MATH MATTERS

DEPARTMENT OF MATHEMATICS • CORNELL UNIVERSITY • ITHACA, NY • DECEMBER 2001

Letter from the Chair, John Smillie

This department is internationally known for the quality of the research it produces, but what may be less widely known is the importance it attaches to teaching. As a means of letting others know about our teaching efforts, the department plans to institute a new teaching award. The award for faculty, adjunct faculty, lecturers and visitors would consist of a certificate of recognition, while the graduate student award would consist of a certificate of recognition and cash prize. We would like to create an endowment for the graduate student award so that the prize could be a generous one. For the time being the award will be called simply the "Department Teaching Award," but we welcome suggestions for a better name.

There have been some changes in the department during the last year. We welcomed four new H.C. Wang Assistant Professors in July 2001: Kai-Uwe Bux (University of Frankfurt); Martin Dindos (University of North Carolina at Chapel Hill); Irina Mitrea (Institute for Advanced Study); and Milen Yakimov (University of California at Berkeley). In addition, we will have two new VIGRE Assistant Professors for the 2001-2002 academic year: Matthew Fickus (University of Maryland, College Park) and Anita Mareno (Cornell University). The following new NSF Postdoctoral Fellows have been in residence since July 2001: Jason Schweinsberg and Alexander Vladimirsky, both of whom recently received their Ph.D.'s from the University of California at Berkeley.

Louis Billera took over as director of graduate studies from Dan Barbasch. Many thanks to Dan for four years of outstanding service to the department. I would like to thank Lou for agreeing to take on this demanding position.

Birgit Speh has assumed the job of director of undergraduate studies, formerly held by Steve Chase. Since the department teaches close to 6,000 students in over 200 courses each year this is a very important position. Steve was originally appointed to the position of associate chair by Peter Kahn. The whole department owes Steve a debt of gratitude, and I would especially like to thank Steve for being willing to extend his term by a year to facilitate this latest transition.

It is my sad duty to relay the news that Paul Olum died January 19, 2001 in Sharon, Massachusetts. Paul was a professor in the Mathematics Department from 1949 to 1974 and chair of the Mathematics Department from 1963 to 1966. For more information about his life, see the article on page 10.

The fall 2001 Battig Graduate Prize was awarded to Fernando Marques, and the Eleanor Norton York Award was given to Chris Francisco. In spring 2001, graduate student Kathryn Nyman won the Clark Distinguished Teaching Award given by the College of Arts and Sciences. The Harry S. Kieval Prize in Mathematics, an undergraduate award, was given to Jesse Alt at the May 2001 commencement reception. The Freshman Math Prize was awarded to Asher Walkover, with second prize going to Omar Nayeem. Undergraduate major Justin Kinney was one of three Cornell recipients of a Barry M. Goldwater Scholarship in science and mathematics. Graduate student Huibin Zhou was chosen to receive the Liu Memorial Award.

At the Joint Mathematics Meetings in New Orleans in January 2001, Harry Kesten was honored with the 2001 Leroy P. Steele Prize for Lifetime Achievement. (See page 2.) Warwick Tucker was awarded the Swedish Mathematical Society's Wallenberg Prize this past June at a ceremony during the SMS's annual meeting in Lund. The Magnus Memorial Prize, awarded by New York University, was presented to José Ramírez.

I am delighted to announce that our search for a senior faculty member resulted in the appointment of a leading probabilist, Gregory Lawler. Greg has been at Duke University since 1979 and is an expert on the theory of random walks. We are delighted that he has decided to join us at Cornell. I would like to congratulate Greg and Harry Kesten for being selected as speakers at the International Congress of Mathematicians that will be held in Beijing, China in 2002. A congress is held every four years, and it is an honor to be invited to speak.

The university has adopted a novel approach to Computer Science. They have created a new college with responsibility for computer science and for interacting with other departments on related issues. This new unit is called Computing and Information Science (CIS). Spanning the entire campus, CIS serves to bring together experts in computing with researchers and scholars in a variety of disciplines. The CIS is run by Dean Robert Constable and a group of faculty called the "Founders," which serve as a kind of "board of trustees." We are delighted that Dean Constable has appointed the first Mathematics Department representative to the group of founders: John Guckenheimer.

Our VIGRE grant continues to fund a variety of interesting activities that benefit our department and the mathematical community. (See page 8.)

For more information, visit our website:

www.math.cornell.edu

Harry Kesten Wins Steele Prize

Goldwin Smith Professor of Mathematics Harry Kesten won the 2001 Leroy P. Steele Prize for Lifetime Achievement. The prize is awarded by the American Mathematical Society and is one of the highest distinctions in mathematics. It was presented to Professor Kesten on January 11 at the Joint Mathematics Meetings in New Orleans.

Professor Kesten was honored for "his many and deep contributions to probability theory and its applications." In addition to his research on such theoretical problems as percolation theory and random walks, he has "dabbled" in models inspired by statistical mechanics. Kesten also has contributed to the understanding of such practical matters as population growth and river networks.

Professor Kesten earned his undergraduate degree at the University of Amsterdam, The Netherlands and received his Ph.D. at Cornell in 1958. He was an instructor at Princeton University for a year and then spent two years at the Hebrew University of Jerusalem. In 1961, he returned to Cornell as a visiting assistant professor, and he has remained here since then.

The American Mathematical Society established the Steele Prize in1970, following a bequest of $145,000 from Leroy P. Steele.

Math Explorers Club

The Math Explorers Club, a program for high school students, began its second full year of operation this fall. The Saturday meetings are open to all interested students at no charge. The goal of the club is two-fold: to stimulate an interest in mathematics by exposing students to material not usually encountered in the high school curriculum, and to provide a peer group of students who share an interest in mathematics.

Participants choose among modules that provide instruction in interesting areas of mathematics, computer lab activities, and problem solving sessions. Two intense hour-long sessions are separated by a break, during which participants of all modules can gather to relax and talk things over. The program is run by four graduate students, Sharad Goel, Todd Kemp, Maria Sloughter, and Tiberiu Tomita, and has modules taught by faculty members.

The modules offered in the first 6-week cycle this fall were knot theory by Graeme Bailey, and the Fibonacci sequence and the golden ratio by Robert Strichartz. Later in the fall, Edward Swartz offered a module on geometry and topology of surfaces. More modules will be announced for the spring semester. (See our department's web page.)

The program is funded by the VIGRE grant, which provides stipends for the graduate students and pays for the refreshments. This is a great opportunity for the graduate students to interact with faculty in an informal setting and to gain valuable experience in education and outreach that will help them in future job searches. Participants enjoy the challenge of communicating the excitement of mathematics to young and eager minds and spreading the word that mathematics is a cool subject. We expect the program to evolve and grow in response to the needs and interests of the participants.

CCC Math Day

Corning Community College sponsors an annual outreach event called Math Career Day, in which high school seniors from three counties are invited to tour campus and attend math talks. This year, on Friday, October 12, CCC Math Day talks were given by several Cornell faculty members, various professionals in the greater area, and Suzanne Hruska, a current graduate student in the Mathematics Department. Suzanne's talk, "Order in Chaos," was about fractals and iteration. CCC Math Day this year included 431 students from seventeen schools in the Corning area.

Math for Monks

By Avery Solomon

Motivated by the vision of His Holiness the Dalai Lama, the second science for monks workshop, held at the Ganden Monastery in Karnataka state in March 2001, had a mathematics component, which I taught concurrently with the science component.

During an audience that I attended with about 50 people in Stockholm in May 2000, His Holiness the Dalai Lama spoke of his idea of a math/science program for monks. He wants math and science to be part of the curriculum for monks at Tibetan monasteries in India so that eventually the monk/scholars could carry on the dialogue between Buddhism and science, which His Holiness initiated about 10 years ago. He feels that the main areas of discussion are cosmology, subatomic physics, brain science/cognitive studies, and psychology. After the audience, I stayed and talked with His Holiness for a few minutes, and I told him I would be willing to help teach the math component of the program. I have known him since 1979 and was thrilled to do something for him in return for all his kindness over the years.

Before coming to the monastery, I had been in India two times but did not know anything of the students' background or abilities. I brought a variety of activities that could be modified to use at many levels. The idea was to provide activities with interesting contexts, the contents being number and operations, patterns, geometry and data/statistics.

During the workshop, I stayed at Ganden Monastery, the rebuilt version of one of the largest monastic institutions in Tibet. I taught two groups of monks essentially the same curriculum. For half of the program, I met a group of 19 students who had been to the workshop the previous year for science, from 8:00-9:30 and 10:00-11:30, while the other group of students did science experiments led by two American scientists/ science educators. In the afternoon I met a group of 37 new students from 2:00-3:30 and 4:00-5:30. We later switched mornings and afternoons. During the program I also spent many evenings with the Rinpoche directing the program and his personal students, discussing math issues, constructing various solids, talking about pi, etc.

Most of the monks were between the ages of 25 and 40. Some had their graduate Geshe degrees, and others were close to graduation. Monks came from more than 6 monasteries representing 3 of the 5 major Tibetan traditions. The math backgrounds of the monks varied greatly. Some of them had trouble reading numbers from the calculator, and many had no formal mathematics schooling. Some of the monks had previous secular educations, a few up to grade 10.

Teaching the course was much like teaching adult education to a group of very interested and intelligent mature students with very weak math skills. The students are good at debate and like to argue points. Almost none speak or understand English well enough to converse, so we had four translators in the room: two Tibetan math teachers from the Tibetan Children's Village and two translators from the Library of Tibetan Archives. The director of the program, Achok Rinpoche, is the current head of the library.

Monks who were returning to the program had already received Tibetan language translations of Indian textbooks for grades 3, 4, and 5. New monks received these books as well. However, the basic abilities of the two groups did not differ significantly.

Over the next 5 years the plan is to continue meeting the monks once a year for three weeks. As I see it, there are three goals for the program. First, to provide a math background to support the science explorations. Second, to give the students experience in exploring mathematics and thinking mathematically. Third, to acquaint the students with the great ideas and concepts in mathematics and to see why mathematics has been so powerful in modeling the nature of the universe.

In addition, we hope that some of the students in the program will learn enough of th English language, science and math so they can eventually spend a year in a university and return to the monasteries to teach mathematics. And, as His Holiness hopes, some of the monks will be able to continue the dialogue between Buddhism and science, which seems to be fruitful for both.

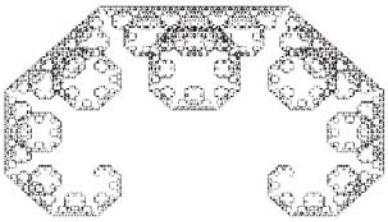
What Are Our Undergraduate Math Majors Doing?

They are doing research. Some are participating in REU programs at Cornell or other universities during the summer, some are supported by summer VIGRE grants, and some are simply finding faculty members with interesting projects to work on. But more and more of our students are working on challenging unsolved problems, writing papers, giving talks at conferences…in short, they are participating in the life of a research mathematician. What are they working on? The following gives just a sampling of what some have done. Keep in mind that there are others who are just beginning research work, and you will read about them in future issues of Math Matters.

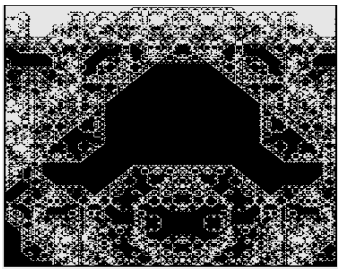
Scott Bailey '02 participated in the REU program at LSU in summer 2001 working under Jerome Hoffman. They are completing a paper entitled "Jacobians and Mackey Functors."

The Jacobian of a graph is a finite abelian group defined analogous to that over compact Riemann surfaces and is an approximate measure of the number of cycles a graph has. That is, the Jacobian is trivial over a tree graph. It is known that the Jacobian is an invariant, albeit weak — one can say nothing about two graphs with the same Jacobian, but if they differ the graphs are non-isomorphic. Originally, the project was to determine exactly how strong the Jacobian is as an invariant, but it wasn't too strong because most graphs had isomorphic Jacobians! The interesting part is that the Jacobian is reminiscent of class groups over intermediate field extensions, in that the Jacobian's nature is predictable — if the Jacobians are going to differ in any way, it is going to be in the p parts (for certain p independent of the graphs themselves). This was a result of being a cohomological Mackey functor.

Scott also worked with Ted Kim (a former CS major at Cornell, now a grad student at the University of North Carolina) and Professor Robert Strichartz in spring 2001 on a project to understand the interior of the Lévy dragon. (See the figures, which show the entire Lévy dragon and some components of its interior.) They have written a paper, "Inside the Lévy dragon," submitted to the American Mathematical Monthly, and a web page, mathlab.cit.cornell.edu/~twk6, that lets the user search for different shapes in the interior. So far, only 16 different shapes have been found. Can you find any more?



The Lévy dragon



Components of the Lévy dragon

Scott gave a talk on this work at a special session on fractals at the AMS meeting in Columbus, Ohio in September 2001.

Ari Blinder '02 worked with Karoly Bezdek in Cornell's summer 2001 REU program. Ari studied some of the properties of the lattice width, a number assigned to a convex body when studied with respect to a lattice. The lattice width is an interesting number for both discrete geometry and applied math since it can be used to optimize integer linear programming and obtain some results in number theory. The primary goal in the study of the lattice width is to determine the maximum lattice width of a convex body which contains no lattice points. Kannan and Lovasz in 1988 conjectured that this number was a constant times d, the dimension of the lattice. However, to date, the best general upper bound is $O(d^2)$ although better results have been achieved for special convex bodies. Ari tried to prove this so-called "Flatness Conjecture" for dimension 2. With the help of Dr. Allen Back, he proved this for most polygons. Ari hopes to complete this proof while also working on his senior thesis in computational model theory, which he is pursuing with Professor Russell Miller.

Debbie Grier '02 started working on her senior thesis with Professor Louis Billera in summer 2001 with support from the NSF VIGRE grant. The research involves a function which operates on a special

(Math Majors Continued)

class of other functions. This function is a linear map and can therefore be represented by a matrix. The eigenvectors of this matrix have some very interesting properties. Suppose you were to randomly shuffle the numbers 1 through n and then examine the pattern of how the numbers in the shuffled sequence increase and decrease. There are several possibilities, each occurring with different probabilities. Surprisingly, the coefficients of the principal eigenvector of the linear map are just the probabilities that the shuffled sequence will "peak" in certain patterns! Debbie is examining whether the other eigenvectors have similar "shuffling" interpretations. In order to carry out computations, she has written programs in GAP, a computing language that is very good at handling permutations (i.e. shuffles).

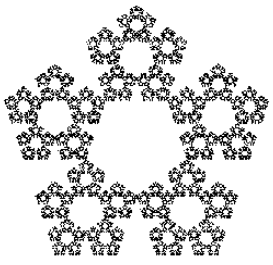
Debbie also participated in Cornell's summer 2000 REU program in the algebraic combinatorics group under supervision of Richard Ehrenborg and Margaret Readdy (both now at the University of Kentucky). Debbie studied *cd*-indexes (a polynomial in noncommuting variables c and d which encodes information about combinatorial properties of the arrangement) of n-dimensional hyperplane arrangements and obtained a recursive formula to compute the *cd*-index of a subclass of hyperplane arrangements.

Justin Matis '03 worked with Karoly Bezdek in the summer 2001 REU program at Cornell in discrete geometry. He worked on an old but still interesting question of Erdös and Bateman: Given any norm in the plane (not necessarily the Euclidean norm), what is the minimum diameter of a set of n points whose distance apart is at least one? Justin gave some new non-trivial estimates and made progress on proving the conjecture that for $n = 7$ the minimum diameter is 2.

Dan Ramras '02 has been working with Professor Ken Brown on geometric complexes related to finite groups for the past year. Groups correspond to symmetries of an object, and these complexes give us information about the overall structure of these symmetries. This has been an active area of research for the past twenty years, combining the techniques and viewpoints of algebra, topology, and combinatorics. Dan has been focusing on a particular type of complex, the coset poset, with the goal to understand the connectivity of this space, which gives information about "holes" in the space. After proving several general results in this direction, he is now studying a certain class of finite simple groups.

Bryan Renne '02 worked under the guidance of Professor Anil Nerode this past summer. Supported by the VIGRE grant, Bryan studied the relationship between a modern proof of the correctness of definition by induction given by a 19th century mathematician, Richard Dedekind. The work will be presented in a paper to be submitted for publication sometime during the spring semester. Discussing in concrete terms the insufficiency of the intuitive conception of why definition by induction works, the paper shows how a denotational semantics-scheme for definition of a programming language that includes "while" loops can be unwound into the more intuitive definition by induction form, once we can be assured definition by induction works as we intuitively expect. The paper also explores connections to algebraic data structures that make use of inductive definitions, giving a specific example of a particular data structure and its algebraic specification.

Alex Smith '02 worked with Bryant Adams (former undergraduate at Washington and Lee University and now a graduate student in Mathematics at Cornell) under the direction of Professor Strichartz and Dr. Alexander Teplyaev (a Cornell Mathematics Ph.D., currently an NSF postdoctoral fellow at UC Riverside) on a project to understand the spectrum of the pentagasket fractal (see figure below). The spectrum represents the frequencies of sound that would be emitted by the vibrations of an object with this shape. By using methods of



PENTAGASKET

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Research Experiences for Undergraduates (REU)

The Cornell Research Experiences for Undergraduates (REU) program, funded through its own grant from the National Science Foundation and supplemented by the department's VIGRE grant, is one of the nation's leading summer programs for undergraduate research. During the summer of 2001, fourteen undergraduate students from across the country, including such well-known institutions as Harvard, Chicago and Cornell, and some lesser-known institutions such as the University of Missouri-Rolla and North Central College, came here to work on research projects in three areas: analysis on fractals, directed by Robert Strichartz, geometry of numbers, directed by Konstantin Rybnikov, and discrete geometry, directed by Károly Bezdek (a visiting professor from Eötvös University, Budapest). Three of our graduate students, Todd Kemp, Melanie Pivarski, and Franco Saliola, assisted with the program. This was the eighth summer for this program and the last under the current grant. The department (with Professor Strichartz as principal investigator) has applied for a renewal in order to continue this exciting program. During the past eight years, this program has served 87 students (20 female) and produced over two dozen research papers published in such journals as Transactions of the AMS, Indiana University Mathematics Journal, Geometria Dedicata and Experimental Mathematics. In a typical year, the department receives over one hundred applications. The students in the program receive a generous stipend, and some students have come with funding from outside sources. One student from the program received the Morgan Prize for Undergraduate Research, a prestigious national award, and another has been nominated for this award based on work done during the program.

The students work individually or in small groups on problems that have been carefully chosen to be accessible to undergraduate students, but are still of interest to the general mathematical community. 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, and many go on to give talks at various conferences. The students get to hone their lecturing skills at a weekly jam session in which they discuss their work with other participants, and they attend a lecture series, the Smorgasbord Seminar. In this seminar, members of the department dish out small tastes of what research is like in many different areas of mathematics (followed by real refreshments in the lounge). The Smorgasbord Seminar has an avid following from throughout the department and is repeated during the fall semester as a one-credit course (Math 402).

Here is a brief description of the work done in summer 2001:

Analysis on Fractals. Students in the REU program working with Professor Strichartz since 1996 have already made important contributions to this developing area, the goal of which is to create the analogs of calculus and differential equations for functions defined on fractals. This 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. This summer, the students explored the sampling problem: recover a function from just a finite set of its values, under appropriate spectral hypotheses. The experimental results suggest that this problem is actually much better behaved than the classical Shannon sampling theorem. They began work on defining a nonlinear differential operator, the p-Laplacian, on the Sierpinski gasket fractal, and on defining a standard Laplacian on the octagasket fractal, which has a more complicated structure than the fractals previously studied. They also continued work begun in summer 2000 in developing a finite element method numerical analysis scheme on the pentagasket fractal and using it to help understand the spectrum of the Laplacian in this case.

Geometry of Numbers. Students working with Assistant Professor Konstantin Rybnikov studied the geometry of quadratic forms over the integers, or, equivalently, lattices in high dimensional Euclidean spaces, and certain geometric objects associated with them: the Delaunay polytopes, and the Voronoi polyhedron in $\mathrm{Sym}(n,R)$. In particular, they studied an infinite

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Curriculum Renewal

By Reyer Sjamaar

A substantial reorganization of the Mathematics Department's undergraduate course offerings is afoot. Much of this activity follows in the wake of a comprehensive review of our entire curriculum by the Curriculum Committee under the chairmanship of Professor John Guckenheimer.

Curriculum renewal was an important component in our successful application for a five-year federal VIGRE grant. New courses are being added, some old ones have been dropped, and several are being extensively revised. One goal of these efforts is to adapt to a changing student population with changing preferences. Another is to expose more undergraduates to contemporary mathematics and to increase the interaction among undergraduates, graduate students, and faculty members. A third goal is to ease the formerly rather sharp transition between the lower-level courses (mainly the various calculus sequences) and the upper-level courses.

Let me briefly describe a sample of our new or revised courses. In response to an increasing influx of architecture and social science majors, Math 106, a calculus course formerly targeted to prospective biology majors, has been revised by Professor Rick Durrett and is now being offered with a new syllabus under the name Calculus for the Life and Social Sciences.

A new course, Math 311, Introduction to Analysis, is to be taught for the first time this coming spring by Professor Irina Mitrea. This course is a replacement for the old Math 411, which carried the same title. It is designed to bridge the gap between calculus and analysis and to provide students with a grounding in theorem-proving skills in this area. (The highly successful Honors Introduction to Analysis, Math 413-414, will remain unchanged.)

Math 321, formerly Applicable Analysis, is now called Manifolds and Differential Forms and is being completely revamped by me. The syllabus now covers topics from differential geometry and various applications to topology, partial differential equations, and mathematical physics, and is intended for an audience of mathematics and science majors.

Math 402, the Smorgasbord Seminar, is a new course for advanced undergraduates. Professor Robert Strichartz originally developed the format, a series of one-hour lectures by department members on current research topics, as part of our Research Experiences for Undergraduates summer program. With a view to reaching a larger audience, it has been made a part of our regular curriculum and is being offered this year for the second time.

Another new course designed by Bob Strichartz is Math 424, Wavelets and Fourier Series. Fourier series first arose in the eighteenth century. They are an analytical tool for decomposing complicated signals into frequency components and for solving differential equations. Wavelets fulfill a similar purpose but were invented only a few decades ago. The course presents the key ideas and main applications of both areas while keeping the analytical prerequisites to a minimum.

2001 Kieval Lecture

Richard Guy, Emeritus and Faculty Professor of the University of Calgary, delivered the 2001 Kieval Lecture on November 9, 2001 in Malott Hall. In the lecture, titled "Fun from Mathematics and Mathematics from Fun," Professor Guy gave an autobiographical history of combinatorial games. Combinatorics is the branch of mathematics that includes the enumeration of complicated configurations and patterns.

Professor Guy has taught mathematics at all levels from kindergarten to post-graduate in Britain, Singapore, India and Canada. He has published over 250 papers and a dozen books, including "Winning Ways" with Elwyn Berlekamp and John Conway.

The Kieval lecture, designed for undergraduate students and members of the public who have a basic scientific and mathematical knowledge, is funded through a bequest of the late Dr. Harry S. Kieval '36. Kieval, a professor of mathematics for many years at Humboldt State University in Arcata, California, died in 1994.

VIGRE Program

The fall semester always brings cooler temperatures and colorful leaves to Ithaca but this year it has for the second time brought a new crop of people supported by our VIGRE grant. The VIGRE program of the National Science Foundation is designed to support the infrastructure of mathematics education in the U.S. by providing support for research and education at all levels from K-12 to postdoctoral studies.

The fact that there are now 31 VIGRE grants has transformed the job market from the buyer's market to one in which new Ph.D.'s have a wide variety of offers. Despite this competitiveness we were able to bring four new Ph.D.'s from this pool to Cornell. There are two new VIGRE postdocs: Matthew Fickus from the University of Maryland, College Park and Anita Moreno, who completed her Ph.D. in the Theoretical and Applied Mechanics Department at Cornell working with Tim Healey. In addition, there are two individuals who won NSF postdoctoral fellowships that brought them to Cornell: Jason Schweinsberg and Alexander Vladimirsky, both from the University of California at Berkeley.

There are 13 new graduate students this year. Two of these, Jason Bode (Calvin College) and William Gryc (Amherst) are supported by VIGRE graduate fellowships, which will relieve them from TA duties for their entire first year and for one semester in each of their second and third years. A third student, Edoardo Carta, from the University of Puerto Rico Humaco, will be supported by a fellowship from the graduate school for the first year and then will be a VIGRE fellow for three years.

VIGRE support is also available to more senior graduate students in the form of VIGRE semesters — one semester free from teaching duties in order to broaden their education or to reduce their time to degree. Seven students were supported in this way during the 2000-2001 academic year to do a wide variety of things: working with the Math Explorer's Club, enhancing their undergraduate teaching skills, or exploring biological applications of probability and computer algebra. Now that our second group of VIGRE fellows has arrived, the number of VIGRE semesters we can offer has decreased. One student will have a VIGRE semester in the fall: Sarah Spence will develop coding theory applications for Math 336. As a VIGRE fellow in the spring semester, Chris Hardin will use his release from teaching to take two courses in Computer Science in order to make progress on his Special Master's degree in that field. Two or three students yet to be selected will also be supported in the spring semester.

The VIGRE grant has again supported the participation of Cornell students in the summer REU program and provided support for the Math Explorer's program, a weekend activity for high school students during the school year. Both of these activities are directed by Bob Strichartz and are the subject of other articles in this newsletter. In addition to support for the REU, three undergraduates each summer have received small grants to work directly with Cornell faculty members. In the summer of 2001, Debbie Grier worked with Lou Billera, Brian Renne with Anil Nerode, and Alex Smith with Bob Strichartz. In addition to those receiving VIGRE support, Dan Ramras had an award from the Arts College to work with Ken Brown. In most of these cases the students are using the summer to get a start on their senior honors theses.

Apart from the planned aspects of the program, the VIGRE grant has been able to do miscellaneous things to benefit undergraduates and K-12 students. Yoon Ha Lee was supported to attend the 3rd Nebraska Conference for Undergraduate Women in Math at the University of Nebraska at Lincoln. As part of Bob Connelly's module in the Math Explorers Club, students used brass rods and steel springs to build polyhedral structures. Each student got a small structure to take home as a souvenir. Several large ones now decorate our fifth floor lounge. The VIGRE grant also provided support for an "Expanding Your Horizons Workshop" for middle school girls, described in another article in this newsletter. The amounts of money involved in supporting these activities were not large but served to create a lot of excitement about math.

The final activity of the VIGRE grant to be mentioned is the VIGRE Interdisciplinary Colloquium. This monthly event aims to expose graduate students, postdocs, and faculty both inside and outside the department to the many uses of mathematics in applications. Lectures on a broad spectrum of topics were

(VIGRE Continued)

given in 2000-2001 by Eva Tardos (Computer Science), Steve Ellner (Ecology and Evolutionary Biology), Steve Tanksley (Plant Breeding and Plant Biology), Steve Strogatz (Theoretical and Applied Mechanics), Jon Kleinberg (Computer Science), Philip Protter (Operations Research and Industrial Engineering), and David Mermin (Physics). This semester will feature talks by Bob Jarrow (Johnson School of Management), Ron Elber (Computer Science), Carlos Castillo-Chavez (Biometrics), Richard Rand (Theoretical & Applied Mechanics), and Viet Elser (Physics).

In addition to these talks, there was a three week mini-symposium on Mathematical Sciences and the Law in February-March 2001 organized by Lou Billera and Marty Wells. Paul Edelman from Vanderbilt University discussed cooperative games, voting power, and the Supreme Court. Walter Mebane presented evidence for excessive Buchannan vote share in Palm Beach County, Florida. The third and final talk was a joint effort by Theodore Eisenberg from the Law School and Marty Wells, a statistician in Industrial and Labor Relations. Their topic was forecasting life and death: a statistical analysis of juries and their death penalty decisions.

Math Majors

(Continued from page 5)

numerical analysis, it is possible to obtain experimental evidence for the nature of the spectrum, leading to a number of interesting conjectures. Some of these conjectures have been proved using the representation theory of the dihedral group of symmetries of the fractal and some scissors-and-paste constructions. A paper on the subject is being prepared. The REU program supported Alex's work in summer 2000 and the VIGRE grant in summer 2001. He will be giving a talk on the work at a special session on fractals in honor of Benoit Mandelbrot at the joint AMS-MAA annual meeting in San Diego in January 2002.

Oded Yacobi '03 participated in the Lafayette College REU program working in a group researching matroid theory directed by Professor Lorenzo Traldi. The group found a new definition of matroids that provided a conceptually simpler model.

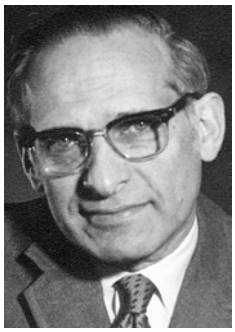
Begin with the question: Given a finite spanning set E of a vector space V, what is the simplest clutter on E which could not possibly be the clutter of all bases of V contained in E? The natural answer is the clutter $C = \{a, bc\}$. Next define matroid basis clutters by excluding this single forbidden minor. Observe that every property of C then gives rise to a theorem of the form "If no minor of a clutter C' has that property, then C' is a matroid basis clutter" and that many of these theorems have valid converses and hence actually characterize matroids. Thus the fact that matroid basis clutters have a single forbidden minor is closely connected to a distinctive characteristic of matroid theory, namely that matroids can be defined in many different equivalent ways.

Expanding Your Horizons

Expanding Your Horizons is an annual day of hands-on workshops in mathematics and science for 7th and 8th grade girls. The program is organized and run by women in mathematics and science to generate interest in these subjects and to motivate the girls to continue taking mathematics and science courses throughout high school. On April 28, 2001, the graduate women of the Mathematics Department once again contributed to the success of the day by offering an exciting workshop on origami and symmetry.

Mathematics graduate students Leah Gold, Kathryn Nyman, Melanie Pivarski, and Maria Sloughter joined other Cornell graduate students and faculty, Angela Baldo, Debra Goldberg, Suzanne Shontz, and Eileen Tan, in the workshop this year. They worked with the girls using kami, origami paper, to study symmetry. The girls created units, which were used as the building blocks for polyhedra. The units themselves were found to have a symmetry — right-handed units would only fit with other right-handed units, and left-handed units would only fit with other left-handed units. The girls paired up and used these units to create a cube. Then, each pair of girls was challenged to create a cube that was a mirror image of the first cube. After playing with the two mirror-image cubes for a while, the girls discovered that there was no way to rotate one to get the other.

Paul Olum, Former Chair, Dies



Paul Olum, former chair of the department, died on January 19, 2001 in Sharon, Mass. He was 82.

In the early 1940's, while working as a physicist at Princeton University, Olum joined Hans Bethe, the eminent Cornell physicist, at Los Alamos on the project to develop the first nuclear weapon. He earned his M.A. in mathematics from Princeton in 1942 and his Ph.D. from Harvard in 1947. After a stay at the Institute for Advanced Study at Princeton, he arrived at Cornell as an assistant professor in 1949. At the time, Olum was the only representative of the burgeoning field of algebraic topology. In the following years, he built the Cornell topology group into one of the strongest in the nation. In 1962 Olum initiated the Topology Festival, an annual regional professional gathering at which the major developments in the subject were presented. This became the most prestigious topology conference in the country and is still held annually.

Olum was department chair 1963- 1966. In 1971 he was elected to the Cornell Board of Trustees. In 1974 he became Dean of the College of Natural Sciences at the University of Texas. He left in 1976 for the University of Oregon and was Vice President for Academic Affairs and Provost and later President, retiring at age 70 in 1988.

Olum's contributions to mathematics were all in the area of algebraic topology, more specifically the subfield of homotopy theory. He was a pioneer in developing a comprehensive theory of algebraic invariants of topological spaces known as obstructions. His 1950 paper on obstructions, which appeared in the Annals of Mathematics, is still one of the standard references on the subject. His work has had influence far beyond his technical specialty. Olum liked to tell a story about how he began his graduate career in mathematics. He began his graduate work as a very bright physics student but was entirely intimidated by his office mate, who seemed so much more able. Olum felt that if that was the standard for a good physics graduate student, then the field was clearly too difficult for him, and he opted to go back into mathematics, which had been his major at Harvard. As a punch line, Olum revealed that the office mate was the legendary Richard Feynman, who later became a Nobel laureate. The two remained close friends until Feynman's death in 1988.

In 1990 he moved to Greece and in 1996 illness forced him to return to the U.S. to live with his son, Ken, and Ken's partner Valerie White, in Sharon, Mass. Olum's wife, Vivian, predeceased him in 1986, as did a daughter, Judith, in 1990. Besides his son, he is survived by his daughter, Joyce, and her husband Philippe Galaski, and their children, Rebecca, Deborah and Aviva of Amherst, Mass. Funeral services were held at the University of Oregon on Jan. 24 and Memorial services on Jan. 25 at the University's Paul Olum Atrium in Willamette Hall.

REU Program

(Continued from page 6)

series of integer polytopes, introduced by Erdahl and Rybnikov, called supertopes. They gathered a great deal of combinatorial information about the supertopes and made progress toward proving their conjectured Delaunay property. In addition, one of the students together with Rybnikov was successful in proving a conjecture of Shtogrin and Ryshkov, dating to 1974, concerning the group of the Voronoi polyhedron.

Discrete Geometry. Students worked with Visiting Professor Károly Bezdek on a number of problems concerning sets of points in finite dimensional vector spaces, not just with respect to the usual Euclidean distance but more general distances defined by arbitrary norms. One of the students was able to find the largest surface density of faces of Voronoi cells in unit sphere packings in Euclidean 3-space. Another student found estimates for the largest number of equidistant points that can be placed in a given normed space and related questions. Other problems studied included estimating the minimum diameter of a set of 7 points in a plane (with arbitrary norm) when the points are at least a distance of 1 from each other.

The Math Club

The Math Club continued to meet weekly this year. Meetings consisted of lectures, both by students and faculty, and puzzle and problem sessions. Several members attended the Hudson River Undergraduate Conference held at Skidmore College on April 28, 2001.

The following students gave talks at the conference:

•Dan Ramras, "Cliques in Random Graphs"
•Jordan Barry, "Information Theory and Cannibalism"
•Ramiro Rodriguez, "Probability Reasoning"
•Chan-Ho Suh, "Being Wild: A Series of Counter-intuitive Embeddings into Euclidean 3-space"

Hutchinson Fellows

Dan Ciubotaru (4th year)
Jean Cortissoz (3rd year)
Yuval Gabay (4th year)
Sam Hsiao (4th year)

Battig Award

Fernando Marques (2nd year)

York Award

Chris Francisco (3rd year)

Notable

Jan Persens (Cornell Ph.D.'86, Lawrence Payne adviser) is President of the African Mathematical Union.

Mathematics Deparment Endowments

Once again, 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 first two endowments are new this year.

The **Cornell University Department of Mathematics Award** is presented to an Ithaca High School student who has excelled in mathematics and who has demonstrated originality and innovative power in mathematics. We would like to create an endowment that will allow us to increase the size of this award, which is currently quite small.

We are instituting new departmental teaching awards for graduate students and faculty. 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 Cornell. Earnings from this endowment are used to pay for honoraria and travel expenses for guest lecturers who speak at the Oliver Club seminars during the academic year. The Oliver Club was founded (as the Mathematical Club of Cornell University) in January 1891 by James E. Oliver, who was then chair of the department.

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 a continuing graduate student at Cornell.

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, who was a professor in this department 1962-1991. The memorial fund has as its central purpose helping young mathematicians in the field of topology. An award has been established for an outstanding graduate student in topology or neighboring areas.

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 in the areas of institutional memberships and travel expenses to the Association for Symbolic Logic meetings and events, as well as other activities in the field of logic.

The **Robert John Battig Endowment** was established by his parents in December 1997 after the untimely death of Robert Battig, who was a graduate student in mathematics. The current purpose of this fund is to provide an annual prize to an outstanding continuing graduate student in mathematics at Cornell.

If you would like to contribute, please make checks payable to Cornell University, indicate the specific endowment on the check, and send to:

The Mathematics Department Endowments
310 Malott Hall
Cornell University
Ithaca, NY 14853-4201

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Catherine Stevens, Editor

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