MATH MATTERS

LETTER FROM THE CHAIR, DAN M. BARBASCH

As in previous years, the Mathematics Department had a very active and exciting year. Several of our faculty and graduate students were honored with awards and invitations to give prestigious lectures. Rick Durrett gave the Wald lectures (see p. 3), the SMI and REU programs were very active this summer (see articles on pp. 3 and 4-5), and we held many conferences. I would like to write about a few events that did not make it in the main body of our newsletter.

John Guckenheimer was inducted into the 2008 Class of Fellows of the American Academy of Arts and Sciences.

Allen Hatcher won the 2008 Stephen and Margery Russell Distinguished Teaching Award given by the College of Arts and Sciences. In addition, he won our senior faculty teaching award. Other recipients of teaching awards announced at our 2007 holiday party included Alvaro Lozano-Robledo and Etienne Rassart, who shared the junior faculty teaching award, and Mia Minnes, who received the graduate student teaching award. Other graduate students who received awards were Alimjon Eshmatov and Jessica Zuniga sharing the Battig Prize, Gregory Muller received the York Award, and the Hutchinson Award was given to Joshua Bowman.

The Cornell Mathematics Department is well known around the world for its "Topology Festival" which has been an annual event for 46 years. Last May ninety mathematicians attended the Festival where we had ten one-hour talks by world-class mathematicians. You can read about this event by going to http://www.math.cornell.edu/~festival/ . It is also an important opportunity for mathematical conversations and socializing. One of the fixtures is the picnic at the end. This year the weather broke with tradition, and it was sunny and pleasant.

In June, we celebrated Louis Billera's 65th birthday with Billerafest 2008, a three-day conference. Many world-class researchers attended and gave lectures. We were happy to welcome back many of Lou's former students. For information about the conference, please see http://www.math.cornell.edu/event/conf/billera65/ .

Effective July 1, 2008, Ravi Ramakrishna was promoted to full Professor, and Camil Muscalu was promoted to Associate Profesor with tenure.

Dave Bock left his position as Senior Lecturer to pursue other projects. He has done an impressive job coordinating our K-12 Outreach Program. His Saturday programs for High School teachers were very well attended. Mary Ann Huntley was hired to fill his position last summer.

The second recipient of the Michler fellowship is Irina Mitrea from Virginia Tech. She was an H.C. Wang Assistant Professor in 2001-04, and we are very happy to welcome her back. She gave a wonderful Oliver Club lecture in October entitled "Boundary Value Problems for Higher-Order Elliptic Operators".

Allen Knutson, mentioned in my 2007 letter, will be joining our department in January 2009. Allen is a very accomplished algebraic geometer whose work reaches into many areas of mathematics. We are very excited about having him as our colleague. Many of us, including Reyer Sjamaar, Tara Holm, Mike Stillman, Ed Swartz, and myself, are looking forward to collaborating with him. He is also a very accomplished teacher; our undergraduate and graduate students will greatly benefit from his presence as well.

We have been working with the engineering faculty to create "workshops" for Engineering Calculus 1910. A "workshop" consists of a more involved engineering problem that requires calculus for its solution. Alex Vladimirsky is implementing the next phase of this project, integrating the workshops into the course. In the near future we are planning to introduce workshops in Math 1920.

Please keep in touch, and visit our web page for more information.

www.math.cornell.edu

PROBABILITY GROUP RECEIVES RTG GRANT
by Rick Durrett

The Cornell probability group–Rick Durrett and Laurent Saloff-Coste in Mathematics, and Philip Protter, Sid Resnick, and Gennady Samorodnitsky in Operations Research–are the recipients of a five-year $2.5 million Research Training Group grant from the National Science Foundation. This grant, like their previous five-year infrastructure grant, will support graduate students during the academic year and summer, two short conferences per year, and the Cornell Probability Summer School. The 2009 summer school will feature three six-lecture series by Ander

Workshop for Women in Probability

Holroyd, Robin Pemantle, and Yuval Peres (now the head of the Microsoft Theory Group in Redmond, WA). In addition, there will be two-lecture series by Rick Kenyon, Scott Sheffield, and Balint Virag. The first short conference, held October 5-7, was a Workshop for Women in Probability. The conference, attended by about twenty female graduate students and young faculty members from across the country, featured one-hour talks by ten of the top women probabilists.

3RD CONFERENCE ON ANALYSIS AND PROBABILITY ON FRACTALS

The department hosted the 3rd Conference on Analysis and Probability on Fractals June 11-15. (The other conferences were held in 2002 and 2005.) The organizing committee was Richard Bass and Alexander Teplyaev (University of Connecticut), Jun Kigami (Kyoto University), and Robert Strichartz (Cornell). About 50 mathematicians from outside Cornell joined our faculty and graduate students for five days of talks, including several mini-courses designed for nonexperts. Cornell has played a prominent role in research in these areas. Professor Strichartz has written an elementary textbook on the subject and many research papers, including work with undergraduate REU students (see article pp. 4-5). Others in the field with Cornell connections include Teplyaev (former graduate student), Luke Rogers and Kasso Okoudjou (former H.C. Wang Assistant Professors), Kigami, Takashi Kumagai, Marius Ionescu, and Erin Pearse (all former visitors). Several current department members–Steven Heilman (undergraduate), Alex Fok (graduate student), and Huo-Jun Ruan (visitor)–gave talks at the conference.

The main goal of research in these areas is to develop analogs of differential equations and stochastic processes when the underlying space is a fractal. This is expected to have scientific applications in the future. For now, this work has many connections with similar theories when the underlying space is smooth or discrete. Best of all, the research has turned up many interesting phenomena that are unique to the fractal setting. One of the highlights of the conference was the announcement of Bass and Teplyaev (joint work with Martin Barlow and Kumagai) of the uniqueness of the diffusion (and associated energy) on the Sierpinski carpet that was first constructed by Barlow and Bass eighteen years ago.

ALUM NEWS

Howard A. Levine, Ph.D. Mathematics 1969, is Distinguished Professor of Liberal Arts and Sciences at Iowa State University. Catch up with him by e-mail at halevine@iastate.edu or search www.public.iastate.edu/~halevine/.

Allan Bennett, Ph.D. Mathematics 1986, has been Vice President and Portfolio Manager at Farmington Asset Management Ltd., a Washington DC investment advisory firm since 1993. Farmington specializes in alternative investment programs involving global government bonds, foreign currencies, and futures contracts on agricultural and industrial products. Farmington's quantitative trading models draw upon techniques from differential equations, stochastic processes, and linear and non-linear optimization. Old friends are welcome to contact him at allan.bennett@verizon.net .

www.math.cornell.edu

Summer Math Institute (SMI)
by Ravi Ramakrishna

The objective of the SMI is to better prepare undergraduate women and underrepresented minorities (from other institutions) for the rigors of doctoral programs in mathematics. The focal point of our program is an analysis class taught at the level of Math 4130, our own undergraduate honors analysis course. Students also do research projects. In 2006 and 2007, SMI was supported by the Sloan Foundation, the Office of the Provost, the College of Engineering, the Center for Applied Mathematics, and the Mathematics Department.

We are pleased to report that the SMI has received long-term funding from the National Science Foundation. In future years, the course work will alternate between analysis and algebra, with algebra being offered in 2009.

Twelve students attended our 2008 program: Konrad Aguilar (Cal State Poly), Kelly Bickel (Centre College), Stefano Campagna (Manhattanville College), Michael Firrisa

Back row (on bench): Jesus, Kristen, Nicole, Kelly, Ashley, Alex
Middle row: Ravi, Stephen, Russell, Konrad, Stefano, Mark
Front row: Michael, Chase, Krista, Andrea, Juan, Sam

(St. Mary's College of Maryland), Krista Heim (Arcadia Univ), Stephen Johnson (Virginia Tech), Ashley Larsen (Univ of Kentucky), Russell Latterman (Univ of Arizona), Juan Ortiz (Cal Lutheran), Kristen Pueschel (Univ of Pittsburgh), Nicole Stawasz (Kings College), and Andrea Stephan (Univ of Missouri at St. Louis).

Jesus Rodriquez (Ph.D. CAM, 2005) taught analysis, and Mark Kozek taught cryptography. Sam Kolins and Alex Roche were the TAs, and Chase (SMI '07 alum) coordinated activities for the students. In addition to their coursework, these students conducted group research in the mathematics of Sudoku tables, pricing of stock options, and a problem on the coverings of the natural numbers via arithmetic moduli posed by renowned mathematician Paul Erdos.

* *

Rick Durrett Gives Wald Lectures

This year, Rick Durrett gave the Wald Lectures, the most prestigious lecture series of the Institute of Mathematical Statistics, at the 7th World Congress in Probability and Statistics held July 14-19 in Singapore. In the previous thirty years, only nine probabilists have given these lectures, and four of those lectures (indicated by *'s), were given by Cornell faculty members: Abel prize winner Srinivasa Varadhan (2005), Charles Newman (1999), Tom Liggett (1996), A.D. White visiting professor David Aldous (1993), E.B. Dynkin* (1991), P. Diaconis (1987), H. Kesten* (1986), F. Spitzer* (1979), and M. Kac* (1978). The first lecture, held right after the opening speeches, was attended by most of the 500+ conference participants. The attendance dwindled over the week, but more than 200 people were there for the third and final lecture on Friday. In his three lectures Durrett surveyed much of the work he has done over the last twenty years applying probability to problems that arise from Ecology and Genetics. More details about the content of the lectures and the conference can be found in the October issue of the IMS Bulletin, available online at http://bulletin.imstat.org/. An article on the contents of the third lecture "Coexistence in Stochastic Spatial Models" will appear in the Annals of Applied Probability.

Research Experiences for Undergraduates

by Bob Strichartz (Director)

Since 1994, Research Experiences for Undergraduates (REU) Programs, supported by the National Science Foundation, have been offered. This program brings talented undergraduates to campus for eight weeks to work with Cornell faculty, visitors, and graduate students on significant research problems. Fourteen students worked in three project areas this summer: **Analysis on Fractals**, led by Robert Strichartz with graduate student Russ Thompson; **Games, Logic, and Linear Orders**, led by François Dorais (visitor) with graduate student Paul Shafer; and **Higher Dimensional R. Thompson's Groups**, led by Collin Bleak (former visitor, currently Assistant Professor at the U. of Nebraska, Lincoln) with graduate student Francesco Matucci. In addition to research work, the students attend the Smorgasbord Seminar where Cornell faculty present small tastes of many different areas.

Students working in **Analysis on Fractals** join a tradition that dates back to 1996 where students use computer experimentation to significantly advance the field. They began the summer by attending the 3rd Conference on Analysis and Probability on Fractals (see article, p. 2), held just prior to the start of REU. **Miles Wheeler** (Cornell) and Sarah Constantin (Princeton) developed algorithms to study Laplacians on Vicsek sets, based on the Ph.D. thesis of Denglin Zhou (U. of Waterloo) that was presented at the conference. Their work highlighted new features that do not occur in other fractals that have been previously studied in detail. Taryn Flock (Yale) studied Laplacians on classical Julia sets, such as the Basilica and the Douady Rabbit. Her work reveals amazingly detailed information and was noteworthy because she had to completely change direction after the initial approach to the problem came to a dead end after four weeks of work. **Steve Heilman** (Cornell) studied homotopies of eigenfunctions of Laplacians on planar domains as the domains are deformed. He used this idea to study eigenfunctions of the Laplacian on the Sierpinski carpet and also to pair up eigenfunctions of the Laplacian on the square and the circle. The eigenfunctions undergo sometimes radical changes under the homotopies, and it is rather challenging to follow them as their eigenvalues cross. Ying Ying Chan (Chinese U. of Hong Kong) gave a complete description of all self-homeomorphisms of the double cover of the Sierpinski gasket. Although the Sierpinski gasket itself is topologically rigid and has only 6 self-homeomorphisms (all isometries), the homeomorphism group of the double cover is infinite and has a rich structure. The students are currently working on papers based on their research.

The students involved in the project **Games, Logic, and Linear Orders** studied the structure of *countably categorical* linear orders which are defined to be finite or countable linear order types that are determined (up to isomorphisms) by statements in first order predicate logic. Michael Solomon (Amherst) and **Christina Zlogar** (Cornell) obtained new lower bounds for the number of such linear orders that may be distinguished by first order statements of quantifier depth n, using certain EF (Ehrenfeucht-Fraïssé) games that characterize such linear orders. The real challenge in their work is to show that linear orders constructed in certain ways based on the simple operation called a *shuffle* (replacing all elements in a linear order by a finite ordered set of k elements) are distinct. Another group of students–Steven Gubkin (Case Western Reserve), Daniel McDonald (Carleton), and Manuel Rivera (MIT)–studied automorphism groups of countably categorical linear orders. They proved that the automorphism group is *extremely amenable* (every continuous action on a compact space must have a fixed point), and moreover they were able to explain this property by showing that certain related finite structures enjoy the Ramsey property.

R. Thompson's Group V is the group of piecewise linear homeomorphisms of the Cantor set (it was intensively studied during the 2007 REU program). The higher dimensional versions nV were introduced by Matthew Brin (current visitor) as groups of certain piecewise linear homeomorphisms of n-fold products of Cantor sets. Now it happens that the topological structure of these products is independent of n, so a natural question is whether or not the groups nV are distinct for different choices of n. Brin was only able to show $1V$ and $2V$ are distinct (of course $1V = V$). This summer, Daniel Lanoue (Northwestern) and Collin Bleak proved the general case using the dynamics of the group actions. Johanna Hennig (Scripps Institute) and Francesco Matucci proved that

all the groups nV are finitely presented, giving explicit finite sets of generators and relations. Roman Kogan (SUNY Stony Brook) developed a Java-based software package for doing computations in nV that will be an important research tool in studying these groups. Finally, Melissa Young (Chicago) investigated a related problem, characterizing conjugacy in a certain group of piecewise linear homeomorphisms of the circle.

* * *

In summer 2009, the REU Program will continue with projects in Analysis on Fractals (led by Robert Strichartz), R. Thompson's Groups (Collin Bleak will return to lead this), and Logic (led by Sasha Rubin, who is a current visitor).

A Mathematical Puzzle For You!

Across:
1. pick a number
5. see 5 Down
8. base times height, for example
10. you roll them
12. true or false
13. a game
14. compare, Latin abbr.
15. orthonormal abbr.
16. the set of eigenvalues of a matr.
18. the Feds
20. closure finite, weak topology
21. several 1001's ?
22. anno domini
24. alternating current
25. nine, roman
26. mathematicians and forests have them
28. math'ms and communities have them?
31. sin integral
32. -ander, he was great
34. curls
35. graphs have them
36. when a baby says 56026 base 16
37. a name I call myself
38. 1004, roman
40. see 15 across
41. electrical engr.
42. some of those alternating multilinear things
43. carbon copy, abbr.
44. subtract them and the matrix becomes sing.
46. the first number?
47. hyperbolic sines to some
48. Maclane's gory animal
49. every circ. has one
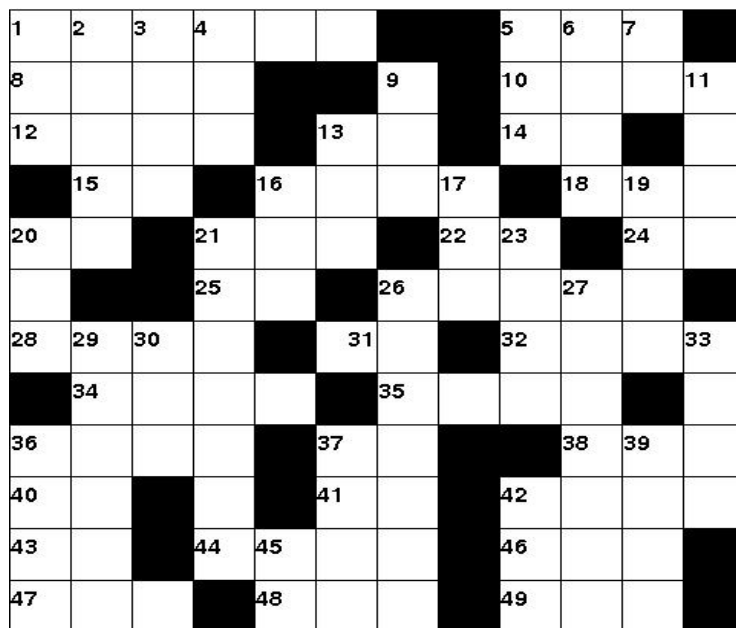
Down:
1. quotient of two ints, or a bad animal
2. it looks like a vector
3. 9 in Berlin
4. differential algebraic eqn
5. the fortieth square number in Rome
6. the sum and the — and the prod and the quot
7. see 43 across
9. they provide funds
11. writer of Men of Mathematics
13. it locates you on the globe
16. 6
17. you drive it
19. 16 of the hexadecimals
20. ~(pro)
21. don't make one of these
23. 57005 hex, or no longer living
26. epsilon?
27. Euclid and the chemists have them
29. 26 across have several
30. they provide funds too
33. several ii times vii?
36. nobody reads them
37. super duper 10 to the power 6
39. compose with itself, abbr.
42. word suffix
45. local college

(Answer p. 7.)

HIGH SCHOOL OUTREACH ACTIVITIES

by Rick Durrett

The department is the recipient of an NSF grant (PI: Rick Durrett) to develop materials about the uses of advanced mathematics accessible to high school students, with the aim of interesting more of them to study and pursue careers in math. Our online materials are of two types:

At http://www.math.cornell.edu/~numb3rs/ you can find and explanation of the math behind the **Numb3rs** TV show, which at this point covers 73 episodes of the first four seasons. These materials were written by graduate students Owen Baker, Marisa Belk, Saul Blanco, Chris Cunningham, Youssef El Fassy Fihry, Victor Kostyuk, Chris Lipa, Ben Lundell, Peter Luthy, Sergio Pulido Nino, Peter Samuelson, Russ Thompson, and Gwyn Whieldon. Princeton University Press has expressed an interest in doing a book compilation of our materials.

At http://www.math.cornell.edu/~mec/ you can find materials based on the **Math Explorer's Club**. An activity started under our VIGRE grant, this club met once a week at Ithaca High School in the 45-minute time slot for clubs right after school with activities that are organized into six- to eight-week modules, each of which is devoted to a specific topic and planned and led by a graduate student. From 2003-2006, the club enjoyed a steady attendance of 10-15 students per week. However in the fall of 2006, school schedules in our district were reorganized and Ithaca High School shifted to a new one-hour later starting time, making the time slot for the club 3:45-4:30, and attendance fell into the low single digits. After another attempt in the fall in 2007, the club was abandoned, and we concentrated our efforts to our online activities.

There is now a wide variety of materials on our site concerning Chaos and Fractals (Chris Lipa), Games (Matt Noonan), Probability (Sam Kolins), Non-Euclidean Geometry (Mircea Pitici), Voting and Elections (Jason Anema), Mathematics of Distance (Kristine Jones), Cryptography (written by Ben Lundell with the help of materials developed by SMI students in 2007), Mathematical Finance (Sergio Pulido Nino), Markov Chains (Youssef El Fassy Fihry), and Combinatorics (Gwyn Whieldon). More materials are being developed this year. Our new outreach person, Mary Ann Huntley, is assisting with putting these materials in the hands of local high schools students. We also are working with MSRI's Math Circles Program.

In addition to our web materials, graduate students go to the high school for two types of activities.

The **Senior Seminar**, started in 2000-2001, is a class on advanced mathematics designed for students who have taken most of the math classes available at Ithaca High School. It meets for one period (45 minutes) during school hours every Monday, Wednesday, and Friday

Victor Kostyuk gave a course on knot theory. This fall, lectures are being given by Saul Blanco and Matt Noonan.

The other activity is the **Math Team**. Last year this was coached by Tim Novikoff, a student in Applied Math, who taught math at Stuyvesant High School for four years. Tim went to IHS every Wednesday to teach problem-solving techniques and prepared the students for the American Mathematics Competition (AMC), the American Invitational Math Exam (AIME), and the on-site New York State Math League (NYSML) competition. Tim guided the team through the logistics of signing up for competitions, started and maintained a team website (actually a Google Group), and in April accompanied the team to NYSML (along with some parents of team members and the teachers who administer the team at IHS). It was a huge success. Sadly, there were insufficient funds to go to the American Regional Math League (ARML) at State

Ithaca High School Math Team

at the high school and introduces students to topics that they would typically not see until their junior or senior years in college. In 2007-2008, Gwyn Whieldon gave an introduction to combinatorics through unusual counting problems, Jonathan Needleman covered group theory with an emphasis on symmetries of mathematical objects, and

College, PA, which is an overnight trip, but we hope to send the team next year. This fall the club conflicts with a class Tim needs to take, so Gwyn Whieldon will coach the team.

* * * * * * * * * *

Please contact us, and give us some news! mathmail@cornell.edu

The Class of 2008

Math Majors

Fifty-four majors (including eight in January) received Bachelor of Arts degrees this year. Honors were awarded to fifteen majors:

Summa Cum Laude
Michael Barany
Hyun Kyu Kim

Magna Cum Laude
Eric Frackleton
Rami Mohieddine
Adrian Chi-Yau So
Daniel Sussman (January)

Cum Laude
Jessica DeGrado
Edward McTighe
Alisa Mo
Andrea Najemy
Vishal Patel
Ken Soong (January)
Yue Xu
Jun Zhou Zhang
Peng Zhao

* * * * * * * * * *

Harry S. Kieval Prize

The *Kieval Prize* is given to an outstanding undergraduate major annually. For 2008, it was awarded jointly to **Michael Barany** and **Hyun Kyu Kim**.

New Staff Members

Kathryn (Katie) Huber joined us in April as Computer Consultant (half-time). Her office is in 314.

Catherine (Kay) Wagner started in July and is Acting Director of the MSC in 252 Malott.

Welcome Katie and Kay!

Graduate Students Awarded Ph.D.'s

Bryant Adams, *Representing Processes as Updated Automata and Transducers*, August.

Edoardo Carta, *Update Transducers and Linear Recurrence Equations over Semirings*, August.

Noam Horwitz, *Free Resolutions of Monomial Ideals,* August.

Sarah Koch, *A New Link Between Teichmüller Theory and Complex Dynamics*, August.

Francesco Matucci, *Algorithms and Classification in Groups of Piece-wise-Linear Homeomorphisms*, August.

Mia Minnes, *Computability and Complexity Properties of Automatic Structures and their Applications*, August.

Michael O'Connor, *Using Tree Automata to Investigate Intuitionistic Propositional Logic*, August.

Jay Schweig, *Poset Convex-Ear Decompositions and Applications to the Flag h-Vector*, May.

John Workman, *End-Point Estimates and Multi-parameter Paraproducts on Higher Dimensional Tori*, August.

Jessica Zuniga, *Merging of Some Time Homogeneous and Inhomogeneous Markov Chains*, August.

(Answer to puzzle from p. 5.)

Mathematics Department Endowments & Gifts

We are grateful to alumni, friends, and family for their generosity in supporting our endowments or providing other gifts and donations to the department.

The **Ruth I. Michler Memorial Prize,** established by Gerhard and Waltraud Michler of Essen, Germany, in memory of their daughter, provides funding for the Ruth I. Michler Memorial Prize of the Association for Women in Mathematics. The awardee spends a semester here without teaching obligations.

The **Chelluri Lecture Series** was established by Raju Chelluri's parents in his memory. Funds are used to invite distinguished mathematicians to give annual lectures.

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

Teaching Awards for Graduate Students and faculty were created in 2001. Prizes are awarded to graduate students.

The **Colloquium Endowment Fund** was instituted to invite distinguished scientists to speak at the Oliver Club seminars. (See www.math.cornell.edu/~oliver/.)

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

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

The **Israel Berstein Memorial Fund** was established in honor of Israel Berstein, a professor in this department from 1962-1991. The memorial fund is intended to help young mathematicians in the field of topology.

The **Logic Endowment** was started with a generous gift from a former Cornell undergraduate. This endowment seeks to actively support promising logic students.

The **Robert John Battig Endowment** was established by his parents after his untimely death. Robert was awarded a January 1998 Ph.D. in mathematics. The fund provides an annual prize to an outstanding continuing graduate student in mathematics at Cornell.

If you would like to contribute, please make your check payable to Cornell University, and indicate the endowment or that it is a gift in support of Mathematics, and send it to:

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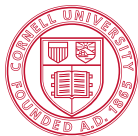
Cornell University
Department of Mathematics

310 Malott Hall
Ithaca, NY 14853-4201