MATH MATTERS

Department of Mathematics Cornell University Ithaca NY November 2007

Letter From The Chair, Dan M. Barbasch

Reflecting back, I would say that we had a very successful year, and I think you will agree when you read the rest of the newsletter.

Justin Moore, the recipient of the 2006 Gödel Centenary Prize in logic, joined us as an associate professor from the University of Idaho this year. Our program in logic is among the top in the world. Another area in which our program is world class is probability. Rick Durrett was recently elected to the National Academy of Sciences. Our other probabilists, Harry Kesten (retired) and Eugene Dynkin, have been long-time members of the Academy. I am also very happy to report that Marek Biskup will join our probability group next year as an associate professor. He was formerly on the faculty at UCLA and is spending this year at Microsoft Research. With these additions to our faculty, we expect to maintain our high status in logic and probability.

The first recipient of the Michler fellowship is Rebecca Goldin from George Mason University. She is here this semester, continuing her collaborations with Tara Holm and Reyer Sjamaar. We had a ceremony in September to celebrate the inauguration of the award, which was well attended by the family of Ruth Michler, members of the mathematics department, the AWM, as well as officials from the university administration.

Our lecture series and workshops have been very active this year. Ken Ribet (UC Berkeley) gave the Chelluri lecture. He made crucial contributions to the solution of Fermat's conjecture. The Kieval lectures were given by two very prominent mathematicians—Richard Hamilton and Allen Knutson. Hamilton is well known for his contributions to the Poincare conjecture and Knutson for his work on the Horn-Weyl conjecture about the spectrum of symmetric matrices. Knutson is the recipient of the 2005 Conant Prize. The "Lie Days at Cornell", a two-day workshop for undergraduates held its second meeting this fall. Victor Kac (MIT) and Gregg Zuckerman (Yale) gave lectures on mathematics relevant to physics. Reyer Sjamaar gave an introductory lecture about Lie groups and Lie algebras, and I gave my talk entitled "E8 for undergraduates". E8 denotes one of the simple Lie groups, perhaps the most interesting of the so-called exceptional ones.

The summer was very busy with our two programs for undergraduates, REU and SMI. The activities of the undergraduates in these programs are detailed in the articles in this newsletter. Particularly exciting is the recent news that our SMI program, led by Ravi Ramakrishna, Ken Brown, and Steve Strogatz, has received preliminary approval for funding from the NSF. We appreciate the financial help given to us by the university the last two years. The mathematics department regards it as one of its very important missions to prepare underrepresented minorities and women for careers in pure and applied mathematics.

Starting last spring and throughout the summer, we have been working with the engineering faculty to create "workshops" for Engineering Mathematics 191. A "workshop" consists of a more involved engineering problem that requires calculus for its solution. Irena Peeva, Bob and Maria Terrell, Vesko Gasharov, and Alex Vladimirsky from the mathematics department and Mike Kelley from engineering, have collected problems from the engineering faculty and edited them for use in Math 191. We plan to expand this project to other courses such as Math 192.

Long-time staff member Arletta Havlik retired early this summer. Arletta was in charge of course registrations for many years. She was also our specialist using TeX, an invaluable skill for many of us for typing research papers and course notes. Heather Peterson was hired as course coordinator in August. We just learned that another member of the staff, Doug Alfors, plans to retire on February 1, 2008. Doug has been director of the Math Support Center for many years, has helped maintain our computer systems, and very importantly, has organized our spring concerts.

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

www.math.cornell.edu

Honors & Awards & News

Annual Department Awards

Our Department awards for faculty and graduate students were presented at our holiday party held on December 1, 2006.

Teaching Awards: senior faculty **Patricia Alessi** and **Irena Peeva**,


Patty Alessi


Irena Peeva


Alessandra Pantano


Luke Rogers


Edoardo Carta

junior faculty **Alessandra Pantano** and **Luke Rogers**, and teaching assistant **Edoardo Carta**.

Additional Graduate Student awards presented at the party were:

Robert John Battig Prize: **Mia Minnes** and **Jay Schweig**.

Eleanor Norton York Award: **Artem Pulemotov**.

Hutchinson Fellowships: **Noam Horwitz** and **James Worthington**.

Harry Kesten Receives Honorary Degree

On June 12, 2007, Professor Emeritus **Harry Kesten** was awarded an honorary degree by the University of Paris-Sud.

(Photo courtesy of Vladas Sidoravicius.)

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Alex Rosenberg

December 5, 1926 - October 27, 2007

It is with great sadness that we announce the death of Professor Emeritus **Alex Rosenberg** (aka A.C. Zitronenbaum). He died on Saturday, October 27, at his home in Germany after a long illness. Alex received his Ph.D. in 1951 from Chicago and held positions at Northwestern and the IAS before coming to Cornell as professor of mathematics in 1961. He served as department chair 1966-1969 and numerous times as acting chair. He accepted a position as Chair at UCSB while on leave in 1986-88. Alex retired from Cornell on June 30, 1988. He is survived by his wife Bruni, sons Teddy and Daniel, and former wife Bea (of Ithaca). He was predeceased by his oldest son David. Further information will appear on our web.

Alex's unique character, and language, made him unforgettable to everyone. We will miss him.

Alum News

Thomas Craven, M.A. and Ph.D. Mathematics, 1971 and 1973, was recently appointed interim dean of the University of Hawaii at Manoa's College of Natural Sciences. He has been professor of mathematics at the University of Hawaii, Honolulu, since 1973, serving as chair since 2003.

Jonathan Insler, B.A. Mathematics/Physics 2003, is a Ph.D. student at the University of Rochester in high energy physics. He is also a visiting fellow at Cornell's Wilson Lab. Email: jinsler@lepp.cornell.edu or jinsler@pas.rochester.edu .

Michael Insler, B.A. Mathematics/Economics 2005, is a Ph.D. student in economics at the University of Rochester. E-mail: minsler@troi.cc.rochester.edu .

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

Ruth I. Michler Memorial Fellowship Awarded

by Tara Holm

Rebecca Goldin (George Mason University) received the first annual Ruth I. Michler Memorial Prize, allowing her to spend the fall semester of 2007 at Cornell. The Michler Prize grants a mid-career woman mathematician in academe a residential fellowship at Cornell without teaching obligations. This fellowship was established through a very generous donation from the Michler family to commemorate Ruth Michler, whose life was tragically cut short in 2000.

Rebecca Goldin

Rebecca received her Bachelor's degree in mathematics with honors from Harvard University and then spent a year in France at the Ecole Normale Superieure working with Bernard Teissier. After earning her doctorate from the Massachusetts Institute of Technology under the supervision of Victor Guillemin, she was an NSF Postdoctoral Fellow at the University of Maryland, and then joined the Mathematics Department at George Mason University and was tenured in 2006. Since 2004 Rebecca has also served as the Director of Research for Statistical Assessment Services, a nonprofit organization affiliated with George Mason University.

Rebecca arrived in Ithaca in August 2007 and gave an Oliver Club lecture on "The Geometry of Polygons" as part of the inauguration of the Michler Prize. Her research concerns symplectic geometry and its relationship with combinatorics, representation theory, and physics. An active participant in the Lie groups seminar, she is also collaborating with Tara Holm and Reyer Sjamaar on projects in equivariant Hamiltonian geometry, including questions on Schubert calculus and its generalizations, and on the topology of orbifolds.

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The NUMB3RS Project

by Rick Durrett

As a mathematician, you have to like a TV show that starts each episode with "We all use math every day; to predict weather, to tell time, to handle money. Math is more than formulas or equations; it's logic, it's rationality, it's using your mind to solve the biggest mysteries we know". That show is NUMB3RS, a crime drama show with a twist. Each week math enters into solving the cases.

After the portrayals of schizophrenic John Nash in "A Beautiful Mind", and Gwyneth Paltrow's deceased father in "Proof", who filled notebooks with incoherent ramblings, it is nice to have a mathematician character that is not a raving lunatic. In fact, one department staff member called him cute, and he even has a girlfriend (who admittedly is another math geek).

Given the potential of the show to interest people in math, Maria Terrell, who watches the show regularly, suggested that it might be a good project for our high school outreach grant to develop web pages to explain some of the math behind the show. Over the summer, Marisa Belk, Saul Blanco, Youssef El Fassy Fihry, Victor Kostyuk, Peter Luthy, Peter Samuelson, and Gwen Whieldon earned money by watching episodes of the first two years of the show and writing explanations of the math involved.

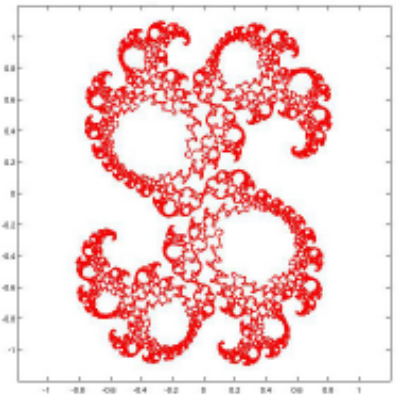
Soon we will tackle season 3 and then move on to the current season 4. The materials can be found at www.math.cornell.edu/~numb3rs/ along with our Math Explorer's Club materials that can be found in /~mec. The web pages are still very much a work in progress, but comments and suggestions can be sent to the project coordinator, Rick Durrett, rtd1@cornell.edu .

Research Experiences for Undergraduates

by Bob Strichartz, Collin Bleak, and Todd Kemp

The 8-week summer 2007 program Research Experiences for Undergraduate Students was our fourteenth offering and the first in a newly approved 5-year grant from the National Science Foundation. Eighteen students (including three from Cornell) worked in three research groups: **Analysis on fractals**, led by Bob Strichartz (REU Program Director) and assisted by postdocs Marius Ionescu, Erin Pearse, Luke Rogers, and Huo-Jun Ruan and graduate student Russ Thompson; **Thompson's groups via topology dynamics**, led by Collin Bleak (currently at the University of Nebraska) and assisted by graduate student Francesco Matucci; and **Free probability and combinatorics**, led by Todd Kemp (currently at MIT) and assisted by graduate student Gwyn Whieldon.

The students in the **Analysis on fractals** group worked in a tradition dating back to 1996, exploring properties of analogs of differential equations on self-similar fractals such as the Sierpinski gasket. One question explored by Miranda Fix (Carleton College) was whether the values of eigenfunctions of the Laplacian on the Sierpinski gasket are distributed approximating a normal distribution (for large eigenvalues). This possibility was suggested by work of Elizabeth Meckes (a postdoc visitor here in 2006-07), who showed the approximate normal distribution of the values of spherical harmonics (for high dimensional spheres). The answer to our question turned out to be negative, but as a result of our numerical computations, we gained some insight into the different distribution of values that do arise in the fractal setting. Another project carried out by **Steve Heilman** (Cornell) involved extending the method of outer approximation, basically approximating the spectrum of a Laplacian on a fractal by the spectrum of the ordinary Laplacian on a planar domain that approximates the fractal from the outside. Although there is no rigorous theory behind this method, it had proved very effective for self-similar fractals in work carried out during the REU program in summers 2005 and 2006. Steve tried it out on two types of more complicated fractals: random Sierpinski carpets and Julia sets of quadratic polynomials. In both cases the



Julia Set

method did not work as well as we had expected. Steve is continuing to work on refining our computations to try to understand the implications of our data. Perhaps the moral of these stories is: in mathematics, it is important to adjust your expectations to the reality of your discoveries, and to try to pull out whatever plums lie hidden in your murky pie.

Students in the **Thompson's groups via topological dynamics** group worked together to understand the algebraic structure of Thompson's group V (a group of piecewise linear homeomorphisms of the Cantor set). They were able to solve completely the problem of classifying the centralizer of any element of the group (the subgroup of all elements that commute with the given element). This result is a major contribution to the area, and used a recent tool of Matt Brin (the "revealing pair") to analyze the orbit structure of points in the Cantor set under the group action. The five students in the group (including Cornell student **Hannah Newfield-Plunkett**) spent the first five weeks of the program learning the required background material and then spent the last three weeks in an intensive scramble to discover and prove the result. It was indeed a cliffhanger, with a few seductive but futile shortcuts threatening to derail the whole enterprise. The final details of the proof only came together in the last week of the program. The students are now working with Collin and Francesco to write up their work. The results will be presented at the annual AMS meeting in January. It is unusual for an accomplishment of this magnitude to come out of a REU program. We are proud that it happened at Cornell.

The **Free probability and combinatorics group** of students worked on the following problem: "Suppose King Arthur holds a party to introduce the Knights of the Round Table to the Ladies of the Court (there are as many Ladies as Knights). The Knights and Ladies all sit down randomly around the Round Table. Is it possible for them to pair off to politely converse, without moving seats, in such a way that no two conversations cross? If so, how many distinct such non-crossing pairings

(REU continued)

are there?" This amusing counting problem is actually very difficult. It has important connections to problems in functional analysis and random matrix theory. Six undergraduate students (including Cornell junior **Julius Poh**), set out to solve the problem of the Knights and the Ladies of the Round Table. They quickly determined that a general solution is not possible to express as a simple formula, although such formulas do exist for some more symmetric seating arrangements (for example, if the Knights and Ladies happen to alternate in groups of 4). They did provide very sharp and useful bounds for random seating arrangements, and quantified how small changes in the seating arrangement can result in arbitrarily large changes in the number of non-crossing pairings. In addition to this excellent work, the students discovered a beautiful new poset structure that governs these pairings, and developed many of its combinatorial properties. Since most of these discoveries were made by our own Julius Poh, they are calling this poset the "Poh-set".

Projects in 2008 will be directed by Bob Strichartz and Collin Bleak continuing the work from last summer and Games, linear orders and logic, directed by François Dorais.

Summer Math Institute (SMI)

by Ravi Ramakrishna

Last year's *Math Matters* included an article on the Summer Math Institute at Cornell (SMI). SMI is a program aimed at better preparing undergraduates (from other institutions) for the rigors of doctoral programs in mathematics and primarily focuses on women and underrepresented minorities. The main concentration of the program for the students was learning analysis taught at the level of Math 413, our own undergraduate honors analysis course.

Mark, Ravi, Chase, Natalia, Brett, Johnny & Samuel

Jorge, Rachel, Amanda, Mercedes, Eric & Charles

We are pleased to report that of the ten students in the SMI 2006 class, six are currently enrolled in graduate programs at North Carolina State University, Purdue University, the University of Iowa, the University of Southern California, and the University of Texas. Another student was accepted in Cornell's Center for Applied Mathematics (CAM) and will enroll in the fall of 2008. Two members of the SMI '06 class are seniors and are applying to graduate schools now.

The Provost's Office, the Engineering Dean, and CAM all provided support in various ways so that we were able to fund the SMI again. Special thanks go to Professor Rick Durrett of the Math Department for all of his assistance and support.

The SMI '07 class included nine students—Charles Burnette, Rachel Chase (nickname Chase), Natalia Cordova, Jorge Gonzalez, Rachel Hodos, Brett Jefferson, Eric Korman, Mercedes Lopez, and Amanda Taylor—from institutions ranging from Arcadia University to the University of Puerto Rico at Rio Piedras. In addition to the analysis class, the students also learned the basics of cryptography; they prepared materials for area high school students in conjunction with Cornell's Mentoring through Critical Transition Points (MCTP) grant for high school outreach from the National Science Foundation. The analysis course was taught by Johnny Guzman (CAM Ph.D. 2005), and Mark Kozek taught cryptography. Samuel Kolins (math graduate student) was the TA this summer, and Huimei Lin (SMI '06 alum, not pictured) was an assistant.

We recently learned that the NSF has recommended that SMI at Cornell be funded for five years. We expect official approval around December 1st.

First Year Graduate Students Experience Hoffman Course

by Donna Smith

On August 18, our first-year graduate students were in for a real treat! They had the opportunity to join **Mike Stillman** (far left in photo below), Director of Graduate Studies, **Maria Terrell** (left in photo at right), Director of Teaching Assistants Program, and a few of our current graduate students to attend one of the largest collegiate team building courses in the country, the Hoffman Challenge Course.

The Hoffman course, located on Mt. Pleasant, has over 30 obstacle courses designed to challenge groups to work together in a variety of ways. Some activities are physically challenging, but most emphasize teamwork through problem-solving and mutual support. The goal of this exercise was to start this group of young mathematicians out as a team, working together to build a strong support group.

Comments from some of our new graduate students:

"I think the Hoffman Challenge is one of the most interesting experiences in my life in a good way. It was definitely helpful for us to get together and to share some interesting memories." Joeun Jung

"I thought that the Hoffman Challenge experience was very positive. The day was a lot of fun and I found it very helpful for starting to get to know my classmates." Jenna Rajchgot

"We played a few games which required everyone in the team to take part. I felt that it was also a good opportunity for me to get to know other first-year graduate students." Ri-Xiang Chen

"The games that we played were intended to build up 'team spirit' and I think that in the end they actually managed to give a sense of team spirit in such a short time. I found it refreshing and interesting overall." Remus Radu

2007 Chelluri Lecture

The Chelluri Lecture, established in 2004 with support from family and friends of Thyagaraju (Raju) Chelluri, is held yearly.

On Wednesday, May 2, 2007, the second Chelluri Lecture was delivered by Professor Kenneth Ribet of the University of California at Berkeley. Professor Ribet spoke on *Recent Progress on Serre's Conjecture*.

Dinner for invited guests followed the lecture.

Kieval Lectures

There were two Harry S. Kieval Lectures this fall. The first lecture was held on September 28 and given by Richard Hamilton of Columbia University. Hamilton, a former Cornell math professor, spoke on *The Past and Future of Geometric Flows*.

The second Kieval Lecture was given by Allen Knutson of the University of California, San Diego on October 26 . He spoke about and demonstrated examples of *The Mathematics of Juggling.*

William Lowell Putnam Competition

Our 2006 team included Hyun Kyu Kim, '08, Julius Poh, '09, and May '07 graduate Zachary Scherr. The team finished in 14th place. This year's national competition will be held on Saturday, December 1st. See www.math.cornell.edu/Undergraduate/contests.html .

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The **Mathematical Contest in Modeling (MCM)** was held October 26-30. For contest results, go to www.math.cornell.edu/%7Emcm/.

The Class of 2007

Math Majors

Commencement was held on Sunday, May 27. Fifty-six mathematics majors received Bachelor of Arts degrees (including 2 in August and 5 in January). Twenty-two majors were awarded honors in mathematics:

Summa Cum Laude
Timothy Cramer
Jeremy Miller
Zachary Scherr
Sherry Wu

Magna Cum Laude
Matthew Fontana
Rafael Frongillo
Evan Marshak
Thiti Taychatanapat
Joshua Wiener

Cum Laude
Yu Tung Cheng
Thummim Cho
Jia-Young Fu
Peter Goldstein
David Lawrie
Daniel LePage
Yancy Lo
Kyle Story
Andre van Rynbach
Gregory Vesper
Daniel Volovik
Liwei Wang
Benjamin Weber

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Harry S. Kieval Prize

The *Kieval Prize* is given to an outstanding undergraduate. In 2007, it was awarded to five students: **Timothy Cramer**, **Rafael Frongillo**, **Jeremy Miller**, **Zachary Scherr**, and **Sherry Wu**.

Graduate Students Awarded Ph.D.'s

Jason Bode, *Isoperimetric Constants and Self-Avoiding Walks and Polygons on Hyperbolic Coxeter Groups*, May.

Benjamin Chan, *Coexistence of Contact Process*, May.

Farkhod Eshmatov, *The Calogero-Moser Correspondence for Noncommutative Deformations of Kleinian Singularities*, August.

Pavel Gyrya, *Heat Kernel Estimates for Inner Uniform Subsets of Harnack-Type Dirichlet Spaces*, August.

Henri Johnston, *The Trace Map and Golois Module Structure of Rings of Integers for Absolutely Abelian Number Fields*, August.

Evgueni Klebanov, *Asymptotic Behavior of Convolutions of Centered Density on Lie Group of Polynomial Volume Growth*, January.

Andrei Maxim, *Aspects of the Finite Element Method for Elliptic Partial Differential Equations*, May.

Vadims Moldavskis, *The New Generic Properties of the Real and Complex Dynamical Systems*, January.

Achilleas Sinefakopoulos, *On Some Classes of Borel Fixed Ideals and their Cellular Resolutions*, August.

Aaron Solo, *Finite Element Methods for Elliptic and Parabolic Problems with Low Regularity Boundary Data*, January.

Mauricio Velasco, *Monomial Resolutions and the Cox Rings of Del Pezzo Surfaces*, August.

Treven Wall, *A Fatou Theorem for a Class of Quasi-linear Elliptic Partial Differential Equations*, January.

Two Long-term Staff Retire

Arletta Havlik retired on June 30, having worked for 43 years at Cornell. She joined the department in 1968 as one of four secretaries in the typing pool. In addition to being the department Registrar for about 35 years, she was an extraordinary technical typist.

Doug Alfors announced his intention to retire early next year, after 24 years with us. In addition to his computer expertise, he hires and supervises tutors for the MSC and course assistants for Math 111-112. We will miss his jokes and limericks.

We all wish Arletta and Doug many happy years of retirement!

New Staff Member

Heather Peterson joined our staff in August. Heather is our Course Enrollment Coordinator and receptionist and is located in 310 Malott. We welcome Heather to our department family!

Math Matters is published through the combined efforts of members of the department. Thanks to Doug Alfors, Allen Back, Dan Barbasch, Rick Durrett, Bill Gilligan, Tara Holm, Joy Jones, Michelle Klinger, Ravi Ramakrishna, Donna Smith, and Bob Strichartz for their help and contributions.

Catherine Stevens, Editor
cls15@cornell.edu

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:

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