LETTER FROM THE CHAIR, DAN M. BARBASCH

The 2005-2006 academic year brought many changes to the mathematics department. An obvious one is that I am writing this letter; I took over as chair from Ken Brown in July. I would like to thank Ken on behalf of the department for his excellent service, and I look forward to the challenge of my new position.

We are excited about our new group of promising undergraduate majors, graduate students, and faculty. On page 7 of this newsletter you can read about our graduating students; we wish them all the best in their future endeavors. Martin Kassabov, an H.C. Wang Instructor from 2004-2006, was promoted to tenure-track assistant professor. Xiaodong Cao from Columbia University and Tara Holm from the University of Connecticut joined us as tenure-track assistant professors.

Faculty member Gregory Lawler recently accepted a position at the University of Chicago. Greg was an active member of the department, taught courses in many areas of mathematics, advised students, and organized conferences. Greg Hjorth was going to join us this year, but opted to take a position in Australia instead. We are actively searching for their replacements. It will be difficult to replace such distinguished faculty.

The University recently received a gift from Professor Gerhard and Mrs. Waltraud Michler in honor of their daughter to endow the "Ruth I. Michler Memorial Prize", a visiting position for a semester in the Cornell Mathematics Department, awarded to a young woman mathematician who has just received tenure. The first recipient will be announced in December by the selection committee of the Association for Women in Mathematics (AWM). Ruth Michler died tragically in an accident in Boston in 2001 while visiting Northeastern on a fellowship similar to the one established in her name. For details about the prize and Ruth's accomplishments go to: http://www.math.cornell.edu/News/news.html

We are very grateful to Professor and Mrs. Michler for their generous gift, and we look forward to hosting the first recipient of the prize next year.

The inaugural Chelluri Lecture took place in early April. Dan Goldston from San Jose State University talked about the existence of twin primes and also shared his experiences with the media. Dinner and a jazz concert followed the talk. Further details can be found at: http://www.math.cornell.edu/Colloquia/Chelluri/index.html

We were successful in securing a SCREMS (Scientific Computing Research Environments for the Mathematical Sciences) grant this year. We used the funds to purchase high-performance computers. One is a cluster, primarily for parallel computations, and the other has a large amount of RAM for memory intensive calculations.

Three new courses are being offered in 2006-07. The first course, "Mathematics and Politics", originated as a topic of MATH 103. The course is so popular that starting in Fall 2006 it is being offered each semester under its own course number, MATH 134.

The other two courses bridge the gap between the freshman/sophomore calculus sequence and the advanced algebra, analysis, and topology senior-level courses. Irena Peeva developed the second course, called "Computational Algebra" (MATH 437). It is an introduction to Gröbner bases theory, which is the foundation of many algorithms useful for applications in computer science, engineering, and physics.

The third course is MATH 450, "Matrix Groups", which is close to my own research. A group is a mathematical notion which is used to capture symmetries, for example, in algebra as a Galois group, geometry and topology as symmetries of an object, and mathematical physics and analysis as the symmetries of a differential equation. Matrix groups are special cases of Lie groups. See Reyer Sjamaar's article on the "Sophus Lie Days", page 3. Allen Hatcher, who is a topologist, is teaching a version of MATH 450 this semester, and many faculty with specialties as diverse as logic and dynamical systems have already volunteered to teach it in the future.

HONORS & AWARDS

KAREN VOGTMANN NAMED AWM 2007 NOETHER LECTURER

Karen Vogtmann

The Association for Women in Mathematics selected Professor **Karen Vogtmann** as the 2007 Noether Lecturer. She will speak at the Joint Mathematics Meetings in New Orleans in January 2007.

LAURENT SALOFF-COSTE WINS GUGGENHEIM FELLOWSHIP

Laurent Saloff-Coste

Professor **Laurent Saloff-Coste** was awarded a John Simon Guggenheim Fellowship for 2006. Fellows are appointed on the basis of distinguished achievement in the past and exceptional promise for future accomplishment.

Laurent joins previous Fellows in our department: Wolfgang Fuchs (1956), Harry Kesten (1972), Clifford Earle (1974), Leonard Gross (1974), Moss Sweedler (1980), John Guckenheimer (1983), and Richard Durrett (1988).

GREGORY LAWLER AWARDED PÓLYA PRIZE

Professor **Gregory Lawler** and two colleagues were chosen by the Society of Industrial and Applied Mathematics to receive the 2006 George Pólya Prize for their groundbreaking work on the development and application of Stochastic Loewner Evolution.

ANNUAL DEPARTMENT AWARDS

The Department awards for 2005 were presented at our holiday party.
Teaching Awards: senior faculty **David Henderson**, junior faculty **Hsiao-Bing Cheng**, and teaching

David Henderson   Hsiao-Bing Cheng

Melanie Pivarski   Treven Wall

assistants **Melanie Pivarski** and **Treven Wall**.

Additional Graduate Student awards presented at the party were:
Robert John Battig Prize: **Sarah Koch** and **Andrei Maxim**.
Eleanor Norton York Award: **Guan-Yu Chen**.
Hutchinson Fellowships: **Henri Johnson** and **Mauricio Velasco**.

"DIFFERENTIAL EQUATIONS ON FRACTALS, A TUTORIAL" BY ROBERT STRICHARTZ

This book was recently published by Princeton University Press. It opens the door to understanding the recently developed area of analysis on fractals, focusing on the construction of a Laplacian on the Sierpinski gasket and related fractals. Written in a lively and informal style, with lots of intriguing exercises on all levels of difficulty, the book is accessible to advanced undergraduates, graduate students, and mathematicians who seek an understanding of analysis on fractals. The author takes the reader to the frontiers of research, starting with carefully motivated examples and constructions.

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ALUM NEWS

Myriam Queshi, B.A. Mathematics 2001, MENG Applied and Engineering Physics 2003. Myriam worked for Lockheed Martin Aeronautics in Ft. Worth, TX as a research scientist for 2.5 years and is currently a Ph.D. student at the University of Oxford in the Particle Physics Sub-Department.
Email: miq1@cornell.edu or myriam.qureshi@physics.ox.ac.uk
James Coykendall, Ph.D. Mathematics 1995, is a Professor at North Dakota State University. He was one of more than 300 nominees for the 2005 Carnegie Foundation for the Advancement of Teaching U.S. Professors of the Year Award. Jim was recognized as a Professor of the Year for the state of North Dakota.

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

THE SOPHUS LIE DAYS
by Reyer Sjamaar

A new Cornell tradition in the making?

What do matrices and groups tell us about sound waves, electromagnetism, and other natural phenomena? In April, about fifty students and faculty from various mathematics, science, and engineering departments at Cornell and neighboring institutions (including Syracuse and Binghamton), came to find out at the Sophus Lie Days, hosted by us.

With his theory of continuous groups developed in the 1870's, Sophus Lie revolutionized the study of differential equations in the same way Evariste Galois transformed the study of algebraic equations by inventing the notion of a finite group forty years earlier. Continuous groups, now called Lie groups, play a vital part in many branches of pure and applied mathematics. The purpose of the Sophus Lie Days was to advertise the subject to a wide audience of students.

Three renowned experts presented five lectures, with a final session held where unsolved problems were posed. The first speaker was **Eugene Dynkin**, who as a young student in the former Soviet Union invented a new combinatorial device for classifying semisimple Lie algebras and their representations. These devices, now called Dynkin diagrams, quickly became extraordinarily influential, and he reminisced on how they were incorporated by physicists such as Neeman into the theory of elementary particles. The other speakers, Roger Howe of Yale and Alexander Veselov of Loughborough University, England, each gave two lectures. Professor Howe developed from first principles the representation theory of the Heisenberg Lie algebra and explained how it governs various equations from classical physics, such as the wave and Maxwell equations. Professor Veselov lectured on the theory of root systems, closely related to that of Dynkin diagrams, and which has recently led to the discovery of new differential equations that satisfy Huygen's principle, one of the fundamental principles of wave propagation.

The event was recorded by Allen Back, and a set of DVD's can be borrowed from the Math Library. The organizing committee (Dan Barbasch, Yuri Berest, Tara Holm, Ravi Ramakrishna, Birgit Speh, and I) is searching for funds to finance a second installment of the Sophus Lie Days, planned for next April with the topic "Infinite-dimensional Lie algebras in mathematical physics". New developments will be announced on our web site.

* *

INTERNATIONAL CONGRESS OF MATHEMATICIANS

Cornell was well represented at the International Congress held in Madrid, Spain, August 22-30. Two of our faculty members gave invited talks: **Birgit Speh** spoke on "Representation theory and the cohomology of arithmetic groups", and **Karen Vogtmann** spoke on "The cohomology of automorphism groups of free groups".

Four Fields Medals were awarded, and three had Cornell connections. Grisha Perelman was awarded one for his work on the Poincaré Conjecture and the Thurston Geometrization Conjecture, both of which he claims to have solved using Hamilton's Ricci flow method. (Experts believe the first claim, but the jury is still out on the second.) **Richard Hamilton** was a faculty member when he invented the Ricci flow method, and **William Thurston** is now on our faculty. One of the tools Perelman used in his work is the Logarithmic Sobelev Inequality, discovered by our own **Len Gross** in the 1970's. A course on the Ricci flow is being taught by **Xiaodong Cao**, a new Asst Prof. (Perelman declined the award.)

Terence Tao of UCLA also won a Fields. Tao has an active collaboration with **Camil Muscalu** on multilinear singular integral operators.

Another Fields was given to Wendelin Werner of Univ. Paris-Sud (Orsay) for joint work with Oded Schramm and **Gregory Lawler**. This work combines probability theory and complex analysis to answer fundamental questions about Brownian motion paths, in particular proving some conjectures made by physicists. They also shared the George Pólya Prize. (See page 2.) Until recently, Lawler was at Cornell.

Kiyoshi Itô, a former faculty member from 1969-1975, won the 2006 Gauss Prize.

Finally, **Jon Kleinberg** of Cornell's Computer Science Department won the Nevanlinna Award.

RESEARCH EXPERIENCES FOR UNDERGRADUATES
by Bob Strichartz, Sarah Day & Ed Swartz

We hosted another Research Experiences for Undergraduates program in Summer 2006. REU has been offered every summer since 1994, supported by the National Science Foundation. This summer there were nineteen participants, including four Cornell students and six international students who came with their own funding. The students worked in three research groups: **Analysis on fractals**, led by Bob Strichartz (REU Program Director) and assisted by Luke Rogers and graduate student Robyn Miller; **Dynamical systems and computer assisted proofs**, led by Sarah Day (now a tenure-track Assistant Professor at William and Mary) and assisted by CAM graduate student Erik Sherwood; and **Geometric and topological combinatorics**, led by Ed Swartz and assisted by graduate student Kristin Camenga.

The students in the **Analysis on fractals** group explored a variety of problems involving Laplacians defined on fractals such as the Sierpinski gasket and the Sierpinski carpet. Much of the work involved computing spectra of different Laplacians, often building on work done by previous REU students.
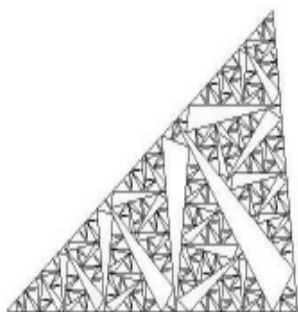

Figure 1

Figure 2

(To view this in color, go to: www.math.cornell.edu/~sgoff/ .)

Notable achievements include understanding the spectra of a family of Laplacians on the Sierpinski gaskets "with twists" and connecting these with different embeddings in the plane (Figure 1), and a conjectured correspondence between eigenvalues of a fractal Laplacian on the Sierpinski carpet (Figure 2). Several students from this group, including **Michael Barany** and **Jessie DeGrado** from Cornell, gave talks on their work at a special session at the AMS meeting held in Storrs, CT, October 28-29. The students also constructed a sculpture (out of straws and strings) of a 3-D Sierpinski gasket which resides on the 5th floor (Figure 3).

Students in the **Dynamical systems** group studied numerical techniques based on the topological Conley Index Theory for discrete dynamical systems. In particular, they obtained information about the Henon map, including new estimates for its topological entropy, and a dynamical model of the population of flour beetles that takes into account cannibalistic behavior. Two Cornell students, **Chris Green** and **Rafael Frongillo**, participated in this work. Frongillo will present a talk on his work at the joint annual mathematical meeting in New Orleans in January.

The **Combinatorics** group worked in three areas: Tutte polynomials of corank 3 matroids, random sampling of simple matroids with more than 8 elements, and triangulations of manifolds using a minimal number of vertices. A notable achievement was a description of the minimal triangulations for infinite families of manifolds constructed as orientable and nonorientable sphere bundles over the circle.

Several papers based on the work of this summer's program are being prepared.

Next summer, we are planning projects on analysis on fractals (Bob Strichartz), free probability (Todd Kemp), and Thompson's groups via topological dynamics (Collin Bleak).
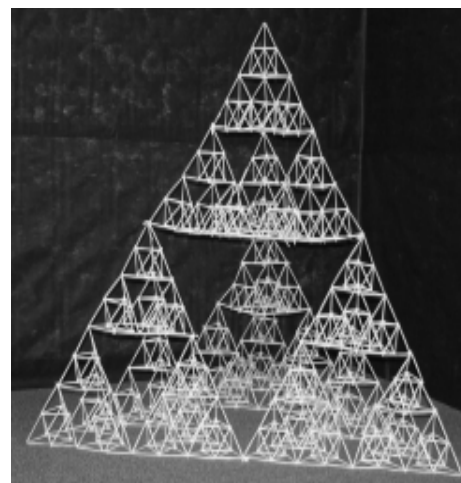

Figure 3

SUMMER MATH INSTITUTE (SMI)
by Ravi Ramakrishna

The first Summer Mathematics Institute (SMI) was held at Cornell June 17-August 6, 2006. The program was aimed at bringing in undergraduates from underrepresented groups in Ph.D. programs in the mathematical sciences with the intent to better prepare the students for the rigors of graduate school in mathematics. Ten students participated in the program—Ashley Crump, Jaret Flores, Selenne Garcia-Torres, Brian Keathley, Huimei Lin, Alexia Mintos, Kevin Mugo, Terrance Pendleton, Nicole Sims, and Shannon Talbott—hailing from a variety of institutions ranging from Agnes Scott College to the University of the Virgin Islands.

The program centered on a seven-week foundational course in real analysis taught at the level of an honors undergraduate introduction to real analysis (at Cornell this is Math 413). The course was taught by Sharad Goel, a Postdoctoral Scholar at Stanford's Department of Mathematics. Dr. Goel earned his Ph.D. from Cornell's Applied Mathematics program in 2005.

In addition to the course in real analysis, SMI students took part in a research project in the mathematical sciences. The goals for the projects were to provide the students with an experience of mathematics research, to develop the collaborative skills necessary to work on group projects, and to learn computational skills that are essential to modern mathematical research. Projects were offered in 'Networks and Algorithms' and 'Dynamical Systems and Neurobiology'. Each student chose one project in which to take part. The projects were led by advanced graduate students (now Ph.D.'s) Yannet Interian and Joe Tien.

The students participating in the project on Networks and Algorithms examined two systems: Committee assignments in the U.S. House of Representatives and regulation of gene expression in Saccharomyces

Faculty: Ravi Ramakrishna, Yannet Interian, Sharad Goel, Joe Tien

Terrance, Ashley, Brian, Huimei, Shannon, Nicole, Kevin, Alexia, Jaret, Selenne

cerevisiae. In particular, the students developed and tested a new network based model for committee assignments that matched the data surprisingly well and applied graph algorithms to uncover biologically significant regulatory pathways.

The Dynamics and Neurobiology group studied the Morris-Lecar equations, a system of ordinary differential equations that have been used to describe a wide range of excitable cells. This system was used to introduce basic dynamical systems theory, with a constant emphasis on interpreting the results in a biologically meaningful way. It focused especially on bifurcations, which are qualitative changes in solution trajectories as parameters vary.

The students presented the results of their research at the Society for Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference held in Tampa in late October, 2006.

All of the students found SMI to be a rewarding experience that significantly broadened their horizons. SMI was funded for the summer of 2006 by the Sloan Foundation, the Office of the Provost, the Engineering Dean, the Center for Applied Mathematics, and the Mathematics Department. The program was run by Ravi Ramakrishna, Program Director, and Professor Steven Strogatz of the Theoretical and Applied Mechanics Department.

The funding for SMI '06 was for the initial pilot program. Although we currently do not have funding for SMI for future years, we are pursuing opportunities through private donations and government agencies.

See Cornell Chronicle article:
www.news.cornell.edu/stories/Aug06/summer.math.html .

PROGRAMS AT ITHACA HIGH SCHOOL
by Rick Durrett

Our high school outreach activities for the Academic Year 2005-2006 were organized by Ed Swartz.

The **Math Explorer's Club (MEC)**, which meets at Ithaca High School in the 2:45-3:30 time slot set aside for after-school clubs, moved from Thursdays to Wednesdays to avoid a conflict with Brain Team. Sarah Koch showed them the game Set, strategies for fair cake division applied to cupcakes, and De Bruijn sequences and a related card trick á la Persi Diaconis. Jessica Zuniga used a sequence of problems to introduce the students to coloring proofs, simple modular arithmetic, combinatorial problems, and logic games.

In David Biddle's module, the students started out using the tiling of the plane by squares to construct a correspondence between torus knots and magic squares. They then moved on to look at closed surfaces and possible tilings of the hyperbolic plane, and finished with a look at the Platonic solids.

Radu Murgescu focused on fun math problems, with much of the material coming from Arthur Engel's 'Problem-Solving Strategies'. Andrei Maxim continued the problem-solving theme with weekly handouts that introduced the students to induction proofs, inequalities and sequences, in addition to some brain teasers.

Senior Seminar 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 on Monday, Wednesday, and Friday and introduces students to topics they would typically not see until their junior or senior years in college.

Matt Noonan taught the first module on various notions of infinity and exposed the students to nonstandard versions of the reals, non-Euclidean geometry, quaternions, and the Banach-Tarksi paradox. Jeff Mermin continued to challenge their long-held notions by discussing flaws in voting systems used in American elections, proving Arrow's Impossibility theorem, which shows that the only rational voting scheme is a dictatorship, and examining measurements of voting power and issues of apportionment. Jay Schweig ended the year by teaching the students some basic notions of graph theory, simplicial complexes, matroids, and posets.

The summer of 2006 brought some good news: Our NSF proposal to the EMSW21-MCTP program was selected for funding, providing one semester of support in each of the next five years for the three students who work with the Senior Seminar and the five students who work with the Math Explorer's Club. The reason for this generous $824,379 grant is to create class notes for senior seminar topics and a web-based archive of materials for MEC to facilitate the development of these activities in other communities.

Maria Terrell recruited graduate students for the 2006-07 high school outreach activities as part of the TA assignment process. Since the proposal promised a more systematic performance evaluation, David Biddle spent time over the summer developing a web-based questionnaire for those who participated or led activities. During the year, Rick Durrett, the grant's principal investigator, will supervise the activities and go to IHS for meetings of the MEC.

The Senior Seminar, which began in the hands of Abra Brisbin lecturing on probability theory, has attracted its usual audience of about 10 students. However, Math Explorer's Club has experienced a sharp decline, with an average of 1.8 students in the first five sessions, compared to a core of a dozen or more in past years. We do not think that Kevin Rompala's lessons on Dynamical Systems and Chaos are to blame, since Chris Lipa used similar materials two years ago. The problem seems to be the new schedule for the high school, which begins and ends one hour later than before. This means that the MEC meets from 3:45-4:30, a time that conflicts with sports, lessons, jobs, and the many other activities high school students do after school.

The first meeting of Daniel Remenik's module on games brought out seven students, so perhaps attendance will rebound. However, the ultimate solution may be a virtual club that provides on-line materials to be enjoyed by students in schools in our region and ultimately across the nation. So, like an old episode of Batman, we must leave the reader with a cliffhanger. Is it curtains for the caped crusader? Will Gotham City be destroyed? Or will Math Explorer's Club once again reinvent itself? Stay tuned to this spot or watch the department's web pages for details.

www.math.cornell.edu

The Class of 2006

Math Majors

Commencement was held on May 28, 2006. Fifty-four mathematics majors received Bachelor of Arts degrees (including one in August 2005 and seven in January). A DVD was made during our department ceremony, and there are a few copies available for graduates. Please contact us if you would like one. Eighteen graduates were awarded honors in mathematics:

Summa Cum Laude
Thomas Church
Wai Wai Liu

Magna Cum Laude
Prakash Balachandran
Philip Owrutsky
Navin Sivakumar

Cum Laude
Dionysios Anninos
Jonathan Bergknoff
Jason Chlipala
Yuantian Leslie Huang
Nabil Iqbal
Max Kaplan*
Matthew Kaschalk
Matthew LaBoda
Jay Lu
Peter Maceli*
Jessica Nadel
Yash Parghi
Noah Spies

*January degree

* * * * * * * * * *

Harry S. Kieval Prize

The *Kieval Prize*, given to outstanding graduating majors, was awarded to **Thomas Church** and **Wai Wai Liu** for 2006.

Graduate Students Awarded Ph.D.'s

Drew Armstrong, *Generalized Noncrossing Partitions and Combinatorics of Coxeter Groups*, August.

Kristin Camenga, *Angle Sums on Polytopes and Polytopal Complexes*, August.

Guan-Yu Chen, *The Cutoff Phenomenon for Finite Markov Chains* August.

William Gryc, *On the Holonomy of the Coulomb Connection over 3-Manifolds with Boundary*, August.

Jason Martin, *Building Infinite Ray-Class Towers with Specific Signatures and Small Bounded Root Discriminants*, August.

Jeffrey Mermin, *Lexicographic Ideals*, May.

Steven Morris, *Four- and Six-Dimensional Nilmanifolds and Symplectic Forms*, January.

Melanie Pivarski, *Heat Kernels on Euclidean Complexes*, August.

Franco Saliola, *The Face Semigroup Algebra of a Hyperplane Arrangement*, August.

Steven Sinnott, *Results in Computational Algebra of Bayesian Networks*, August.

John Thacker, *Properties of Brownian and Random Walk Loop Soups*, May.

Brigitta Vermesi, *Intersection Exponents for Random Walks on Cylinders*, August.

Yan Zeng, *Compensators of Stopping Times*, January.

William Lowell Putnam Competition

Last spring, we learned that Julius Poh (then a freshman) won Honorable Mention in the very tough 2005 competition. Four other Cornell students made the top 200 nationally, and five more joined the top 500. Our team—Anand Bhaskar, Hyun Kyu Kim, and Kun Hyong Kim—placed 20th in the nation.

Our 2006 team will include Hyun Kyu Kim, Julius Poh, and Zachary Scherr. The national competition will be held on December 2. See www.math.cornell.edu/Undergraduate/contests.html for information about the competition.

The **Mathematical Contest in Modeling (MCM)** was held October 28-30. For contest results, go to www.math.cornell.edu/%7Emcm/.

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 will spend a semester here without teaching obligations starting in 2007-08.

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
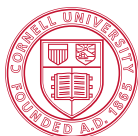
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