
Math Matters

The Cornell Mathematics Department Newsletter

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Former Alumni and Donor Dies

Harry Sears Kieval '36, a long-time benefactor of the Mathematics Department, died on September 9, 1994. Dr. Kieval earned his BA in physics and mathematics from Cornell University and later received his Ph.D. from the University of Cincinnati. He went on to teach math at the State University of New York, Brooklyn College, the University of Arizona, and Humboldt State University in California. He retired from Humboldt State in 1978.

Dr. Kieval was a generous man who fervently believed in undergraduate education. In 1983, he established the Harry S. Kieval Prize in Mathematics. This prize is presented to an outstanding graduating senior. The seniors are chosen by the Mathematics Honors Committee, who make their selection based on academic performance, the quality and variety of math courses taken and faculty recommendation.

One of the very first recipients, **Mark Gross**, returned to Cornell as a tenure-track assistant professor in 1993. **Benson Farb**, who received the prize in 1989, went on to attend Princeton University. Benson considered his prize, "...an award to inspire someone who is just at the beginning of the long road..." Others receiving the prize over the years include: **Eugene Sorets, Lance Fortnow, Mark Hansen, Denise Freed, Steven Golowich, Brian Hall, Ravi Ramakrishna, Daniel Brown, Thomas Kang-Po Yan, Michael Maltenfort, Re-Pan Chang, Benjamin Hinkle, John Kleinberg, Charles Irwin, William Dickinson and Tong Zhang.**

Dr. Kieval's generosity continues even after his death. His trust provides for donations to Cornell

University, as well as two other colleges. He left behind an endowment to support the Kieval Prize, as well as an honorarium of \$500 each year to visiting lecturers who will speak to undergraduates or the public. In addition, Professor Kieval established an additional endowment to provide financial aid to an undergraduate scholarship fund in mathematics.

At the present, faculty have contributed and are providing the funds to continue this annual prize until sufficient interest is established to fund this award indefinitely.

Reception To be Held in San Francisco

Joint Meeting of the Mathematical Sciences
San Francisco
January 5, 1995

Cornell Professor **John Smillie** will give an invited address on his paper, "Complex analytic dynamics in two dimensions" on *Wednesday, January 4, 1995 at 10:05 a.m.*

Please join Mathematics Chair **Peter Kahn**, faculty and graduate students at a reception held in honor of Cornell alumni. Come talk over old times, browse through recent faculty publications, share ideas on forthcoming departmental goals and accomplishments, and partake in refreshments with former instructors and faculty, as well as current associates and colleagues. *The reception will be held in Union Square 17/18 of the San Francisco Hilton and Towers from 5:45 to 7:30.*

Professor's Generosity Preserves Area Resource

The generosity of Professor **Moss Sweedler** and his wife, Kristen, made possible the acquisition of Lick Brook by the Finger Lakes Land Trust. The Land Trust, a non-profit organization that works to preserve natural resources in the Finger Lakes region, purchased the Lick Brook gorge and 127 acres of adjacent forest lands from the Sweedlers. Even those familiar with Ithaca's beauty are most likely unaware of this spectacular undeveloped area, which, for the last 200 years until recently, has been in the hands of private owners.

Professor Sweedler said that he had originally planned on bequeathing the property to the Land Trust in his will, but when approached in 1989 by Bob Beck, one of the trust's founders and its executive director, decided now was the time.

"They approached, so I thought that I didn't have to wait until I die to do something with the land trust," Professor Sweedler said.

According to Beck, the Lick Brook land was "number one" on the trust's priority list for protection. A description of the property makes it understandable why. The area consists of a 140-foot waterfall, lower falls, mature trees and many rare plants. Wildflowers grow in abundance, and the property is populated with three dozen species of trees and shrubs, as well as over 17 species of ferns, some of which are leftovers from the last Ice Age. The wildlife population, due to the lack of development in the triangle-shaped parcel of land, is also abundant.

"I bought the land because it was so special," says Moss Sweedler. "As time went on, it seemed to me that something this important should be shared."

To reach Lick Brook, head south on Route 13 until you cross a small bridge over the Cayuga inlet, just south of Turback's Restaurant. Turn left immediately after the bridge, park your car, and follow the signs for the Finger Lakes Trail. A smaller parking area is also found above the gorge, where Town Line Road crosses Lick Brook; again, look for the FLT signs.

*Information for this article was taken from the Thursday, July 15, 1993 edition of **The Ithaca Journal**; **The Land Steward**, vol. 5, no.3, the newsletter of the Finger Lakes Land Trust; and **Ithaca Times** for July 8, 1993.*

Keith Dennis appointed to Edit *Math Reviews*

Keith Dennis has been appointed executive editor of *Math Reviews* for three years, beginning January 1995. He has been

Dennis appointment, con't.

a faculty member at Cornell since 1971 and was chair of the Department from 1987 to 1993.

Math Reviews, published by the American Mathematical Society since 1940, is an abstracting journal that is considered the leading source of information about mathematical articles published worldwide. As executive editor, Professor Dennis will oversee the transition to a fully electronic format that will enable users to access *Math Reviews* via the internet and search for sources in a variety of ways. Another challenge will be to restructure the pricing of *Math Reviews* to balance the conflicting needs of raising enough money to pay for the cost of publication, while making *Math Reviews* available to the whole mathematical community.

Professor Dennis will be on leave from Cornell during his three-year tenure at *Math Reviews*. He will be missed, but the department is proud that one of our members will have the opportunity to render an important service to the mathematical community.

The Goldberg Collection

Math Matters volume 1, number 2 mentioned the Goldberg Collection. For those unfamiliar with the collection, the family of Michael Goldberg, an engineer by profession and mathematician by avocation, donated geometric models. In addition to the collection of models, however, the Goldberg family also gave a large number of mathematics books, personal papers, and notes. Of these, approximately 100 books were placed in the Mathematics Library's permanent collection. The remainders were sold through a Friends of the Math Library book sale, with the earnings donated towards the Faculty Book Endowment.

Ina Kersten Elected President of DMV

Former Mathematics Department visitor, **Ina Kersten**, has been elected the new president of the Deutsche Mathematiker Vereinigung (DMV), the German Mathematical Society, effective January 1, 1995. She was the first woman member of the Board of Trustees (Presidium) of the DMV.

Her recent work has been in the field of algebraic groups, and she has spent the last several years as a member of the SFB (special research group) in discrete mathematics at the Universität at Bielefeld. She was the last Ph.D. student of Ernst Witt (Hamburg) and is currently editing his collected works for publication by Springer-Verlag.

During her visit to the department in 1992, Dr. Kersten taught Math 431 and Math 632.

Faculty Publications

James Bramble, *Multigrid Methods*. Pitman Research Notes in Mathematics Series, Longman Scientific & Technical, London, co-published in the United States with John Wiley and Sons, New York, 1993.

Every researcher working in the area of the numerical solutions of partial differential equations, as well as practitioners in the field of scientific computations, should have at least some familiarity with this powerful technique. Multigrid methods are among the most efficient iterative methods for the solution of linear systems which arise in many large scale scientific calculations. Consequently, the invention of the multigrid method in the 1960s and its subsequent development up until the present is an extremely important area of research with great practical implications. This book presents old and new results concerning the rates of convergence of multigrid iterations.

Bernd Sturmfels, *Algorithms in Invariant Theory*. Springer-Verlag, 1993.

This book is both an easy-to-read text for invariant theory and a challenging research monograph that introduces a new approach to the algorithmic side of invariant theory. The Gröbner bases method is the main tool by which the central problems in invariant theory become amenable to algorithmic solutions. Students will find the book an easy introduction to this “classical and new” area of mathematics. Researchers in mathematics, symbolic computation and computer science will get access to a wealth of research ideas, hints for applications, outlines and details of algorithms, worked out examples and research problems.

Keith Dennis and Benson Farb, *Noncommutative Algebra*. Springer-Verlag, 1993.

Richard Durrett, *The Essentials of Probability*. Duxbury Press, 1993.

Anil Nerode and Richard Shore, *Logic for Applications*. Springer-Verlag, 1993.

Robert Strichartz, *A Guide to Distribution Theory and Fourier Transforms*. Studies in Advanced Mathematics, CRC Press, 1993.



Billera Awarded Fulkerson Prize

Louis Billera was awarded the D. Ray Fulkerson Prize for papers in discrete mathematics. Professor Billera’s paper, entitled “Homology of smooth splines: Generic triangulations and a conjecture of Sang,” was one of three papers selected for this prestigious award.

The citation says, “For a long time numerical analysts have studied vector spaces of splines, or piecewise polynomial functions. Billera’s paper gives a new approach, expressing the spaces in question as graded components of a commutative ring or module. This leads to a proof of Strang’s conjecture of 1973 concerning the dimension of the space of differentiable functions on a plane 2-manifold that are piecewise polynomial of degree at most r . Billera’s highly unexpected techniques solve several problems where others got stuck when attempting to solve the Strang conjecture. Not only did Billera’s techniques prove Strang’s conjecture, they also yield lower bounds for dimensions larger than 2 and open up a new field of algebraic techniques (modules instead of vector spaces) to be used for splines. The article is exemplary in its effectiveness in creating bridges between pure mathematics (commutative algebra, Groebner basis methods) and a central field of applied mathematics (the computation of splines).”

The Fulkerson Prize was established in 1979 by the American Mathematical Society and the Mathematical Programming Society in memory of D. Ray Fulkerson, a pioneer in graph theory and combinatorial optimization. The prize is awarded every three years at the International Symposium on Mathematical Programming and goes to outstanding papers published in a recognized journal during the six calendar years preceding the year of the symposium.

Information for this article was taken from Notices of the American Mathematical Society.

Harry Kesten Receives Polya Prize

Harry Kesten was awarded one of two George Polya Prizes for 1994 by the Society for Industrial and Applied Mathematics at its annual meeting in July. Professor Kesten is a specialist in probability theory, an area in which the Cornell Mathematics Department has traditionally been extremely strong. We are all very proud of this latest recognition of Harry's outstanding achievements.

The selection committee, consisting of Richard A. Askey, chair; George E. Andrews; Donald L. Burkholder; Frederick W. Gehring; and Joseph B. Keller, issued the following citation:

*In one of his most celebrated papers, Harry Kesten was able to state his main result in the title, 'The critical probability of bond percolation on the square lattice equals 1/2.' This paper, published in 1980 in the **Communications of Mathematical Physics**, has had an enormous impact. Together with his papers on random walks (a phrase due to Polya), this work of Kesten follows Polya in combining deep mathematics with physics."*

Professor Kesten received a \$10,000 cash award and a medal engraved with a likeness of George Polya.

Preparing Future Faculty

The Mathematics Department recently announced plans for a proposed new program, the Preparing Future Faculty grant from the Pew Foundation, AAC&U and CGS. The purpose of the program is to allow graduate students a chance to interact with other colleges, as well as providing further on-campus opportunities.

Presently the proposal, still in the planning stages, is divided into five sections. Cornell graduate students receive the opportunity to speak at colloquia at other

Future Faculty, con't.

institutions while at the same time observing the faculty. This overview allows for students to understand the differing priorities faculty face. The cluster institutions are Hobart, Wells and Ithaca colleges; one graduate student coordinates twelve talks.

The second part of the proposal centers on an observation and discussion program between Cornell and Ithaca College. This program allows Cornell graduate students to observe courses taught at Ithaca College with the focus on project-oriented calculus. Ithaca College faculty would also conduct workshops on their methodology for "reform calculus". The Cornell student coordinator for this section is **Lisa Orlandi**. Professor **Clifford Earle** has been named as faculty overseer.

Another part of this proposal would allow a "home-and-home" discussion between the female graduate students at Cornell and Wells College. Cornell would sponsor a Mathematics Day, featuring talks given by Cornell graduate students. As the term progresses, Wells students would be invited to the campus to observe classes and meet faculty. The student coordinator is **Debra Boutin** while Professor **Karl David** of Wells College will be assuming the position of faculty overseer.

In the fourth stage of this proposal, Cornell would sponsor a Job Fair. Faculty from the smaller colleges will be invited to discuss jobs at their institutions, what faculty look for in new recruits and how to shape a resume, among other topics. The faculty overseer for this project is Professor **Tom Rishel**.

Finally, in the last step of the program, Cornell graduate students will be taken to the Mathematical Association of America regional meetings. Cornell students get a chance to meet faculty from regional colleges and find out their concerns as well as be invited to speak. Overseeing this aspect of the project is also **Professor Rishel**.

“Expanding Your Horizons”

Expanding Your Horizons, a day of hands-on workshops, was held this year on Saturday, November 12, 1994. It was put on by women in math and science for 6th, 7th and 8th grade girls to motivate them to stay in these disciplines throughout high school. Following the success of last year’s workshop, this year the Math Department presented two different presentations.

Graduate students **Debra Boutin**, **Jennifer Davoren** and **Lisa Orlandi** again presented their workshop “Knots, Donuts, Surfaces and Teacups — an Exploration.” On the basis of material provided by Professor **Bob Strichartz**, this workshop allowed the girls to explore the topological similarities and differences between certain surfaces. By molding clay, the girls discovered how donuts and teacups are the same. They learned about the one-sidedness of Mobius bands by creating and coloring them; they demonstrated how spheres and donuts are different by attempting to wind string around a donut to get a knotted loop. Unfortunately, the only way for the girls to discover whether or not they had succeeded was to eat the donut to free the string! This workshop was quite a success last year.

Graduate students **Maria Gargova**, **Rachel Hastings** and **Anke Walz** prepared a new math workshop called “Smart Bubbles.” In this workshop, the girls used specially designed wire frames and a special soap bubble solution (both courtesy of former graduate student Rob Ghrist) to explore the surface-minimizing properties of soap bubbles. They “discovered” the fact that soap bubbles connecting points on a grid can be used to solve other optimization problems.

Summer R.E.U. Program

This past summer, the Cornell Mathematics Department hosted its first full Research Experiences for Undergraduates (R.E.U.) program. Ten students, including two from Cornell, **Arthur Taylor** and **Marina Zaretsky**, spent eight weeks working on research problems. The projects involved computer experiments under the direction of Professors **Rick Durrett**, **Lars Wahlbin** and **Robert Strichartz**. Three graduate students, **Robert Battig**, **Richard Dunlap** and **Min Kang** assisted with the program, as well as Visiting Professor **Ka Sing Lau** from the University of Pittsburgh.

Professor Durrett’s students worked on computer simulations of interacting particle system models of biological

R.E.U., con’t.

systems, such as competing species of *e. coli*, one of which tries to poison its competitors. These models use probability, rather than differential equations, and make assumptions about the spatial limits of transmission that are considered biologically realistic. The students produced “movies” to show the evolution of these systems under a variety of assumptions and were able to determine ranges of parameters in which co-existence of two competing species is possible. While these simulations do not provide mathematical proofs of the properties of the systems, they do suggest hypotheses that may eventually be proven rigorously.

Professor Wahlbin’s students studied the phenomena of “superconvergence” in numerical solutions of differential equations by the spline Galerkin method. The spline Galerkin method finds approximate solutions to ordinary differential equations (o.d.e.’s) by selecting the “best choice” among a family of piecewise linear polynomials (splines). There is a general “order of convergence” from each type of spline, which says how fast the approximate solution converges to the true solution as a function of the length of the intervals in the partition (the interval on which the o.d.e. is defined is partitioned into subintervals on which the splines are given by polynomials). The phenomenon of superconvergence refers to the remarkable fact that there are a few special points where the convergence is faster and these superconvergent points are independent of the particular o.d.e. being approximated. It is then possible to study superconvergence “experimentally” by doing the approximation for an o.d.e. whose solution is known exactly. The students were able to carry out the computations and detected an unsuspected pattern of “pairing”: every spline appears to have another spline with exactly the same superconvergent points. Previously, Wahlbin had been able to prove the existence of one such pair. Now there is a new challenge to numerical analysts: give a rigorous proof of the pairing suggested by this study.

The students working under Professor Strichartz did computer experiments in harmonic analysis and fractals. Among the discoveries made this summer were: 1) an algorithm for finding the exact Hausdorff measure of linear Cantor sets; 2) conjectured best constants in the Hardy-Littlewood Maximal Theorem; 3) an approximate computation of dimensions of self-similar measures with overlaps.

R.E.U., con't.

the students attended a twice weekly "Smorgasbord Seminar" in which Cornell faculty presented a small sample of research mathematics in a wide variety of mathematical areas. The R.E.U. students gave public talks on their work as part of a campus-wide undergraduate research forum at the end of the program and several went to the summer Mathematical Association of America (M.A.A.) meeting in Minneapolis to present their work.

The R.E.U. program at Cornell will continue next summer. It is sponsored by the National Science Foundation and is open to undergraduates who have not yet received their degrees and who are citizens or permanent residents of the United States.

Mathlab Update

Fall has been an active time in the undergraduate Mathlab. With projector, software and the new Silicon Graphics workstation reliably in place, it has become easier for people to quickly find the resources they wish to use. A number of courses have settled into using the lab weekly, and homework due dates make the lab a little *too* busy at times!

One of the regular users this semester has been Professor **John Hubbard**'s class, Math 420: Applicable Analysis. Given the wonderful geometric nature of the qualitative theory of differential equations, the lab with MacMath software is a really natural accompaniment to this course. Students can, with virtually no assistance, enter systems of equations, generate pictures of solutions and then work at understanding and explaining them. Professor Hubbard has also contributed newly improved unreleased versions of the software, including some that do a very large amount of bifurcation theory for vector fields in the plane.

An exciting event that happened in mid-October was the orientation week for Math 111: Calculus. Organized primarily by lab Associate Director **Doug Alfors**, each of the 26 sections of Math 111 visited once during a busy week to see demonstrations, do some experiments and generally become more aware of how computation can complement and enrich the topics they work at semester long. Students will be able to later use either our lab or the Upton Hall CIT lab for follow-up with Analyzer*.

Another big group of users in the lab has been Math 103: Mathematical Exploration. **Beverly West**'s section fo-

Mathlab, con't.

cus on iteration and has been greatly enriched by convenient access to computation. In addition to the many fine locally produced tools for studying this topic, Beverly's class had the opportunity to work with software materials from a recent thirty week closed-circuit televised course by Hubert Hohn. The materials are tightly targeted and range from charming movies (e.g., linear planar vector field phase portraits as functions of their coefficients) to highly interactive.

Other sections of 103 have been concentrating on geometry and have enjoyed working with Professor **Bob Connelly** at concepts like drawing in perspective with Geometer's Sketchpad. The Department now has a site license for this software so use and preparation are easier than last spring.

Another interesting activity this semester is weekly computer use by students in several sections of Math 222: Multivariable Calculus. Primarily using Maple and MacMath, students get a much more concrete feeling for the often hard-to-visualize objects they work with all semester. Professor **Birgit Speh** and Lab Director **Allen Back** have been providing numerous sample worksheets and other materials. With this format, students can concentrate on the ideas being illuminated with minimal distractions from the complexities that often go with powerful systems.

There have been many other enriching uses of the lab, as well: Math 121: Modern Calculus, taught by Professors Johnsgard and Akman; Professor Gene Hwang continues to have his Math 171 students work with DataDesk for Elementary Statistics; and Professor Lou Billera's Math 455: Applicable Geometry students build convex polytopes and then view them on the Indigo2 with Geomview.

New Calculus Sections Being Offered

In the spring semester, the Mathematics Department will offer five new calculus sections with a slightly different focus. These sections of Math 112 will be more project-oriented than traditional teachings of the course, allowing students to work together in small teams to facilitate problem-solving. Professor **Clifford Earle**, coordinator of the experimental program, is teaching one section of the course; the remaining four will be taught by graduate students.

Special Calculus Sections, con't.

The nationwide movement for calculus reform has produced a large number of suitable projects. Four graduate students in the Mathematics Department, **Harel Barzilai**, **Maria Gargova**, **Bob Milnikel** and **Lisa Orlandi**, have been at work selecting appropriate projects and planning how to integrate them into the course.

According to Senior Lecturer and Director of Undergraduate Teaching **Tom Rishel**, the projects also involve a greater deal of application. "You can give a project, not just to solve differential equations, but to use these differential equations to model building an energy efficient car or an aerodynamic car."

The purpose of these special sections is to present calculus in such a way that students will retain the information long after they have completed the course, Professor **Clifford Earle**, coordinator of the new sections, said. "What we hope is that the experience of working together on projects will help students to understand how to use mathematics. The ability to work together on problem solving will stay with the students much longer than just learning equations."

The information provided was taken from the article entitled "C.U. Math Prof to Offer New Calculus Sections" by Alice Gong, The Cornell Daily Sun, Friday, September 16, 1994. Additional information was provided by Professor Earle.

Undergraduate Seminar

The Mathematics Department is pleased to continue its offering of Math 401: Undergraduate Seminar taught by Professor **Bob Connelly**. The course will be a participatory seminar in which each student will give at least two one-half hour talks. In addition, the students will have an opportunity to solve problems and prove theorems on their own as well as lead discussions on the topics presented.

The following partial list of possible topics covers a wide range of celebrated mathematical problems:

* *The classical construction problems: why you cannot construct with a straight edge and compass the side of a cube with volume two, or trisect an angle in general.*

* *The Gauss-Bonnet Theorem in the geometry of surfaces, especially the polyhedral surfaces.*

Undergraduate Seminar, con't.

* *Cauchy's theorem about the rigidity of closed polyhedral surfaces in three-space.*

* *Hilbert's third problem, which asks whether it is possible to dissect a cube into a finite number of polyhedra and reassemble the pieces to form a regular tetrahedron of the same volume.*

* *The problem of solving a general fifth degree polynomial equation in term of radicals.*



We wish to extend our gratitude to those who have made contributions to the Department over the past year or more:

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Spotlight on: Alumni News

It was a pleasure recently to see **Harold Finkelstein**, a 1961 graduate and former advisee of **Anil Nerode**, on campus. Dr. Finkelstein now runs a business which “teaches how to teach.” He resides in Atlanta, Georgia.

John Klopp of Telford, Pennsylvania, writes that his “recollection of math at Cornell was not one of great fondness,” but that, “over the years since, I’ve come to the realization that I should have paid more attention as math is so central to making good engineering ‘guesses’.”

Bob Lubarsky plans to attend the Cornell Reception in San Francisco in January of 1995.

Reuben O. Ayeni, Ph.D. ‘78, writes from Nigeria. Professors Fuchs and Payne were on his committee. Professor Reuben served as chair of the Department of Mathematics at Obafemi Awolowo University Ile-Ife from 1983-86. Reuben, who became a full professor in 1990, is currently chair of the Department of Mathematics at

Lodoke Akintola University of Technology and is business manager of the *Journal Afrika Matematika*.

Benson Farb ‘89 attended Princeton after graduating Cornell. His advisor was Bill Thurston, whom he visited frequently in Berkeley, as well as working extensively with John Stallings there. He is now a L.E. Dickson Instructor at the University of Chicago and has an NSF Postdoctoral Fellowship. His research interests have been in geometric group theory, hyperbolic and automatic groups and low-dimensional topology and geometry. Recently, he has begun working on large-scale geometry and rigidity problems for discrete subgroups of Lie groups, and is currently teaching a course on geometric group theory. He has also co-written a book entitled *Noncommutative Algebra* with **Keith Dennis**.

If you have noteworthy alumni news items to share, please contact Karen Finch at the address below or e-mail karen@math.cornell.edu.

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