the solution is not only difficult to approximate but often lowers the quality of (pollutes) the approximation even where the solution is nice. I have been involved in understanding this phenomena and finding a way to improve the approximations.

Another facet of the research is to find properties of the computed approximate solutions which, when taken into account, can be used to produce better approximations than one has before. These are so called superconvergent approximations and their importance resides in the fact that the original approximations are usually difficult to obtain but usually the new approximates may be orders of magnitude better and easily computed from them.

Selected Publications

Superconvergence in finite element methods and meshes which are locally symmetric with respect to a point (with I. Sloan and L. Wahlbin), SIAM J. Num. Anal. (to appear).

Interior maximum norm estimates for Ritz Galerkin methods, part II (with L. Wahlbin), Mathematics of Computation (to appear).

Some new error estimates for Ritz Galerkin methods with minimal regularity assumptions (with J. Wang), Mathematics of Computation (submitted).

Shankar Sen

Professor of Mathematics

Most of my research concerns invariants associated with representations of Galois groups of p-adic fields and algebraic number fields. These invariants, though of an arithmetic nature, are related to classical invariants arising in complex algebraic geometry; their study should shed light on geometric aspects of equations over number fields or p-adic fields. Recently, I have studied families of Galois representations depending analytically on p-adic parameters, and how the invariants for such families change with the parameters. Techniques from p-adic analytic function theory and functional analysis have proved useful in this connection.

Selected Publications

Lie algebras of Galois groups arising from Hodge-Tate modules, Annals of Math. (1973).

Integral representations associated with p-adic field extensions, Inventiones Math. (1988).

The analytic variation of p-adic Hodge structure, Annals of Math. (1988).

An infinite-dimensional Hodge-Tate theory, Bulletin Math. Soc. France (1992).

Galois cohomology and Galois representations, Inventiones Math. (1993).

Richard A. Shore

Professor of Mathematics

My major research interests have centered around analyzing the structures of relative complexity of computation of functions on the natural numbers. The primary measure of such complexity is given by Turing reducibility: f is easier to compute than g, if there is a (Turing) machine which can compute f if it is given access to the values of g. I have also worked with various other interesting measures of complexity that are defined by restricting the resources available primarily in terms of access to g. The general thrust of my work has been to show that these structures are as complicated as possible both algebraically and logically (in terms of the complexity of the decision problems for their theories). These results also allow one to differentiate among different notions of relative complexity in terms of the orderings they define.

Another major theme in my work has been the relationship between these notions of computational complexity and ones based on the difficulty of defining functions in arithmetic. Restricting the computational resources more directly in terms of time or space leads out of recursion theory and into complexity theory. Relaxing the restrictions by allowing various infinitary procedures leads instead into generalized recursion theory or set theory.

The methods developed in these investigations are also useful in determining the effective content of standard mathematical theorems (when can existence proofs be made effective) and the inherent difficulty of combinatorial theorems in proof theoretic terms. Recently, I have also been working on issues in effective model theory and algebra connected with the problem of how the computational properties of algebraic structures can vary with different (but always computable) presentations of the models.

Selected Publications

The degrees of unsolvability: the ordering of functions by relative computability; in Proceedings of the International Congress of Mathematicians (Warsaw) 1983, PWN-Polish Scientific Publishers, Warsaw 1984, Vol. 1, 337–346.

Logic for Applications (with A. Nerode), Texts and Monographs in Computer Science, Springer-Verlag, New York, 1993; second edition, Graduate Texts in Computer Science, Springer-Verlag, New York, 1997.

Definability in the recursively enumerable degrees (with A. Nies and T. Slaman), Bull. Symb. Logic **2** (1996), 392–404.

Defining the Turing jump (with T. Slaman), Math. Research Letters **6** (1999), 711–722.

Computable structures: presentations matter; In the Scope of Logic, Methodology and the Philosophy of Science, Vol. 1, International Congress of LMPS, Cracow, August 1999 (P. Gardenfors, J. Wolenski and K. Kijania-Placek, eds.), Synthese Library **315**, Kluwer Academic Publishers, Dordrecht, 2002, pp. 81–95.

Reyer Sjamaar

Associate Professor of Mathematics

I study actions of Lie groups on symplectic manifolds. This is an area of differential geometry related to algebraic geometry and mathematical physics. Some of my recent work concerns moment polytopes and leads to improved versions of certain eigenvalue inequalities in matrix analysis.

Selected Publications

Holomorphic slices, symplectic reduction and multiplicities of representations, Ann. Math. (2) **141** (1995), 87–129.

Singular reduction and quantization (with E. Meinrenken), Topology **38** (1998), 699–762.

Moment maps and Riemannian symmetric pairs (with L. O'Shea), Math. Ann. **317** no. 3 (2000), 415–457.
Projections of coadjoint orbits, moment polytopes and the Hilbert-Mumford criterion (with A. Berenstein), J. Amer. Math. Soc. **13** no. 2 (2000), 433–466.

John Smillie

Professor of Mathematics

My area of interest is dynamical systems. I have done work on polygonal billiards and dynamics of flows on Teichmüller space; analysis of algorithms; and diffeomorphisms of surfaces. I am currently working on complex dynamics in two dimensions.

Selected Publications

Ergodicity of billiard flows and quadratic differentials (with S. Kerckhoff and H. Masur), Ann. Math. **124** (1986), 293–311.
Polynomial diffeomorphisms of C^2 VI: connectivity of J (with E. Bedford), Ann. Math., **148** (1998), 695–735.
Polynomial diffeomorphisms of C^2 VII: hyperbolicity and external rays (with E. Bedford), Ann. Scient. Ec. Norm. Sup. **4** (32) (1999), 455–497.
The dynamics of billiard flows in rational polygons; in Encyclopedia of Mathematical Sciences, vol. 100 (edited by Yu. Sinai), Springer-Verlag, 1999.
Billiards on rational-angled triangles (with R. Kenyon), Comment. Math. Helv. **75** (2000), 65–108.
Dynamics in Two Complex Dimensions; in Proceedings of the International Congress of Mathematicians, Beijing 2002, Vol. III: Invited Lectures, Higher Education Press, Beijing 2002, pp. 373–382.
Real polynomial diffeomorphisms with maximal entropy: tangencies (with E. Bedford), Ann. Math. **160** (2004), 1–26.

Brian Smith

VIGRE Assistant Professor of Mathematics

I am primarily interested in asymptotically flat Riemannian 3-manifolds of non-negative scalar curvature, which are used in general relativity to construct asymptotically flat, maximal initial data for the Einstein equations. More specifically, I am currently studying the construction of metrics for such manifolds using a parabolic partial differential equation.

Selected Publications

On the connectedness of the space of initial data for the Einstein equations (with G. Weinstein), Electron. Res. Announc. Amer. Math. Soc. **6** (2000), 52–63.
Quasiconvex foliations and asymptotically flat metrics of non-negative scalar curvature (with G. Weinstein), Communications in Analysis and Geometry **12** no. 3 (2004) 511–551.
On the parabolic scalar curvature equation, in preparation.

Avery Solomon

Senior Lecturer of Mathematics

My position involves me in mathematics courses, mathematics education and outreach programs in several area schools. My position in the Cornell Teacher Education program in the Department of Education has involved me in supervising student teachers and co-teaching math/science methods courses.

In addition to these courses, I am the director of the Cornell/Schools Mathematics Resource Program (CSMRP). Through this program I organize and co-teach Saturday workshops and summer programs, consult with school districts, work with teachers directly to develop curriculum and programs, visit classrooms and occasionally teach classes in middle schools or high schools, and teach workshops in schools and at BOCES.

My current interests include the use of Sketchpad as an environment for learning geometry, the role of intuition in mathematical exploration, and integrating mathematics and philosophy in a humanist context. I am also the mathematics advisor to the Tibetan math/science for monks program, which is in the process of training 60 Tibetan monks in India to become future leaders in the dialogue between Western Science and Tibetan Buddhism.

Selected Publications

A fractal outline of a fractal course, AMTYS journal, 1989.
Proportions and levels of meaning in mathematics; in For the Learning of Mathematics, 1991.
What is a line?; in For the Learning of Mathematics, 1991.
Levels of knowledge, Parabola (submitted.
Geometric patterns in nature, in preparation.

Birgit E. Speh

Professor of Mathematics

I am interested in the representation theory of reductive Lie groups, the cohomology of arithmetic groups and automorphic forms. In last few years, most of my work was related to geometric and topological properties of locally symmetric spaces. Some of my work also involves the Arthur Selberg Trace Formula.

Selected Publications

Pseudo-Eisenstein forms and cohomology of arithmetic groups (with J. Rohlfs), Manuscripta Mathematica **106** (2001), 505–518.

Absolute convergence of the spectral side of the Arthur trace formula for GL(n) (with W. Mueller), GAFA (to appear).

Pseudo-Eisenstein forms and cohomology of arithemtic groups II (with J. Rohlfs), Proceedings of Conference in honor of Ragunathan (to appear).

Construction of some modular symbols (with T. N. Venkataramana), Math. Zeit. (submitted).

Michael E. Stillman

Professor of Mathematics

My main areas of interest are computational algebra and algebraic geometry, commutative algebra, and algebraic geometry. My original interest in computational methods was their application to problems in algebraic geometry. Since then, my work has proceeded in several related directions. I have studied the complexity of the algorithms (mainly Gröbner bases). I have been developing algorithms for computing in commutative algebra and algebraic geometry (e.g. computing with line bundles, computing Hilbert functions, free resolutions, sheaf cohomology, computing with Hilbert schemes). In the last few years, Peeva and I have been interested in Hilbert schemes: classical ones, toric Hilbert schemes, and parameter spaces over the exterior algebra.

A major part of my research has been the development, with Dan Grayson at University of Illinois at Urbana, of Macaulay 2, a computer algebra system for research in commutative algebra and algebraic geometry. This system has a large following worldwide, a book written about it, and has been in active development for almost ten years.

Recently, I have become interested in the application of computational algebraic geometry to problems in statistics and molecular biology. The joint paper with Garcia and Sturmfels studies ideals and projective varieties that arise naturally when studying Bayesian networks on discrete random variables.

Selected Publications

A criterion for detecting m-regularity (with D. Bayer), Invent. Math. **87** (1987), 1–11.

Computing sheaf cohomology on toric varieties (with D. Eisenbud and M. Mustata), J. Symbolic Computation **29** (2000), 583–600.

Computations in Algebraic Geometry with Macaulay 2 (D. Eisenbud, D. Grayson, M. Stillman, B. Sturmfels, eds.), Springer, 2001.

Toric Hilbert schemes (with I. Peeva), Duke Math. J. **111** (2002), 419–449.

Algebraic geometry of Bayesian networks (with L. Garcia and B. Sturmfels), preprint (2003), available at http://front.math.ucdavis.edu/math.AG/0301255

Robert S. Strichartz

Professor of Mathematics

My research interests cover a wide range of topics in analysis, including harmonic analysis, partial differential equations, analysis on Lie groups and manifolds, integral geometry, wavelets and fractals. My early work using methods of harmonic analysis to obtain fundamental estimates for linear wave equations has played an important role in recent developments in the theory of nonlinear wave equations. My work on fractals began with the study of self-similar measures and their Fourier transforms. More recently I have been concentrating on a theory of differential equations on fractals created by Jun Kigami. Much of this work has been done in collaboration with undergraduate students through a summer Research Experiences for Undergraduates (REU) program at Cornell that I direct. I wrote an expository article — *Analysis on fractals*, Notices of the AMS **46** (1999), 1199–1208 — explaining the basic ideas in this subject area and the connections with other areas of mathematics. An informal textbook I am writing on the subject will be published by Princeton University Press in 2006. In 2004 I discovered two examples of a convergence phenomenon for fractal analogs of Fourier series. (Ordinary Fourier series fail to converge in the expected way.) They are both related to the existence of infinitely many large gaps… something that does not appear to happen in smooth analysis. These are the first examples of theorems in fractal analysis that actually improve on the analogous theorems in smooth analysis. The proofs of the two results are unrelated. One of the results was inspired by experimental evidence gathered during the summer 2002 REU program.

Web sites created by students working with me may be found at www.mathlab.cornell.edu/reu/reu.html

Selected Publications

My web site, www.math.cornell.edu/~str, contains a complete list of my publications.

Steven H. Strogatz

Professor of Theoretical & Applied Mechanics

I have broad interests in applied mathematics. At the beginning of my career I was fascinated by mathematical biology and worked on a variety of problems, including the geometry of supercoiled DNA, the dynamics of the human sleep-wake cycle, the topology of three-dimensional chemical waves, and the collective behavior of biological oscillators, such as swarms of synchronously flashing fireflies.

In the 1990's, my work focused on nonlinear dynamics and chaos applied to physics, engineering, and biology. Several of these projects dealt with coupled oscillators, such as lasers, superconducting Josephson junctions, and crickets that chirp in unison. In each case, the research involved close collaborations with experimentalists.

I also love branching out into new areas, often with students taking the lead. In the past few years, this has led us into such topics as parametric resonance in microelectromechanical systems (MEMS); the nonlinear dynamics of HIV interacting with the immune system; and mathematical explorations of the small-world phenomenon in social networks (popularly known as "six degrees of separation"). Currently, we have been studying a wide variety of complex networks in both the natural and social sciences, using ideas from graph theory, statistical physics, and nonlinear dynamics.

Selected Publications

Sync: The Emerging Science of Spontaneous Order, Hyperion, 2003.

Exploring complex networks, Nature **410** (2001), 268–276.

Collective dynamics of 'small-world' networks (with D. J. Watts), Nature **393** (1998), 440–442.

Synchronization transitions in a disordered Josephson series array (with P. Colet and Wiesenfeld), Physical Review Letters **76** (1996), 404–407.

Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, Perseus Books, 1994.

Edward Swartz

Assistant Professor of Mathematics

My research centers on the interplay between combinatorics, geometry/topology and algebra with a special emphasis on matroids and f-vectors of simplicial complexes. Matroids are combinatorial abstractions of linear independence. Their enumerative properties have applications in a variety of fields, including graph coloring and flows, linear coding, arrangements of hyperplanes, and problems in reliability theory. My interest in matroids originally started with the discovery of a close connection between matroids and quotients of spheres by elementary abelian p-groups. More recently, I have used face rings to establish analogues of the g-theorem for simplicial polytopes for a variety of simplicial complexes.

Selected Publications

Matroids and quotients of spheres, Mathematische Zeitschrift **241** (2002), 247–269.

Topological representations of matroids, Journal of the Amer. Math. Soc. **16** (2003), 427–442.

g-elements of matroid complexes, J. Comb. Theory Ser. B **88** no. 2 (2003), 369–375.

Lower bounds for h-vectors of k – CM, independence and broken circuit complexes, SIAM Journal on Discrete Mathematics **18** no. 3 (2005), 647–661.

Moss E. Sweedler

Professor Emeritus of Mathematics

First I worked in the area of Hopf algebras and wrote *Hopf Algebras*, which came to be the standard reference book on the subject. H. Allen and I used Hopf algebras to prove a 25-year-old conjecture of Jacobson. Over the ensuing years until about the mid eighties, I worked and published in the areas of commutative algebra and algebraic geometry, real-algebraic geometry, homological algebra, algebraic groups, purely inseparable field extensions and general positive characteristic phenomena, simple algebras and generalizations of the Brauer group, and differential algebra. Since the mid eighties I have primarily worked in the area of computer algebra, especially computational commutative algebra. This has produced both theoretical and applied results with applications beyond mathematics, such as to error control codes and resulted in my position as Director of the Army Center of Excellence for computer algebra.

Selected Publications

Groups of simple algebras, Institut des Hautes Etudes Scientifiques **44** (1975), 79–189.

A new invariant for the complex numbers over the real numbers (with D. Haile and R. Larson), American Journal of Mathematics **105** (1983), 689–814.

Gröbner bases for linear recursion relations on m-D arrays and applications to decoding (with I. Rubio and C. Heegard), Proc. IEEE Int'l Symp. on Information Theory, June 29–July 4, 1997, Ulm, Germany.

Remarks on automatic algorithm stabilization (with K. Shirayanagi), invited contribution to (fourth) IMACS Conf. on Appl. of Computer Algebra (1998).

Ideal and subalgebra coefficients (with L. Robbiano), Proceedings of the AMS (1998), to appear.

Maria S. Terrell

Senior Lecturer of Mathematics and Director of Teaching Assistant Programs

My recent interests in geometry have included tensegrities and the history of geometrical optics and linear perspective. I am collaborating with a group of faculty and graduate students in an effort to improve undergraduate mathematics instruction through a project we call GoodQuestions. The project is developing materials to help instructors engage students in meaningful discussions about key concepts in calculus. At a recent MER (Mathematicians in Education Reform) workshop I presented a paper about my recent experience in the project. (The GoodQuestions web site is located at www.math.cornell.edu/~goodquestions/.)

Selected Publications

Kaleidoscopes and mechanisms (with R. Connelly and B. Hendrickson), Colloqui Mathematica Societatis Janos Boyai **63** (1991).

Behind the scenes of a random dot stereogram (with R. Terrell), Amer. Math. Monthly **101** no. 8 (1994), 715–724.

Globally rigid symmetric tensegrities (with R. Connelly), Structural Topology **21** (1995).

Asking good questions in the mathematics classroom, paper presented at AMS-MER Workshop on Excellence in Undergraduate Mathematics: Mathematics for Teachers and Mathematics for Teaching, Ithaca College, March 13–16, 2003.

Robert E. Terrell

Senior Lecturer of Mathematics

Most of my creative work has been in writing educational mathematics software. I have interactive ODE solvers, PDE solvers, IFS makers, a linear algebra program, and various other things available on my web page. These are directed primarily to undergraduates, and the purpose of them is to let the student learn by exploring.

Selected Publications

Behind the scenes of a random dot stereogram (with M. Terrell), Amer. Math. Monthly **101** no. 8 (1994), 715–724.

William Thurston

Professor of Mathematics

Bill Thurston is a topologist, though his work impinges on many other areas of mathematics. He has discovered unexpected links between topology, hyperbolic geometry, and complex analysis.

Highlights of his career include his classification of foliations of codimension greater than one, his classification of surface automorphisms, his hyperbolization theorem in three-dimensional topology, and the theories of automatic groups and confoliations. Thurston has also made fundamental contributions to the theory of symplectic and contact manifolds, dynamics of surface diffeomorphisms, and the combinatorics of rational maps.

His current research includes random 3-manifolds and relations of knot theory to computational complexity. His main interest remains his geometrization conjecture, a far-reaching proposed generalization of his hyperpolization theorem.

Selected Publications

Three-dimensional manifolds, Kleinian groups and hyperbolic geometry, Bull. AMS **6** (1982), 357–381.

Hyperbolic structures on 3-manifolds, I. Deformation of acylindrical manifolds, Ann. Math. **124** (1986), 203–246.

Word Processing in Groups (with D. B. A. Epstein, J. W. Cannon, D. F. Holt, S. V. F. Levy, and M. S. Paterson), Jones and Bartlet Publ., Boston, MA, 1992.

Three-Dimensional Geometry and Topology, Princeton Mathematical Series **35**, Princeton University Press, Princeton, NJ, 1997.

Confoliations (with Y. Eliashberg), AMS, Providence, RI, 1998.

Alexander Vladimirsky

Assistant Professor of Mathematics

My research is mostly focused on building fast methods for problems in which the direction of information flow can be used to speed up the computations. For example, numerical schemes for non-linear static PDEs often require solving coupled systems of non-linear discretized equations. For the first-order PDEs, partial knowledge of characteristic directions can be used to de-couple those systems: solving the discretized equations one at a time is much more efficient. My thesis was devoted to construction of Ordered Upwind Methods (OUMs) for the PDEs arising in the anisotropic exit-time optimal trajectory problems. These methods were later extended to a wider class of problems in anisotropic (and hybrid) control and in front propagation.

My current work (joint with John Guckenheimer) concerns fast methods for approximating invariant manifolds of vector fields. This problem is numerically challenging not only because of the complicated manifold-geometry but also because of the anisotropic behavior of the vector field on that manifold. In our approach, a (co-dimension one) invariant manifold is locally modeled as a graph of some function satisfying a particular quasi-linear PDE, which can be quickly solved using yet another version of OUMs. A recent extension allows treating manifolds of higher co-dimension by (locally) solving a system of quasi-linear PDEs.

Recently I became interested in the methods of dimensional reduction in the context of turbulent combustion simulations. This NSF-ITR sponsored project is led by S. Pope's group and collaborators in Mechanical Engineering, but also involves researchers from Computer Science (S. Vavasis, P. Chew), and Mathematics (J. Guckenheimer). Computing the chemical evolution of the full system is prohibitively expensive due to the stiffness of equations and high dimensionality. The idea is to efficiently compute and tabulate a lower-dimensional attracting invariant manifold, and to use database retrievals/interpolations to approximate the evolution of the reduced system (thus avoiding the expensive stiff time-integration).

Selected Publications

Fast methods for the Eikonal and related Hamilton-Jacobi equations on unstructured meshes (with J. A. Sethian), Proc. Natl. Acad. Sci. USA **97** no. 11 (2000), 5699–5703.

Ordered upwind methods for static Hamilton-Jacobi equations (with J. A. Sethian), Proc. Natl. Acad. Sci. USA **98** no. 20 (2001), 11069–11074.

Ordered upwind methods for static Hamilton-Jacobi equations: theory & applications (with J. A. Sethian), SIAM J. Num. Anal. **41** no. 1 (2003), 325–363.

A fast method for approximating invariant manifolds (with J. Guckenheimer), SIAM J. on Applied Dynamical Systems **3** no. 3 (2004) 232–260.

A survey of methods for computing (un)stable manifolds of vector fields (with M. Dellnitz, E. J. Doedel, J. Guckenheimer, M. E. Henderson, O. Junge, B. Krauskopf, and H. M. Osinga), Int. J. Bifurcation and Chaos **15** no. 3 (2005).

Static PDEs for time-dependent control problems, submitted.

Karen Vogtmann

Professor of Mathematics

A fundamental technique for studying a group G is to view G as a group of automorphisms of a geometric object X. Geometric and topological properties of X can then be used to study algebraic properties of G. Beautiful classical examples of this are the theory of arithmetic and S-arithmetic groups acting on homogeneous spaces and buildings, including work of Borel and Serre on cohomological properties of these classes of groups, and the theory of groups of surface homeomorphisms acting on the Teichmüller space of the surface. I am interested in developing geometric theories for other classes of groups. In particular, I have worked with orthogonal and symplectic groups, SL(2) of rings of imaginary quadratic integers, groups of automorphisms of free groups, and mapping class groups of surfaces. My main focus in recent years has been on the group of outer automorphisms of a free group, where the appropriate geometric object is called Outer space. This space turns out to have surprising connections with certain infinite-dimensional Lie algebras (discovered by Kontsevich) and also with the study of phylogenetic trees in biology.

Selected Publications

Moduli of graphs and automorphisms of free groups (with M. Culler), Inventionnes **84** (1986), 91–119.

Cerf theory for graphs (with A. Hatcher), J. London Math. Soc. **58** part 3 (1998), 633–655.

The symmetries of Outer space (with M. Bridson), Duke Math Journal **106** no. 2 (2001), 391–409.

Geometry of the space of phylogenetic trees (with L. J. Billera and S. Holmes), Advances in Applied Math **27** (2001), 733–767.

Infinitesimal operations on complexes of graphs (with J. Conant), Math. Ann. **327** (2003), 545–573.

Lars B. Wahlbin

Professor of Mathematics

At present one can compute "solutions" to very tough nonlinear, singular problems on, say, a supercomputer. Most often, numerical analysis does not furnish theorems that cover a practical situation, but it provides insight into the behavior of the relevant numerical method on carefully chosen model problems with, at best, some of the most pertinent difficulties of the real problem present.

My work in numerical analysis is aimed at gaining a fundamental understanding of numerical methods. Such insight is also necessary for constructing better algorithms. My particular interest is in methods for partial differential equations, and lately I have been studying the precise and detailed behavior of the finite-element methods in a variety of problems; the most interesting ones contain singularities of various degrees of nastiness.

Selected Publications

Local behavior in finite element methods; in Handbook of Numerical Analysis (P. G. Ciarlet and J. L. Lions, eds.), vol. II (part 1), North Holland, 1991, pp. 353–522.

Superconvergence in Galerkin Finite Element Methods, Springer Lecture Notes in Mathematics **1605**, Springer-Verlag New York, 1995.

James E. West

Professor of Mathematics

My research has focused on the topology and symmetries of manifolds of finite and infinite dimensions, and on the related topics of polyhedra, absolute neighborhood retracts, function spaces and spaces of sets.

An example of the interplay between these theories is that manifolds modeled on the Hilbert cube appear naturally in several ways as limits of stabilization processes for finite-dimensional objects, and, unlike standard function space stabilization, retain more of their important properties, e.g. simple homotopy type. Study of the Hilbert cube manifolds has produced several of the initial breakthroughs in introducing control into the homeomorphism theory of finite-dimensional manifolds. This in turn, has been useful in analyzing the failure of the classical matrix algebra to describe equivariant homeomorphisms and homotopy types of manifolds with locally linearizable transformation groups, which in turn has led to new results on the topological classification of linear representations of finite groups. I have been involved in these studies.

Selected Publications

Mapping Hilbert cube manifolds to ANR's, Ann. Math. **106** (1977), 1–18.

Equivariant h-cobordisms and finiteness obstructions (with M. Steinberger), Bull. AMS **12** (1985), 217–220.

Nonlinear similarity begins in dimension 6 (with S. Cappell, J. Shaneson, and M. Steinberger), Amer. J. Math. **111** (1989), 717–752.

Fibrations and Bundles with Hilbert Cube Manifold Fibers (with H. Torunczyk), Memoirs of the AMS **406**, 1989, iv + 75 pp.

Compact group actions that raise dimension to infinity (with A. N. Dranishnikov), Topology and its Applications **80** (1997), 101–114.

Kevin Wortman

H. C. Wang Assistant Professor of Mathematics

I study the large-scale geometry of discrete subgroups of semisimple Lie groups, and more generally, groups that act on nonpositively curved spaces. Most of my research to this point has focused on quasi-isometries and finiteness properties.

Selected Publications

Quasi-isometric rigidity of higher rank S-arithmetic lattices, preprint (Jan. 2004).

Quasiflats with holes in reductive groups, preprint (Jan. 2004).

Dan Zaffran

H. C. Wang Assistant Professor of Mathematics

Complex manifolds and holomorphic maps are the basic objects of study of “complex differential topology” (a close relative to “complex algebraic geometry”). Within this area, I'm especially interested in surfaces (i.e., compact complex manifolds of complex dimension two), Stein manifolds (see below), complex dynamical systems, singularities and foliations.

More details:

- The Kodaira-Enriques classification of surfaces is incomplete. An important aspect of this incompleteness concerns the surfaces “of class VII,” which are exactly the surfaces with first Betti number equal to one. Many such surfaces are known, but the existence of other examples is still an open problem. It is a remarkable (and recently discovered) fact that each Hénon mapping of $\mathbf{C}^2$ ($=\mathbf{C}\times\mathbf{C}$, where $\mathbf{C}$ is the field of complex numbers) is strongly related to a (uniquely determined) surface of class VII.

- Compared with the smooth category, the holomorphic category features several striking differences. For example, a compact complex manifold of positive dimension is never embeddable in $\mathbf{C}^n$. Stein manifolds are precisely those that admit an embedding in some $\mathbf{C}^n$. Being in some sense similar to smooth manifolds, they have attracted special attention. I'm working on the problem raised by J.-P. Serre of understanding the Steinness of any given fiber bundle with Stein fiber and Stein basis.

Selected Publications

Serre problem and Inoue-Hirzebruch surfaces, Math. Annalen **319** (2001).

Une caractérisation des surfaces d'Inoue-Hirzebruch (A characterization of Inoue-Hirzebruch surfaces) (with K. Oeljeklaus and M. Toma), Ann. Inst. Fourier **51**, fasc. 5 (2001).

Steinness of bundles with fiber a Reinhardt bounded domain (with K. Oeljeklaus), Bull. Soc. Math. Fr. (to appear).

Non-Kaehler manifolds and GIT-quotients (with S.Cupit), submitted.

Ode to Geometric Group Theory

by Marshall Cohen

We look not askance upon those days of innocence
When we knew groups, unclad and axiomatic,
As sets with a binary operation
From which mere logic and sometime cleverness
Might a fine and elegant fabric weave.
Nor begrudge we such simple joys
To those yet in that pristince state.

But who of us — having once been smitten
By the beauty of a well presented group
Or having been swept freely away by its cocompact action
By homeomorphisms or (gasp) isometries on a waiting space,
With all its cohomology hanging spectrally in the balance,
Or having seen its boundary on a starry night
Or having followed in its quasigeodesics to their very ends —
Who of us would return from this garden
To that ascetic plane from which we came?

Rather, we entreat the Uninitiate:
Come, come with us through the garden gate
That in unison we might tessellate
And together of that awesome Tree[†] of Knowledge taste.

[†]It is as yet unknown whether this is an R-tree or a Λ-tree for some other ordered group Λ.

The *Ode to Geometric Group Theory* will appear in the August/September issue of the American Mathematical Monthly. It can be viewed in its entirety at www.math.cornell.edu/News/AnnRep/poem.pdf