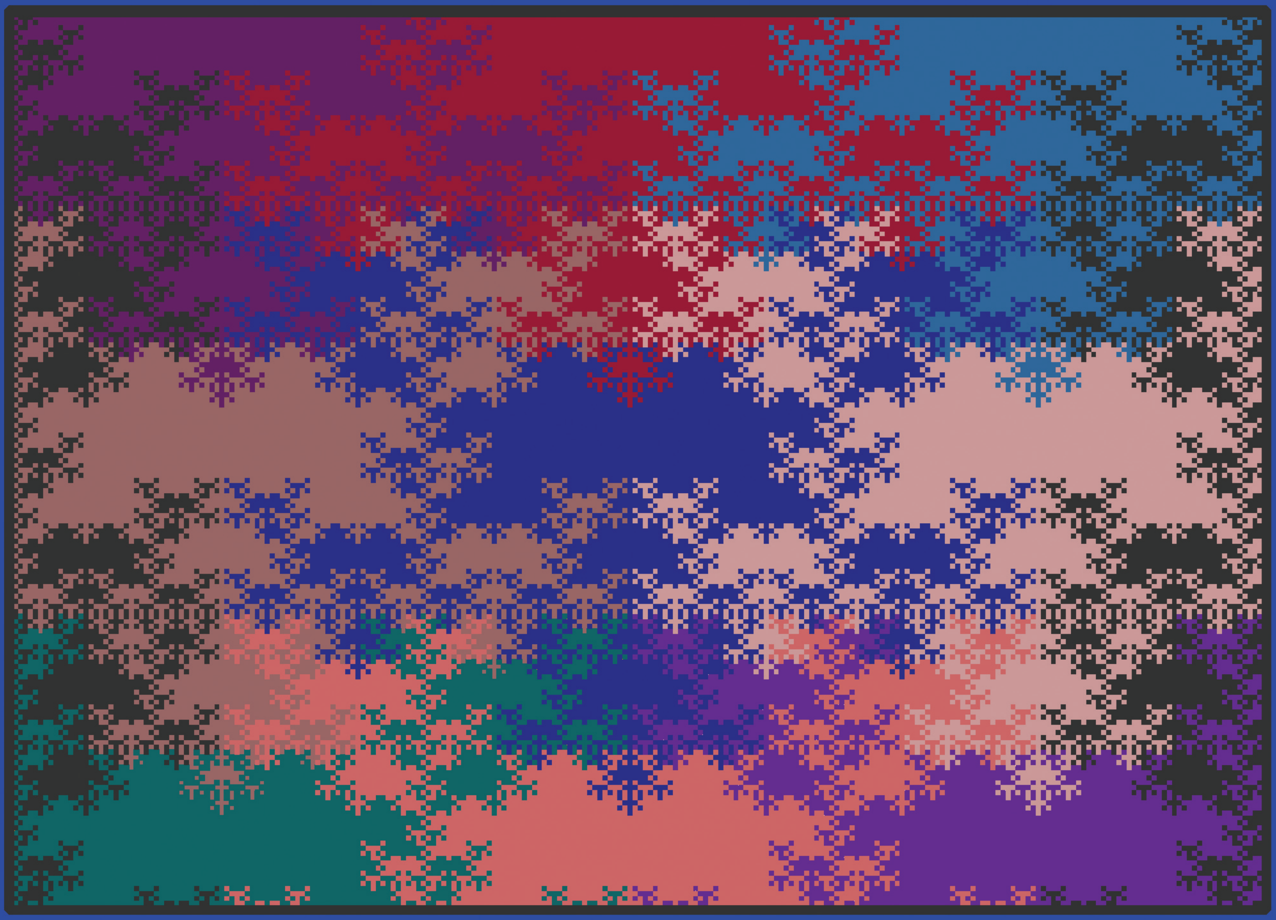
CORNELL

Department of Mathematics

Annual Report 2002–2003



The cover shows a portion of a tiling of the plane by self-similar tiles. The tiling is produced by translating a single tile by the standard square lattice. The tile is the invariant set for an iterated function system with 9 mappings. The tile is connected, but its interior is disconnected with infinitely many components, each component similar to one of 3 shapes. The boundary of the tile is a fractal. The outer boundary (those points that can be connected to infinity) is a fractal of smaller dimension, and can be described by a generalized iterated function system. Also, the boundaries of the components of the interior are described by a finite union of pieces of the outer boundary.

This image was generated by Shawn Drenning, a junior mathematics major and Cornell Presidential Research Scholar. Shawn has been working on a research project on self-similar tiles with Prof. Robert Strichartz, as well as Judy Palagallo and Thomas Price, who visited Cornell in fall 2002 from the University of Dayton. More information may be found at www.math.cornell.edu/~sld32/.

CORNELL UNIVERSITY
DEPARTMENT OF MATHEMATICS

ANNUAL REPORT 2002-2003

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 40 departments in the humanities, social sciences, and the physical and natural sciences. There are approximately 19,000 students at Cornell, of which 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. Birgit Speh
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
Phone: (607) 255-4013 Fax: (607) 255-7149 email: *math@math.cornell.edu*

Dear friends and colleagues,

As you browse through the following pages, I hope you will be as proud as I am of the accomplishments of the faculty and students in the Mathematics Department. We are carrying out our research, teaching, and service missions admirably. Our VIGRE program (p. 7) got a very favorable third-year review, and we received funding for years four and five.

Many people are responsible for our successes, but I would like to mention a few who have played particularly important roles: Rick Durrett (VIGRE coordinator), Peter Kahn (Chair of the Math Major Committee), Birgit Speh (Director of Undergraduate Studies), Mike Stillman (Director of Graduate Studies), Bob Strichartz (Director of the Research Experiences for Undergraduates Program), and Maria Terrell (Director of Teaching Assistant Programs). I would also like to call your attention to some of the awards and honors received by our faculty and students (p. 1).

Our ability to keep up the good work will depend on maintaining and renewing our most valuable resource — the faculty. My highest priority since becoming chair has been hiring and retention, and I am very pleased with the results achieved during the past year:

- Bill Thurston, who received the Fields Medal in 1982 for his work in geometry and topology, has joined our faculty. Thurston is the first Fields Medalist to ever hold a position at Cornell. He will have a joint appointment in the faculty of Computing and Information Science, thanks to Dean Bob Constable.

- Greg Lawler, a probabilist from Duke University who was hired to replace Harry Kesten, resigned from Duke and announced his intention to stay at Cornell.

- Ravi Ramakrishna, a young number theorist who has won awards for both his research and his teaching, was promoted to associate professor with tenure. One of the high points of the year for me was the phone call from Ravi saying that he had decided to return to Cornell after a semester at McGill University, where he also held a tenured position.

- We have hired two new tenure-track assistant professors, Camil Muscalu and Ed Swartz.

- Seven young mathematicians who have just received their Ph.D.s are joining the department in non-tenure-track positions, including two with NSF postdoctoral fellowships and three others coming in as VIGRE postdocs.

In spite of these successes, we desperately need to bring in more young faculty, especially at the tenure-track assistant professor or beginning associate professor level. Indeed, at this writing we have 33 full professors but only 2 associate professors and 4 tenure-track assistant professors. We are sitting on a demographic time bomb.

We can expect several retirements over the next five years, probably about one per year on average, and the future of the department depends on our ability to replace the retirees with first-rate young mathematicians. This will be quite a challenge in view of the budgetary pressures facing the college and the university, but I look forward to working with the dean's office and finding a way to make it happen.

Here are a few other projects that will occupy us in the coming year:

1. We will have our first external review in about 30 years. This involves a self-study in the fall, followed by a visit by a team of four eminent mathematicians in February 2004. This is a great opportunity for us to take stock and decide what we want our future to look like.

2. We will be gearing up to apply for new VIGRE-like grants. The VIGRE program has been subsumed under a new NSF program called EMSW21 (Enhancing the Mathematical Sciences Workforce in the 21st Century). This includes a broadened VIGRE program and two new components. As a starting point, Rick Durrett and Maria Terrell have been hard at work on a proposal for an expanded Math Explorers Club, called Project STEAM (STimulating Excitement About Mathematics).

3. We will continue the efforts, begun by my predecessor John Smillie, to strengthen Cornell's program in mathematics teacher education. We made some progress on that this year, but much remains to be done.

4. We will also continue to try to strengthen our ties with other departments and programs throughout the university. Mathematics is increasingly becoming a gateway to a variety of areas of science and engineering, and there will probably be many opportunities for interdisciplinary cooperation.

I would like to close on a personal note as I reflect on my first year as chair. I've been lucky enough to be part of this department for over 30 years. It's a good department, and I am grateful to have a chance to give something back by serving as chair. I thank my colleagues for giving me this opportunity, and I thank my excellent staff, under the direction of department manager Colette Walls, for their help and support. The college administration has been a pleasure to work with, especially Dean Phil Lewis and Senior Associate Dean Jonathan Culler. Phil and Jonathan have completed their terms, and I look forward to working in the same cooperative spirit with Interim Dean Peter Lepage and Senior Associate Dean Harry Shaw.

I offer thanks and best wishes to this year's retirees — Marshall Cohen, Michael Morley, and Beverly West. And I offer my condolences to the family of Oscar Rothaus. Oscar announced in the spring his intention to retire as of June 30, 2003, after 37 years of service to the department. We were all saddened when he died on May 24, before having a chance to enjoy his retirement.

Sincerely yours,
Ken Brown

Awards and Honors

Harry Kesten, **Gregory Lawler** and **John Smillie** gave invited addresses at the International Congress of Mathematicians in August 2002 in Beijing, China. The ICM is held once every four years and is attended by thousands of mathematicians from around the world.

Karen Vogtmann was elected vice president of the American Mathematical Society. Her term began on February 1 and will run three years, ending January 1, 2006. The AMS has three vice presidents who attend meetings of the Council of the AMS, serve on one of the five policy committees and support the president on special projects. Karen is currently serving on the Education Committee and helping to draft a proposal for instituting a program of Fellows of the AMS. Should the president become unable to serve, the Council appoints one of the three vice presidents to serve as president.

At the Joint Mathematics Meetings in Baltimore, Maryland in January 2003, **Michael Morley** was presented with the 2003 AMS Steele Prize, one of the highest distinctions in mathematics. The award was given in honor of Professor Morley's paper *Categoricity in Power* (Transactions of the AMS **114** (1965) 514–538), which set in motion an extensive development of pure model theory by proving the first deep theorem in this subject and introducing in the process completely new tools to analyze theories and their models. Past Cornell recipients of the Steele Prize are Lawrence Payne (1972), Eugene Dynkin (1993) and Harry Kesten (2001).

Former graduate student **John Meier** — who earned his Ph.D. in 1992 under the direction of Ken Brown — has been awarded a 2003–2004 Centennial Fellowship by the American Mathematical Society. Meier's research has touched on many areas in geometric group theory, with a heavy emphasis on the use of geometry in studying group cohomology. The Centennial Fellowship will allow him to spend the coming year visiting Columbia University and the University of California, Santa Barbara. Past Cornell recipients of a Centennial Fellowship are Richard Durrett (1984–1985) and Ravi Ramakrishna (2002–2003).

The Council of the University of Warwick presented **Eugene Dynkin** with the Honorary Degree of Doctor of Science at a Summer Degree Congregation on July 10th, when candidates from their Mathematics Department were presented their degrees.

Marshall Cohen, who retired this June after 35 years of distinguished service to Cornell and the Mathematics Department, is the proud recipient of a 2003 Kendall S. Carpenter Memorial Advising Award. Marshall has been an extraordinarily devoted advisor with a special interest in the advising of minority students. He is known throughout the university for this work and received the Arts & Sciences Dean's Award for Excellence in Advising (later called the Paul Award) the first year that it was given (in 1992). Stephen Ashley, a member of the Board of Trustees, established the Carpenter Award in February 2002 to honor his former advisor. Four individual awards of $5000 each are made annually.

One graduate student and three undergraduate mathematics majors were recognized with Cornell awards this year. **Samuel Hsiao**, who will receive his Ph.D. in August 2003, is the recipient of a $2,000 Liu Memorial Award from the Cornell Graduate School. (For more information, see Graduate Program, p. 21.) Graduating seniors **Salman Arif** and **Yousi Daniel Hue** were two of thirty-five Cornell students named *Cornell Merrill Presidential Scholars*. **Matthew Wachs**, a junior mathematics major, won the spring 2003 *Knight Prize in Writing in the Majors.* (For more information, see Undergraduate Program, p. 27.)

Department Prizes and Awards

Department Teaching Awards

Senior Faculty Award: Michael Stillman
Junior Faculty Award: Matthew Fickus
Graduate Student Award: Christopher Francisco

Graduate Student Awards

Battig Graduate Prize: Todd Kemp
Hutchinson Fellowships: Radu Haiduc
Fernando Schwartz
York Award: Christopher Hardin
Lynn Carter (Astronomy)

Harry S. Kieval Prize in Mathematics

Justin Conrad Sinz

Freshman Math Prize Exam

First prize (tied): Daniel Goldin, Anna Sonkina
Third Prize: Navin Sivakumar

Michael D. Morley Senior Prize in Mathematics

(formerly the Ithaca High School Senior Prize)
Peter Speh

Mathematics Department Directory 2002–2003

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

Professors Emeritus
James Bramble
Roger Farrell
Harry Kesten
G. Roger Livesay
Lawrence Payne
Alex Rosenberg
Moss Sweedler

Associate Professors
Reyer Sjamaar

Assistant Professors
Yuri Berest
Irena Peeva
Ravi Ramakrishna

H.C. Wang Assistant Professors
Kai-Uwe Bux
Indira Chatterji
Martin Dindos
Irina Mitrea
Rodrigo Perez
José Ramírez
Jason Schweinsberg
Harrison Tsai
Alexander Vladimirsky
Milen Yakimov
Dan Zaffran

VIGRE Assistant Professors
Tara Brendle
James Conant
Matthew Fickus
Anita Mareno
Alexander Meadows
Russell Miller
Brian Smith
Lawren Smithline
Edward Swartz

Senior Lecturers
Allen Back
Avery Solomon
Maria Terrell
Robert Terrell
Beverly West

Lecturer
Patricia Alessi

Senior Research Associate
Daina Taimina

Adjunct Professor
Graeme Bailey

Adjunct Assistant Professors
Vlada Limic
Warwick Tucker

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

Visiting Faculty
Alexander Bendikov
Károly Bezdek
Oleg Chalykh
Vesselin Gasharov
Patrick Iglesias
Bent Ørsted

Visiting Program Participants
Alan Demlow
Steve Seif
Homer White

Visiting Scholars
Anton Gorodetski
Judith Palagallo
Thomas Price
George Wilson
Sergei Yakovenko
Iljana Zähle

2002–2003 Faculty Leaves

Eugene Dynkin	sabbatical leave, spring 2003
Clifford Earle	sabbatical leave, academic year
Leonard Gross	sabbatical leave, fall 2002
John Guckenheimer	sabbatical leave, fall 2002
J. T. Gene Hwang	sabbatical leave, spring 2003
Michael Morley	sabbatical leave, fall 2002
Ravi Ramakrishna	leave, academic year
Laurent Saloff-Coste	sabbatical leave, spring 2003
Shankar Sen	sabbatical leave, fall 2002
John Smillie	sabbatical leave, fall 2002

Teaching Associates
Richard Furnas
Shawn Harahush

Graduate Students
Bryant Adams
Drew Armstrong
James Belk
David Benbennick
Christian Benes (nondegree)
Nathanael Berestycki (nondegree)
Janet Best
David Biddle
Jason Bode
Sylvain Bonnot (nondegree)
Kristin Camenga
Andrew Cameron
Edoardo Carta
Benjamin Chan
Nelia Charalambous
Dan Ciubotaru
Jean Cortissoz
Francoise Coudeyre (nondegree)
Nikolai Dimitrov
Farkhod Eshmatov
Bradley Forrest
Christopher Francisco
Yuval Gabay
Lee Gibson
Timothy Goldberg
Noam Greenberg
William Gryc
Pavel Gyrya
Radu Haiduc
Spencer Hamblen
Christopher Hardin
Heather Heston
Matthew Horak
Samuel Hsiao
Henri Johnston
Todd Kemp
Evgueni Klebanov
Sarah Koch
Michael Kozdron (nondegree)
JaEun Ku
Dmitriy Leykekhman
Hway Kiong Lim
Yi Lin
Fernando Marques
Jason Martin
Andrei Maxim
Jeffrey Mermin
Vadims Moldavskis
Antonio Montalban
Steven Morris
Radu Murgescu
Michael O'Connor
Melanie Pivarski
Roland Roeder
Franco Saliola
Everilis Santana-Vega
Hasanjan Sayit
Rebecca Schuller
Fernando Schwartz
Jay Schweig
Achilleas Sinefakopoulos
Steven Sinnott
Sergey Slavnov
Maria Sloughter
Aaron Solo
John Thacker
José Antonio Trujillo Ferreras
Mauricio Velasco
Brigitta Vermesi
Shawn Walker
Treven Wall
Russell Woodroofe
James Worthington
Yan Zeng
Yan Zhang
Harrison Huibin Zhou
Jessica Zuniga

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

Computer Consultants
Douglas Alfors
Allen Back
Robert Terrell

Instructional Computer Lab
Allen Back, director

Mathematics Support Center
Douglas Alfors, director
Richard Furnas

Mathematics Library Staff
Steven Rockey, librarian
Natalie Sheridan

Faculty, Staff and Graduate Student Changes for 2003-2004

A Memorial to Oscar Rothaus

The Mathematics Department mourns the passing of Professor Oscar Rothaus. Born November 10, 1927, he passed away on May 24, 2003.

Oscar was a deeply respected and strong presence in the Department. A highly distinguished mathematician, he was straightforward and unassuming, treating each person he met with kindness and respect. He served as chair of the Mathematics Department from 1973 to 1976 and as acting chair during fall 1995.

He received his Bachelor's degree at Princeton University in 1948 and his Master's degree there in 1950. After serving in the U.S. Army Signal Corps 1951–1953, during the Korean War, he went on to receive his Ph.D. from Princeton in 1958. He worked for the Institute for Defense Analysis (IDA) 1960–66. Serving as Deputy Director of its Communications Research Division 1963–66, he continued to contribute to classified projects throughout his life. He came to Cornell in 1966.

His primary (unclassified) research interests were in the theory of several complex variables, combinatorics and coding theory, Lie and Jordan algebras, Sobolev and Log-Sobolev inequalities, with a famous side trip to combinatorial group theory ("the Gerstenhaber-Rothaus theorem"). He was the author of about forty research papers. In his classified work he did fundamental research on cryptology, characterized by a top IDA official as follows: "His contributions were considerable. His lectures were elegant and memorable. He was one of the most important teachers of cryptology to mathematicians and mathematics to cryptologists." Oscar also made crucial contributions to the Hidden Markov Model, which was originally classified but is now very widely used in the open literature.

We will miss him.

Faculty Who Have Left Cornell

(Includes destination, if known)

James Conant	University of Tennessee
Anita Mareno	*unknown*
Russell Miller	Queens College, CUNY
José Ramírez	Universidad de Costa Rica
Harrison Tsai	Goldman, Sachs & Co.
Milen Yakimov	Univ. of California, Santa Barbara

Faculty Retirements

Marshall Cohen	June 30, 2003
Michael Morley	December 31, 2002
Beverly West	December 31, 2002

2002-2003 Ph.D. Recipients

(Includes location of first position; details on pp. 22–26)

Ryan Budney	University of Rochester
Alan Robert Demlow	Cornell University
Ferenc Gerlits	Alfred Renyi Institute
Leah Gold	Texas A&M University
G. Christopher Hruska	University of Chicago
Suzanne Lynch Hruska	SUNY at Stony Brook
Swapneel Mahajan	Free University of Brussels
Joseph Miller	Indiana University
David Revelle	Univ. of California, Berkeley

Faculty Promotions / Title Changes

Allen Back to senior lecturer, half-time (eff. 1/1/03)
Ravi Ramakrishna to associate professor

New Faculty and Graduate Students

(Includes Ph.D. institution for faculty and undergraduate institution for graduate students.)

Professor

William Thurston	University of California, Berkeley

Assistant Professors

Camil Muscalu	Brown University
Edward Swartz	Univ. of Maryland, College Park

H. C. Wang Assistant Professors

Nathan Broaddus	Columbia University
Barbara Csima	University of Chicago
Kasso Okoudjou	Georgia Institute of Technology
Kevin Wortman	University of Chicago

VIGRE Assistant Professors

Hsiao-Bing Cheng	Harvard University
Sarah Day	Georgia Institute of Technology
Paul Jung	Univ. of California, Los Angeles

Graduate Students

Nathanael Berestycki	Ecole Normale Superieure
Joshua Bowman	St. Olaf College
Liang Chen	Univ. of Wisconsin, Madison

Alimjon Eshmatov	National Univ. of Uzbekistan
Jennifer Fawcett	University of California, Davis
Chris Alan Lipa	North Carolina State University
Mia Minnes	Queen's University
Jonathan Needleman	Oberlin College
Matthew Noonan	Hampshire College
Anael Verdugo	California Inst. of Technology
Biao Wang	East China Normal University

2003-2004 Visiting Faculty

(Includes the faculty members' home institutions.)

Stephen Andrea	Universidad Simon Bolivar, Venezuela
Alexander Bendikov	Rostov-on-Don State University
Oleg Chalykh	Loughborough University, UK
Vesselin Gasharov	
Takashi Kumagai	Kyoto University, Japan
Gerhard Michler	Essen University, Germany
Piergiorgio Odifreddi	University of Turin, Italy
Victor Protsak	University of Minnesota
Lawren Smithline	
T. N. Venkataramana	Tata Institute of Fundamental Research, India

2003-2004 Visiting Program Faculty

(Includes the faculty members' home institutions.)

Mercedes Franco	
Stephen Hilbert	Ithaca College
Mark McClure	University of North Carolina
John Thurber	Eastern Oregon University

2003-2004 Faculty Leaves

Indira Chatterji	leave, fall 2003
Sarah Day	leave, academic year
R. Keith Dennis	administrative leave, fall 2003
Eugene Dynkin	sabbatical leave, fall 2003
José Escobar	sabbatical leave, academic year
Allen Hatcher	sabbatical leave, academic year
John Hubbard	sabbatical leave, academic year
Camil Muscalu	leave, academic year
Anil Nerode	administrative leave, fall 2003
Ravi Ramakrishna	leave, fall 2003
John Smillie	administrative leave, fall 2003
William Thurston	leave, fall 2003

Staff Changes

A number of issues or events affected the staff this year. These included adjusting to and supporting a new chair, losing a position and laying off an employee, reorganizing the workload to accommodate the elimination of one clerical position, and replacing a computer network administrator position within the department.

Layoff

Budgetary constraints confronted the college and university when the economy floundered after 9/11. During spring 2002, we were informed that we would have to eliminate a staff position at the end of June 2003. After careful consideration, we opted to lay off the staff member with the least seniority, Brenda Smith. Making such a decision based on seniority can be problematic; however, in this case it seemed the most equitable and reasonable alternative. Brenda received an official layoff notice on March 26, 2003, and her last working day was July 9, 2003. In no way did this decision reflect on Brenda's ability or performance. Brenda had been a well-liked and valued staff member in the department since July 2001. She will be missed.

Reorganization

In spring 2003, Brenda Smith, Cathy Stevens, Michelle Klinger, Arletta Havlik and Colette Walls worked together to develop a reorganization plan that would accommodate the reduction of one staff position. The majority of the job duties held by Brenda were distributed among Cathy Stevens, Michelle Klinger and Arletta Havlik. Linda Clasby (assistant to the chair), Gayle Lippincott (accounts representative), Donna Smith (graduate field coordinator) and Colette Walls (administrative manager) also picked up some additional job tasks. The reorganization committee functioned well, and the staff is committed to making the changes work.

Computer Support Position

In early May, Bob Terrell announced his intention to resign from the half-time computer network administrator position he has held since December 1997. Bob has been a hard-working and effective network administrator, and we were very sorry to accept his resignation. Fortunately, he remains in the department as a senior lecturer. After Bob announced his resignation, Allen Back stepped forward to declare his interest in applying for the position of network administrator. Allen was then transferred from his position as Director of the Mathematics Instructional Computer Lab to the network administrator position left vacant by Bob's departure. We conducted a search for Allen's replacement in the Math Lab and hired Todd Cullen, effective August 18, 2003.

Gifts and Endowments

As always, we appreciate the kindness and generosity of alumni and other friends of mathematics. During the 2002–2003 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.

2002-2003 Contributors

Jesse Alt
Barry Belkin
Paul Michael Cashman
Sean Cleary
Alan Cody
R. Keith Dennis
Michael Dupont
Jill Fisch
Joshua Goldberg
Andrew Joskow
John W. Klopp
Alison Klugherz-Kideckel
Lillian Lee
Martin Lesser
Charlotte Lin
Shirley McGrath
Jean Pierre Meyer
Michael Parker
Gerald Porter
Robert Prener
Ravi Ramakrishna
John Rosenthal
Michael Schumacher
David Wall
Harold Weber

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 **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.

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

The **Colloquium Endowment Fund** was instituted to invite distinguished scientists to speak at the Oliver Club seminars. 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 in December 1997 to honor a Cornell mathematics Ph.D. Founded by Battig's parents after his untimely death, the fund provides an annual prize to an outstanding continuing graduate student in mathematics at Cornell.

VIGRE

The 2002–2003 academic year was the third year of the Mathematics Department's NSF VIGRE grant, which provides $500,000 a year to support postdocs, graduate students, undergraduate research, and our outreach activities to high school students. This NSF funding is supplemented by generous matching funds from the College of Arts and Sciences and the Cornell Graduate School. The big event this year was the grant's third-year review, a process that began in the summer with the preparation of 18 single-spaced pages of data about the program and answers to eight essay questions designed to judge our effectiveness in addressing the goals of the VIGRE program. November brought to campus a three-person review team from the NSF, led by the new head of the VIGRE program, Richard Millman. Most of their time was devoted to closed-door meetings with Associate Dean Jonathan Culler and with groups of postdocs, graduate students, and undergraduates. At the end of the day, they reported that they were pleased with what they had seen, but we needed to supply a little more data and we would have to wait until all site visits were completed for an official reply. The good word finally came in February, but due to the delay in Congress in passing the budget, we had to wait until late March (and write another report!) before the NSF made an official award for the final two years.

VIGRE Postdocs

The first four years of our VIGRE grant have seen the arrival of eleven VIGRE postdocs and five NSF postdocs. Three new VIGRE postdocs — Tara Brendle (Columbia University), mentored by Karen Vogtmann; Alexander Meadows (Stanford University), mentored by José Escobar; and Brian Smith (University of Alabama, Birmingham), mentored by José Escobar — and an NSF postdoc — Rodrigo Perez (SUNY, Stony Brook), mentored by John Smillie — arrived in fall 2002.

In February, we recruited our target of three incoming postdocs for fall 2003 — Hsiao-Bing Cheng (Harvard University), to be mentored by José Escobar; Paul Jung (UCLA), to be mentored by Rick Durrett; and Sarah Day (Georgia Tech), to be mentored by John Guckenheimer. Sarah will be on leave for a year at Free University in the Netherlands. Two NSF postdocs will also join us in fall 2003 — Nathan Broaddus (Columbia University), to be mentored by Bill Thurston, and Kevin Wortman (University of Chicago), to be mentored by Karen Vogtmann.

VIGRE Graduate Fellows

The new baby boom generation arrived on campus in fall 2002. Our target was four VIGRE fellows but we ended up with seven — David Biddle (Binghamton University), Andrew Cameron (University of Virginia), Benjamin Chan (Rochester University), Heather Heston (Millersville University), Michael O'Connor (University of Massachusetts, Amherst), Jay Schweig (George Mason University), and Jessica Zuniga (Rice University). Recruiting for fall 2003 produced five new VIGRE graduate fellows. Four will be supported by our VIGRE grant — Joshua Bowman (St. Olaf College), Matt Noonan (Hampshire College), Chris Lipa (North Carolina State University), and Jonathan Needleman (Oberlin College). The fifth, Anael Verdugo (Caltech), will be supported by a two-year fellowship from the graduate school.

VIGRE Semesters

Continuing graduate students Spencer Hamblen, Dmitriy Leykekhman and Brigitta Vermesi benefited from the teaching relief provided by VIGRE semesters. Spencer used his free semester to make extended trips to Berkeley where Ravi Ramakrishna was enjoying his AMS Centennial Fellowship. Working with Lars Wahlbin, Dmitriy finished up his Master's in computer science and took several 700-level courses. Working with Greg Lawler, Brigitta started an article about the multi-fractal structure of Brownian motion and began to formulate the plans for her thesis in anticipation of her A exam.

VIGRE Interdisciplinary Colloquium

In fall 2002 the Interdisciplinary Colloquium focused on the interface between mathematics and molecular biology, featuring molecular biology and genetics.

Eric Siggia, Center for Studies in Physics and Biology, Rockefeller University: *The bioinformatics of gene regulation*

Andrew Clark, Molecular Biology and Genetics, Cornell University: *An overview of some problems in mathematical population genetics*

David Shalloway, Molecular Biology and Genetics, Cornell University: *Hierarchical global minimization on protein potential energy landscapes*

Chip Aquadro, Molecular Biology and Genetics, Cornell University: *Finding function in genomes: insights from an evolutionary perspective*

The genetics theme continued in spring 2003:

Carlos Bustamante, Biological Statistics and Computational Biology, Cornell University: *The evolutionary consequences of amino acid variation: results from weeds, humans and flies*

Kevin Brown, Veterinary Medicine, Cornell University: *How many parameters does it take to fit an elephant? Signal transduction, statistical mechanics and sloppy models*

Elizabeth Housworth, Mathematics, Indiana University: *Modeling recombination*

Michael Macy, Sociology, Cornell University: *Culture wars and dynamic networks: a Hopfield model of emergent structure*

Lawren Smithline, Mathematics, Cornell University: *Ideas on global alignments of biological sequences*

Undergraduate Research

VIGRE funds allow two Cornell students to participate in the Research Experience for Undergraduates program each year, under the direction of Robert Strichartz. VIGRE also provides additional financial support for the faculty members who direct the projects, for visitors who work with the program, and for three graduate students to work with the project. (See p. 28.)

Several Cornell undergraduates receive VIGRE awards of $1,000 to do summer research with faculty members. In most cases, these efforts are preliminary work for a senior thesis to be completed during the following academic year. Brian Cooper studied knot theory with Allen Hatcher. Oded Yacobi learned simplicial homology under Ed Swartz's guidance. Joey Palin worked with Konstantin Rybnikov on an open problem concerning polytopes. Finally, Paul Young explored algorithms for constructing groups with Keith Dennis. This led to the final solution of a problem in finite group theory posed in 1974 concerning Scharlau invariants.

Outreach Activities

VIGRE funds contribute significantly to the department's outreach activities in the form of the Math Explorers Club (p. 41) and the Ithaca High School Senior Seminar (p. 41).

Faculty Research and Professional Activities

Department-sponsored research expenditures for the fiscal year 2002–2003 totaled $2,350,170. This included 40 grants and contracts from federal, state and private agencies awarded to 33 faculty members. Faculty submitted 27 new grant proposals, 12 of which (shown below) have been funded to date by the National Science Foundation.

P.I.	Amount	Duration	Title of Grant
James Conant	$64,532	7/1/03–6/30/06	Invariants in Low Dimensional Topology
Richard Durrett*	$2,160,730	9/1/03–5/31/08	Graduate and Postdoctoral Training in Probability Theory and Its Applications
*Co-PIs: Gregory Lawler, Laurent Saloff-Coste, Philip Protter, Sidney Resnick and Gennady Samorodnitsky			
José Escobar	$320,397	7/1/03–6/30/06	Nonlinear Analysis in Riemannian Geometry
Leonard Gross	$53,964	5/1/03–4/30/06	Dirichlet Forms over Holomorphic Function Spaces
Peter Kahn	$66,982	5/1/03–4/30/06	The Cornell Topology Festival
Irina Mitrea	$80,793	7/1/03–6/30/06	Mellin Transform and Global Optimization Techniques for Partial Differential Equators
Michael Nussbaum	$373,735	6/1/03–5/31/08	Asymptotic Equivalence of Statistical Experiments
John Smillie	$180,529	6/1/03–5/31/06	Dynamics in Two Complex Variables
Birgit Speh & Dan Barbasch	$671,145	7/1/03–6/30/08	Representation Theory and Automorphic Forms
Michael Stillman	$589,010	7/1/03–6/30/08	Collaborative Research: A Software System for Algebraic Geometry Research
Edward Swartz	$70,733	7/1/03–6/30/06	Enumerative and Topological Properties of Matroids
Maria Terrell & Robert Connelly	$74,996	12/1/02–11/30/03	Improving Calculus: Developing Concepts through Good Questions

NSF/NIGMS Grant

In summer 2002, Rick Durrett, Chip Aquadro (Molecular Biology and Genetics) and Rasmus Nielsen (Biological Statistics and Computational Biology) were awarded a five-year grant under a new program jointly administered by the National Science Foundation and the National Institute of General Medical Sciences. The two major research directions of that grant are to develop mathematical results and statistical techniques to understand the causes of observed DNA sequence patterns, and to study the evolution of genomes due to large scale processes: inversions within chromosomes, translocations between chromosomes, chromosome fission and fusion, and gene duplication.

In addition to a month of summer salary for each investigator, the grant provides course relief for Durrett, supports three graduate students, a programmer, and a postdoc. Working with Chip Aquadro, Floyd Reed is investigating the consequences of background selection (removal of deleterious mutations) as one explanation for the observed genome wide positive correlation between recombination rates and DNA sequence variability. Working with Rasmus Nielsen, Wendy Wong is developing methods for detecting positive selection in non-coding regions of DNA, where binding sites for proteins that regulate the expression of genes lie.

Programmer Tom York works with Rasmus Nielsen and Rick Durrett to develop Monte Carlo Markov chain methods to study genome rearrangements and to test hypotheses concerning underlying mechanisms. Nathanael Berestycki, a graduate student from Paris who is also enrolled in the Ph.D. program at Cornell, worked this year with Rick Durrett on a mathematical problem that arose from simulation results of Bourque and Pevzner on the inversion distance between two chromosomes. This question led naturally to a problem about the effect of random transposition on permutations, which made an unexpected connection with random graphs.

Lawren Smithline will be supported over the summer and partially during the 2003–2004 academic year as a postdoc on the grant. He will use his expertise on algorithms for DNA sequence comparison to build comparative maps between regions of the mouse and human genomes, which will be used to study the sizes of track lengths that are involved in chromosomal inversions. This project builds on a project done in the spring semester by undergraduate mathematics major David Russell.

Kinematic Models for Design Digital Library (K-MODDL)

K-MODDL is an NSF-funded project involving a collaboration between the Cornell University Libraries, the Department of Mechanical Engineering, and from the Department of Mathematics, Professor David Henderson and Senior Research Associate Daina Taimina.

K-MODDL will document a beautiful and historically significant artifact collection. Just as importantly, the project will virtually restore the objects to their intended classroom use as teaching models of geometric and kinematic principles. Cornell librarians and professors are working with secondary school teachers to design educational materials that deploy the collection in middle and high school math instruction and in university-level courses in mathematics and engineering.

K-MODDL will be a freely accessible, web-based resource. The collection will be incorporated into the NSF-funded National Science Digital Library (NSDL), whose goal is to bring together in one place access to all quality information and learning resources pertaining to science, technology, engineering and mathematics for all age levels. The NSDL will offer services such as annotations, which will allow users to review and comment on items in the NSDL, including the K-MODDL collection.

K-MODDL will incorporate:

- Still and navigable moving images of kinematic mechanisms, with systematic descriptions, beginning with Cornell's Reuleaux collection;
- Historical and contemporary documents related to the history and theory of machines and mechanisms;
- Computer simulations of mathematical relationships associated with the mechanisms' movements; and
- Sample teaching modules that employ the models, simulations and other materials in the classroom at the undergraduate, high school, and middle school levels.

The K-MODDL project combines the efforts of librarians and educators and expands the library's traditional role by linking textual holdings with an important artifact collection. The project team envisions K-MODDL as a significant step toward the conservation — in physical and virtual form — of a whole array of scientific artifacts held by Cornell. Henderson and Taimina will be unpacking and writing about the mathematics inherent in the mechanisms, writing teaching modules for schools and undergraduates, and exploring the history of the mechanisms and the related mathematics. The project web site at kmoddl.library.cornell.edu currently contains a small preview that will grow over the next year.

Faculty Editorships

Dan Barbasch, editor of *Proceedings of the AMS*

Yuri Berest, editor of the *Journal of Nonlinear Mathematical Physics*

Louis Billera, editorial board of *Discrete and Computational Geometry* and *Journal of Algebraic Combinatorics*

Robert Connelly, editor of *Contributions to Algebra and Geometry*

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

Eugene Dynkin, editor of *Mathematics in Operations Research* and *Probability Theory and its Applications*

Clifford Earle, editor of the book *Complex Manifolds and Hyperbolic Geometry*

José Escobar, editorial boards of *Revista Colombiana de Matematicas*, *Electronic Journal of Differential Equations* and *Innovacion y Ciencia*

Leonard Gross, 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 *Journal of Experimental Mathematics*, *SIAM Journal of Applied Dynamical Systems*, *Moscow Mathematical Journal* and *International Journal of Bifurcation and Chaos*; managing editor of *DSWeb*

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

Gregory Lawler, associate editor of *Combinatorics, Probability and Computing* and *Mathematics Survey*, a new online archive

Anil Nerode, editorial boards of *Pure and Applied Algebra*, *International Journal of Hybrid Systems*, *Mathematics & AI*, *Documenta Mathematica* and *Math & Computer Modeling*

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

Laurent Saloff-Coste, editor of *Mathematische Zeitschrift*; associate editor of *Stochastic Processes and their Applications*, *ESAIM: Probability and Statistics*, *Journal of Theoretical Probability* and *Annales de la faculté des sciences de Toulouse*

Shankar Sen, editor of *Journal of the Ramanujan Mathematical Society*

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

Birgit Speh, editor of the *New York Journal of Mathematics* and *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, editorial board, *Fundamenta Mathematicae*

2002-2003 Faculty Publications

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Lars Wahlbin, *Asymptotically exact a posteriori estimators for the pointwise gradient error on each element in irregular meshes, Part II: The piecewise linear case,* Mathematics of Computation, to appear.

James West, 2-d encyclopedia article *Topological characterizations*, Kluwer Encyclopedia of General Topology, to appear.

Teaching Program

During the 2002–2003 academic year, the Mathematics Department offered 121 courses in 214 lectures and 165 recitations to 5,733 students, generating 22,463 credit hours. (See pp. 16–17.) While students were drawn from every college at Cornell, the majority came from the College of Agriculture & Life Sciences (14%), Arts & Sciences (32%), Engineering (41%) and the Graduate School (10%).

The Department of Theoretical & Applied Mechanics supported instructors for 12 lectures and provided 8 full-time teaching assistants for the engineering calculus sequence. The remaining 202 lectures, plus a freshman writing seminar (MATH 189), 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 2002–2003 by teaching lectures of engineering calculus: K. Bingham Cady (T&AM), T. Michael Duncan (Chem. Eng.), Chung-Yuen Hui (T&AM), James Jenkins (T&AM), Subrata Mukherjee (T&AM), Phoebus Rosakis (T&AM), Steven Strogatz (T&AM) and Z. Jane Wang (T&AM). 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 3,706 credits for 2002–2003.

The 2002–2003 teaching program was supported by 91 teaching assistants and associates, who served as TA instructors for 32 lectures of MATH 111 and 112, as recitation TAs for our freshman- and sophomore-level courses and as graders for our upper-level undergraduate and first-year graduate courses. In addition to the 8 full-time TAs supported by T&AM, the department benefited from 2 full-time TAs supported by the Center for Applied Mathematics (CAM) and 1 full-time TA supported by the Knight Writing Program for our Writing-in-the-Major (WIM) courses. The majority of our TAs are mathematics graduate students, but in 2002–2003 10 students were from T&AM, 9 from CAM, 5 from Statistics, 2 from Education, 1 from Applied & Engineering Physics, 1 from Chemical Engineering, 1 from Computer Science and 1 from Landscape Architecture.

During summer session 2002, the Mathematics Department offered 12 courses to 223 students, generating 828 credit hours. (Enrollments and credit hours are displayed in the table below.)

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. Alan Demlow (Ph.D. 2003, Cornell University), Steve Seif (University of Louisville, Kentucky) and Homer White (Georgetown College, Kentucky) participated in this year's visiting program. We appreciate their efforts.

Teaching Awards

Recipients of three new Department Teaching Awards were announced at the department's annual holiday party. The *Teaching Recognition Award* was given to Michael Stillman for his dedication and enthusiastic teaching at all levels of the Engineering Mathematics sequence — in small sections, in large lectures and as an active member of the Mathematics/Engineering Liaison Committee. The *Junior Faculty Teaching Award* was given to Matthew Fickus in recognition of the high quality of his teaching to both engineering students and
(Continued on page 18)

Summer Session 2002 Course Enrollment Statistics

Course and Title		Format	Instructor	Enroll	Cr Hrs	Session
103	Mathematical Explorations	Lecture	M. Terrell	8	24	3-week
103	Mathematical Explorations	Lecture	Barr	15	45	6-week
109	Precalculus Mathematics	Lecture	Alessi, Cochell, C. Johnson	41	123	6-week
111	Calculus I	Lecture	Alfors, D. Brown	17	68	6-week
112	Calculus II	Lecture	Kemp	7	28	6-week
171	Statistical Theory and Applications	Lecture	Back	26	104	6-week
191	Calculus For Engineers	Lecture	Turner	15	60	6-week
192	Calculus For Engineers	Lecture	R. Terrell	13	52	6-week
293	Engineering Mathematics	Lecture	Pfaff	22	88	8-week
294	Engineering Mathematics	Lecture	DeSilva, Rosenzweig	33	132	8-week
332	Algebra and Number Theory	Lecture	Bajnok	15	60	6-week
336	Applicable Algebra	Lecture	Cochell	11	44	6-week

Academic Year Course Enrollment Statistics

Course and Title		Format	Instructor	Enroll	Cr Hrs	Term
103	Mathematical Explorations	Lecture	B. West, H. White	55	165	Fall 2002
103	Mathematical Explorations	Lecture	Seif, Solomon, J. West	72	216	Spring 2003
105	Finite Math For the Life and Social Sciences	Lec/Sec	Saloff-Coste	100	300	Fall 2002
106	Calculus For The Life and Social Sciences	Lec/Sec	Sjamaar	165	495	Spring 2003
111	Calculus I	Lecture	Bezdek, Demlow, Seif, Strichartz (Czar)	371	1,484	Fall 2002
111	Calculus I	Lecture	M. Terrell (Czar)	105	420	Spring 2003
112	Calculus II	Lecture	Cohen (Czar)	151	604	Fall 2002
112	Calculus II	Lecture	Demlow, Vogtmann (Czar)	180	720	Spring 2003
121	Honors Calculus	Lec/Sec	Henderson	16	64	Fall 2002
122	Honors Calculus	Lec/Sec	Lawler, Smithline	43	172	Fall 2002
122	Honors Calculus	Lec/Sec	Bezdek	13	52	Spring 2003
171	Statistical Theory and Applications	Lec/Sec	Bendikov, Hwang, Nussbaum	85	340	Fall 2002
171	Statistical Theory and Applications	Lec/Sec	Bendikov, Nussbaum, H. White	108	432	Spring 2003
189	FWS: To Infinity and Beyond	Seminar	Goel (CAM)	16	48	Spring 2003
190	Calculus For Engineers	Lec/Sec	Schatz	31	124	Fall 2002
191	Calculus For Engineers	Lec/Sec	Connelly (Czar), Escobar, Mareno, Rosakis (T&AM)*	306	1,224	Fall 2002
191	Calculus For Engineers	Lec/Sec	Schatz	12	36	Spring 2003
192	Calculus For Engineers	Lec/Sec	Brendle, Cady (T&AM)*, Chatterji, Conant, Duncan (ChemE), Gasharov, Meadows, Mitrea, Mukherjee (T&AM)*, Peeva, Strogatz (T&AM)*	428	1,712	Fall 2002
192	Calculus For Engineers	Lec/Sec	Gasharov, B. Smith	312	1,248	Spring 2003
213	Calculus III	Lec/Sec	Ramírez	17	68	Fall 2002
213	Calculus III	Lec/Sec	Yakimov	29	116	Spring 2003
221	Linear Algebra and Differential Equations	Lec/Sec	Nerode, Ramírez, Swartz	124	496	Fall 2002
221	Linear Algebra and Differential Equations	Lec/Sec	Dindos, Gasharov, Smillie, Yakimov	91	364	Spring 2003
222	Multivariable Calculus	Lec/Sec	Back, Chalykh	43	172	Fall 2002
222	Multivariable Calculus	Lec/Sec	Back, Bux, Chalykh, Meadows, Zaffran	76	304	Spring 2003
223	Theoretical Linear Algebra and Calculus	Lec/Sec	Ørsted, Tsai	23	92	Fall 2002
224	Theoretical Linear Algebra and Calculus	Lec/Sec	Hubbard	16	64	Spring 2003
231	Linear Algebra	Lecture	Berest	18	54	Spring 2003
281	Deductive Logic	Lecture	Fara (Philosophy)	3	12	Spring 2003
293	Engineering Mathematics	Lec/Sec	Fickus, Hatcher, J. Wang (T&AM)*	347	1,388	Fall 2002
293	Engineering Mathematics	Lec/Sec	Jenkins (T&AM)*, Wahlbin	424	1,696	Spring 2003
294	Engineering Mathematics	Lec/Sec	Hui (T&AM)*	381	1,524	Fall 2002
294	Engineering Mathematics	Lec/Sec	R. Terrell	364	1,456	Spring 2003
311	Introduction to Analysis	Lecture	Barbasch, Bezdek	37	148	Spring 2003
321	Manifolds and Differential Forms	Lec/Sec	Sjamaar	16	64	Fall 2002
323	Introduction to Differential Equations	Lecture	Wahlbin	25	100	Fall 2002
332	Algebra and Number Theory	Lecture	Speh	23	92	Fall 2002
336	Applicable Algebra	Lecture	Billera, Kahn	62	248	Spring 2003
356	Groups and Geometry	Lecture	Cohen	20	80	Spring 2003
401	Honors Seminar: Topics In Modern Math.	Lecture	Strichartz	9	36	Spring 2003
403	History of Mathematics	Lecture	Henderson	21	84	Spring 2003
408	Mathematics in Perspective	Lecture	Nerode	3	12	Spring 2003
413	Honors Introduction to Analysis I	Lecture	Berest, Dindos, Ilyashenko	80	320	Fall 2002
414	Honors Introduction to Analysis II	Lecture	Mitrea	29	116	Spring 2003
418	Function Theory of One Complex Var.	Ind Stud	Morley	1	4	Fall 2002
418	Function Theory of One Complex Var.	Lecture	Guckenheimer	10	40	Spring 2003
420	Differential Equations & Dynamical Systems	Lec/Sec	Perez	27	108	Fall 2002
420	Differential Equations & Dynamical Systems	Lec/Sec	Perez	24	96	Spring 2003
422	Applied Complex Analysis	Lec/Sec	L. Gross	32	128	Spring 2003
424	Wavelets and Fourier Series	Lecture	Fickus	20	80	Spring 2003
425	Numerical Solutions of Differential Equations	Lecture	Demlow	2	8	Fall 2002
427	Intro. to Ordinary Differential Equations	Lecture	Rothaus	3	12	Fall 2002
428	Intro. to Partial Differential Equations	Lecture	Ramírez	16	64	Spring 2003
431	Linear Algebra	Lecture	Kahn	37	148	Fall 2002
432	Introduction to Algebra	Lecture	Chase	21	84	Spring 2003
433	Honors Introduction to Algebra I	Lecture	Vogtmann, Zaffran	47	188	Fall 2002
434	Honors Introduction to Algebra II	Lecture	Dennis	29	116	Spring 2003
441	Introduction to Combinatorics	Lecture	Billera	20	80	Fall 2002
451	Euclidean and Spherical Geometry	Lecture	Henderson	25	100	Fall 2002
452	Classical Geometries	Lecture	Connelly	5	20	Spring 2003
453	Introduction to Topology	Lecture	J. West	11	44	Fall 2002
454	Introduction to Differential Geometry	Lecture	Hatcher	31	124	Spring 2003
471	Basic Probability	Lecture	Dynkin	34	136	Fall 2002
472	Statistics	Lecture	Schweinsberg	26	104	Spring 2003
481	Mathematical Logic (also PHIL 431)	Lecture	R. Miller	15	60	Spring 2003
482	Topics in Logic (also PHIL 432)	Lecture	Hodes (Philosophy)	1	4	Fall 2002
486	Applied Logic (also COM S 486)	Lecture	Constable (Computer Science)	5	20	Spring 2003

Course and Title		Format	Instructor	Auditors	Enroll	Cr Hrs	Term
490	Supervised Reading and Research	Ind Stud	Faculty		6	23	Fall 2002
490	Supervised Reading and Research	Ind Stud	Faculty		10	38	Spring 2003
500	College Teaching	Lecture	M. Terrell		11	11	Fall 2002
507	Teaching Secondary Mathematics	Lecture	A. Solomon		8	32	Spring 2003
508	Math. For Secondary School Teachers	Lecture	A. Solomon		1	1	Fall 2002
508	Math. For Secondary School Teachers	Lecture	A. Solomon		4	5	Spring 2003
611	Real Analysis	Lecture	Dynkin	4	24	96	Fall 2002
612	Complex Analysis	Lecture	Hubbard	2	18	72	Spring 2003
613	Topics in Analysis	Lecture	Lawler	4	9	36	Fall 2002
614	Topics in Analysis	Lecture	Ørsted	2	8	32	Spring 2003
615	Mathematical Methods in Physics	Lecture	Barbasch	8	9	36	Fall 2002
621	Measure Theory and Lebesgue Integration	Lecture	Bendikov	1	13	52	Fall 2002
622	Applied Functional Analysis	Lecture	Bendikov	9	9	36	Spring 2003
631	Algebra	Lecture	Berest	2	21	84	Fall 2002
632	Algebra	Lecture	Dennis		3	12	Spring 2003
649	Lie Algebras	Lecture	Barbasch	7	4	16	Fall 2002
651	Introductory Algebraic Topology	Lecture	J. West	2	16	64	Spring 2003
652	Differentiable Manifolds	Lecture	Sjamaar	9	12	48	Fall 2002
653	Differentiable Manifolds II	Lecture	Iglesias		5	20	Spring 2003
661	Geometric Topology	Lecture	Bux	16	14	56	Fall 2002
671	Probability Theory	Lecture	Durrett	10	15	60	Fall 2002
672	Probability Theory	Lecture	Durrett	4	21	84	Spring 2003
674	Introduction to Mathematical Statistics	Lecture	Nussbaum	2	7	28	Spring 2003
681	Logic	Lecture	Nerode		5	20	Spring 2003
712	Seminar in Analysis	Seminar	L. Gross		12	48	Spring 2003
713	Functional Analysis	Lecture	Dindos	5	5	20	Spring 2003
722	Topics in Complex Analysis	Lecture	Hubbard	1	4	16	Fall 2002
728	Seminar in Partial Differential Equations	Seminar	Mitrea	4	4	16	Fall 2002
728	Seminar in Partial Differential Equations	Seminar	Wahlbin		7	28	Spring 2003
731	Seminar in Algebra	Seminar	Dennis	5	6	24	Fall 2002
731	Seminar in Algebra	Seminar	Billera	1	5	20	Spring 2003
732	Seminar in Algebra	Seminar	Chalykh	5	2	8	Spring 2003
735	Topics in Algebra	Lecture	Yakimov	2	6	24	Fall 2002
739	Topics in Algebra	Lecture	Zaffran		2	8	Spring 2003
740	Homological Algebra	Lecture	Stillman		12	48	Spring 2003
751	Seminar in Topology	Seminar	Vogtmann	7	5	20	Fall 2002
752	Seminar in Topology	Seminar	Chatterji	2	5	20	Spring 2003
753	Algebraic Topology	Lecture	Hatcher		2	8	Fall 2002
755	Topology and Geometric Group Theory Seminar	Seminar	Seminar		4	16	Fall 2002
756	Topology and Geometric Group Theory Seminar	Seminar	Seminar		4	16	Spring 2003
757	Topics in Topology	Lecture	Conant	3	2	8	Fall 2002
758	Topics in Topology	Lecture	Bux	3	5	20	Spring 2003
761	Seminar in Geometry	Seminar	B. Smith	5	3	12	Fall 2002
762	Seminar in Geometry	Seminar	Escobar	4	4	16	Spring 2003
767	Algebraic Geometry	Lecture	Peeva	3	5	20	Spring 2003
771	Seminar in Probability and Statistics	Seminar	Seminar		2	8	Fall 2002
772	Seminar in Probability and Statistics	Seminar	Seminar		3	12	Spring 2003
777	Stochastic Processes	Lecture	Saloff-Coste	3	13	52	Fall 2002
778	Stochastic Processes	Lecture	Lawler	5	8	32	Spring 2003
781	Seminar in Logic	Seminar	Shore	7	6	24	Fall 2002
782	Seminar in Logic	Seminar	Shore	8	4	16	Spring 2003
784	Recursion Theory	Lecture	Shore	1	5	20	Fall 2002
787	Set Theory	Lecture	R. Miller	1	5	20	Spring 2003
790	Supervised Reading and Research	Ind Stud	Faculty		21	103	Fall 2002
790	Supervised Reading and Research	Ind Stud	Faculty		17	68	Spring 2003

TOTALS	Courses	Enroll	Dept* Cr Hrs	Total Cr Hrs
Fall Semester	57	3,095	10,077	12,207
Spring Semester	64	2,638	8,672	10,256
Academic Year	121	5,733	18,749	22,463

* 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 are accredited to Mathematics.

(Continued from page 15)
mathematics majors and for his work in developing a new course, MATH 424. The *Graduate Student Teaching Award* was given to Christopher Francisco in recognition of his high quality of teaching and for bringing improvements to teaching and teacher training in the Department of Mathematics through his dedication, enthusiasm and creativity.

The GoodQuestions Project

The GoodQuestions project aims to improve calculus instruction by adapting to mathematics two techniques developed in physics instruction: ConcepTests and Just-in-Time-Teaching (JiTT). ConcepTests are questions designed for use in class to stimulate discussion of key concepts and to promote a more active classroom learning environment. JiTT questions are web-based questions that encourage students to prepare, or warm up, for class discussions by reading ahead and answering questions based on the reading before class.

ConcepTest questions are designed to stimulate students' interest in and curiosity about the key mathematical concepts; to help students monitor their understanding; and to offer students frequent opportunities to make conjectures and argue about their validity. The project's team of faculty and experienced graduate students has been designing questions that reflect the role of the student's prior knowledge and misconceptions in building conceptual understanding; that provide instructors with frequent formative assessments of what their students are learning; and that support instructors' efforts to foster an active learning environment. The questions are posed and students are polled for their responses through an electronic in-class polling system that allows students to register their responses anonymously, and that allows the instructor to see the distribution of student responses immediately. After the initial vote, students discuss a question and share their thoughts about the correct response with each other. This peer instruction engages students in thoughtful debate and inquiry, and usually results in a higher number of correct responses on a subsequent polling.

JiTT questions are offered to students through the web via a web-based tool, MapleTA. MapleTA offers a way for students to access the question in a timely manner, to think about and answer questions before class, and get prompt graded feedback on their work. Through the web, instructors are able to access students' responses to the pre-class warm-up assignments as they prepare their class presentations. Pre-class warm-up questions can provide an excellent lead-in for discussion of a new topic.

The GoodQuestions project is a team effort by department faculty — Robert Connelly, David Henderson, Oscar Rothaus, Robert Strichartz and Maria Terrell — and graduate students — Nelia Charalambous, Christopher Francisco, Lee Gibson, Carla Martin (CAM), Everilis Santana-Vega, Brigitta Vermesi and Treven Wall. The project has received significant support from Diane Kubarek of the Cornell Information Technologies Academic Technology Center and David Way of the Center for Teaching and Learning.

Support for the GoodQuestions project is provided in part by the National Science Foundation's Course, Curriculum, and Laboratory Improvement Program under grant DUE-0231154. The technological aspects of the project are supported through a Faculty Innovation in Teaching grant at Cornell.

Curriculum Changes

MATH 323, *Introduction to Differential Equations*, was introduced this year. It is intended for students who want a brief one-semester introduction to the theory of and techniques in ordinary and partial differential equations, rather than the yearlong sequence MATH 427–428.

Starting in the fall of 2003 we will no longer teach MATH 105, *Finite Mathematics for the Life and Social Sciences*, in a large lecture format with small sections. It will instead be taught in five small lectures. A faculty member will teach one lecture and serve as czar (supervisor) for the course, while instructional teaching assistants teach the other lectures.

Next spring, we will introduce MATH 135, *The Art of Secret Writing*, and MATH 275, *Elementary Probability.* These courses are designed to fulfill the quantitative reasoning distribution requirement for students in the Arts College.

Mathematics/Engineering Liaison

In the fall of 2002 and the spring of 2003 the Mathematics/Engineering Liaison Committee met with representatives of the departments of Mathematics, Theoretical and Applied Mechanics, Computer Science, and Operations Research and Industrial Engineering concerning the engineering mathematics courses, MATH 190/191, 192, 293 and 294. Several matters were discussed and actions taken, including the following:

The group reviewed the syllabi and textbooks for all the courses and decided to take a good look at MATH 293 and MATH 294. After some investigation, they decided to add some discussion of differential equations into MATH 294 as an application of the linear algebra that is the core of the course. There is now a revised syllabus for MATH 294, which incorporates most of the changes.

Following a report by Jim Jenkins and Leigh Phoenix from the Department of Theoretical and Applied Mechanics, the group also decided to change the MATH 294 textbook to one by Bretscher starting in summer and fall 2003. This book was felt to be better suited to what needs to be covered and more digestible for the students.

Graduate Curriculum Review

A committee chaired by Dan Barbasch finished its review of the curriculum for new graduate students this year, and the faculty has approved the following rules and recommendations for the graduate program.

All students will be required to pass (or place out of) four basic courses from among MATH 611, 612 (analysis), MATH 631, 632 (algebra) and MATH 651, 652 (topology/geometry) by the time they are ready to take the A exam. All students must take at least one course from each of the three main areas — algebra, analysis and topology/geometry. A basic course is required to have substantial graded work, but even so students should be able to take three courses a semester. The amount of total work (class meeting, reading and homework assignments) for a basic course should be about 10–15 hours per week. Entering graduate students shall receive a copy of the rules encouraging them to eventually take all six core courses with the option of a grade of S/U for two of them. Faculty preparing the syllabi for individual core courses should keep in mind that graduate students and faculty prefer that roughly 2/3 of the material be part of the minimum portion common to all years and 1/3 be optional. The aim is to insure some uniformity while faculty still have the flexibility to present material where they have expertise.

It is strongly recommended that the committees monitor the workload closely so that students are able to take three courses each semester, advise students not to take too many core courses in the first semester of the first year, and advise students to (eventually) take all six core courses. Advanced courses should be able to assume that students have taken the basic courses and are familiar with specified material. Faculty who are teaching basic courses are encouraged to communicate with each other to avoid heavy assignments and exams at the same time. The basic courses should undergo a review every five years.

Instructional Support

Computer Lab

Classes making major use of the lab this year were Statistical Theory and Applications (MATH 171), Mathematical Explorations (MATH 103), Statistics (MATH 472) and Multivariable Calculus (MATH 222). Theoretical Linear Algebra and Calculus (MATH 223), Teaching Secondary Mathematics (MATH 507), Honors Introduction to Algebra II (MATH 434) and Differential Equations and Dynamical Systems (MATH 420) also made some limited use of the lab.

Major use of the lab by several 400-level mathematics courses was a highlight of spring 2003. Most significantly, Professor Jason Schweinsberg introduced an active data analysis side to MATH 472. Students completed five rather intensive two-week-long projects in which they had to do lots of independent thinking about how to best come to conclusions. Prof. Schweinsberg also came in one evening a week to help the students with this work.

Another new program was an optional computer algebra with gap component for MATH 434, which was put in place by undergraduate Paul Young under the supervision of Professor Keith Dennis.

Lab Director Allen Back produced and maintained a compendium of ideas for computer usage in courses with web references at the Math Lab website. A student-oriented MATH 221 version on the linear algebra portions was also created and displayed at our support site.

High school students in the Math Explorers Club, students working on senior theses, and Research Experiences for Undergraduates program participants were also significant users of the lab.

The frontline resources of the lab continued to center on the thirteen 1.4 gigahertz Pentium 4's dual booting Windows 2000 and Redhat Linux. These Pentium 4's are supported by the two two-year-old fast Pentium 3 SCSI servers. We continued to use three older 266 megahertz NT machines to meet our course capacity of 30 students working in partners at 15 machines.

Mathematics Support Center

An academic support wing of the Mathematics Department, the Mathematics Support Center 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 or referrals for students. Although the Center focuses on the 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 2002–2003 academic year, in addition to paid tutors, several volunteers donated their time and expertise: Professor Emeritus Roger Farrell, Harry Bowman, David Cohodes and Joey Palin. Douglas S. Alfors directs the operations of the MSC and coordinates 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. We have several tutoring areas that are sufficiently separated from one another to address privacy and noise issues, yet are not so widely separated that we lose contact with someone who is working on something. Our reception area can adequately accommodate students who are waiting for their turn to be tutored, and we have a couple of sites that work nicely for small groups. The small library of texts that we maintain can be accessed easily by tutors and tutees, and mathematics computer programs provide additional support when needed. We anticipate having a more visible web presence soon and plan to replace some antiquated computer equipment. We maintain weekday hours of service (10 AM–5 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, 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 2002–2003 academic year, under the direction of Patricia Alessi, the LSC provided academic support for MATH 105, MATH 106, MATH 111 and MATH 112. Support included respective supplemental courses MATH 005, MATH 006, MATH 011 and MATH 012. These courses 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.

Support for MATH 171, as well as other undergraduate statistics courses, was also provided by the LSC in the Center for Learning and Teaching Support Instructional Lab. The tutor-staffed lab was open three evenings and one afternoon per week, equipped with statistical software and respective problem sets for the courses supported. During the 2003–2004 academic year, support will continue to be provided as described above for MATH 105, MATH 106, MATH 111, MATH 112 and MATH 171.

Graduate Program

The American Mathematical Society rates Cornell's Mathematics Department among the top in the country. The U.S. News and World Report placed Cornell ninth in the nation in its 2002 national ranking of graduate mathematics programs.

The Ph.D. program included 72 graduate students during the 2002–2003 academic year. That number will increase to 77 graduate students in the coming year. The entering class this fall will consist of eleven new Ph.D. students. Liang Chen, Alimjon Eshmatov and Mia Minnes have been awarded one-year fellowships from the Cornell Graduate School to cover full tuition and stipend. Joshua Bowman, Chris Lipa, Jonathan Needleman, Matthew Noonan and Anael Verdugo have been awarded VIGRE fellowships under the department's NSF VIGRE grant. Sunny Fawcett and Biao Wang are transferring to Cornell to continue their work with William Thurston. Nathanael Berestycki, who was a non-degree student in 2002–2003, will work as a GRA with Richard Durrett.

The department hosted five non-degree students in 2002–2003 and will host two in 2003–2004. Marie Sawicki, from University of Paris VII (France), will be supported under an exchange agreement with the Cornell Abroad EDUCO Center in Paris. Guan-Yu Chen comes from the Department of Applied Mathematics at the National Chiao Tung University in Taiwan. Both students will work with Laurent Saloff-Coste.

Graduate Student Awards

August 2003 Ph.D. candidate Samuel Hsiao is the recipient of a **Liu Memorial Award** for $2000 from the Cornell Graduate School. Established by friends and colleagues in memory of the late professor Ta-Chung Liu and his wife, Ya-Chao, the award is based on demonstrated academic ability and performance, with some consideration given to character and financial need. Sam is a student of Lou Billera. He is an outstanding researcher and one of the department's leading teaching assistants. He has been awarded a prestigious NSF Postdoctoral Fellowship at the University of Michigan.

The **Robert John Battig Graduate Prize** was awarded to Todd Kemp. 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 and financial background. Todd is a student of Leonard Gross. He is an outstanding student researcher and teacher. Todd helped to organize the first prospective graduate student weekend and was also involved in creating preparatory material for the core graduate courses. He cotaught a new course at Ithaca High School (see p. 41) this year and gave several talks off campus at conferences and as an invited speaker.

Hutchinson Fellowships were awarded to Radu Haiduc and Fernando Schwartz, providing one semester of relief from teaching to allow them to work on their thesis problems. Hutchinson fellowships are awarded annually to mathematics graduate students who have been outstanding in their 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. Radu and Fernando are both doing exceptional research work, with John Guckenheimer and José Escobar, respectively. Both students are in their fourth year of study.

The **Eleanor Norton York Award** was awarded to Lynn Carter in Astronomy and Christopher Hardin 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. Christopher Hardin is a student of Richard Shore and Dexter Kozen (Computer Science). He is in his fourth year of graduate study.

Christopher Francisco was presented the **Graduate Student Teaching Award** at the Mathematics Department's annual holiday party. He is the second recipient of this award.

Graduate Student Activities

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

Kristin Camenga, Todd Kemp and Jeff Mermin, conceived, planned, and co-taught a new course at Ithaca High School called the Senior Mathematics Seminar. The program was a *huge* success. (See p. 41 for details.) Many students are also active in the Preparing Future Professors program (see below), Expanding Your Horizons (p. 42) and the Math Explorers Club (p. 41).

James Belk, Christopher Francisco and Todd Kemp created a syllabus of preparatory material for the core graduate courses and gave a series of lectures to the incoming graduate students before classes began in the fall. Heather Heston, Todd Kemp, Sarah Koch, Treven Wall and James Worthington planned and executed a very successful second annual Graduate Student Prospective Weekend. Four of the eight students who attended the weekend have decided to attend Cornell.

Class representatives were Noam Greenberg (fifth and sixth year), Christopher Francisco (fourth year), Todd Kemp (third year), Henri Johnston (second year) and Bradley Forrest (first year). Treven Wall served as the graduate and professional student representative.

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. Will Gryc and Fernando Schwartz served as organizers in the fall and Steve Sinnott and Mauricio Velasco organized talks in the spring. (See pp. 36–37 for a list of talks.)

Thirty-three graduate students gave 101 talks in department seminars. Graduate students were also active in giving off-campus research presentations at meetings and specialized conferences. A sampling of these follows:

- Nelia Charalambous gave a series of lectures at IMPA in Brazil and another series of lectures at the Geometry Summer School in Goiania;
- Christopher Francisco spoke at the Route 81 Conference on Commutative Algebra & Algebraic Geometry, held at Queen's University in Kingston, Ontario;
- Noam Greenberg gave a talk at the Notre Dame Logic Seminar and was invited to speak at the ASL annual meeting in Chicago and at the Recursion Theory Workshop in Heidelberg;
- Todd Kemp gave a lecture on his research in the Operator Algebras seminar at Queens University in Kingston, Ontario, Canada and at the Southeast Sectional Meeting of the AMS, in Baton Rouge, LA;
- Michael Kozdron gave talks at the Cornell Undergraduate Math Club;
- Roland Roeder has had a paper accepted for publication "Explicit Calculations of homoclinic tangles in tokamaks," Physics of Plasmas, April 2003;
- Reba Schuller gave a poster presentation at The International Conference on Knowledge Discovery and Data Mining, Edmonton, Ontario;
- Serguei Slavnov gave a talk at the Federated Logic Conference in Copenhagen;
- Fernando Schwartz gave a talk at CECS in Valdivia, Chile;
- Harrison H. Zhou gave talks at the International Congress of Mathematicians, Beijing and the Seventh Purdue International Symposium on Statistics.

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 Heather Heston, Lee Gibson, and Roland Roeder coordinated the following talks:

Christian Benes, *An introduction to randomness* or *How knowing probability can help you save money!* (Hamilton College, & Ithaca College)
Kristin Camenga, *A tale of two proofs* (SUNY, Cortland)
Lee Gibson, *The gambler's ruin* (Hamilton College)
Noam Greenberg, *Paradoxes and the foundations of mathematics: how to escape the serpent's tongue* (Hobart and William Smith College)
Evgenii Klebanov, *Introduction to complex analysis* (SUNY Binghamton)
Michael Kozdron, *Stirling's formula: an application of calculus* (Hobart and William Smith College)
Melanie Pivarski, *Dance, baby, dance: wandering in the labyrinth of permutation groups* (Hobart and William Smith College)
Roland Roeder, *Hamiltonian chaos, homoclinic triangles and magnetic footprints in tokamaks* (Rochester Institute of Technology)
Fernando Schwartz, *What is curvature?* (Rochester Institute of Technology and Wells College)

Doctoral Degrees

Nine Ph.D. degrees were conferred in August 2002. Five other students are preparing to complete their degrees in August 2003. Of the five, one (Sam Hsiao) has been awarded the prestigious NSF Mathematical Science Postdoctoral Fellowship at the University of Michigan, three took assistant professor postdoctoral positions and one will be returning to his home country of Brazil to work at IMPA in Rio de Janeiro.

August 2002

Ryan Budney

Representations of Mapping Class Groups via Topological Constructions

MS Special (1997) Cornell University
BS (1995) University of Alberta
Committee: Hatcher, Kahn, Vogtmann
First Position: assistant professor, University of Rochester

Abstract: This dissertation is an investigation into the action of mapping class groups on objects one would naturally associate with such groups, such as the homology of configuration spaces, homology of covering spaces of configuration spaces and generalized homology theories associated to the underlying surface. The main results are explicit CW decompositions of configuration spaces, constructed using Morse electrostatic potential functions. In Chapter 3, these are applied to give insight into the Lawrence-Krammer representation, showing that it is a unitary representation and giving some insight into the conjugacy problem for braid groups. Chapter 4 is concerned with the construction of an analogue of the Lawrence-Krammer representation. Chapter 2 is concerned with the action of mapping class groups on the homology of configuration spaces, the main result being that these representations are largely not faithful. In Chapter 5 generalized homology theories are shown to be very similar to standard, singular homology from the point of view of representations of mapping class groups.

Alan Robert Demlow

Estimates for and Properties of Mixed Finite Element Methods for Elliptic Problems

BS (1996) Spring Arbor University
Committee: Wahlbin, Barbasch, Schatz
First Position: visiting assistant professor, Cornell University

Abstract: We consider two mixed finite element methods for a general second-order linear elliptic problem on a domain $\Omega \subset R^n$. These methods originate from two different forms of the same partial differential equation, and they sometimes behave in substantially different ways. The choice of element space used in these methods also has an effect on their behavior. In this thesis we consider the effects of different choices of elements and methods on the optimality and localization properties of the resulting approximations.

In the "divergence" form method, the vector variable in the mixed method approximates $-A\nabla u$, while in the "conservation" form method, the vector variable approximates $-\left(A\nabla u - \vec{b}u\right)$. Here u solves the given elliptic scalar problem, A is a matrix of coefficients, and $\vec{b}$ is a vector of coefficients. We demonstrate via general L_2 error estimates that, in the divergence form method, the errors in the vector and scalar variables are weakly coupled, while in the conservation form method they are strongly coupled. The strong coupling in the latter case leads to suboptimal convergence when members of the Brezzi-Douglas-Marini (BDM) family of elements for simplicial spaces are used, a fact that we demonstrate computationally. The well-known Raviart-Thomas-Nedelec family of spaces, in contrast, always gives optimal convergence.

Using pointwise error estimates, which generalize previously known almost-best-approximation maximum-norm estimates, Schatz has recently shown that standard finite element methods for elliptic problems yield errors that are in a certain sense mostly local in character, except in the lowest-order piecewise linear case. We carry out a similar pointwise error analysis for the mixed methods described above. Our estimates indicate that localization occurs in both of these mixed methods except when the lowest order BDM simplicial elements are used, and we again confirm the sharpness of our theoretical results via computational examples.

Ferenc Gerlits

Invariants in Chain Complexes of Graphs

MS (1995) Eötvös Loránd University (Hungary)
Committee: Vogtmann, Cohen, Hatcher
Position: junior research fellow, Alfred Renyi Institute of Mathematics

Abstract: We study the homology of various graph complexes. These are chain complexes where the chain groups are spanned by a finite set of graphs.

Graph complexes were first used to compute the homology of mapping class groups. The group of outer automorphisms of the free group Out(F_n), and the group of automorphisms of the free group Aut(F_n) are similar to the mapping class groups in many ways. In particular, their homology can be computed using a similar graph complex.

In Chapter 2, we compute $H^*(\mathrm{Out}(F_n);Q)$ for $n \le 5$ using the cell decomposition of Culler and Vogtmann. Hatcher constructed a graph complex to compute the rational homology of $\mathrm{Aut}(F_n)$. Hatcher and Vogtmann simplified the graph complex and computed $H_i(\mathrm{Aut}(F_n);Q)$ for $i \le 6$ (and all n). In Chapter 3, we use new algorithms to compute the homology of their graph complex. Our results confirm their computation, and extend it one step further: we compute $H_7(\mathrm{Aut}(F_5);Q) \cong Q$. This is interesting, because it is the first known case where the homology of $\mathrm{Out}(F_n)$ and $\mathrm{Aut}(F_n)$ are different, thus establishing a lower bound for the stability range of the map $H^*(\mathrm{Aut}(F_n)) \to H^*(\mathrm{Out}(F_n))$, which was shown to be an isomorphism for large n by Hatcher.

In Chapter 4, we consider a family of graph complexes introduced by Kontsevich in the study of "non-commutative symplectic geometry." He showed that the homology of the Lie algebra of certain symplectic vector fields on R^{2n}, and of non-commutative analogs of this Lie algebra, can be computed by a fairly simple graph complex. We give a short summary of the proof of this theorem and compute the homology in the commutative case in low dimensions.

Chapter 5 contains a proof of Kontsevich's formula for the Euler characteristic of his graph complexes. This is an application of the method of Feynman diagrams from quantum physics, combined with the combinatorics of species developed by A. Joyal.

Leah Gold
Homological Results in Commutative Algebra

MS Special (1998) Cornell University
BS (1995) University of Chicago
Committee: Stillman, Billera, Barbasch
Position: VIGRE postdoctoral position, Texas A&M University

Abstract: We discuss a bound on the multiplicity of ideals in the first chapter. Herzog and Srinivasan have conjectured that for any homogeneous k-algebra of codimension d, the multiplicity is bounded by

$$\prod_{i=1}^{d} \frac{M_i}{d!},$$

where M_i is the maximal degree of an ith syzygy. Using the minimal free resolutions as constructed by Peeva and Sturmfels, we show that this bound holds for codimension-2 lattice ideals.

The topic of chapter two is ideals having three generators. It is known due to work by Burch and by Kohn that any projective dimension may be realized by a 3-generated ideal. Buchsbaum and Eisenbud conjectured that the tail of any resolution may be realized by a 3-generated ideal. This result and a generalization was shown by Bruns. We introduce a family of ideals and prove that for each n the resolution of the ideal in n variables from the family has the same tail as the Koszul resolution on those n variables.

In chapter three we attempt to extend the result of chapter two to ideals generated by binomials. We display binomial examples in 4, 5 and 6 variables. A binomial example having the same tail as the Koszul complex for $n = 7$ is not found, but we do display 3-generated binomial examples having projective dimensions seven and eight.

Geoffrey Christopher Hruska
Nonpositively Curved Spaces with Isolated Flats

BS (1995) University of Maryland at College Park
Committee: Vogtmann & Wise, Cohen, Hatcher
Position: NSF postdoctoral research fellow, University of Chicago

Abstract: The mildest way that a nonpositively curved space can fail to be negatively curved is for it to contain only a sparse collection of isolated flat Euclidean subspaces. The concept of a CAT(0) space whose flat planes are isolated is implicit in work of Michael Kapovich and Bernhard Leeb and of Daniel Wise and has also been studied by Bruce Kleiner. In this dissertation, we introduce the *Isolated Flats Property*, which makes this notion explicit, and we show that several important results about Mikhail Gromov's δ-hyperbolic spaces extend to the class of CAT(0) spaces with this property.

More specifically, we consider a large class of groups that act properly and cocompactly by isometries on CAT(0) spaces with the Isolated Flats Property. We show that the family of groups in question includes all those groups that act on 2-dimensional complexes with the Isolated Flats Property as well as all geometrically finite subgroups of $\mathrm{Isom}(\mathrm{Hyp}_n)$. We also show that for each such group there is a well-defined notion of a boundary at infinity and an intrinsic notion of a subgroup being quasiconvex. These results were established by Gromov in the negatively curved setting and do not extend to general nonpositively curved spaces.

It is reasonable to interpret the present results as indicating that groups that act properly and cocompactly by isometries on CAT(0) spaces with isolated flats are

very nearly word hyperbolic. In fact, much of the inspiration for the present theory comes from a philosophy that spaces with isolated flats are hyperbolic relative to their flat Euclidean subspaces.

Our main theme is to formulate relative versions of several of the basic properties of hyperbolic spaces. For instance in the presence of the Isolated Flats Property, one can often conclude that geodesic triangles are thin relative to flats and that pairs of quasigeodesics fellow travel relative to flats in a suitable sense. In the setting of CAT(0) 2-complexes, we show that each of these relative properties is equivalent to the Isolated Flats Property.

Suzanne Lynch Hruska
On the Numerical Construction of Hyperbolic Structures for Complex Dynamical Systems

MS Special (1999) Cornell University
BS (1997) University of Missouri at Rolla
Committee: Smillie, Earle, Hubbard
Position: assistant professor, SUNY at Stony Brook

Abstract: Our main interest is using a computer to rigorously study ε-pseudo orbits for polynomial diffeomorphisms of $\mathbf{C}^2$. Periodic ε-pseudo orbits form the ε-*chain recurrent set*, R_ε. The intersection $\cap_{\varepsilon>0} R_\varepsilon$ is the *chain recurrent set*, R. This set is of fundamental importance in dynamical systems.

Due to the theoretical and practical difficulties involved in the study of $\mathbf{C}^2$, computers will presumably play a role in such efforts. Our aim is to use computers not only for inspiration, but to perform rigorous mathematical proofs.

In this dissertation, we develop a computer program, called *Hypatia*, which locates R_ε, sorts points into components according to their ε-dynamics, and investigates the property of *hyperbolicity* on R_ε. The output is either "yes," in which case the computation *proves* hyperbolicity, or "not for this ε," in which case information is provided on numerical or dynamical obstructions.

A diffeomorphism f is *hyperbolic on a set X* if for each x there is a splitting of the tangent bundle of x into an *unstable* and a *stable* direction, with the unstable (stable) direction expanded by $f\,(f^{-1})$. A diffeomorphism is *hyperbolic* if it is hyperbolic on its chain recurrent set.
Hyperbolicity is an interesting property for several reasons. Hyperbolic diffeomorphisms exhibit *shadowing* on R, i.e., ε-pseudo orbits are *delta*-close to true orbits. Thus they can be understood using combinatorial models. Shadowing also implies *structural stability*, i.e., in a neighborhood in parameter space the behavior is constant. These properties make hyperbolic diffeomorphisms amenable to computer investigation via ε-pseudo orbits.

We first discuss *Hypatia* for polynomial maps of $\mathbf{C}$. We then extend to polynomial diffeomorphisms of $\mathbf{C}^2$. In particular, we examine the class of Hénon diffeomorphisms, given by

$$H_{a,c} : (x, y) \to (x^2 + c - ay, x).$$

This is a large class of diffeomorphisms, which provide a good starting point for understanding polynomial diffeomorphisms of $\mathbf{C}^2$. However, basic questions about the complex Hénon family remain unanswered.

In this work, we describe some Hénon diffeomorphisms for which *Hypatia* verifies hyperbolicity, and the obstructions found in testing hyperbolicity of other examples.

Swapneel Mahajan
Shuffles, Shellings and Projections

BS (1996) Indian Institute of Technology
Committee: Brown, Saloff-Coste, Vogtmann
Position: invited researcher, Free University of Brussels

Abstract: Projection maps which appear in the theory of buildings and oriented matroids are closely related to the notion of shellability. This was first observed by Björner. In the first chapter, we give an axiomatic treatment of either concept and show their equivalence. We also axiomatize duality in this setting. As applications of these ideas, we prove a duality theorem on buildings and give a geometric interpretation of the flag h vector. The former may be regarded as a q-analogue of the Dehn-Sommerville equations. We also briefly discuss the connection with the random walks introduced by Bidigare, Hanlon and Rockmore.

The random-to-top and the riffle shuffle are two well-studied methods for shuffling a deck of cards. These correspond to the symmetric group S_n, i.e., the Coxeter group of type A_{n-1}. In the second chapter, we give analogous shuffles for the Coxeter groups of type B_n and D_n. These can be interpreted as shuffles on a "signed" deck of cards. With these examples as motivation, we abstract the notion of a shuffle algebra, which captures the connection between the algebraic structure of the shuffles and the geometry of the Coxeter groups. We also give new joker shuffles of type A_{n-1} and briefly

discuss the generalization to buildings, which leads to *q*-analogues.

Joseph Miller
Pi-0-1 Classes in Computable Analysis and Topology

MS Special (2002) Cornell University
BS (1995) University of Maryland
Committee: Nerode, Shore, Kozen
Position: postdoctoral fellow, Indiana University

Abstract: We explore aspects of Π_1^0 classes in R^n. These are the effective closed sets of computable analysis and natural analogs of the Π_1^0 classes in 2^ω, widely studied by computability theorists. In Chapter II, we characterize the fixable classes — the sets of fixed point of computable maps from the unit cube $[0,1]^n$ to itself — as the Π_1^0 classes which contain a nonempty, connected Π_1^0 subclass. This settles a question asked in Cenzer and Jockusch (2000). To prove that Brouwer's theorem is inconsistent with Russian constructivism, Orevkov gave a fixable class with no computable points (1963). Our proof employs a generalization of Orevkov's construction, as well as the notion of topological degree. Homology theory is used in the definition and computation of the topological degree. Homology returns in Chapter III, where chains are used to take algorithmic advantage of the topological structure of a Π_1^0 class. We show that a Π_1^0 class homeomorphic to a sphere is located: the distance to the class is computable. Closed balls embedded as Π_1^0 classes are also studied. Chapter IV studies members of Π_1^0 classes that contain no computable points. These avoidable points were introduced by Kalantari and Welch. Avoidability is a type of effective non-computability; we introduce hyperavoidability, a stronger notion, and initiate the computability theoretic study of both classes, including their behavior in the Turing and weak truth-table degrees.

David Revelle
Random Walks on Solvable Groups

MS Special (1999) Cornell University
BS (1996) Harvard University
Committee: Saloff-Coste, Durrett, Brown
Position: NSF postdoctoral position, University of California at Berkeley

Abstract: We study a number of questions about random walks on solvable groups. For random walks on nilpotent groups, we determine which subgroups are recurrent, and for a random walk on the Heisenberg group, we study the number of distinct visited cosets at time *n*.

The bulk of the examples considered are about the behavior of random walks away from their starting point in groups of exponential growth. In particular, we examine the rate of escape of some inward biased random walks, as well as some unbiased walks that have an intermediate escape rate. We also compute asymptotics for transition probabilities on some semi-direct products, both at the origin and at more general points.

Master of Science Special Degrees

(No Thesis Required)

August 2002

Christopher Hardin, Mathematics
BS (1998) Amherst College
Committee: Shore, Kozen, Nerode

Antonio Montalban, Mathematics
BS (2000) Universidad de la Republica
Committee: Shore, Kozen, Nerode

January 2003

JaEun Ku, Mathematics
BS (1995) Pohang University
Committee: Wahlbin, Schatz, Vavasis

Jason Martin, Mathematics
BS (1996) Virginia Polytechnic Institute
Committee: Ramakrishna, Sen, Stillman

Shawn Walker, Mathematics
BS (1999) University of Georgia
Committee: Billera, Connelly, Dennis

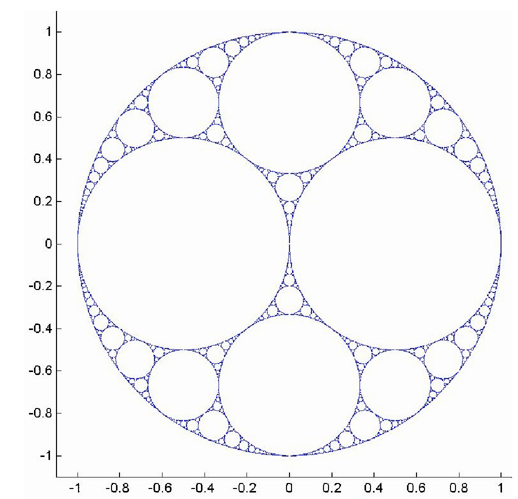
May 2003

Aaron Solo, Mathematics
BS (1999) University of Chicago
Committee: Wahlbin, Schatz, Strichartz

Undergraduate Program

The Cornell undergraduate program in mathematics in the academic year 2002–2003 included 137 majors (plus 3 conditional acceptances). Bachelors' degrees in mathematics were awarded to 63 students. These numbers show an acceleration of the increases in the major that began a few years ago.

The overall increase in numbers was even more pronounced in our honors program, indicating an overall increase in the *quality* of our majors as well. This May, we awarded degrees with honors to 18 students, of which 6 were cum laude, 8 magna cum laude, and 4 summa cum laude! Salman Arif, Alan Ferguson, Jason Gertz (January '03 degree), Jonathan Helm, Anselm Levskaya and Alan Pogrebinschi graduated cum laude. Adam Barth, Sami Can, Benjamin Cooper, Chien Meng Simon Ho, Robert Marangell, Michael O'Neil, Oded Yacobi and Paul Young graduated magna cum laude. Charles Abbott, Daniel Hue, Gideon Simpson and Justin Sinz graduated summa cum laude. This was an extremely talented group of undergraduates. Many of them elicited words of high praise from their professors and advisors.



Computer visualizations of Kleinian group limit sets, an image taken from Daniel Hue's senior thesis.

Undergraduate Awards and Honors

The *Harry S. Kieval Prize in Mathematics* for 2003 was awarded to **Justin Sinz** for his outstanding achievement in a broad array of difficult undergraduate and graduate courses, as well as for his original research on symplectic quotients under the supervision of Professor Yuri Berest. This work, while not submitted as a senior thesis, answers a difficult open question and will be published. Justin will be doing graduate work in mathematics at the University of Chicago next year. Harry S. Kieval '36 established the Kieval Prize in 1994 to provide an annual award for outstanding graduating senior mathematics majors. The department's honors committee chooses the recipient on the basis of academic performance, the quality and variety of mathematics courses taken, and faculty recommendations.

Cornell's *Merrill Presidential Scholars* Program honored the excellence of 35 Cornell undergraduate students this year, among them two mathematics majors: **Salman Arif** and **Yousi Daniel Hue**. Salman Arif, a student of Richard Durrett, graduated Cum Laude in Mathematics with distinction in all subjects. Salman worked on the problem of image compression on the 2003 Mars Exploration Rovers, did research on market microstructure in the Department of Economics and studied the 'New Economy' in the Johnson Graduate School of Management. Salman writes for one of Malaysia's largest newspapers, the New Strait Times. He will go to work for J. P. Morgan in New York as an investment bank sales and trading analyst. Yousi Daniel Hue, a student of Laurent Saloff-Coste graduated Summa Cum Laude in Mathematics with distinction in all subjects. Daniel received honorable mention for his outstanding performance on the Putnam exam. He will attend the London School of Economics. Daniel named **Laurent Saloff-Coste** as the Cornell faculty member who most significantly contributed to his college education and experience.

Matthew Wachs, a junior mathematics major, won the spring *2003 Knight Prize in Writing in the Majors* for his research paper on Charles Babbage in David Henderson's *History of Mathematics* course (MATH 403). According to Keith Hjortshoj, director of the Writing in the Majors program, Wachs wrote an extremely thorough, engaging paper with critical use of sources to trace factors of personality that contributed to Babbage's successes and failures.

Undergraduate Receptions

We conducted two undergraduate receptions this year, one in the fall and two in the spring. Both receptions had multiple functions: advertising courses for the next semester, presenting some information to students about the major, about research opportunities in the department during the summer, and some career information recruiting interested students into the major.

The fall reception focused more on formal presentations, whereas the spring reception reduced the number of these and replaced them with a short (20–30 minute) lecture by John Hubbard illustrating three mathematical gems. Both approaches have their place, but equally important is the 'free' time at these receptions for students to socialize with each other and with faculty and graduate students.

The receptions attracted a substantial turnout, both from undergraduates and department faculty. The receptions are likely useful as recruiting tools and may have played some positive role in the recent increase of our majors.

Putnam Competition

The Mathematics Department again fielded a team for the annual William Lowell Putnam competition, a prestigious nationwide mathematics competition, attracting many of the best students in the country. After some controversy concerning an error in scoring, it was established that the Cornell team scored approximately 25th in the country, a respectable showing if somewhat lower than in some recent previous years. Daniel Hue of Cornell did exceptionally well, receiving an Honorable Mention. The team was selected from a Putnam study group that met weekly throughout the fall semester under the guidance of Professor Kai-Uwe Bux.

Mathematical Contest in Modelling

The Mathematical Contest in Modelling (MCM) is an international team contest for undergraduates, conducted every year by COMAP, the Consortium for Mathematics and Its Applications. (COMAP is an award-winning non-profit organization whose mission is to improve mathematics education for students of all ages.) Alexander Vladimirsky held preparation sessions for all interested students, starting in November until the first week of February, when the contest was held. Two teams of three members each participated in the contest. One team, made up of Vorrapan Chandee, Tian Tian Qiu and Thitidej Tularak received an honorable mention, having placed in the top third among 638 participating teams from nine countries.

Undergraduate Research

Undergraduate research opportunities for mathematics majors have been steadily increasing over the past few years, thanks largely to the sponsorship of the National Science Foundation through its VIGRE and REU programs (both described elsewhere in this report) but also thanks to the university and to the individual efforts of department faculty. The NSF's REU program funds a number of summer programs in institutes throughout the country to help promote undergraduate research in mathematics and science, each program open to competitive applications by qualified, interested students from all institutions. Last summer two Cornell students participated in the Cornell REU mathematics program, whereas this summer the number will be four. Furthermore, this summer four Cornell mathematics majors have been accepted to study at REU mathematics programs elsewhere, which can be taken as a small positive token of the success and quality of our undergraduate program.

In a small way, both the REU and VIGRE programs have supported undergraduate research in mathematics during the school year. However, much of it was independent of these funding sources, relying instead on university support through the Cornell Presidential Research Scholars program and on the efforts of individual faculty. For example, students conducted some significant research activity in their senior-thesis projects (listed above) and reading courses. Our Honors Seminar, which emphasizes student presentations of advanced material, has been a valuable feeder to the mathematics research track. This year nine students used the seminar to study analysis on fractals under the direction of Professor Robert Strichartz.

Undergraduate Mathematics Club

The undergraduate Mathematics Club, under the leadership of president Joe Otchin, organized a series of talks by Cornell faculty and graduate students. Attendance for the talks ranged from eight to twenty-five people, primarily undergraduates but also faculty and graduate students. The following talks were given:

John Hubbard, *The KAM theorem*
Dexter Kozen, *The algebra of programs*
James West, *The magic of Cantor sets*
Gregory Lawler, *The places visited by a random walker*
Michael Kozdron, *A random look at Brownian motion*
Robert Strichartz, Rodrigo Perez and Richard Durrett, *Research Experiences for Undergraduates (REU)*
Lawren Smithline, *Professional strength integer factorization*
Robert Connelly, *Pushing disks together*
Alexander Vladimirsky, *Truly dynamic programming*

Some more informal talks were also given, including a puzzle session to which participants brought their favorite mathematical puzzles.

Senior Theses

Five graduating majors submitted senior theses:

Benjamin Cooper, *Realizability of Brunnian Links* (Supervisor: James Conant);
Daniel Hue, *Computer Visualizations of Kleinian Group Limit Sets* (Supervisor: John Hubbard);
Robert Marangell, *Classification of Wallpaper Groups* (Supervisor: Marshall Cohen);
Gideon Simpson, *Order of Convergence of Adaptive Step Algorithms for Ordinary Differential Equations* (Supervisor: John Hubbard);
Paul K. Young, *The Scharlau Invariant* (Supervisor: R. Keith Dennis);

These theses were all of high quality, three of them containing publishable results. The Mathematics Library has begun a collection of selected senior theses, to which the above-named will be added.

Bachelor of Arts Degrees

Bachelor's degrees were awarded to 63 students, including four in January 2003. Four students graduated summa cum laude, eight graduated magna cum laude, and six graduated cum laude.

January 2003

James Sinclair Dowd
Jason Gertz, *Cum Laude (Mathematics)*
Jergent Kabashi
Ravi Saksena

May 2003

Charles O. Abbott†, *Summa Cum Laude (Mathematics)*
Esra Yonca Aksu
Jacob Alpert
Peter Ammon
Salman Arif†, *Cum Laude (Mathematics)*
Faisal Asghar
Adam Chandler Barth†, *Magna Cum Laude (Mathematics)*
Michelle Behrend
Ilya Berdnikov †, *Magna Cum Laude (Physics)*
Jacob Edward Boon †
Jonathan Braus
Sami Umut Can†, *Magna Cum Laude (Mathematics)*
Hailin Chen
Benjamin Cooper †, *Magna Cum Laude (Mathematics)*
Michael P. Ferguson†, *Cum Laude (Mathematics)*
Amanda Folkman
Mikolaj Franaszcznk
Sujata Ganpule
Keith Flax Gray
Jennifer Heather Harber†
Jonathan Helm†, *Cum Laude (Mathematics)*
Chien Meng Simon Ho†, *Magna Cum Laude (Mathematics) & Summa Cum Laude (Physics)*
Yousi Daniel Hue†, *Summa Cum Laude (Mathematics)*
Jonathan Insler
Matthew Karr
Brian Kulis
Daniel Kupriyenko
Bhargav Kura
Eun Seung Lee
Anselm Levskaya†, *Cum Laude (Mathematics) & Magna Cum Laude* (*Physics*)
Robert Marangell†, *Magna Cum Laude (Mathematics)*
Peter McNamara
James Odierna
Michael Patrick O'Neil†, *Magna Cum Laude (Mathematics)*
Natan Ovshey
Saumil Patel
Rian Pillitteri
Gabriel Plunk†, *Cum Laude (Physics)*
Alan Pogrebinschi†, *Cum Laude (Mathematics) & Magna Cum Laude (Economics)*
Katherine Pollak
Randolph Rodrigues
David Rosen
David Russell
Suvarna Sampale
David Schwab†, *Cum Laude (Physics)*
Gideon Simpson†, *Summa Cum Laude (Mathematics)*
Neil Sinha
Justin Conrad Sinz†, *Summa Cum Laude (Mathematics) & Kieval Prize in Mathematics*
Michael Steinfeld
Jacob Stevenson, *Cum Laude (Physics)*
Winnie Sin Wei Tan†
Adam David Towsley
Justin Tung
Benjamin VanEvery
Jonathan Weinberg
Tristan Alexander Wietsma
Timothy Wong
Oded Yacobi†, *Magna Cum Laude (Mathematics)*
Paul Young†, *Magna Cum Laude (Mathematics)*

† **Distinction in all subjects**

Department Conferences and Seminars

Cornell Topology Festival

The topology/geometry group of the Mathematics Department hosted the forty-first annual Cornell Topology Festival on May 1–4 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 number of significant changes in the scope and format of the Festival, due in part to new funding from the National Science Foundation. The scope was enlarged from that of a three-day to a four-day conference (which allowed an increase in the number of speakers from about 8 to about 11), and special outreach efforts were made to attract participants from categories not heretofore well-represented: minorities, women, and younger mathematicians, including graduate students. A total of about 21 participants from such groups received support from the Festival. The total number of participants was 85, a significant increase over the numbers in recent years.

The new, enlarged Festival consisted of 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 one third of the talks — approximately those added on in the enlarged format — focused on a special area, geometric group theory. There will be 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 were innovations that drew widespread praise from the participants. Other activities included an opening reception, a 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 topics were: Dror Bar-Natan, Hebrew University and University of Toronto: *The unreasonable affinity of knot theory and the algebraic sciences*; Joan Birman, Columbia University: *Stabilization in the braid groups*; Fred Cohen, University of Rochester: *Braid groups, the topology of configuration spaces and homotopy groups*; Benson Farb, University of Chicago: *Hidden symmetries of Riemannian manifolds*; Gilbert Levitt, Université Paul Sabatier: *Automorphisms of canonical splittings*; John Meier, Lafayette College: *Asymptotic cohomology for the motion group of a trivial n-component link*; Justin Roberts, University of California at San Diego: *Rozansky-Witten theory*; Dylan Thurston, Harvard University: *How efficiently do 3-manifolds bound 4-manifolds?* Ulrike Tillman, University of Oxford: *The topology of the space of strings*; Alain Valette, Université de Neuchatel: *Vanishing results for the first L2 Betti number of a group*; Karen Vogtmann, Cornell University: *Graph homology and outer space*.

The forty-second Cornell Topology Festival will be held in early May 2004. (Next year's schedule will be posted at www.math.cornell.edu/~festival/.)

Analysis Seminar

September 2002

Bent Ørsted, University of Southern Denmark and Cornell University: *Some analysis aspects of the minimal representation of O(p,q)*

Irina Mitrea, Cornell University: *On elliptic Dirichlet problems in multi-connected domains*

Alexander Meadows, Cornell University: *The quest for singular solutions of a semilinear elliptic equation on domains of* R^n

Alexander Bendikov, Cornell University: *Ultracontractivity and embedding into* L^∞

October 2002

Robert Strichartz, Cornell University: *Power series on the Sierpinski gasket*

Mikhail Safonov, University of Minnesota: *Harmonic analysis of second order elliptic and parabolic equation*

Martin Dindos, Cornell University: *Large solutions for Yamabe and similar problems on domains in Riemannian manifolds*

November 2002

Laurent Saloff-Coste, Cornell University: *On the spectral gap of operators invariant under a quasi-transitive group action*

Todd Kemp, Cornell University: *Strong hypercontractivity in holomorphic Clifford algebras*

Clifford Earle, Cornell University: *The isometries between some* L^1 *spaces of meromorphic quadratic differentials on compact Riemann surfaces*

Matthew Fickus, Cornell University: *Generalizing orthogonal bases using classical physics*

December 2002
Wolfgang Staubach, University of Toronto (Canada): *Wiener path integrals and the fundamental solution for the Heisenberg Laplacian*

January 2003
Camil Muscalu, UCLA: *On some multilinear singular integrals in Fourier analysis*

Marcus Khuri, University of Pennsylvania: *The local isometric embedding problem for 2-dimensional Riemannian manifolds*

February 2003
Bing Cheng, Harvard University: *Differential Harnacks for the Ricci flow*

Dimitri Gioev, New York University: *Szego type asymptotics for integral operators with discontinuous symbols and inequalities between moduli of continuity of $L^p(R^d)$ functions and tail integrals of their Fourier transforms*

March 2003
Kasso Okoudjou, Georgia Institute of Technology: *Modulation spaces: sufficient conditions for membership and applications to pseudodifferential operators*

Laurent Saloff-Coste, Cornell University: *Computing spectral radii*

April 2003
Irina Mitrea, Cornell University: *Estimating the norms of singular integrals and their inverses*

Oleg Kovrijkine, Massachusetts Institute of Technology: *Periodizations over integer lattices*

Jaigyoung Choe, Stanford University and Seoul National University: *Relative isoperimetric inequality: an extension of the classical isoperimetric inequality*

Dorina Mitrea, University of Missouri at Columbia: *2D potential theory via harmonic analysis techniques*

Computational and Commutative Algebra Seminar

September 2002
Irena Peeva, Cornell University: *Open problems on generators of toric ideals* (in two parts)

October 2002
Christopher Francisco, Cornell University: *Hilbert functions and the Eisenbud-Green-Harris conjecture*

November 2002
Michael Stillman, Cornell University: *Resolutions* (in two parts)

January 2003
Jason Starr, Massachusetts Institute of Technology: *Rationally connected varieties and sections of algebraic fibrations*

February 2003
Edward Swartz, Cornell University: *Face rings of simplicial complexes*

Christopher Francisco, Cornell University: *Almost complete intersections*

Achilleas Sinefakopoulos, Cornell University: *Generic initial ideals* (in four parts)

April 2003
Steven Sinnott, Cornell University: *Points in P^2 and curves in P^3* (in four parts)

Discrete Geometry and Combinatorics Seminar

September 2002
Edward Swartz, Cornell University: *Topological representations of matroids*

Sam Hsiao, Cornell University: *Structure of the peak Hopf algebra*

Richard Pollack, New York University: *On the Betti numbers of semi-algebraic sets*

Károly Bezdek, Eötvös University, Budapest (Hungary): *On the Petty numbers of normed spaces*

October 2002
Robert Connelly, Cornell University: *Rigidity and the Kneser-Poulsen conjecture*

Robert Connelly, Cornell University: *Unique factorization and rigidity*

Stephanie van Willigenburg, University of British Columbia: *Acyclic graphs and excedence permutations*

Aleksandar Donev, Princeton University: *Jamming in hard-sphere packings*

November 2002
Louis Billera, Cornell University: *Some curious properties of the descent-to-peak map*

Kristin Camenga, Cornell University: *Euler-like relations for angle sums: geometry meets combinatorics*

December 2002
Sue Whitesides, McGill University: *Box visibility graphs*

January 2003

Károly Bezdek, Eötvös University, Budapest (Hungary) and Cornell University: *The Kneser-Poulsen conjecture for spherical polytopes*

John Hubbard, Cornell University: *The radius of injectivity of a quasi-Fuchsian manifold* (in two parts)

February 2003

Edward Swartz, Cornell University: *Representation of matroids*

Mike Develin, University of California at Berkeley: *LP-orientations of cubes and crosspolytopes*

March 2003

Jean-Noel Roux, Institut Navier (France): *Geometry and mechanics of model granular packings*

April 2003

Matthias Beck, SUNY at Binghamton: *Brion's theorem and its applications*

Roland Roeder, Cornell University: *The combinatorial aspects of Andreev's characterization of hyperbolic polyhedra*

Allen Back, Cornell University: *Group rings and global rigidity of symmetric tensegrities*

May 2003

Kalle Karu, Harvard University: *On rational and nonrational polytopes*

Igor Rivin, Temple University: *Measuring ellipsoids*

Dynamical Systems Seminar

September 2002

Rodrigo Perez, Cornell University: *Finite recurrence patterns in the quadratic family*

Jean-Yves Briend, Université de Provence: *The uniqueness of the maximizing measure for holomorphic maps of $P_k(C)$*

Yulij Ilyashenko, Cornell University: *Persistence problems for complex foliations and KS property of the Hénon mappings*

October 2002

Lasse Rempe, Christian-Albrechts-Universität zu Kiel (Germany): *External rays in the exponential family*

Sylvain Bonnot, Cornell University: *Value distribution for sequences of rational mappings*

Adrien Douady, Université Paris-Sud (France): *Polynomial vector fields: an application*

November 2002

Serge Cantat, Université de Rennes I (France): *Anosov and pseudo-Anosov holomorphic dynamics on compact complex surfaces*

Roman Fedorov, University of Chicago: *Number of orbital topological types of planar polynomial vector fields modulo limit cycles*

Adrien Douady, Université Paris-Sud (France): *News from Toronto*

Jane Wang, Cornell University: *Glider, falling paper and flapping flight*

Robert Gilmour, Cornell University: *Electrical restitution, memory and cardiac arrhythmias*

December 2002

Alexander Bufetov, Princeton University: *Interval exchange transformations and the Teichmüller flow*

February 2003

John Guckenheimer, Cornell University: *Folded singularities in singularly perturbed systems*

Rodrigo Perez, Cornell University: *Iterated monodromy groups: an expository account* (in two parts)

March 2003

Martin Wechselberger, Ohio State University: *Studying canards in R^3 using geometric singular perturbation theory and blow-ups*

Alexander Vladimirsky, Cornell University: *Computing invariant manifolds for dynamical systems with multiple time-scales*

April 2003

Kai-Uwe Bux, Cornell University: *Groups of intermediate growth*

Rodrigo Perez, Cornell University: *Thurston maps*

John Smillie, Cornell University: *One-dimensional techniques in two-dimensional dynamics*

Finite Element Seminar

September 2002

Lars Wahlbin, Cornell University: *FEM for strongly damped wave equations* (in two parts)

Aaron Solo, Cornell University: *FEM error estimates for wave equations* (in two parts)

October 2002

Al Schatz, Cornell University: *Maximum norm estimates on highly refined grids* (in two parts)

Zhimin Zhang, Wayne State University: *A posteriori error estimators on meshes with little (but some) structure*

November 2002

JaEun Ku, Cornell University: *Least squares finite element methods*

Varis Carey, Cornell University: *An introduction to finite element methods for fourth-order elliptic problems* (in two parts)

December 2002

Johnny Guzman, Cornell University: *Discontinuous Galerkin methods*

January 2003

Dmitriy Leykekhman, Cornell University: *Localization properties of fully discrete FEM for parabolic problems*

February 2003

Varis Carey, Cornell University: *An optimal control approach to a posteriori estimation*

Johnny Guzman, Cornell University: *Meshless Galerkin methods*

Alan Demlow, Cornell University: *Viscosity solutions for mean curvature flows*

March 2003

Aaron Solo, Cornell University: *Hyperbolic conservation laws* (in two parts)

April 2003

Alan Demlow, Cornell University: *Numerical methods for mean curvature flow*

Varis Carey, Cornell University: *Calculation of boundary fluxes*

Al Schatz, Cornell University: *Local L_p estimates for the finite element estimates*

Alan Demlow, Cornell University: *Pointwise estimates on general meshes*

Graduate Probability Seminar

January 2003

Melanie Pivarski, Cornell University: *Evolving sets and mixing*

February 2003

Nathanael Berestycki, Cornell University: *Important facts on Brownian local time*

Lee Gibson, Cornell University: *The number of visited sites and the method of enlargement of obstacles*

Michael Kozdron, Cornell University: *Green's function estimates with applications to loop-erased random walk*

José Ramírez, Cornell University: *Gaussian unitary ensemble*

March 2003

Hasanjan Sayit, Cornell University: *Abstract Wiener space*

April 2003

Yan Zheng, Cornell University: *Local characteristics of semimartingales*

Christian Benes, Cornell University: *Strong approximation of Brownian motion by random walk*

Sharad Goel, Cornell University: *Mixing times and Sobolev-type inequalities*

May 2003

Jesus Rodriguez, Cornell University: *A partial introduction to financial asset pricing theory*

Lie Groups Seminar

September 2002

Nolan Wallach, University of California, San Diego: *Holonomic continuation of Jacquet integrals*

Bent Ørsted, University of Southern Denmark and Cornell University: *The Gromov norm of the Kaehler class and the Maslov index*

October 2002

Victor Kac, Massachusetts Institute of Technology: *Quantum reduction*

Oleg Chalykh, Loughborough University and Cornell University: *Cherednik algebras and differential operators on singular algebraic varieties* (in two parts)

November 2002

Jonathan Weitsman, University of California, Santa Cruz: *Lattice points in convex polytopes, signature operators, and multidimensional Euler-MacLaurin formulas*

Dan Ciubotaru, Cornell University: *Unitary spherical dual for p-adic groups*

Joshua Lansky, Bucknell University: *K-types and base change for $U(3)$*

Farkhod Eshmatov, Cornell University: *Regular algebras and noncommutative spaces*

January 2003

Alexei Oblomkov, Massachusetts Institute of Technology: *Symmetric spaces and orthogonal polynomials in the classical and quantum cases*

Milen Yakimov, Cornell University: *A Kostant type finiteness for the Kazhdan-Lusztig tensor product*

February 2003

Julianna Tymoczko, Princeton University: *An introduction to Hessenberg varieties*

Indira Chatterji, Cornell University: *On the exceptional group $SL_3(\mathbf{O})$*

Patrick Iglesias, University of Provence and Cornell University: *$SL(2,\mathbf{R})$-invariant dynamical systems on the Poincaré disc: an illustration of the moment map*

March 2003

Karl-Hermann Neeb, Darmstadt: *Period maps in infinite-dimensional Lie theory*

Patrick Iglesias, University of Provence and Cornell University: *Extension of the moment map to spaces which are not manifolds, and coadjoint orbits*

April 2003

David Vogan, Massachusetts Institute of Technology: *Cutting and pasting unitary representations*

Yi Lin, Cornell University: *Symplectic Hodge theory and the equivariant $d\delta$-lemma*

Vladimir Retakh, Rutgers University: *Quasideterminants and their applications*

Reyer Sjamaar, Cornell University: Kaehler potentials on orbits of Borel subgroups

Logic Seminar

September 2002

Denis Hirschfeldt, University of Chicago: *Classes of degrees and the complexity of model-theoretic constructions* (in four parts)

Anil Nerode, Cornell University: *Automata theory, introduction*

Adam Barth, Cornell University: *Finite automata* (in two parts)

October 2002

Antonio Montalban, Cornell University: *Generalized finite automata*

Yuval Gabay, Cornell University: *Strong minimal covers and weakly recursive sets*

Antonio Montalban, Cornell University: *Monadic second order logic of strings*

Noam Greenberg, Cornell University: *Namba forcing* (in two parts)

Peter Cholak, University of Notre Dame: *Orbits of computably enumerable sets* (in two parts)

Christopher Hardin, Cornell University: *Buchi automata*

Russell Miller, Cornell University: *Order computable sets* (in two parts)

November 2002

Noam Greenberg, Cornell University: *Buchi automata* (in two parts)

Dexter Kozen, Cornell University: *Some results in dynamic model theory*

Russell Miller, Cornell University: *Games on finite graphs* (in two parts)

Richard Shore, Cornell University: *Intrinsically Pi-1-1 relations and paths through (Kleene's) 0* (in two parts)

January 2003

Itay Ben-Yaacov, University of Paris and University of Illinois at Urbana: *Positive model theory*

Bakhadyr Khoussainov, University of Auckland (New Zealand): *Automatic structures*

Bakhadyr Khoussainov, University of Auckland (New Zealand): *Computably enumerable algebras: expansions, finite presentations and isomorphisms*

February 2003

Yuval Gabay, Cornell University: *Rabin automata* (in two parts)

Antonio Montalban, Cornell University: *Embedding jump upper semilattices in D* (in two parts)

Yuval Gabay, Cornell University: *Rabin automata and S2S*

Noam Greenberg, Cornell University: *Embedding quasilattices in the r.e. degrees* (in three parts)

March 2003

Vivienne Morley, Cornell University: *Decidability applications of Rabin automata and S2S* (in two parts)

Christopher Hardin, Cornell University: *Kleene algebras with tests* (in three parts)

Barbara Csima, University of Chicago: *Computability theory for differential geometry*

April 2003

Joseph Miller, University of Indiana at Bloomington: *Degrees of unsolvability of continuous functions* (in two parts)

Richard Shore, Cornell University: *The borderline between decidability and undecidability in degree structures*

Richard Shore, Cornell University: *The undecidability of the two quantifier theory of D with jump and join* (in two parts)

Noam Greenberg, Cornell University: *The covering lemma* (in three parts)

Mathematics Education Occasional Seminar

October 2002

David Henderson, Cornell University: *Educational mathematics*

Homer White, Georgetown College and Cornell University: *More veterum geometrarum ("In the manner of the ancient geometers")*

November 2002
Daina Taimina, Cornell University: *Creativity in mathematics*
Avery Solomon, Cornell University: *The act of creation: a continuing discussion of discovery and invention in mathematics*

February 2003
Thomas Rishel, Weill Cornell Medical College-Qatar: *Teaching mathematics in the Middle East: What's the same? What's not?*

Number Theory and Algebraic Geometry Seminar

January 2003
Jason Martin, Cornell University: *Quadratic reciprocity*
Jason Martin, Cornell University: *Hensel's lemma*
Jeffrey Mermin, Cornell University: *Introduction to schemes*

February 2003
Jeffrey Mermin, Cornell University: *More schemes*
Henri Johnston, Cornell University: *Structure of p-adic units* (in three parts)
Jason Martin, Cornell University: *Some one-dimensional schemes in number theory* (in two parts)
Justin Sinz, Cornell University: *The Hilbert symbol* (in two parts)
Jeffrey Mermin, Cornell University: *First properties of schemes*
Jeffrey Mermin, Cornell University: *Second properties of schemes*
Jason Martin, Cornell University: *Quadratic forms*
Justin Sinz, Cornell University: *Third properties of schemes*

March 2003
Steven Sinnott, Cornell University: *More properties of schemes*
Justin Sinz, Cornell University: *Introduction to Adeles*
Jason Martin, Cornell University: *Adeles and ideles*
Jason Martin, Cornell University: *Quadratic forms over* Q_p
Jeffrey Mermin, Cornell University: *Second properties of schemes*
Jeffrey Mermin, Cornell University: *Still scheming*

April 2003
Jason Martin, Cornell University: *Modular forms*
Steven Sinnott, Cornell University: *Something from Hartshorne*
Jeffrey Mermin, Cornell University: *More on modular forms*
Henri Johnston, Cornell University: *Modular forms continued*
Jason Martin, Cornell University: *Proper morphism of schemes*
Jason Martin, Cornell University: *More on modular forms*
Jason Martin, Cornell University: *Yet again, modular forms*
Steven Sinnott, Cornell University: *Scheming*
Jeffrey Mermin, Cornell University: *Dirichlet L functions*
Jason Martin, Cornell University: *Hasse-Weil L functions*

May 2003
Jason Martin, Cornell University: *G.R.H.*

Oliver Club

September 2002
Sergiu Klainerman, Princeton University: *Mathematical problems of general relativity*
William Thurston, University of California, Davis: *The genus of curves in 3-manifolds is NP-complete*
Nolan Wallach, University of California, San Diego: *The structure of the ring of quasi-symmetric polynomials*
Michael Taylor, University of North Carolina, Chapel Hill: *Analysis on rough Riemannian manifolds*
Jean-Yves Briend, Université de Provence: *The equilibrium measure of holomorphic self maps of* $P_k(C)$

October 2002
Victor Kac, Massachusetts Institute of Technology: *Boson-fermion correspondence*
Bent Ørsted, University of Southern Denmark and Cornell University: *The Bargmann transform*
Indira Chatterji, Cornell University: *The rapid decay property for discrete groups*
Mikhail Safonov, University of Minnesota: *Local and asymptotic behavior of solutions to elliptic and parabolic equation*
Vincent Guedj, Université de Toulouse (France): *A new approach to the Russakovski measure*
Jonathan Weitsman, University of California, Santa Cruz: *The topology of Hamiltonian loop group spaces*

November 2002
Adrien Douady, Université Paris-Sud (France): *The present state of the measure zero conjecture for Julia sets*
Johan de Jong, Massachusetts Institute of Technology: *Rational connectivity and spaces of rational curves*
Alex Martsinkovsky, Northeastern University: *Recent developments in sheaves*

December 2002
Irena Peeva, Cornell University: *Hilbert schemes*

January 2003
Itay Ben-Yaacov, University of Paris and University of Illinois at Urbana: *Extending the scope of independence theory*
Oleg Chalykh, Moscow State University and Cornell University: *Commutative rings of differential operators*

February 2003
Eric Bedford, Indiana University: *Dynamics of rational mappings of the plane*
George Willis, University of Newcastle: *A canonical form for automorphisms of totally disconnected groups*
Ricardo Nochetto, University of Maryland at College Park: *Surface motion by surface diffusion*

March 2003
Cristian Popescu, Johns Hopkins University: *Stark-type conjectures "over Z"*
Peter Abramenko, University of Virginia: *On finite and elementary generation of $SL_2(R)$*
Kai-Uwe Bux, Cornell University: *An introduction to Thompson's group F*
Lai-Sang Young, New York University: *Strange attractors in periodically kicked systems*

April 2003
David Vogan, Massachusetts Institute of Technology: *431 reasons to love unitary representations*
Patrick Iglesias, University of Provence and Cornell University: *Origins of symplectic geometry*
Vladimir Retakh, Rutgers University: *Noncommutative algebra and geometry: a down-to-earth approach*
James Stasheff, University of Pennsylvania: *A survey of cohomological physics*

May 2003
Dror Bar-Natan, Hebrew University and University of Toronto: *The unreasonable affinity of knot theory and the algebraic sciences*

Olivetti Club

September 2002
Michael Kozdron, Cornell University: *The Loewner equation and an introduction to SLE*
Noam Greenberg, Cornell University: *Nullstellensatz — like you've never seen before*

October 2002
Alexander Meadows, Cornell University: *Brower, a beautiful mind and birthday cakes*
Yuval Gabay, Cornell University: *The generalized liar*
John Hubbard, Cornell University: *The etale topology: a paean in honor of Grothendieck*
Christian Benes, Cornell University: *An introduction to random walk*

November 2002
Todd Kemp, Cornell University: *Through the looking glass: an introduction to quantum and noncommutative analysis*
Bryant Adams, Cornell University: *Grey areas of self-replication*
Yi Lin, Cornell University: *Convexity property of moment maps*
Jean Cortissoz, Cornell University: *Nonstandard analysis*

December 2002
Spencer Hamblen, Cornell University: *The Conway-Schneeberger fifteen theorem*

January 2003
John Hubbard, Cornell University: *Classical mechanics: completely integrable systems and the KAM theorem*

February 2003
Noam Greenberg, Cornell University: *Non-distributive lattices and generalized recursion theory*
Jessica Zuniga, Cornell University: *Balanced incomplete block designs and projective geometry*
Todd Kemp, Cornell University: *Weird probability*

March 2003
Jean Cortissoz, Cornell University: *The Poincaré conjecture in dimension greater than 4*
Franco Saliola, Cornell University: *Quivers and Gabriel's theorem*

April 2003
Justin Sinz, Cornell University: *How not to be solved*
Drew Armstrong, Cornell University: *A stupendous classification of projective planes*
Henri Johnston, Cornell University: *(Non-)unique factorization and Fermat's last theorem*
Roland Roeder, Cornell University: *Making hyperbolic polyhedra — a computational approach*
Jason Martin, Cornell University: *The Birch and Swinnerton-Dyer Conjecture*

May 2003
Arthur Jaffe, Harvard University: *Dirac operators arising from quantum fields*

Probability Seminar

September 2002

Wenbo V. Li, University of Delaware: *The exit time of Brownian motion from unbounded domain*

Eugene Dynkin, Cornell University: *Superdiffusions and positive solutions of semilinear partial differential equations*

Harry Kesten, Cornell University: *Particles that interact with a "gas" of random walks*

October 2002

Iljana Zähle, Cornell University: *A functional central limit theorem for the branching random walk*

Michael Cranston, University of Rochester: *Lyapunov exponent for the parabolic Anderson model*

Keith Crank, National Science Foundation: *Interruptible exact sampling in the passive case*

November 2002

Richard Durrett, Cornell University: *Rigorous results for the Callaway-Hopcroft-Kleinberg-Newman-Strogatz percolation model*

Gyula Pap, Southern Illinois University: *Brownian motions on matrix groups*

Gregory Lawler, Cornell University: *Conformal restriction properties*

Krishna Athreya, Cornell University: *Harris irreducibility of iterates of random S-unimodal interval maps*

December 2002

Tobias Kuna, University of Bielefeld (Germany): *A Bochner type theorem for measures on configuration spaces*

February 2003

Ben Morris, University of California at Berkeley: *Evolving sets and mixing*

Nadav Shnerb, Bar Ilan University (Israel): *Discreteness, noise and pattern formation in reactive systems*

Carl Mueller, University of Rochester: *The wave equation with a multiplicative noise term*

Robert Adler, Technion: *Gaussian random fields on manifolds*

March 2003

Gregory Lawler, Cornell University: *Brownian loop soup*

Jason Schweinsberg, Cornell University: *Approximating the effects of beneficial mutations by coalescents with multiple collisions*

Iljana Zähle, Cornell University: *Genealogies in the stepping stone model*

April 2003

Jose Ramirez, Cornell University: *Superdiffusivity of two-dimensional lattice gas models*

Gerard Ben Arous, New York University: *Aging and slow diffusion in disordered media*

Paul Jung, University of California, Los Angeles: *Invariant measures of the exclusion process*

Mike Keane, Wesleyan University: *Tubular recurrence*

Timo Seppalainen, University of Wisconsin at Madison: *Hydrodynamic limit and fluctuation results for Hammersley's process*

May 2003

Vlada Limic, University of British Columbia and Cornell University: *Rigorous results for the NK model*

Topology and Geometric Group Theory Seminar

September 2002

William Thurston, University of California, Davis: *When is a three-manifold virtually Haken?*

Indira Chatterji, Cornell University: *On and around the Bass conjecture*

Edward Swartz, Cornell University: *Arrangements of homotopy spheres: part 1 1/2*

October 2002

James Conant, Cornell University: *Torsion invariants of knots*

Tara Brendle, Cornell University: *On the linearity question for mapping class groups* (in two parts)

Kiyoshi Igusa, Brandeis University: *Combinatorial Miller-Mumford-Morita classes and the Witten-Kontsevich conjecture*

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

Hee Oh, Princeton University: *Uniform exponential growth for linear groups*

November 2002

Kai-Uwe Bux, Cornell University: *Higher generation in braid groups*

James Conant, Cornell University: *A tour of knot theory from the perspective of the simplest Vassiliev invariant*

Jean-Francois Lafont, SUNY Binghamton: *Rigidity results for certain singular spaces*

December 2002

Abhijit Champanerkar, Columbia University: *The next simplest hyperbolic knots*

January 2003

Nathan Dunfield, Harvard University: *3-manifolds and groups of homeomorphisms of the circle*

February 2003

Kai-Uwe Bux, Cornell University: *An Out(F_n)-analogue for the Johnson homomorphism*

Indira Chatterji, Cornell University: *Twisted idempotent conjectures*

Tara Brendle, Cornell University: *Relations in the Torelli group*

March 2003

Olga Buse, SUNY at Stony Brook: *From J-holomorphic curves to the topology of symplectomorphism groups*

Melanie Stein, Trinity College: *Establishing nonexistence of laminations and foliations in 3-manifolds using group actions on order trees*

Greg Kuperberg, University of California at Davis: *Perturbative Chern-Simons invariants are finite type*

Ilya Kapovich, University of Illinois at Urbana-Champaign: *On generic properties of one-relator groups*

Kevin Wortman, University of Chicago: *On quasi-isometric rigidity of S-arithmetic classes*

April 2003

Matthew Horak, Cornell University: *Relations among graph complexes*

James Conant, Cornell University: *Morita's trace cocycles in H*[Out(F_n)]*

Ian Leary, University of Southampton: *Finiteness conditions and K_0 of group algebras*

James Belk, Cornell University: *Almost convex groups*

James Stasheff, University of Pennsylvania: *Poisson sigma models and L_∞ algebras*

Kim Ruane, Tufts University: *Boundaries of certain 2-dimensional CAT(0) groups*

Chris Leininger, Columbia University: *On groups generated by two positive multi-twists*

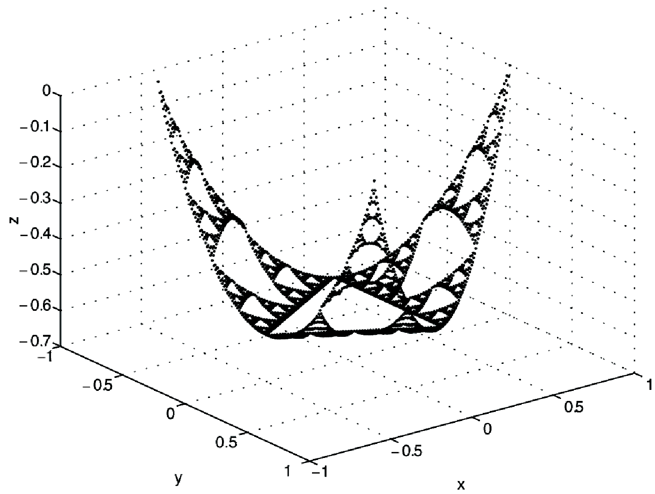
Research Experiences for Undergraduates Program

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

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

Analysis on Fractals

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



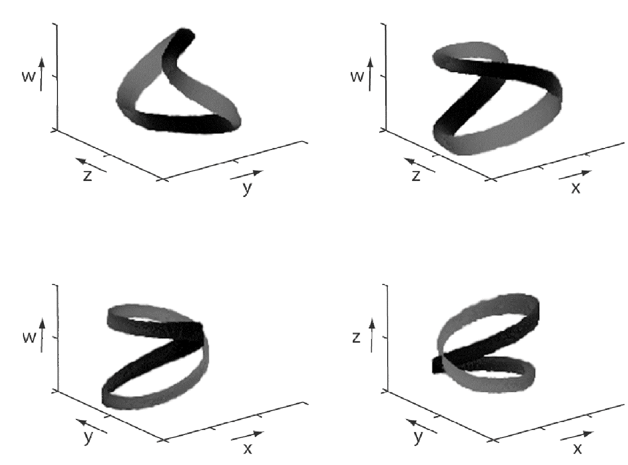
The graph of a solution of a nonlinear differential equation on the Sierpinski gasket fractal, created by Carto Wang.

Dynamical Systems

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

Visualizing Dynamics in 4-Space

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

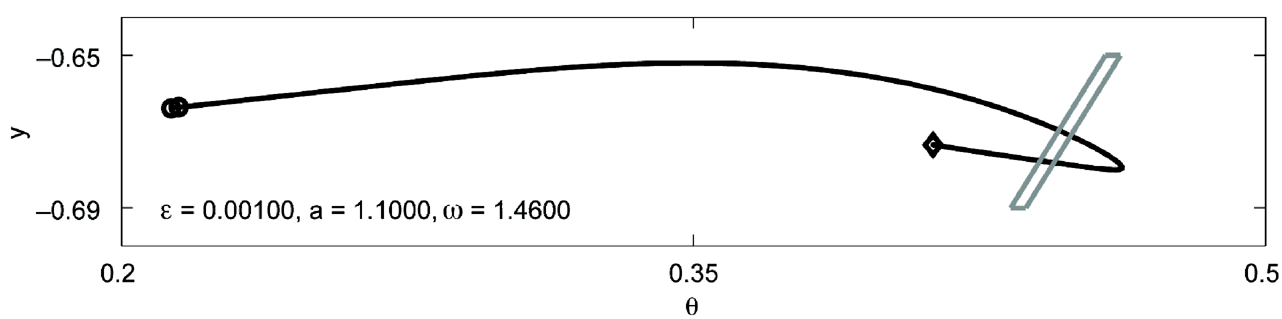


Projections from $\mathbf{C}^2$ to $\mathbf{R}^3$ of the level surfaces for the Green's functions associated with the Henon mapping, which were created in the Visualizing Dynamics in 4-Space project.

Another problem arising from the study of Hénon mappings led to a very interesting detour into the theory of Diophantine approximation. A great deal is known about the approximation of a single irrational number by rational numbers, thanks to the theory of continued fractions. There is an analogous procedure, called the Farey triangle, for a pair of irrational numbers, but how well does it work? Justin Grosslight (Stanford University) and Asher Walkover (Cornell University) explored this problem. First they gathered experimental evidence that it does not work well at all, in that a certain sequence of triangles that must converge to a point for the method to be effective actually converges to a line. By the end of the summer, Asher Walkover had a proof that this happens with probability one. As often happens in mathematical research, someone else was onto the same result. It turns out that Nogeira had published a 30-page paper in 1995 proving this result. But Walkover's proof is better, shorter and more direct, and it will be submitted for publication.

Summer 2003

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



The forced van der Pol equation is the nonlinear system of differential equations in which the phenomenon of "chaos" was first described. The 2002 REU project supervised by Guckenheimer and Weckesser contributed to a deeper, more complete understanding of this system. The figure shows an example of a "horseshoe" return map of the forced van der Pol system. This map shows where chaotic trajectories occur in the system.

Community Outreach

Math Explorers Club

The Math Explorers Club is an outreach activity for high school students, supported by the department's VIGRE grant. In fall 2002, two six-week sessions were held on Saturday mornings at Cornell in the same format as the previous two years. Students were presented with a mathematical idea, problem, or exploration during a one-hour period, followed by a half-hour break for refreshments, and a second one-hour period devoted to problem solving or computer lab activities. Robert Strichartz led a session on fractal tilings, and Brian Smith led a session on relativity. These modules were sparsely attended, by six or fewer students, and it is hard to ask someone to devote their time and energy to preparing talks for such a small audience, so we decided to change the format of the Math Explorers Club in the spring.

After some discussions with Ithaca High School, the club was reformulated as an after-school activity held at the high school. Beginning on February 26, Rick Durrett gave a module on cellular automata. To make the content available to students who were not able to attend, notes were put on a web page and explorations were done with Java applets. The response to the new program was hardly overwhelming. Nine students came to at least one session. However, at this point in the year many students had their schedules already set, so we hope to have more success offering a selection of modules in the fall. The current plan is to offer three modules in the fall and three in the spring, taught by graduate students and faculty. By delivering the content through a web site, we hope to reach students throughout the country. The scope and content of these activities will depend on our ability to raise money from Cornell sources and funding agencies.

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 undergraduate main stream courses. During the 2002–2003 academic year, three Cornell graduate students — Kristin Camenga, Todd Kemp, and Jeffrey Mermin — organized the seminar. The class met for three periods a week during school hours at the high school, and was attended by ten IHS students (nine seniors and one junior).

The first six months were taught as three two-month modules, each by one of the graduate students. In September and October, Todd Kemp taught a module on random walks, grapshs and electric network theory. Topics included discrete harmonic functions, Kirkhoff's laws, the interplay between electric networks and random walks, Polya's results on recurrence or transience of random walks on integer lattices, and random walks on trees. In November and December, Jeffrey Mermin gave a six-week overview of cryptology. Topics included substitution ciphers, detailed analysis of the Vigenere cipher, shift registers, a brief description of DES, and several public-key protocols, including RSA and Diffie-Hellman. Also discussed were complexity analysis of encryption and decryption algorithms, and the difference between known plain- and known cipher-text attacks throughout. Finally, in January and February, Kristin Camenga taught a module on graph theory. Topics included Eulerian circuits and Hamiltonian cycles, edge and vertex coloring, graph Ramsey theory, and algorithms for shortest paths and minimum spanning trees.

During the last three months of the school year, the students worked on individual projects with direction from the organizers. Students chose projects ranging from random walks on groups to cellular automata, compression algorithms, and cracking random number generators. The seminar was consistently well attended with no attrition, and the Cornell organizers and IHS administrators are extremely pleased with its success. Fifteen students are interested in taking the course next year.

Cornell/Schools Mathematics Resource Program

Initiated in 1985 by Cornell's Committee on Education and the Community, the Cornell/Schools Mathematics Resource Program was developed and facilitated by David Henderson and Avery Solomon and has received continued funding and support from Cornell. The CSMRP is aimed at improving the state of mathematics teaching and learning by providing in-service mathematics courses and workshops for teachers, researching and developing materials for the classroom that follow a broader approach to mathematics, and initiating and supporting cooperative efforts between Cornell University and local schools.

The Saturday workshops during 2002–2003 focused on helping teachers to explore the challenges of the new 10th grade state math assessment. Teachers from several school districts shared their approaches, problems, successes and needs with the group. We discussed issues of tracking, curriculum and assessment. David Henderson, Daina Taimina, David Bock and Avery Solomon gave presentations.

The program worked closely with the Ithaca High School Mathematics Department to implement their pilot program teaching a new, NSF-funded curriculum. Almost every mathematics teacher at the high school has been involved, along with all the Cornell students who will be student teaching next year. The CSMRP also helped to initiate a pilot math club at Boynton Middle School, with the help of two sixth-grade teachers and a student teacher. Sessions for the 6th graders included problem solving, explorations on Geometer's Sketchpad, labyrinths, magic squares and math-related games from around the world. Avery Solomon also presented two sessions at the Corning Community College math day to about 100 high school students.

Michael D. Morley Senior Prize in Mathematics

Robert Connelly presented the Michael D. Morley Senior Prize in Mathematics to Peter Speh, a senior at Ithaca High School who demonstrated substantial interest and significant native ability in mathematics. Peter was one of four finalists chosen by faculty at Ithaca High School. A panel made up of Michael Morley, Lawren Smithline and Kristin Camenga interviewed the four finalists, posing thought-provoking mathematical problems designed to test for cleverness and the ability to "think like a mathematician." The prize, formerly known as the Ithaca High School Senior Prize, is funded largely by faculty contributions. Lawren Smithline won the prize as an Ithaca High School student one of the first years it was given.

Mathematics Awareness Month

The American Mathematical Society encourages universities to support the idea of a math awareness week in April at area schools, and Cornell has participated in this practice since its inception. Michael Perl, a student at Ithaca High School, won the Cornell-sponsored T-shirt design contest this year. The Departments of Mathematics at Cornell University and Ithaca High School underwrote the cost of producing 84 shirts that were distributed to staff and students at Cornell and area schools. At Ithaca High, students won the shirts as prizes for solving a math problem of the day, or a more extensive weeklong challenge.

Robert Strichartz, David Henderson and Avery Solomon were among several members of the Cornell Mathematics Department who gave talks in local math classrooms as part of Mathematics Awareness Month.

Freshman Math Prize Exam

The department sponsored the fourth annual Freshman Math Prize Exam this year. 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. This year, Daniel Goldin and Anna Sonkina tied for first prize, and third prize was awarded to Navin Sivakumar.

Cornell Teacher Education

Sponsored jointly by the departments of Mathematics and Education, this five-year program seeks to recruit and prepare students to become secondary mathematics teachers, allowing participants to attain a Master of Arts in Teaching and New York State certification. During the academic year, a successful search for new Science Education and Agricultural Education professors was completed.

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 26, 2003, the graduate students of the Cornell Mathematics Department once again participated in a day of hands-on workshops in mathematics for 7th, 8th, and 9th grade girls. The Mathematics Department sponsored a workshop on game theory, run by several students in the department. In the workshop *The Secret of Nim*, Kenneth Burns, Cynthia Bowers Francisco, Evgueni Klebanov, Melanie Pivarski, Maria Sloughter, and Treven Wall worked with a group of girls using M&Ms and pretzels to study the game of Nim. They started by having the girls pair up to play the 20 game: Starting at the number 20, each player takes turns subtracting an integer between 1 and 4 until zero remains; the player who ends at zero wins. After playing the game for a bit, the girls found the pattern and generalized it to similar games. Then the entire group challenged an "Expert" (one of the graduate students) to a game, and by correctly deciding whether or not to go first the girls defeated the Expert! From there the group moved on to two-pile Nim, where players take turns removing however many items they want from exactly one of two piles. The player who takes the last item wins. Some of the girls solved this and moved on to the three-pile case. After experimenting with different strategies for a while, the entire group challenged and defeated the Expert.

Mathematics Library

The Mathematics Library continues to have a high level of use. One often finds most of the library computers in use 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, who started the department colloquium series in 1891.

The Cornell Mathematics Library collection is one of the finest in the nation, supporting research and instruction in mathematics and statistics for the Cornell community. It consists of works on mathematics, statistics, applied mathematics, mathematics education and the history of mathematics. For undergraduates, 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.

An increasing portion of the library's collection of journals is now available both on paper and online to all Cornell users. A number of journals are now available *only* online. In these cases, the University Library has negotiated site license contracts that make the online-only option financially favorable and provide archival reliability. 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 some commercial publishers are pushing up the prices of their journals at a rate that is not sustainable. More on this can be found at www.library.cornell.edu/scholarlycomm/issues.html. The university-appropriated budget for the library continues to grow, but not as fast as the cost of journals from a few large commercial publishers. In stark contrast, independent, society, university press, and not for profit journals are increasing prices at a rate more consistent with library budget increases. Relatively few titles from a few large commercial publishers consume the majority of our appropriated budget.

Gifts have made the library endowment income the primary source of funds for the purchase of books. Thanks to the continued support of our donors, endowment income has grown from 1.5% of our budget in 1990 to 20% for the coming fiscal year. Gifts make the difference between an excellent library and a mediocre one.

The Mathematics Library encourages and welcomes all patrons in the Cornell community to use its resources. Reciprocal interlibrary loan agreements with other institutions make Cornell's resources available throughout the world and open the world to Cornell researchers. 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 World Wide Web.

The library staff consists of Steven Rockey, the 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 World Wide Web home page includes information on the Mathematics Library's services and 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, which was recently redesigned and relocated to www.library.cornell.edu/math/. Visit our library, our home page, or contact us electronically or by telephone to find out how the Mathematics Library can serve you.

Special Projects

Cornell is involved in a number of mathematics digitization projects (www.library.cornell.edu/digital/math-projects.html). An overview of worldwide mathematics digitization efforts is available at www.library.cornell.edu/math/digitalization.php. Below 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 with 19 journals at this writing. Project Euclid's mission is to advance scholarly communication in the field of theoretical and applied mathematics and statistics. Project Euclid is designed to address the unique needs of low-cost independent and society journals. Through a collaborative partnership arrangement, these 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 University Math Collection (library5.library.cornell.edu/math.html)

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 Math 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. Newer titles where copyright clearance is available are being added to the collection.

DML — Digital Mathematics Library (www.library.cornell.edu/dmlib/)

The very successful Cornell-coordinated planning of the DML is drawing to a close. DML coordination will continue under the auspices of the International Mathematical Union.

EMANI — Electronic Mathematics Archives Initiative (www.emani.org)

EMANI is a collaborative effort between the German scientific publisher Springer and the libraries at Cornell, Goettingen, Tsinghua (Beijing) and Orsay (Paris). 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.

The Faculty and their Research Areas

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.

James H. Bramble, Professor Emeritus; Ph.D. (1958) University of Maryland; Numerical solutions of partial differential equations.

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.

Marshall M. Cohen, Professor Emeritus; Ph.D. (1965) University of Michigan; Topology, geometric (and combinatorial) 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.

José F. Escobar, Professor; Ph.D. (1986) University of California at Berkeley; Partial differential equations; differential geometry.

Roger H. Farrell, Professor Emeritus; Ph.D. (1959) University of Illinois; Mathematical statistics, measure theory.

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.

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.

Harry Kesten, Professor Emeritus; Ph.D. (1958) Cornell University; Probability theory, limit theorems, percolation theory.

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.

G. Roger Livesay, Professor Emeritus; Ph.D. (1952) University of Illinois; Differential topology, group actions.

Michael D. Morley, Professor Emeritus; Ph.D. (1962) University of Chicago; Mathematical logic, model theory.

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

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

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

Lawrence E. Payne, Professor Emeritus; Ph.D. (1950) Iowa State University; Partial differential equations, ill posed and nonstandard problems.

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) University 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; Applied mathematics and differential equations.

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

Oscar S. Rothaus, Professor; Ph.D. (1958) Princeton University; Several complex variables, combinatorics, Sobolev inequalities.

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.

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

Moss E. Sweedler, Professor Emeritus; Ph.D. (1965) Massachusetts Institute of Technology; Algebra, algorithms.

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

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 and Network Administrator

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. Differential 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

Assistant 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), Internat. Math. Res. Notices **26** (2002), 1347–1396.

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

Cherednik algebras and differential operators on quasi-invariants (with P. Etingof and V. Ginzburg), Duke Math. J., to appear.

Morita equivalence for Cherednik algebras (with P. Etingof and V. Ginzburg), J. Reine Angew. Math., to appear.

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, to appear.

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.

Selected Publications

A locking-free finite element method for Naghdi shells (with T. Sun), J. Comp. and Applied Math. **89** (1997), 119–133.

Least squares for second order elliptic problems (with R. Lazarov and J. Pasciak), Comp. Meth. Appl. Eng. **152** (1998), 195–210.

Non-overlapping domain decomposition algorithms with inexact solves (with J. Pasciak and A. Vassilev), Math. Comp. **67** (1998), 1–20.

A negative-norm least squares method for Reissner-Mindlin plates (with T. Sun), Math. Comp. **67** (1998), 901–916.

Multigrid Methods; in Handbook for Numerical Analysis (with X. Zhang), P. Ciarlet and J. Lions, eds., North Holland, 250 pages.

Tara Brendle

VIGRE Assistant Professor of Mathematics

Currently I am interested in representations of mapping class groups of surfaces (particularly the linearity question) and in the Torelli subgroup of mapping class groups. I am also interested in applications to 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.

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.

Kenneth Brown

Professor and Chair of Mathematics

Until recently 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 which can be presented by means of a complete rewriting system.

I have recently incorporated methods of probability theory into my research. In work with L. Billera and P. Diaconis, for example, we combine tools from geometry, topology, and probability 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.

Random walks and hyperplane arrangements (with P. Diaconis), Ann. Prob. **26** (1998), 1813–1854.

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

Kai-Uwe Bux

H. C. Wang Assistant Professor of Mathematics

The underlying idea of geometric group theory is that groups are meant to act on geometric objects. The properties of the action can be used to study both the group and the geometry. From this point of view, the first step in understanding a group is to find a space on which it acts "nicely." Classical examples of this technique include the work on arithmetic and S-arithmetic groups by means of buildings and symmetric spaces, the study of mapping class groups via Teichmüller theory, and the results about outer automorphism groups of free groups via their actions on Culler-Vogtmann spaces.

Once a space X and an action $G \to \mathrm{Aut}(X)$ are chosen, there is still the problem of understanding the space. In this context, combinatorial Morse theory is an important tool: If there is a real-valued function $f : X \to \mathbf{R}$ on the space, whose level sets are invariant with respect to the group action, then the homotopy type of the space and of the sublevel sets $f^{-1}(-\infty, t)$ can be understood in terms of incremental changes as the value of t varies.

I have applied some of these ideas to solvable S-arithmetic groups over global function fields in order to determine their finiteness properties and geometric invariants — finiteness properties and geometric invariants extend and refine the notions of finite generation and finite presentability of groups.

Selected Publications

Finiteness properties of some metabelian S-arithmetic groups, Proceedings of the London Mathematical Society **75** (1997), 308–322.

The Bestvina-Brady construction revisited — geometric computation of Σ-invariants of right-angled Artin groups (with C. Gonzalez), Journal of the London Mathematical Society (2) **60** (1999), 793–801.

Orbit spaces of subgroup complexes and Morse theory, Topology Proceedings **24** (Spring 1999), 39–51.

Finiteness properties of soluble S-arithmetic groups — a survey; in Proceedings of the conference "Groups: Geometric and Combinatorial Aspects," Bielefeld, 1999, to appear.

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), FIM preprint 2002, submitted.

Atiyah's L^2-index theorem (with G. Mislin), Enseignement Mathematique, to appear.

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 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.

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.

James Conant

VIGRE Assistant Professor of Mathematics

I am interested in essentially all areas of mathematics although I tend to do research in areas closely related to low-dimensional topology, and especially to Vassiliev knot and three-manifold invariants. One of my favorite results, which is joint with Peter Teichner, is a characterization of when two knots share Vassiliev invariants up to a given degree in terms of ambient cobordism by certain 2-complexes called gropes. This can be found in our preprint, *Grope cobordism of classical knots*, available at arxiv.org. I am currently thinking about graph homology and operads. Karen Vogtmann and I have a preprint on the subject, *A Lie bialgebra structure on graphs and graph homology*, which is also available at arxiv.org.

Selected Publications

Fusion and fission in graph complexes, Pacific Journal of Mathematics **209** no. 2 (2003), 219–230.

Infinitesimal operations on chain complexes of graphs (with Karen Vogtmann), Mathematische Annalen, to appear.

New perspectives on self-linking (with Ryan Budney, Kevin Scannell and Dev Sinha), submitted.

On a theorem of Kontsevich (with Karen Vogtmann), submitted.

Grope cobordism and Feynman diagrams (with Peter Teichner), submitted.

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.

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), 87–97.

A rigorous numerical method for the global analysis of infinite dimensional discrete dynamical systems (with O. Junge and K. Mischaikow), submitted for publication.

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.

Martin Dindos

H. C. Wang Assistant Professor of Mathematics

Harmonic analysis is one of the pillars of modern PDE theory. In fact, most of the problems harmonic analysis deals with have their origins in PDEs. In return, harmonic analysis substantially contributes to the development of PDE by providing sharp and refined techniques such as pseudodifferential operators, singular and oscillatory integrals, etc.

For this reason, in my research I am sometimes interested in questions that originate purely in harmonic analysis, such as my Ph.D. thesis Hardy spaces and potential theory on C^1 domains in Riemannian manifolds that I wrote under Michael Taylor (UNC). In other instances I use harmonic analysis techniques to study PDE problems. (See the last two papers below.)

Harmonic analysis is particularly well suited for studying PDE on rough domains, i.e., domains whose boundary is not smooth. So far most work in this direction was done for linear elliptic PDEs. I am particularly interested in nonlinear problems, which still remain a great challenge.

Selected Publications

Filippov implicit function theorem for Quasi-Caratheodory functions (with V. Toma), Journal of Mathematical Analysis and Applications **214** (1997), 475–481.

On series with alternating signs in the Euclidean metric, Real Analysis Exchange **25** no. 2 (1999/2000), 599–616.

Existence and uniqueness for a semilinear elliptic problem on Lipschitz domains in Riemannian manifolds, Comm. PDE **27** (2002), 219–291.

Existence and uniqueness for a semilinear elliptic problem on Lipschitz domains in Riemannian manifolds II, Trans. AMS **355** (2003), 1365–1399.

Semilinear Poisson problems in Sobolev-Bessov spaces on Lipschitz domains (with M. Mitrea), Publicacions Mathematiques, submitted.

Richard Durrett

Professor of Mathematics

My research concerns problems in probability theory that arise from ecology and genetics. Much of this research has been carried out with biologists.

- In a decade-long collaboration with Simon Levin in Ecology and Evolutionary Biology at Princeton, I have written a number of papers concerning the effect of spatial structure on the outcome of ecological competition.

- With Rick Harrison in Ecology and Evolutionary Biology at Cornell, I have developed and analyzed stochastic spatial models for hybrid zones that he has studied experimentally.

- With Chip Aquadro in Molecular Biology and Genetics at Cornell, I have investigated the evolution of DNA repeat sequences and the use of polymorphism data to detect the footprints of adaptive evolution.

- With Steve Tanksley in Plant Breeding, I have worked to develop strategies for optimizing the construction of high-density linkage maps genetic markers, and for estimating the sample sizes needed to locate a gene within a specified distance on a chromosome.

- With Rasmus Nielsen in Biological Statistics and Computational Biology, I am developing 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.

My work with Simon Levin is partially supported by a subcontract to his Biocomplexity grant. My initiation into the mysteries of genetics was facilitated by an add-on to Aquadro's NIH grant, funded by an initiative to get mathematicians and computer scientists working with biologists. My current work with Aquadro and Nielsen is funded by a grant from a joint NIGMS/NIH program.

Selected Publications

Competition and species packing in patchy environments (with L. Buttel and S. Levin), Theor. Pop. Biol. **61**, 265–276.

Spatial models for hybrid zone evolution (with L. Buttel and R. Harrison), Heredity **84** (2000), 9–19.

Distribution and abundance of microsatellites in the yeast genome can be explained by a balance between slippage events and point mutations (with S. Kruglyak, M. Schug and C. F. Aquadro), Mol. Biol. Evol. **17** (2000), 1210–1219.

A simple formula useful for positional cloning (with K. Y. Chen and S. D. Tanksley), Genetics **160** (2002), 353–355.

Bayesian estimation of the number of inversions in the history of two chromosomes (with T. York and R. Nielsen), J. Comp. Bio., 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 recent monograph of Dynkin.

Selected Publications

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

Superdiffusions and removable singularities for quasilinear partial differential equations (with S. E. Kuznetsov), Communications on Pure and Applied Mathematics **49** (1996), 125–176.

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.

Clifford J. Earle

Professor 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.

José F. Escobar

Professor of Mathematics

My research has focused on the study of linear and non-linear partial differential equations arising in differential geometry. The basic purpose of geometry is to give a good description of a class of geometric objects. The geometric objects I study are the so-called Riemannian manifolds. These are spaces endowed with analytical structures, like the metric, which provide us with a way to measure lengths and angles. It is natural to study deformations of these structures to realize what properties in the space remain stable under such perturbations. The description of all these deformations is usually governed by differential equations. The curvature tensor of a Riemannian manifold (a measure for the "non-Euclideanness'' of a Riemannian space) usually makes such equations non-linear, although as in physics, most of them are of variational nature. I have been able to develop the existence theory of solutions to semilinear elliptic equations with non-linear boundary conditions. These equations appear in the problem of conformal deformation of a Riemannian metric on a manifold with boundary and in some non-linear problems in physics.

Selected Publications

The Yamabe problem on manifolds with boundary, J. Diff. Geom. **25** (1992), 21–84.

Conformal deformation of a Riemannian metric to a scalar flat metric with constant scalar curvature, Annals of Mathematics **136** (1992), 1–50.

Conformal deformation of a Riemannian metric to a constant scalar curvature metric with mean curvature on the boundary, Indiana U. Math. J. **45** no. 4 (1996), 917–943.

An isoperimetric inequality and the first Steklov eigenvalue, J. Func. Anal. **165** (1999), 101–116.

Conformal metrics on the ball with zero scalar curvature and prescribed mean curvature on the boundary, Journal of Functional Analysis, to appear.

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), Jour. Amer. Statist. Assoc. **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.

Matthew Fickus

VIGRE Assistant Professor of Mathematics

The field of harmonic analysis is composed of many branches. In the same way one may decompose a harmony into pure tones, linear algebra provides a formalism for breaking vectors apart into basis elements. My interests lie in further developing the theory of bases in both the pure and applied (signal processing) setting.

Specifically, I am studying bases of complex exponential functions on fractal measures with the goal of generalizing Fourier series. I also am interested in frames, a way of performing basis-type decompositions that allow redundancy. My hope is that redundant frame decompositions may be used to build error correction directly into Fourier and wavelet transforms, and thus help bridge the gap between channel and source coding.

Selected Publications

Finite normalized tight frames (with J. Benedetto), Advances in Computational Mathematics **18** (2003), 357–385.

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 recent years, I have been interested in properties of the Dirichlet form associated to pinned Brownian motion on loop groups. A long-range goal is proof of a Hodge-deRham theorem for these manifolds of maps. This has led, most recently, to a study of Dirichlet forms in holomorphic function spaces over a complex manifold.

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.

Logarithmic Sobolev inequalities on loop groups, J. Func. Anal. **102** (1991), 268–313.

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.

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

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 am interested in nonlinear elasticity and nonlinear analysis, with applications to flexible structures and solids, including biological filaments and martensitic phase transitions. The subject is a rich source of unsolved nonlinear problems in applied analysis and computation. The two primary goals of the work are to uncover new physical and/or mathematical phenomena and to develop efficient solution strategies for the analysis of such problems.

Selected Publications

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.

Hidden symmetry of global solutions in twisted elastic rings (with G. Domokos), J. Nonlinear Science **11** (2001), 47.

Material symmetry and chirality in nonlinearly elastic rods, Math. Mech. Solids, to appear.

A simple approach to the 1:1 resonance bifurcation in follower-load problems (with K. MacEwen), Nonlinear Dynamics, to appear.

David W. Henderson

Professor of Mathematics

I would classify my work as pertaining to aspects of mathematics that impinge on the teaching and learning of mathematics — the emphasis is on the mathematics not on education and thus I use the term, educational mathematics. My main theme 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. Other books are in process.

Selected Publications

I learn mathematics from my students — multiculturalism in action, For the Learning of Mathematics **16**, 2 (1996).

Experiencing Geometry in Euclidean, Spherical and Hyperbolic Spaces (with Daina Taimina), Prentice-Hall, 2001.

Crocheting the hyperbolic plane (with Daina Taimina), Mathematical Intelligencer **23** no. 2 (spring 2001), 17–28.

Review of Geometry: Euclid and Beyond by Robin Hartshorne, Bulletin of the AMS **39** (Oct. 2002), 563–571.

How to use history to clarify common confusions in geometry (with Daina Taimina), Chapter 1 of forthcoming MAA volume "Using Recent History in the Teaching of Mathematics," publication expected in fall 2003.

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 Beverly West), Texts in Applied Mathematics No. 5, Springer-Verlag, NY, 1991.

Differential Equations, A Dynamical Systems Approach: Higher Dimensional Systems (with Beverly West), Texts in Applied Mathematics No. 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

My research interests are several branches of dynamical systems, both in real and complex domains. They include: limit cycles in real and complex planes; analytic differential equations, with relations to complex analysis and algebraic geometry; local and nonlocal bifurcations and so on. Some main objects to study are: (1) Limit cycles of polynomial vector fields in the real plane. For instance, in *Finiteness Theorems for Limit Cycles*, I proved that for a *fixed* polynomial vector field the number of limit cycles is finite. (2) Geometric properties of foliations determined by analytic vector fields in the complex plane. (3) Bifurcations of planar polycycles (separatrix polygons). (4) New nonlocal bifurcations in higher-dimensional spaces, and many others.

Selected Publications

Finiteness Theorems for Limit Cycles, Amer. Math. Soc., Transl. Vol. 94, 1991, 288 pp.

Editor of *Nonlinear Stokes Phenomena*, Advances in Soviet Mathematics, Vol. 14, Amer. Math. Soc., 1993.

Editor of *Concerning Hilbert's 16th Problem* (with Yakovenko), Amer. Math. Soc., 1995, 219 pp.

Editor of *Differential Equations with Real and Complex Time*, a collection of papers, proceedings of the Steklov Institute, Vol. 213, 1996.

Nonlocal Bifurcations (with Li Weigu), Mathematical Surveys and Monographs **66**, Amer. Math. Soc., 1998.

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 equilibrium statistical mechanics (an area of mathematical physics). Recently, I am interested in the application of these processes to ecology and biology.

Selected Publications

The noisy voter-exclusion process, Stochastic Processes and Applications (2003), to appear.

Extremal reversible measures for the exclusion process, Journal of Statistical Physics (2003), to appear.

The quasi-symmetric exclusion process, in preparation.

Peter J. Kahn

Professor of Mathematics

I am currently interested in a number of problems involving the algebraic topology of symplectomorphism groups and certain subgroups. Two examples are the Flux Conjecture, which deals with fundamental group information, and a more general question involving all the homotopy groups, indeed, the entire homotopy type of the symplectomorphism group. In both cases, I am seeking to extend what is understood in special cases to a broader range of manifolds.

Selected Publications

Pseudohomology and homology, Nov. 2001, 35 pp.

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 no. 93, Amer. Math. Soc. (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, program logic and semantics, and computational algebra. Recent work includes: new polynomial-time algorithms for type inference in type systems with subtypes and recursive types; algorithms solving systems of set constraints as used in program analysis; a unification algorithm for set constraints and a new constraint logic programming language based on set constraints; development of the theory of rational spaces and their relationship to set constraints; an algorithm for decomposition of algebraic functions; a new polynomial-time algorithm for resolution of singularities of plane curves; efficient algorithms for optimal transmission of encoded video data; optimality results for digital interleavers; and complexity and completeness results for Kleene algebras with tests. Recently I have begun to investigate the application of Kleene algebra and the modal mu-calculus to problems in software security.

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.

Recently, I have been working with Oded Schramm and Wendelin Werner investigating the limit of lattice models that possess certain conformal invariance properties in the continuum limit. This project has 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.

Selected Publications

Intersections of Random Walks, Birkhäuser-Boston, 1991.

Universality for conformally invariant intersection exponents (with W. Werner), J. European Math. Soc. **2** (2000), 291–328.

Values of Brownian intersection exponents I and II (with O. Schramm and W. Werner), Acta Mathematica **187** (2001), 237–273, 275–308.

Analyticity of intersection exponents for planar Brownian motion (with O. Schramm and W. Werner), Acta Mathematica (2002), 179–201.

Conformal restriction: the chordal case (with O. Schramm and W. Werner), JAMS, to appear.

G. Roger Livesay

Professor Emeritus of Mathematics

My major area of research is in topology, 3-dimensional manifolds with finite cyclic fundamental groups.

Anita Mareno

VIGRE Assistant Professor of Mathematics

My most recent work involves the use of the Leray-Schauder degree to prove the existence of global solution continua to various boundary value problems in higher-gradient 3D nonlinear elasticity. In classical nonlinear elasticity the complementing condition fails for certain boundary value problems and due to a natural growth condition on the material response function, the governing equations exhibit singular behavior; the existence of classical smooth solutions to the equilibrium equations has yet to be shown. In my work, the higher-order term in the response function effectively regularizes an ill-posed problem.

This research has prompted my interest in various problems in degree theory (in a more general sense) and in particular, its applications to PDEs with nonlinear boundary conditions. I am also interested in obtaining existence results for higher-order systems of PDEs with nonstandard boundary conditions. For these types of systems, I am currently investigating whether or not the trivial solution to these equations is unique under certain constraints on the geometry of the domain. For this purpose, I am exploring symmetry methods and developing generalized Rellich-type identities. In general, I am also interested in overdetermined systems of fourth-order PDEs and problems pertaining to phase transitions in elasticity.

Selected Publications

Numerical simulation of blow-up of a 2D generalized Ginzburg-Landau equation (with C. Bu and R. Shull), Applied Math Letters **9** no. 6 (1996), 13–17.

Uniqueness of classical solutions in higher-gradient nonlinear elasticity, Journal of Elasticity, submitted.

Some global continuation results in higher-gradient nonlinear elasticity (with T. Healey), to be submitted.

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 $\Delta u = 1/u$, preprint, 2003.

A note on free boundary problems for $\Delta u = f(u)$, in preparation, 2003.

Russell Miller

VIGRE Assistant Professor of Mathematics

I study computability theory, the branch of mathematical logic concerned with finite algorithms and the mathematical problems that such algorithms can or cannot solve. By relativizing, one forms a partial order of the degrees of difficulty (the *Turing degrees*) of such problems. Computable model theory, one of my specialties, applies such techniques to general mathematical structures such as trees, linear orders, groups and graphs. Other interests of mine include automorphisms of the lattice of computably enumerable sets (i.e., sets whose elements can be listed by an algorithm) and undecidability of the partial order of Turing degrees of those sets. Finally, one can use computability-theoretic approaches to consider randomness, the question of what we mean when we say that a particular set or real number is "random," and I have begun examining questions in this area.

Selected Publications

The Δ^0_2-spectrum of a linear order, Journal of Symbolic Logic **66** (2001), 470–486.

Definable incompleteness and Friedberg splittings, Journal of Symbolic Logic **67** (2002), 679–696.

Orbits of computably enumerable sets: low sets can avoid an upper cone, Annals of Pure and Applied Logic **118** (2002), 61–85.

The $\forall\exists$-theory of $\Re(<,\vee,\wedge)$ is undecidable (with A. Nies and R. Shore), Trans. AMS, to appear.

Irina Mitrea

H. C. Wang Assistant Professor of Mathematics

My specific interests are in the general areas of real and harmonic analysis and partial differential equations. I am particularly interested in the study of PDE problems arising from mathematical physics with emphasis on the study of fluid dynamics, elasticity and electromagnetism. One of the main themes of my work deals with understanding the nature of the boundary integral operators associated with the aforementioned PDE problems in irregular domains.

Selected Publications

Monogenic Hardy spaces on Lipschitz domains and compensated compactness (with M. Mitrea), Complex Variables Theory Appl. **35** no. 3 (1998), 225–282.

On the boundedness singular integrals (with E. Fabes and M. Mitrea), Pacific Journal of Mathematics **189** no. 1 (1999), 21–29.

Spectral radius properties for layer potentials associated with the elastostatics and hydrostatics equations in nonsmooth domains, Journal of Fourier Analysis and Applications **5** no. 4 (1999), 385–408.

On the spectra of elastostatics and hydrostatics layer potentials on curvilinear polygons, Journal of Fourier Analysis and Applications **8** no. 5 (2002), 443–487.

On the Besov regularity of conformal maps and layer potentials on nonsmooth domains (with D. Mitrea), Journal of Functional Analysis, to appear.

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

A joint norm control Nehari type theorem for N-tuples of Hardy spaces, J. Geom. Anal. **4** (1999), 683–692.

On the Harnack principle for strongly elliptic systems with non-smooth coefficients, Comm. Pure Appl. Math. **52** (1999), 1213–1230.

Multi-linear operators given by singular multipliers (with T. Tao and C. Thiele), J. Amer. Math. Soc. **15** (2002), 469–496.

Uniform estimates on multi-linear operators with modulation symmetry (with T. Tao and C. Thiele), J. D'Analyse Math. **88** (2002), 255–309.

On the bi-Carleson operator I. The Walsh case (with T. Tao and C. Thiele), GAFA **12** (2002), 1324–1364.

Anil Nerode

Goldwin Smith Professor of Mathematics

My principal research at present is in hybrid systems. This is both the logic of hybrid systems (program specification and verification) and extracting digital control programs for hybrid systems. The former is developed in modal logics, the latter using the relaxed calculus of variations on manifolds and the apparatus of connections as controls. I also continue work on model theory and recursive model theory of nonstandard logics, foundations of logic programming, and multiple agent hybrid systems. The latest round of publications is below. A full bibliography is on the website www.math.cornell.edu/~anil/.

Selected Publications

Foreword to: Principles of Modeling and Asynchronous Distributed Simulation of Complex Systems by S. Ghosh, IEEE Press, 2000.

Automata Theory and Its Applications (with B. Khoussainov), Birkhauser, 2000, 480 pp., in press.

Normal forms and Syntactic completeness proofs for functional independencies (with M. Ganesh, J. Srivastava, D. Wijesekera), J. Theoretical Computer Science, to appear.

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.

Finally, I am also interested in applications of frames to signal processing, both in the finite and infinite dimensional settings.

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, Proceedings of the American Mathematical Society, to appear.

Bilinear pseudodifferential operators on modulation spaces (with A. Benyi), Journal of Fourier Analysis and Applications, to appear.

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. My most recent interests have been in the study of over-determined systems and Saint Venant type problems for nonlinear equations.

Selected Publications

Growth and decay in generalized thermoelasticity (with J. C. Song), Int. J. Eng. Sci. **40** (2002), 385–400.

Energy bounds for some nonstandard problems in partial differential equations (with P. W. Schaefer) JMAA **273** (2002), 75–92.

Spatial decay bounds for the Forchheimer equations (with J. C. Song), Int. J. Eng. Sci. **40** (2002), 943–956.

Decay bounds in initial-boundary value problems for nonlinear parabolic systems (with P. W. Schaefer), Nonlinear Analysis **50** (2002), 899–912.

Spatial behavior for constrained motion in an elastic cylinder (with R. J. Knops), Structured Media-Trecop '01, 144–152.

Irena Peeva

Assistant Professor of Mathematics

My research is on problems at the interface between commutative algebra, algebraic geometry, computational algebra, topological combinatorics, and non-commutative algebra. I have worked on problems involving free resolutions, toric varieties, Hilbert schemes, complete intersections, subspace arrangements, monomial resolutions, Castelnuovo-Mumford regularity, Koszul algebras, shellings, and Grobner basis. My major research interests are focused on the properties and applications of minimal free resolutions.

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.

How to shell a monoid (with V. Reiner and B. Sturmfels), Math. Annalen **310** (1998), 379–393.

Deformations of codimension 2 toric varieties (with V. Gasharov), Compositio Mathematica **123** (2000), 225–241.

Toric Hilbert schemes (with M. Stillman), Duke Math. J. **111** (2002), 419–449.

Rodrigo Perez

H. C. Wang Assistant Professor of Mathematics

Improving on classical results, sharper estimates can be obtained by a careful study of the combinatorics of a given dynamical system. I am interested in analytic properties of some sub-families of parameters in the quadratic family; for instance, their Hausdorff dimension or harmonic measure. I am also interested in problems of dynamics in several complex variables.

Selected Publications

Dynamics of Quadratics Polynomials: Geometry and Combinatorics of the Principal Nest, Ph.D. Thesis, SUNY Stony Brook, 2002.

A new partition identity coming from complex dynamics, submitted to Discrete Mathematics.

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, spline estimations, and the Malliavin calculus. I am also working on a historical treatment of stochastic calculus.

Selected Publications

An extension of Ito's formula in n dimensions (with Hans Follmer), Probability Theory and Related Fields **116** (2000), 1–20.

A partial introduction to financial asset pricing theory, Stochastic Processes and their Applications **91** (2001), 169–203.

Probability Essentials (with Jean Jacod), Second Edition, Springer-Verlag, 2002.

Liquidity risk and arbitrage pricing theory (with Robert Jarrow and Umut Cetin), Finance and Stochastics, to appear.

The approximate Euler method for Levy driven stochastic differential equations (with Jean Jacod, Thomas Kurtz, and Sylvie Meleard), submitted for publication.

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

Deforming an even representation. II. Raising the level, J. Number Theory **72** no. 1 (1998), 92–109.

Lifting Galois representations, Invent. Math. **138** no. 3 (1999), 537–562.

Infinitely ramified Galois representations, Ann. of Math. (2) **151** no. 2 (2000), 793–815.

Deforming Galois representations and the conjectures of Serre and Fontaine-Mazur, Ann. of Math. (2) **156** no. 1 (2002), 115–154.

Deformations of certain reducible Galois representations, J. Ramanujan Math. Soc. **17** no. 1 (2002), 51–63.

José Ramírez

H. C. Wang Assistant Professor of Mathematics

My main focus of research is on the intersection between analysis (PDEs) and probability. I study parabolic operators. The main objective is to try to prove "Gaussian type bounds" on heat kernels, that is, transition probabilities for the associated processes. The premise here is that there should be some kind of (Gaussian) universality in the behavior of such processes when time is made small. The particularities of different generators (operators) are mainly given through a metric. The need for a very general setting led me to work on Dirichlet spaces. Another problem of interest to me is that of studying the asymptotics of the distribution of the lowest eigenvalue for one-dimensional Schrödinger operators with random potential. I have also started to wander into the problem of recurrence of certain reinforced random walks, that is random processes that like to travel through places that they already visited.

Selected Publications

Short time asymptotics in Dirichlet spaces, Comm. Pure Appl. Math. **54** (2001), 259–293.

Richard H. Rand

Professor of Theoretical and 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

Global behavior of a nonlinear quasiperiodic Mathieu equation (with R. S. Zounes), Nonlinear Dynamics **27** (2002), 87–105.

Analysis of a nonlinear partial difference equation and its application to cardiac dynamics (with M. D. Stubna and R. F. Gilmour), Journal of Difference Equations and Applications **8** (2002),1147–1169.

Nonlinear effects on coexistence phenomenon in parametric excitation (with L. Ng), Nonlinear Dynamics **31** (2003), 73–89.

2:2:1 resonance in the quasiperiodic Mathieu equation (with K. Guennoun and M. Belhaq), Nonlinear Dynamics **31** (2003), 367–374.

Lecture Notes on Nonlinear Vibrations, version 45, 2003.

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.

Oscar S. Rothaus

Professor of Mathematics

My principal mathematical interest in the last 10 years or so has been logarithmic Sobolev inequalities and Spectral Geometry. I was drawn to log-Sobolev inequalities because of their connection with ground state for Schrödinger and other operators.

During my most recent sabbatical in London, I worked with Professor E. B. Davies on the problem of estimating ground state for Bochner Laplacian on Euclidean vector bundles. We hoped to generalize to this setting the mechanism of Bochner-Lichnerowicz-Weitzenbock inequalities, and their use by Li and Yau particularly. To a degree we succeeded; our results are contained in two papers published recently in the Journal of Functional Analysis.

Most recently, I am returning to combinatorial problems in coding theory and to new questions in logarithmic Sobolev inequalities.

Selected Publications

Construction of homogeneous convex cones, Ann. Math. (2) **83** (1966), 358–376.

On the non-triviality of some groups given by generators and relations, Ann. Math. (2) **106** no. 3 (1977), 599–612.

Logarithmic Sobolev inequalities and the spectrum of Sturm-Liouville operators, J. Funct. Anal. **39** no. 1 (1980), 42–56.

Herbst inequalities for super-contractive semigroups (with L. Gross), J. Math. Kyoto Univ. **38** no. 2 (1998), 295–318.

Sharp log-Sobolev inequalities, Proc. Amer. Math. Soc. **126** no. 10 (1998), 2903–2904.

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

Central Gaussian semigroups of measures with continuous density (with A. Bendikov), Journal of Functional Analysis **186** (2001), 206–268.
On the relation between elliptic and parabolic Harnack inequalities (with W. Hebisch), Annales de l'Institut Fourier **51** (2001), 1437–1481.
Aspects of Sobolev Type Inequalities, London Mathematical Society Lecture Notes Series **289**, Cambridge University Press, 2002.
On random walks on wreath products (with C. Pittet), Annals of Probability **30** (2002), 948–977.
Hitting probabilities for Brownian motion on Riemannian manifolds (with A. Grigor'yan), Journal de Mathématiques Pures et Appliquées **81** (2002), 115–142.

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 Journal of Numerical Analysis, 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.

Jason Schweinsberg

H. C. Wang Assistant Professor of Mathematics

I work in probability theory. Much of my research has focused on stochastic processes involving coalescence. One can think of coalescent processes as modeling a system of particles in which the particles start out separated and then merge into clusters as time goes forward. The probabilistic behavior of a coalescent process is determined by the rates at which clusters merge.

Coalescent processes can be used to model the genealogy of a population. In this application, the particles represent individuals in the current generation, and the merging of particles corresponds to the merging of ancestral lines going backward in time. The genealogy of many populations can be described by Kingman's coalescent, in which each pair of particles merges at rate one. I have studied primarily alternative models of coalescence. These include coalescents with multiple collisions, in which many particles can merge together at once, and coalescents with simultaneous multiple collisions, in which many such mergers can occur simultaneously. These coalescent processes can be used to model populations in which there can be very large families. In some recent joint work with Rick Durrett, we have shown that coalescents with simultaneous multiple collisions can also be used to model the genealogy of populations that are periodically affected by beneficial mutations. At the time of a beneficial mutation, multiple ancestral lines will coalesce nearly simultaneously if the new, favorable gene spreads to the entire population in a relatively short time.

I have also worked on some problems involving fragmentation processes, which can be viewed as coalescent processes run in reverse. In addition, I have done research related to reversible Markov chains. Some of this work has focused on the link between the recurrence and transience of reversible Markov chains and the notion of *P*-admissibility in statistical decision theory.

Selected Publications

A necessary and sufficient condition for the Lambda-coalescent to come down from infinity, Electron. Comm. Probab. **5** (2000), 1–11.

Coalescents with simultaneous multiple collisions, Electron. J. Probab. **5** (2000), 1–50.

Applications of the continuous-time ballot theorem to Brownian motion and related processes, Stochastic Process. Appl. **95** (2001), 151–176.

An $O(n^2)$ bound for the relaxation time of a Markov chain on cladograms, Random Structures Algorithms **20** (2002), 59–70.

Conditions for recurrence and transience of a Markov chain on Z+ and estimation of a geometric success probability (with James P. Hobert), Ann. Statist. **30** (2002), 1214–1223.

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.

Effective model theory: the number of models and their complexity (with B. Khoussainov); in Models and Computability, Invited Papers from Logic Colloquium '97 (S. Cooper and J. Truss, eds.) LMSLNS 259, Cambridge University Press, Cambridge, England, 1999, pp. 193–240.

Defining the Turing jump (with T. Slaman), Math. Research Letters **6** (1999), 711–722.

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), Annals of Mathematics **124** (1986), 293–311.

Polynomial diffeomorphisms of C2 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.

Polynomial diffeomorphisms of C2 VI: connectivity of J (with E. Bedford), Annals of Mathematics, to appear.

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 on 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), submitted.

Lawren Smithline

VIGRE Assistant Professor of Mathematics

I study p-adic modular forms. This area of number theory generalizes classical modular forms, which have starred in the resolution of long-standing problems such as Fermat's Last Theorem. The methods of p-adic analysis bridge algebraic geometry and classical analysis.

The combinatorial properties of the Atkin U operator have held special interest for me. Their structure makes computer experiments easy. The data suggest properties of the operator that result from the mode of generation, rather than the particular parameters derived from the modular forms. As described in recent seminars and a forthcoming paper, the U operator is an example of a compact operator with rational generating function.

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, submitted for publication in Parabola, 1997.
Geometric patterns in nature, being prepared for publication.

Birgit E. Speh

Professor of Mathematics and Director of Undergraduate Studies

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), preprint (2002).
Pseudo-Eisenstein forms and cohomology of arithemtic groups II (with J. Rohlfs), preprint.

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 theorem on refining division orders by the reverse lexicographic order (with D. Bayer), Duke Math. J. **55** (1987), 321–328.
Determinantal equations for algebraic curves of high degree (with D. Eisenbud and J. Koh), Amer. J. Math. **110** (1988), 135–147.
On the complexity of computing syzygies (with D. Bayer), J. Symbolic Comp. **6** (1988), 135–147.
Computing the equations of a variety (with M. Brundu), Trans. AMS (1991), to appear.
Some matrices related to Green's conjecture (with D. Bayer), Sundance Conference Proceedings on Free Resolutions (1991), to appear.

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.

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.

Edward Swartz

VIGRE Assistant Professor of Mathematics

My research centers on the interplay between matroids, geometry/topology and algebra. 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 a matroid analog of the g-theorem for simplicial polytopes. I have also established a universal representation theorem for all matroids as arrangements of homotopy spheres.

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, to appear.

Lower bounds for h-vectors of k – CM, independence and broken circuit complexes, submitted.

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/Courses/GQ)

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), American Mathematical Monthly **101** no. 8 (1994).

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. Amer. Math. Soc. (N.S.) **6** (1982), 357–381.

Hyperbolic structures on 3-manifolds, I. Deformation of acylindrical manifolds, Ann. of 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 Publishers, 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.

Harrison Tsai

H. C. Wang Assistant Professor of Mathematics

I am interested in the application of algorithms in mathematics and science. Since my background is in algebraic geometry, I usually study algorithms, which are based upon algebra. My doctoral thesis concentrated on finding algebraic solutions to systems of linear partial differential equations with polynomial coefficients. Recently, I have become interested in optimization, in particular of polynomial functions. In practice, heuristic methods are necessary to optimize functions of many variables, and the behavior of these methods can be quite varied. However, for the special case of polynomials, heuristic methods can sometimes be robust and I hope to identify and understand these situations.

Selected Publications

Using SAGBI bases to compute invariants (with Michael Stillman), Journal of Pure and Applied Algebra (1999), 285–302.

Weyl closure of a linear differential operator, Journal of Symbolic Computation **29** (2000), 747–775.

Polynomial and rational solutions of holonomic systems (with Toshinori Oaku and Nobuki Takayama), Journal of Pure and Applied Algebra **164** (2001), 199–220.

D-modules on smooth toric varieties (with Mircea Mustata, Greg Smith and Uli Walther), Journal of Algebra **240** (2001), 744–770.

Alexander Vladimirsky

H. C. Wang 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 decouple 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 (& 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.

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 Journal on Numerical Analysis **41** no. 1 (2003), 325–363.

A fast method for approximating invariant manifolds, (with J. Guckenheimer), SIAM J. on Applied Dynamical Systems, 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.

Selected Publications

Moduli of graphs and automorphisms of free groups (with M. Culler), Inventionnes **84** (1986), 91–119.

Equivariant Outer space and automorphisms of free-by-finite groups (with S. Krstic), Comment. Math. Helvetici **68** (1993) 216–262.

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.

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.

Beverly H. West

Senior Lecturer of Mathematics

My chief interest is in mathematics teaching, using interactive computer graphics, particularly in differential equations, multivariable/vector calculus, and dynamical systems (both real and complex). I've coauthored development of several software packages since the mid 1980s: MacMath, Analyzer*, Interactive Differential Equations and ODE Architect.

Selected Publications

A new look at the Airy equation with fences and funnels (with J. H. Hubbard, J. M. McDill and A. Noonburg) Organic Mathematics (Burnaby, BC, 1995), CMS Conf. Proc. **20**, AMS, Providence, RI, 1997, pp. 277–303.

Differential Equations: a Dynamical Systems Approach (with J. H. Hubbard); *Part I: Ordinary Differential Equations*, Texts in Applied Mathematics **5**, Springer-Verlag, NY, 1991; *Part II: Higher-Dimensional Systems*, Texts in Applied Mathematics **18**, Springer-Verlag, NY, 1995.

Technology in differential equations courses: my experiences, student reactions; in Revolutions in Differential Equations, MAA Notes **50**, Washington, DC, 1999, pp. 79–89.

The convergence of an Euler approximation of an initial value problem is not always obvious (with J. H. Hubbard and S. Habre), Amer. Math. Monthly (April 2001), 326–335.

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 (NS) **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

My research interests lie in the field of geometric group theory. My thesis involved studying the quasi-isometry types of lattices in semisimple Lie groups over local fields.

Milen Yakimov

H. C. Wang Assistant Professor of Mathematics

The main areas of my research interests are Lie theory and representation theory of Hopf algebras (quantum groups). One of the approaches to the latter is through the geometry of the related semiclassical objects Poisson-Lie groups, which is similar to Kirillov-Kostant orbit method for Lie groups. I am interested in the applications of the above structures in classical and quantum completely integrable systems, mathematical physics, and special functions.

Selected Publications

Highest weight modules over the $W_{1+\infty}$ algebra and the bispectral problem (with B. Bakalov and E. Horozov), Duke Math. J. **93** (1998), 41–72.

Symplectic leaves of complex reductive Poisson-Lie groups, Duke Math. J. (2001).

Quantum invariant measures (with N. Reshetikhin), Comm. Math. Phys. (2001).

Discrete Darboux transformations from Jacobi polynomials (with F. A. Grünbaum), Pacific J. Math. (2001).

The double and dual of a quasitriangular Lie bialgebra (with T. Hodges), Math. Res. Lett. **8** (2001), 91–105.

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).