Math Matters

Department of Mathematics • Cornell University • Ithaca, New York Fall 1996/Winter 1997

Diaconis Gives Gibbs Lecture in San Diego

Persi Diaconis, who is visiting Cornell from Harvard University this year, was invited to give the 70th Josiah Willard Gibbs Lecture at the winter meetings of the AMS and MAA, held in San Diego in January, 1997. The American Mathematical Society established this honorary lectureship in 1923 to commemorate the name of Professor Gibbs. The lectures, which are given by invitation, are usually devoted to mathematics or its applications. The list of invited speakers is long and distinguished, including Albert Einstein, Kenneth Wilson, Sir Michael Atiyah and Steven Weinberg.

Prof. Diaconis' lecture, *Patterns in Eigenvalues*, addressed the remarkable patterns in the eigenvalue distributions of typical large orthogonal matrices. These same patterns occur in the zeros of the Zeta function, particle scattering experiments, telephone encryption and prediction problems. He showed how probabilistic thinking can help illuminate the pattern, while many mysteries remain.

Persi Diaconis is a mathematical statistician who works in probability theory and Bayesian statistics. In probability, he works on problems like "How many times should a deck of cards be shuffled to mix it?" (Answer: 7) or, more generally, "What is the rate of convergence of a Markov chain to stationarity?" In statistics, he studies the pros and cons of combining a priori information with data, the philosophical foundations of randomness and efficient algorithms for day to day statistical problems.

Professor Diaconis received his undergraduate training in mathematics at New York's City College and a Ph.D. in statistics from Harvard University. From 1974 to 1986, he taught at Stanford's Statistics Department. Since then, he has been Professor of Mathematics at Harvard University. He is currently (1996–1997) a visiting professor at Cornell University's Department of Mathematics and School of Operations Research.

Professor Diaconis was an early recipient of a MacArthur Award, a member of the American Academy of Arts and Sciences and the National Academy of Sciences. He is currently president elect of the Institute of Mathematical Statistics.

Letter from the Chair, Bob Connelly

1996 was an exciting year for the Mathematics Department at Cornell. The following are just a few of the high spots.

Persi Diaconis gave his course on Markov Chains to a packed house of undergraduates,graduate students,and faculty from all parts of the University. One of the high points for me was when he explained his analysis of when a deck of cards becomes "randomized" by ordinary shuffling. We are very hopeful that Persi will be with us on a permanent basis.

The department is looking for some brilliant new faces to join our permanent faculty next year; we are currently in the midst of the faculty recruitment process. We have asked for and received permission to search for three separate positions. One of these is targeted for a senior position in Statistics. The other two are meant for Algebra, Analysis or Applied Mathematics.

We have been working strenuously with Jim Jenkins, Chair of Theoretical and Applied Mechanics, on a proposal to restructure the teaching of Math 191, 193 and 192 starting in the Fall of 1997. The restructuring will have the effect of eliminating the fall semester large lectures for 192, replacing them with small sections. By doing so, we hope the first semester of engineering mathematics for entering freshmen will be an even more enriching and rewarding experience. Smaller class sizes will help us to reach this goal. The additional teaching load will be covered by an additional H. C. Wang post-doc in Mathematics, a few additional instructional teaching assistants and some faculty recruited from the Engineering and Arts and Sciences Colleges. We have recently received approval for this very worthy project. I hope to have more to report on this effort in our June 1997 issue of *Math Matters*.

1997 Joint Mathematics Meetings Held in San Diego

Cornell University was well-represented at the 1997 Joint Mathematics Meetings, held in San Diego in January. Numerous department faculty members, visiting faculty and graduate students attended, along with several former visitors and recent Ph.D.s. Special session talks were given by Prof. Robert Strichartz (with Jade Vinson) and graduate students Edward Bueler, Maria Gordina, Henry Schenck and Alexander Teplyaev. The department sponsored the attendance of two Cornell undergraduates: Jeremy Bem, a sophomore, and Robert Kleinberg, a senior.

Bem and Kleinberg were invited to speak at the AMS Special Session on Research in Mathematics by Undergraduates, co-organized by department visitor John Meier, who received his Ph.D. from Cornell in 1992. Bem and Kleinberg gave the talk *Is Thompson's group F amenable?*, and Kleinberg gave an additional talk entitled *Train tracks and zipping sequences for pseudo-Anosov braids*. Jade Vinson and Shelly Harvey, who participated in the department's Research Experiences for Undergraduates program last summer, also gave talks during this special session.

Thomas Rishel, director of undergraduate teaching, moderated an MAA Panel Discussion, *Teaching at a College or University—Advice about Preparing for and Securing such Positions*, sponsored by the MAA Task Force on Graduate Students. Panelists—Richard Cleary, a former visiting program participant, John Meier, Teresa Moore of Ithaca College and graduate student Nikhil Shah—discussed the job interview process from the institution's perspective, what teaching at such institutions actually entails, the ingredients of a good vita and cover letter and programs on teaching designed for graduate students and how they affect the job search process. Rishel talked about preparing CVs and cover letters. He and Shah then spoke on the special programs for graduate students to interact with students and faculty at traditionally four-year colleges. Cleary and his current chair, Zsuzsanna Kadas, "interviewed" John Meier, asking the kinds of questions that job applicants would see in an employment register interview. Finally, Meier and Moore discussed the pleasures and pitfalls of being a young faculty member.

Highlights from the San Diego Meetings
by Bob Connelly

I arrived Tuesday night on the seventh of January at San Diego after having come from a workshop in Israel, a ten hour time difference!

The next day I heard a very exciting talk by Mort Brown, my mentor from my student days at the University of Michigan. Mort talked about the reform calculus movement that he helped lead at Michigan. The room was packed, and there was a great amount of excitement about the experiment at Michigan.

I went to three talks by some of our younger Cornell people. Hal Schenck gave a very clear and interesting talk about his work with the homology of spline spaces. Then in the session for research by undergraduates, Bobby Kleinberg talked about train tracks and zipping sequences, and later Jeremy Bem talked about amenable groups. The talks were professional and informative. That night Persi Diaconis gave the Gibbs lecture on patterns in eigenvalues. This was an exciting time for our people at Cornell.

On Thursday I met with Mort Brown and Doug Anderson, an old friend and now Chair at Syracuse University. One of the mandates that we will have when we do the Engineering calculus reform, is to provide an increased amount of evaluation and oversight. In his talk Mort discussed an evaluation technique used at Michigan. At about the midterm for each class an outside evaluator had come in to have a discussion with the students and the instructor about the nature of what was happening in class. In our case, we were given the task of evaluating "learning." Although this is very difficult to do and difficult to agree about, Mort offered suggestions for implementing similar evaluations here at Cornell.

Tom Rishel led a session aimed at helping recent graduates with the interviewing process. There was an instructive role-playing session where John Meier played the role of a recent Ph.D. interviewing for a job at a small liberal arts college. The message that I heard was *let people know what you really want from them*.

One of the highlights of the meeting was the reception put on by *Math. Reviews* (MR). The master of ceremonies was our very own Keith Dennis, assisted by Jane Kister. One of the quiz questions was "Who had a paper reviewed in both the first issue of MR as well as the most recent issue, December 1996?"*

A personal highlight was the reunion of some Michigan alumni at a local restaurant. Most of whom had actually been around when our most infamous colleague, Ted Kosinski, was there!

*(Answer: Paul Erdős)

Research Experiences for Undergraduates Program

During the summer of 1996, the Cornell Mathematics Department held its third Research Experiences for Undergraduates (REU) program. Ten undergraduate students from colleges across the country participated in this research program, which is sponsored by the National Science Foundation. Three faculty members—Robert Strichartz, Kevin Pilgrim and Karoly Bezdek—directed the research projects. In addition to the research work, the students attended a Smorgasbord Seminar, in which members of the department gave lectures about their research specialties—a little taste of a lot of mathematics—and the students gave public lectures at the Undergraduate Research Forum. Quite a few of the students also went to the Seattle Mathfest to talk about their work at the summer MAA meeting. Several papers reporting on the research work have already been submitted for publication, and more are in the process of being prepared.

Students working with Prof. Strichartz studied analysis of fractals. One area of research concerned the analog of differential equations, to be named Fractal Differential Equations (FDE) on the Sierpinski Gasket (SG). For the first time, computer generated images of solutions to FDEs were produced. The figure shows the graph of an eigenfunction of the Laplacian—the fractal analog of the sine function. Other images, including a "movie" of the fundamental solution of the wave equation on SG are available*.

Students of Prof. Pilgrim worked on the dynamics of rational mappings of the complex plane. They constructed a catalog of examples of mappings with a finite postcritical set. These examples will be useful for gaining insight and formulating conjectures. Already they have led to a counterexample to a "theorem" that had been believed to be true.

Students of Prof. Bezdek studied geometric problems involving lattices in Euclidean space and sphere packings. Among the new discoveries: 1) a lattice in d-dimensional space with exactly $2(2d–1)$ Voronoi vectors, 2) a lattice in 31-dimensional space generated by minimal vectors but with no minimal basis, 3) a new upper bound for the number of touching pairs in a packing of unit spheres in d-dimensional space.

The department has received funding to continue this program for the next five summers. The selection process for this summer's participants is currently underway. All undergraduates who are citizens or permanent residents and who will not graduate before 1998 are eligible to participate. For more information, see our Web page** or talk to Prof. Strichartz. The faculty supervisors for the summer will be Robert Strichartz, Kevin Pilgrim and Richard Ehrenborg. Prof. Ehrenborg will be directing research in combinatorics.

There is a related program (SPUR***) through the Theory Center which will allow students to work with Professors Strichartz and Durrett. There are also many other REU programs in mathematics departments at other schools. Interested students are urged to apply to several different programs to improve the chances of being accepted. These programs all pay stipends and have the same eligibility requirements.

Web Pages for the REU and Related Programs:

* <http://www.tc.cornell.edu/Edu/SPUR/SPUR96/Kyal/cover.html>
** <http://math.cornell.edu/~michelle/reu.html>
*** <http://www.tc.cornell.edu/Edu/SPUR>

Computer Images Reach the Classroom

Thanks to a grant from FABIT, the department has a new LCD projector, together with a Macintosh powerbook to drive it. The InFocus Litepro 210 has its own light source built in and projects excellent color images in both large and small classrooms. One of its key uses is projecting computer images in classes that are too big to fit in the department's Instructional Computing Lab, which accommodates only 30 students. Screen size is 640 by 480 pixels, or 800 by 600 compressed. Weighing in at 16 pounds, the projector is readily portable and easy to set up. It will also work readily with PC notebooks.

FABIT, the Faculty Advisory Board on Instructional Technology, is involved in an ambitious multi-year plan to bring campus classrooms up to 21st century technological standards. More information on this program, which may be very relevant to the department's upcoming move to Malott Hall, is available on the World Wide Web at the URL <http://instruct1.cit.cornell.edu/FABIT/>.

Calculus Reform Continues

Beginning this spring, the graphing calculator will be used in the instruction of all sections of Math 111. Graphing calculators were originally introduced as an experiment in three sections of Math 111 taught by David Henderson and former visitor Carolyn DeSilva in the spring of 1996, while the other five sections followed the traditional calculus curriculum. Throughout that spring and the following fall semester, instructors of these experimental sections incorporated the use of the graphing calculator into lectures and required their students to use them on homeworks and examinations. The graphing calculator has many useful applications. For example, it is stated in calculus that the tangent line is the "best linear approximation" to a function near the point of tangency. Using a graphing calculator, students can see graphically the relationship between the tangent line and the function, enabling them to see how good the "best approximation" really is. It is expected that the graphing calculator will continue to be an integral part of the teaching and learning of Math 111.

Another development in the calculus curriculum originated in the spring of 1995, when calculus reform was introduced into Math 112. A small band of graduate students—including Harel Barzilai and Lisa Orlandi, who later went on to teach some of these sections—proposed the introduction of project-based sections, which incorporate in-class cooperative learning, long-term group projects and group presentations. Several project-based sections of Math 112 have continued to be offered each semester since their introduction two years ago, and student feedback and evaluations continue to be enthusiastically positive. In light of this success, project-based sections are being introduced into Math 111. Graduate students Harel Barzilai and Maria Fung are each teaching a project-based section of Math 111 this spring.

Undergraduate Honors Seminar

The topic for the Undergraduate Honors Seminar (Math 401) this spring is *Fractals*. The course, which meets Tuesday and Thursday 11:40–12:55, is taught by Prof. R. Strichartz. The honors seminar is a unique learning experience in our undergraduate curriculum. Students will participate in all aspects of the course, from the selection of material to be covered, to the actual lecturing.

The class will cover the basic core material together, and then each student will explore more specialized areas in depth. In addition to readings from the text, students will read research papers and make oral and written presentations in class. The emphasis will be on the mathematical theory, but students who are interested in the applications of fractals in the sciences will have an opportunity to explore these topics.

Students will also do a construction project, to make an interesting fractal using either computers, photocopying machines, or physical materials (toys, clothing, wallpaper, …).

Sjamaar Awarded Sloan Research Fellowship

The department is extremely pleased to announce the awarding of a Sloan Research Fellowship to Prof. Reyer Sjamaar. Prior to joining the department as an assistant professor in the fall of 1994, he held lectureships at the University of Pennsylvania and MIT, was a CLE Moore instructor at MIT and was a member at IAS in Princeton and MSRI in Berkeley. In recognition of his accomplishments, he has held several grants from the NSF and from the Netherlands Organization for Scientific Research. Sjamaar received his Ph.D. fairly recently (1990), but has already amassed an impressive amount of work, some of it published in the most prestigious journals, such as *Annals of Mathematics*. He is working in the general area of symplectic geometry. This area is at the crossroads between classical mechanics, differential geometry, complex analysis, topology, algebraic geometry and representation theory. Sjamaar's research reflects unusual talent and maturity in bringing all these fields to bear on the problems on which he works.

Sjamaar was nominated for a 1996 Sloan Research Fellowship by the Department of Mathematics and the Center for Applied Mathematics. The Sloan Research Fellowship was established in 1955 by the Sloan Foundation to provide support and recognition to young scientists, often in their first appointments to university faculties. Selection procedures are designed to identify those who show the most outstanding promise of making fundamental contributions to new knowledge. Financial assistance at this crucial point often pays handsome dividends to society. The early recognition of distinguished performance which the fellowship confers can be immensely encouraging and a stimulus to personal and career development. Seventeen Sloan Fellows have won Nobel Prizes later in their careers, and hundreds have received other honors.

Sjamaar is a young mathematician whose work has provided a breakthrough in his field; the tools he has developed will allow mathematicians to deal with problems that were previously inaccessible.

Contribute!

Math Matters is always looking for interesting articles for future editions. If you have any information or questions relevant to the mathematics community, we want to hear from you!

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Faculty Publications

George Metakides and **Anil Nerode**, *Principles of Logic & Logic Programming*, Studies in Computer Science & Artificial Intelligence Vol. 13, Elsevier Science, 1996.

Principles of Logic & Logic Programming was developed as a beginning course, suitable for beginning college students, over a period of 25 years at Cornell and at the University of Patras in Greece. It combines a very complete elementary exposition of the tableaux method in logic with a very large number of elementary exercises and an introduction to logic programming. As such, it is suitable for both mathematics and beginning computer science students.

Anil Nerode, W. M. Marek and M. Truszczynski, *Logic Programming & Non-Monotonic Reasoning: Third Int'l Conference, LPNMR'95, Lexington, KY, June 24–26, 1995:* Proceedings, Lecture Notes in Computer Science 928, Springer-Verlag New York, 1995.

Nerode has sponsored three international conferences in the mathematics of so-called *non-monotonic reasoning*, which deals with the mathematical form of arguments which are based on lack of information as well as presence of information. This volume represents the main contributors to the field world wide.

Anil Nerode and **Richard Shore**, *Logic for Applications*, Second Edition, Springer-Verlag, 1997.

This textbook provides a first introduction to mathematical logic which is closely attuned to the applications of logic in computer science. In it the authors emphasize the notion that deduction is a form of computation. While all the traditional subjects of logic are covered thoroughly—syntax, semantics, completeness and compactness—much of the book deals with less traditional topics such as resolution theorem proving, logic programming, and non-classical logics—modal and intuitionistic—which are becoming increasingly important in computer science. The book also provides a systematic treatment of the elements of set theory, a historical overview of its subjects, and an extensive annotated bibliography.

No previous exposure to logic is assumed, and so this will be suitable for upper level undergraduate or beginning graduate students in computer science or mathematics.

(continued, p. 6)

Comings and Goings...

New Faculty

Arkady Berenstein, H. C. Wang Assistant Professor, received his Ph.D. in mathematics from Northeastern University in 1996. Berenstein's research interests include representation theory and combinatorics. Prof. Berenstein taught Math 111, *Calculus*, and Math 549, *Lie Algebras*, in the fall and is teaching Math 221, *Linear Algebra & Calculus*, and Math 532, *Algebra*, this spring.

Noel Brady, H. C. Wang Assistant Professor, received his Ph.D. in mathematics from the University of California at Berkeley in 1993. Prior to his appointment here, Brady was an instructor at the University of Utah. His research involves the geometry and topology of piecewise Euclidean cubical complexes and finiteness properties of groups. Prof. Brady taught two sections of Math 111, *Calculus*, in the fall and is teaching two sections of Math 122, *Honors Calculus*, this spring.

Miklós Erdélyi-Szabó, H. C. Wang Assistant Professor, received his Ph.D. in mathematics from Wesleyan University in 1996. His research interests include decidability in constructive analysis and topological and Sheaf models. Prof. Erdélyi-Szabó taught two sections of Math 122, *Honors Calculus*, in the fall and is teaching Math 581, *Logic*, and Math 683, *Model Theory*, this spring.

Visiting Program Faculty

Stephen Hilbert	academic year
Kazem Mahdavi	academic year
John Meier	academic year
Thomas Stiadle	academic year
Michael White	academic year

Visiting Faculty

Roger Alperin	fall 1996
Sergei Artemov	academic year
Károly Bezdek	fall 1996
Persi Diaconis	academic year
Cynthia Hog-Angeloni	spring 1997
Sergei Kuznetsov	academic year
J. Martin Lindsay	academic year
Margaret Readdy	academic year
Daina Taimina	spring 1997
Vladimir Veselov	academic year
Yang Wang	spring 1997

New Department Manager

Colette Walls joined us as Department Administrator in September. In addition to her cheerful personality, Colette brings 20 years of university experience to the department. She is truly someone who has "worked her way up the ladder." Beginning as an administrative secretary in 1976, Colette has worked as a secretary, accounts assistant, accounts coordinator, graduate field secretary and administrative manager. She has worked in different departments, colleges and central accounting. She knows first hand what it takes to run a complex department.

Colette is simply nice. She's a champion of those she serves and those who serve her. She offers the soothing calmness that counteracts the high-stress activities associated with providing a learning environment for over 6,000 students a year.

At the Fall Reception, departing manager **Diane Downing** said, "I cannot think of a better person to take over running the Mathematics Department than Colette."

Support Staff Changes

The past six months have brought a number of changes for the administrative staff in the Department of Mathematics. Besides losing a long-term and well-loved administrative manager in the person of Diane Downing, and adjusting to/being a new man-

Faculty Publications

(cont. from p. 5)

Lars Wahlbin, *Superconvergence in Galerkin Finite Element Methods*, Springer Lecture Notes in Mathematics 1605, Springer-Verlag NY, 1995.

When superconvergence is present in a numerical method it is like a free lunch. For very little or no additional work, you get a higher rate of convergence. But you have to know where and how, which, in practical terms, motivates the theory of superconvergence.

The book grew out of the lecture notes for a graduate seminar in spring 1994. All important subjects in basic theory of superconvergence are covered, and the result is a somewhat comprehensive book; it is the first such book in English. (There are two previous books in Chinese which, however, concentrated on one method only.) Many results are due to the author and to his colleague Al Schatz.

The presentation is mathematical theorem-proof style although some proofs are merely referenced. Thus only secure knowledge is given; there is no loose speculation. The book has been found of use also to practitioners who wish to actually use the theory in numerical computation.

ager (Colette Walls), there have been other personnel changes.

Karen Finch, the undergraduate coordinator since September 1994, left us in July 1996 to move to Fort Collins, Colorado. In addition to supporting the administrative needs of mathematics majors and teaching staff, her undergraduate duties included the awesome task of classroom scheduling. Karen was also the editor for previous departmental newsletters. She will be missed for her ready smile and quick wit.

Rachel Engler joined us as a temporary employee last January to develop our departmental web pages. She did a terrific job, and it became apparent that we couldn't let her go. In November 1996, Rachel became our office system support specialist. As such, she is responsible for maintaining and developing department web pages, managing the computer network for administrative systems, and assisting in the maintenance of the UNIX and SUN operating systems. We're delighted to have her on board.

Departures

Füsun Akman
Eric Babson
Lawrence Brown
Sa'ar Hersonsky
Karin Johnsgard
Bernd Sturmfels

Leaves

Louis Billera	academic year
Jianguo Cao	academic year
R. Keith Dennis	academic year
Eugene Dynkin	fall 1996
José Escobar	academic year
Harry Kesten	spring 1997
B. Khoussainov	academic year
Richard Liu	fall 1996
Anil Nerode	academic year
Richard Shore	spring 1997
Moss Sweedler	fall 1996
Beverly West	academic year
James West	spring 1997

Yes, I would like to help support the Mathematics Department endowments with my donation of $_____ for:

❑ **The Mathematics Faculty Book Fund:** provides the Cornell Community with immediate access to one of the world's finest assortments of mathematics books and publications by enriching the collection of the Mathematics Library.

❑ **The Mathematics Colloquium Endowment Fund:** instituted to invite distinguished scientists to speak at Cornell. Major contributions come from faculty who teach extra courses and donate their earnings to the fund.

❑ **The Eleanor Norton York Award in Astronomy and Mathematics:** established in honor of Eleanor Norton York, a valued Astronomy Department employee who worked closely with graduate students. Recognizes outstanding graduate students in Astronomy and Mathematics with an annual prize.

❑ **The Israel Berstein Memorial Fund:** honors the memory of a former Mathematics Department professor with an initial donation from his sister, Gita Fonarov. Funds annual awards for deserving graduate students in the fields of topology and/or geometry.

❑ **The Logic Endowment:** recently established by a donation from a former Cornell undergraduate. Seeks to actively support promising logic students in the areas of institutional memberships and travel expenses, for Association for Symbolic Logic meetings and events, and other activities in the field of logic.

Make checks payable to Cornell University. Please send to

The Mathematics Department Endowments
135 White Hall
Cornell University
Ithaca, NY 14853-7901.

Name: _____

Address: _____

_____

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❑ Please send me a receipt for tax purposes.
❑ Please send me a copy of the 1997-98 Annual Report, when it becomes available.

What's New on the World Wide Web?

http://math.cornell.edu/

The Mathematics Department Web Site has grown over the past year. The homepage offers links to a variety of Mathematics Department information.

We have directory information for faculty, staff, and graduate students, which includes links to personal homepages. A new addition is a search engine that enables users to search the directories by name, title, office, office phone, or email address.

The *Course Home Page* has grown to accommodate the increasing number of students who seek course information on the web. We have not only individual course homepages but also other course related information, such as textbooks and office hours.

Other web pages include a weekly seminar bulletin and information on our graduate and undergraduate programs. Even the Annual Report is online! In the near future, we will also have documentation about Cornell mathematics computer systems online.

Another internet development is the recent addition of an anonymous ftp server, available at <ftp://math.cornell.edu>. It accepts incoming documents as well as the standard downloads. We have much more, so browse around!

Math Matters is published through a joint effort by members of the Mathematics Department. Special thanks to:

Allen Back
Steve Chase
Bob Connelly
Persi Diaconis
Diane Downing
David Henderson
Tom Rishel
Catherine Stevens
Bob Strichartz
Colette Walls

for their contributions.

Michelle M. Klinger
Editor

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