Berkeley

# Mathematics

Newsletter

Department of Mathematics
University of California at Berkeley

## MESSAGE FROM THE CHAIR

By Jack Wagoner

Greetings to all. I was pleased to receive many favorable responses to our first Berkeley Mathematics Newsletter, especially from so many of our alumni. Thanks for letting us know how you're doing. We hope you continue to stay in touch.

I've been Chair for almost a year now, and things continue to move along at a fast pace. We are feeling the loss of faculty from the first two early retirement offerings by the Campus – both in teaching and in reduced numbers to serve on departmental committees. A third early retirement program will be offered in July 1994, and we expect to lose several more senior colleagues. On the other hand, three people joined our ranks this Fall as Full Professors to bring us back to 59 regular faculty. These three new members of our department are Professor Richard Borcherds, Professor Jenny Harrison, and Professor Maxim Kontsevich (on leave until July 1994). Borcherds is interested in mathematical physics, Kac-Moody algebras, and number theory. Harrison studies fractals and geometric measure theory. Kontsevich works in mathematical physics and knot theory.

The Mathematics Department was recently reviewed by the Campus' Academic Planning Board, as were most academic units on the campus. These reviews will help the Berkeley Campus administration make long-range planning decisions. Also, we have been informed of an upcoming 5-year review by two committees, external and internal. The 5-year review is scheduled every five or so years to help ensure the maintenance of quality programs in academic departments and to aid the campus in strategic planning. Comments will be solicited from faculty, students, and staff during this process. Note: Our Department continues its No. 1 ranking in the Annual Report on Graduate Schools, issued by US WORLD AND NEWS

*see pg. 2*

## Congratulations to Our Faculty

### MARINA RATNER

By Jack Feldman

Marina Ratner has been a member of the UC Berkeley Mathematics Department since 1975.

Marina was born in Moscow; her parents were scientists. She studied at the University of Moscow, receiving an M.A. in 1961. For several years she worked in Kolmogorov's Applied Statistics group, as well as in his special school for gifted high school students. Her main mathematical influences in those years were Dobrushin, Kolmogorov, and Sinai. In 1965 she returned to graduate school, receiving the Kandidat (= Ph.D.) degree three years later. After briefly teaching at a technical institute she emigrated to Israel, working for several years at Hebrew University in Jerusalem. During this period she was in active mathematical correspondence with R. Bowen at Berkeley. In 1975 she was invited to join the Berkeley faculty.

Marina Ratner's main work has been in Ergodic Theory and, more importantly, the use of ideas and techniques from Ergodic Theory in other, more classical contexts. Much of her best work has

*see pg. 10*

## LETTER FROM THE EDITOR

By Rondi Phillips, Editor

Thank you for the abundant responses to our first newsletter. I had hoped to respond personally to each one but my time did not permit this. Please accept this as a type of response.

Many of you expressed a desire to hear about other alumni. We have started a section in this letter giving some tidbits about those of you who responded. Perhaps in the future we shall be able to start a directory for those interested in keeping in touch with one another.

Another frequent request was information on research, lectures, events, etc. offered by UCB's Mathematics Department. This newsletter addresses that with a report on several past events and an announcement of a forthcoming event and publications.

Many of you expressed a desire to see the newsletter at least two times a year. It is our goal to publish once a semester (not including summer session.) We plan to have the newsletter come out just at the end of a semester, and you will receive it at that time.

Do keep us informed of your address changes and other updates in your life. From the majority of responses, it is of interest to our readers! By the way, if you don't see your name, it is due to limited space. I hope to include more in the spring edition.

*Chair, cont. from pg. 1*

REPORT this Fall.

Budget news for 1994-95 is bleak again. We have been told by Letters and Science College Administrators to begin planning for another round of cuts, probably at least 5-8% reductions from last year's budget. The departments may have to cover some temporary cuts that were absorbed last year by the College as well as additional permanent cuts slated for the upcoming year. We hope to have more definite information about this in our Spring 1994 newsletter.

In the meantime, I wish you all a happy holiday season and a productive New Year. ■

## ALUMNI UPDATES

By Rondi Phillips

So many Alumni responded to the first newsletter that I haven't been able to include all who responded. Many of you asked what graduates were doing, what field they had found work in, etc. When it was provided we included the degree and year graduated. Due to space limitations, we have only included a part of the information from the responses. Next spring edition will carry on with others who responded.

— The Editor.

**Helmer Aslaksen** (Ph.D. '88) is teaching at the National University of Singapore. Helmer mentions others who have "converged" in Singapore: Ka Hin Leung '88, Yan Loi Wong '88, San Ling '90, Jimmy Chong Hai Lim '90, Steven Seng Hwang Lee '93.

**Sara Baase** is a professor of Computer Science at San Diego State University. She has written two textbooks in Computer Science which are entitled, COMPUTER ALGORITHMS: INTRODUCTION TO DESIGN AND ANALYSIS and VAX ASSEMBLY LANGUAGE. She is currently working on a chapter, "Social and Legal Issues", for an introductory computer science text when she is not hiking, birding, and camping.

**Meyer Bar** (Class of '54) recently paid us a visit. He worked as an engineer after graduation, and later, taught high school math in an inner Los Angeles school district. He says of a college degree, "Graduating from college in those days was prestigious. They knew you could think and solve problems, so it was easy to get any job."

**David P. Bernier** is a lecturer at Prince of Songkla University, Thailand until end of August, 1994. He is teaching a course on coding theory, and a seminar for the staff. He is privileged to have geckos living in his apartment. (I hear that brings good luck!) David is thinking about writing an article about "Applying To Teach In Foreign Countries".

**Dudley Brooks** is the Artistic Director of VOICES/SF and Co-Director of RUN FOR YOUR LIFE! A DANCE COMPANY! in San Francisco.

**John Brosnan** (Class of '69) does legal research in Utica, New York. For 25 years he has been studying and mastering classical Hebrew and Greek. He finds " The problem of understanding a book so old (The Old Testament) can be very mathematical in nature".

*see pg. 16*

## CONGRATULATIONS CLASS OF '93

By Janet Yonan

The Department of Mathematics' Commencement Ceremonies were held in Zellerbach Auditorium on the Berkeley campus on Sunday, May 15, 1993 at 1:00 pm. Once again the Department sent a large group of bright graduates on their way to new adventures. 101 Bachelors degrees, 12 Masters, and 38 Doctoral degrees (including 2 in Logic and the Methodology of Science) were awarded at this traditional ceremony which was attended by hundreds of the graduates' parents and friends, as well as many faculty and staff. Besides the actual presentation of commencement scrolls, there were several memorable moments, such as the very thoughtful valedictory address given by undergraduate student, Stephen Miller; the entertaining commencement address, given by Professor James Sethian, which many times amused the audience; and the awarding of the Distinguished Undergraduate Teaching Award to one of our finest teachers, Professor Paul Chernoff. Several other awards and prizes were presented to well-deserving students. Congratulations were exchanged over refreshments during the reception that followed.

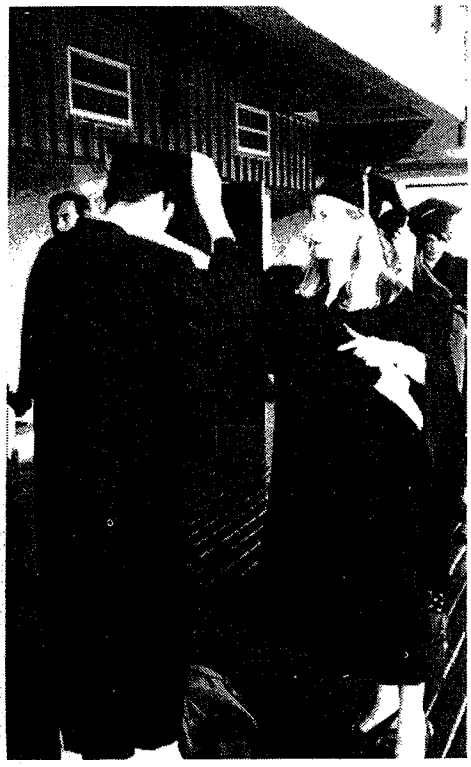
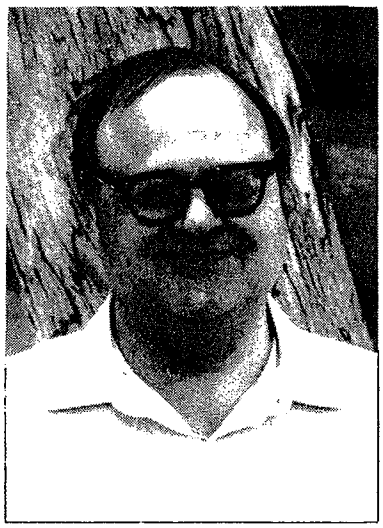


*Photo by Carolyn Katz*

## PROFESSOR CHERNOFF SPEAKS AT FALL COMMENCEMENT



By Graham L. Randall

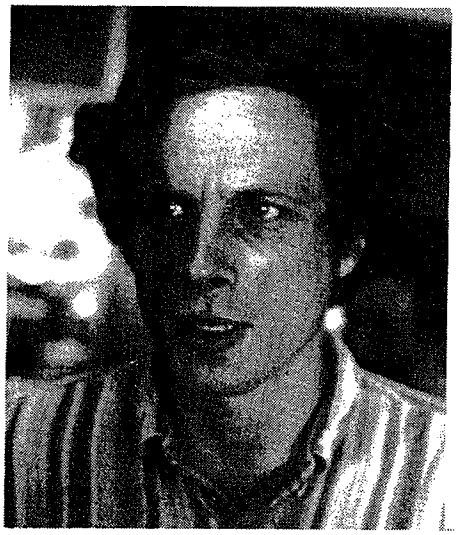
This fall the Commencement Speaker was Professor Paul Chernoff. Professor Chernoff has been the recipient of the Mathematics Undergraduate Student Association's Distinguished Teaching Award for the past two or three years. Naturally, his overwhelming popularity puts his courses in high demand, and it is not uncommon for students to take courses just to be in his class. Recently his Lectures on Topology and Analysis have been published by the Berkeley Mathematics Lecture Notes series.

After obtaining his PhD from Harvard University in 1968, Professor Chernoff came to Berkeley with an interest in functional analysis. Since then he has won the 1983-1984, 1991-1992, and 1992-1993 Distinguished Teaching Award and the 1977-1978 Lili Fabilli and Eric Hoffer Essay Prize.

**DEPARTMENT OF MATHEMATICS**
**University of California at Berkeley**
*SPRING COMMENCEMENT 1994*
**Sunday, May 15, 1994, 1:00 p.m.**
**Zellerbach Auditorium**

# WELCOME NEW FACULTY

## TOM WOLFF



By Don Sarason

Tom Wolff did his undergraduate work at Harvard and his graduate work in Berkeley, receiving his Ph.D. in 1979. Before joining our faculty in 1992 he held teaching positions at the University of Washington, New York University, and California Institute of Technology. He visited the University of Chicago in 1980–82 as an NSF Postdoctoral Fellow, and was a Sloan Foundation Fellow in 1984–86.

Wolff is an analyst who has made fundamental contributions in several areas, including function theory, harmonic analysis, nonlinear potential theory, interpolation of Banach spaces, harmonic measure, and partial differential equations. In 1985 he was awarded the Salem Prize for work in harmonic analysis.

## VERA SERGANOVA

By Joseph Wolf

Vera Serganova was born in Moscow in 1960. She graduated from the Department of Mathematics and Mechanics at Moscow State University in 1983, the year in which her first paper on Lie superalgebras was published. She held various research positions in Moscow and published extensively in Lie superalgebras until she received her Ph.D. from the Department of Mathematics and Mechanics at Leningrad State University in 1988. At that time she had published some 17 papers, mostly on Lie superalgebras but some on Yang-Baxter, on combinatorics, and on special functions. She also did a paper in biology. Since her doctorate, Vera Serganova has been very active in the development of a character theory for representatations of Lie superalgebras and in the study of geometry and cohomology of associated super symmetric spaces and super flag manifolds.

Vera Serganova held a Harvard fellowship and then went to Yale on a Gibbs Instructorship, both in 1990. She joined us in Berkeley as Assistant Professor in 1992. At about that time she conjectured the details of the general character formula for finite dimensional representations of simple Lie superalgebras. Currently she is working on this important problem.

## JOHN STRAIN

By Alexandre Chorin

John Strain joined our department last year as an assistant professor. A native Californian, Professor Strain is a graduate of UC Berkeley, where he completed his math degree in one year (having spent most of his undergraduate career studying ancient Chinese). After breezing through our Ph.D. program, he made a whirlwind tour of the East Coast, where he held an NSF postdoctoral fellowship at the Courant Institute of Mathematical Sciences, a visiting membership at the Institute for Advanced Study, and served briefly as assistant professor at Princeton University. He holds a prestigious NSF Young Investigator award.

Professor Strain's interests are in applied mathematics, numerical analysis and scientific computing. He is probably best known for his work on

"analysis-based fast algorithms". The paradigm of such an algorithm is the fast multipole method, which makes possible the evaluation of $N$ harmonic functions at $N$ arbitrary points at a cost of $O(N)$ operations (rather than the $N * N$ operations that may be expected at first sight). This evaluation is not exact, but may be indistinguishable from an exact algorithm on a finite computer. We are finding that there are more algorithms with such properties, and Strain is responsible for some of the more remarkable ones, as well as for interesting applications. In a problem involving a zero dispersion limit for a non-linear problem, Professor Strain's reformulation has reduced the computational cost by 4 orders of magnitude (compressing a year's work into less than an hour)!

# WELL DONE!

## DANIEL ISAKSEN

By Stephanie Reynolds

**Daniel Isaksen**, Senior, Applied Mathematics, attended the National Science Foundation's Research Experience for Undergraduates (REU) program at the University of Minnesota, Duluth in Summer 1993. He will present the resulting paper, entitled "Graphs that are Randomly Traceable from a Vertex", at the January 1994 meeting of the American Mathematical Society (AMS) in Cincinnati, Ohio.

Mr. Isaksen's research was carried out under the supervision of Joseph Gallian, Professor of Mathematics, UM, Duluth.

## DIPERNA MEMORIAL COLLOQUIUM LECTURE

By Lawrence C. Evans

Professor Constantine Dafermos of the Applied Mathematics Division of Brown University will present the fourth Diperna Memorial Colloquium Lecture on January 27, 1994, at 4:00 in 60 Evans Hall. Professor Dafermos is a leading expert on the theory of conservation laws, which are systems of nonlinear partial differential equations expressing the invariance in time of energy, momentum, etc., for physical phenomena. Solutions of such equations typically develop complex "shock wave" structures, determined by "entropy" criteria. Professor Dafermos' talk is entitled "Hyperbolic Systems of Conservation Laws in Several Space Variables".

# FERMAT'S LAST THEOREM — A PERSONAL HISTORY

By Kenneth Ribet

My interest in Fermat's Last "Theorem" began in 1981, when Gerhard Frey visited Berkeley while on sabbatical leave from his university in Germany. At the time, Frey was studying diverse questions about rational elliptic curves, plane curves defined by cubic equations with integer coefficients. Frey's starting point was the conviction that Fermat's Last Theorem was probably true. To the extent that Frey could link up Fermat's equation with elliptic curves, he could shed light on the questions he was studying.

Frey noticed that every solution $(a, b, c)$ to Fermat's equation $a^n + b^n = c^n$ with $n > 2$ gives rise to a cubic equation with peculiar properties. Namely, using $a$ and $b$, we can manufacture the elliptic curve $E$ given by the equation

$$y^2 = x(x - a^n)(x + b^n).$$

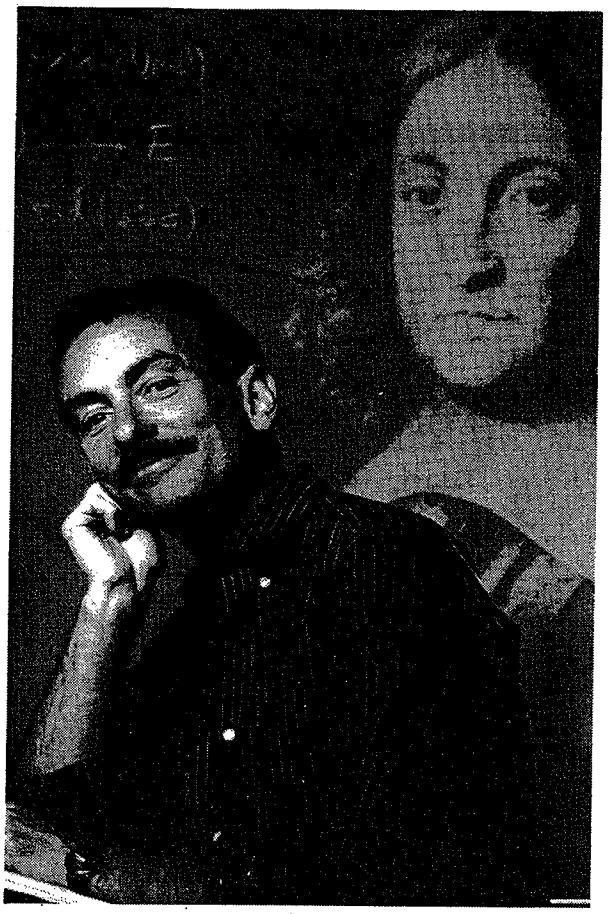
Because $a^n + b^n$ is a perfect $n$th power, it turns out that the fields generated by the coordinates of special points on $E$ (the *torsion points*) have discriminants which are surprisingly small. Although Frey realized that this circumstance was quite striking, he was initially unable to glean any new information from his construction.

After he left Berkeley, Frey continued to work on the elliptic curves he had manufactured. By 1984, he had found a specific reason for believing that his elliptic curves were implausible—they seemed to be incompatible with an established conjecture of Taniyama and Shimura to the effect that all elliptic curves defined over the rational number field are "modular" in the sense that they are related to analytic functions called modular forms. Roughly, the point is that modular forms cannot have small "level," so that the number fields associated with them must have large discriminants. This was new information about Fermat's Last Theorem—showing that $E$ was not modular would prove the implication

Taniyama-Shimura $\Longrightarrow$ Fermat's Last Theorem.

Mathematicians felt that the Taniyama-Shimura conjecture would surely be proved one day, since it is part of a vast conceptual framework involving the behavior of $L$-functions associated to the cohomology of algebraic varieties. Thus Frey's implication would push Fermat's Last Theorem into the realm of the "probably true" (but unproved).

In mathematics, it is very important to know that something is "probably true"—we are usually unable to prove assertions until we are persuaded that they must be correct. In 1985, there was



KEN RIBET W/GHOST OF FERMAT

*Photo by Catherine Karnow*

some degree of uncertainty concerning Fermat's Last Theorem. One knew of computer-aided calculations proving that the equation $a^n + b^n = c^n$ had no solutions for $n < 125000$. But on the other hand, it is a familiar phenomenon in number theory that simple equations may admit large solutions but no small solutions. A striking example is found in a 1988 article by Noam Elkies of Harvard University. Elkies refuted a conjecture made by L. Euler in 1769 which states that a sum of three perfect fourth powers can never be a perfect fourth power. Elkies exhibited the explicit counterexample

$$2682440^4 + 15365639^4 + 18796760^4 = 20615673^4,$$

which was found by combining theoretical arguments with a computer search. Because of such incidents, it was extremely important to link Fermat's Last Theorem to a broad set of coherent concepts.

In January, 1985, Frey gave a lecture to a seminar audience at the conference center in Oberwolfach, in the Black Forest. He explained his interest in proving that Fermat's Last Theorem is a consequence of the Taniyama-Shimura conjecture, and sketched an argument which he hoped

*see pg. 7*

*cont. from pg. 6*
could be used to establish this implication. Although he knew that his argument was flawed, Frey expected that the audience of specialists in Oberwolfach would be able to repair it for him. To his surprise, no one in the audience was able to help, although many people in the room were quite excited by the prospect of linking Fermat's Last Theorem with the conjecture that all elliptic curves over the rational number field are modular. Members of the audience returned home with a three-page manuscript that Frey had distributed at Oberwolfach. Within a week or two, the manuscript became widely known in the community of number theorists.

During the winter and spring of 1985, many mathematicians struggled to produce arguments that would justify the three-page manuscript.

An important step was taken in August, 1985 by Jean-Pierre Serre of Paris. Serre formulated two specific conjectures, which he called $C_1$ and $C_2$. In a letter to Jean-François Mestre, Serre showed that Fermat's Last Theorem is a consequence of the Taniyama-Shimura conjecture *together with* the two new conjectures. In other words, one had

$$C_1 + C_2 + \text{Taniyama-Shimura} \Longrightarrow \text{Fermat}.$$

This set off a scramble to prove $C_1$ and $C_2$.

I came up with a proof of $C_1$ and $C_2$ in July, 1986. At first it seemed that I could deal only with a special case. However, I met up with Harvard's Barry Mazur at a café during the International Congress of Mathematicians, which by coincidence was held in Berkeley in August, 1986. Mazur, who had read my argument over the summer, surprised me by pointing out that it could be modified to treat the general case. In other words, he convinced me that I had a proof that Taniyama-Shimura implied Fermat! I told this to mathematicians at the Congress, and I was deluged almost immediately with requests for a preprint on the subject. I spent much of the following two academic years writing, and then refining, my preprint. During the first year, I gave weekly lectures on my proof of Serre's conjectures at Berkeley's Mathematical Sciences Research Institute, which was hosting a special year on arithmetical algebraic geometry. Questions and comments by the seminar audience were enormously helpful to me. My article containing the proof of $C_1$ and $C_2$ appeared in 1990.

In June, Andrew Wiles announced a proof of the Taniyama-Shimura conjecture for the class of "semistable" elliptic curves, a large class including those which Frey had constructed. Wiles's proof, coupled with the fact that Fermat's Last Theorem follows from the Taniyama-Shimura conjecture, will show that Fermat's Last Theorem is true. Wiles has written a 200-page preliminary manuscript which contains the essential ideas of his proof. Among the techniques used by Wiles are many that became available only after Wiles began working on the Taniyama-Shimura conjecture. Perhaps most significantly, Wiles uses the technique of "Euler systems" that was fashioned by V. Kolyvagin in the mid-1980's. The transposition of this technique to the relevant context was begun in an article by M. Flach that was published only recently.

Wiles's announcement has created a huge splash inside the mathematics community, and well beyond it—**People** magazine plans to include the story in its 1993 year-end issue. ■

## WILES ACKNOWLEDGES RUMORS

On December 3, Andrew Wiles posted the following announcement on the electronic news group, sci.math:

"In view of the speculation on the status of my work on the Taniyama-Shimura conjecture and Fermat's Last Theorem I will give a brief account of the situation. During the review process a number of problems emerged, most of which have been resolved, but one in particular I have not yet settled. The key reduction of (most cases of) the Taniyama-Shimura conjecture to the calculation of the Selmer group is correct. However the final calculation of a precise upper bound for the Selmer group in the semistable case (of the symmetric square representation associated to a modular form) is not yet complete as it stands. I believe that I will be able to finish this in the near future using the ideas explained in my Cambridge lectures.

"The fact that a lot of work remains to be done on the manuscript makes it still unsuitable for release as a preprint. In my course in Princeton beginning in February I will give a full account of this work."

— Andrew Wiles.

# UCB FERMAT EVENING

By Carolyn Katz

*Photos by Arlene Baxter*

Who would have thought that after MSRI's sold-out Fermat Fest in July that there would still be enough interested people to almost fill Wheeler Auditorium for over two hours of mathematics?

Indeed, our Berkeley Campus Fermat evening on October 14 held the rapt attention of a diverse audience (which, we were happy to see, including many Bay Area Math alumni). The attendees gave such a positive response, both during and after the event, that the planning team could say later "It was a major undertaking, and we're glad we did this!"

The Mathematics Department wanted to share with the campus, local community, and its alumni

LEE DEMBART

the history and events leading up to the recently announced proof of Fermat's Last Theorem. We chose a multi-media, varied format so that it would be entertaining and interesting. It is natural that this proof of Fermat's Last Theorem by Professor Andrew Wiles will undergo extensive and thorough review by mathematicians throughout the world. Whether the proof holds up, and whether all of the gaps that will be discovered can be resolved, only time will tell. Regardless of the outcome, a better understanding of mathematics, and perhaps more interest in the subject and profession, will result from sharing this development with the public community.

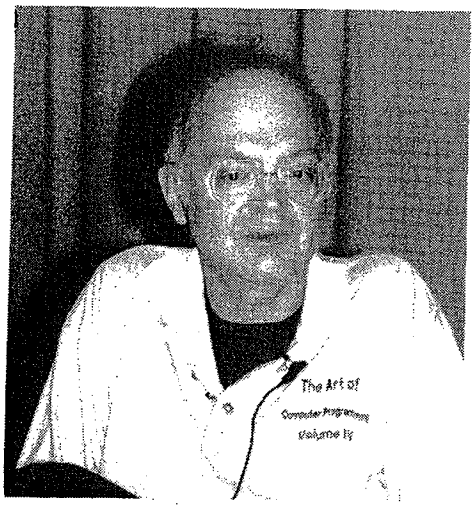
The evening began with a surprise dissertation by Vice Chancellor Heilbron, who in his opening remarks gave a snapshot historical view of marginalia leading up to Fermat's famous quotation. Another highlight was the showing of a very brief filmed interview of Andrew Wiles that we had received just the day before the event. MSRI obtained the film from producers of the independent British TV, Channel 4. Journalist Lee Dembart performed admirably as Master of Ceremonies, providing continuity throughout the program.

MSRI's Robert Osserman's video presentation from the July Fermat Fest opened the program with some historical perspective. He described the Pythagorean Theorem (illustrated with cutouts of pizzas) and the relationship between Pythagorean triangles and musical sounds. The segment concluded with a musical piece performed by Morris Bobrow.

Next was Professor Joe Buhler of Reed College, who gave the history leading up to Fermat's Last Theorem, as well as an explanation of modular elliptic curves.

After intermission, Professor Kenneth Ribet of UCB's Math Department presented an articulate view of his role in laying the foundation for Wiles' proof. He described the relationship of The Taniyama–Shimura Conjecture to the proof of Fermat's Last Theorem.

Closing the program was a panel, moderated by Bay Area media personality Sedge Thomson, which discussed the significance of this development to the profession of mathematics and to the public. Donald Knuth stimulated the discussion with his opening commentary about the tragedy this proof may engender for mathematics—for if the Fermat's Last Theorem has been proven, what outstanding problems could replace this 350 year-old mystery? And what about all the textbooks, including his, that would need to be revised? These comments led off a lively discussion as fellow panelists Joe Buhler, Hendrik Lenstra, Dusa




DONALD KNUTH

McDuff, and Ken Ribet answered questions from the audience.

This public service event was co-sponsored by the Department of Mathematics, Center for Pure & Applied Mathematics, and MSRI. Credit for the event goes to planning team members Arlene Baxter, Carolyn Katz, Hendrik Lenstra, Rondi Phillips, Ken Ribet, Bill Thurston, Jack Wagoner, and Alan Weinstein. We give special thanks to

*see pg. 9*

*cont. from pg. 8*

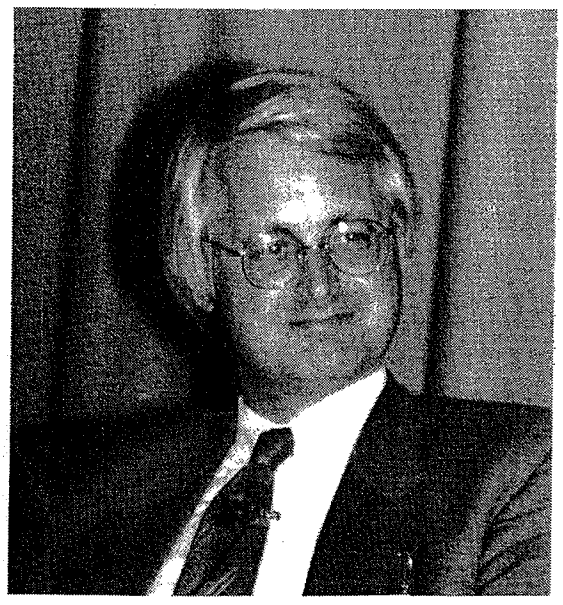
MSRI's Steve Stapleton for his special pre-event help, and to Paulo De Souza, Dave Hernes, Lou Maull, Doris Smith, and Marsha Snow for their help both before and during the event. We also thank our students and faculty who volunteered to help with logistics and the "Ask the Mathematician" tables during intermission. ■

DUSA MCDUFF

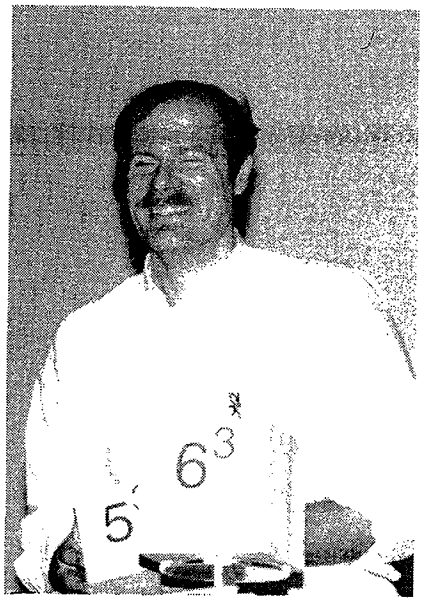
**$X^n + Y^n = Z^n$ Limerick**

A challenge for many long ages
Had baffled the savants and sages.
Yet at last came the light:
Seems old Fermat was right—
To the margin add 200 pages.

—Paul Chernoff



HENDRIK LENSTRA



JOE BUHLER

## THANK YOU FOR YOUR PARTICIPATION AND PREPARATION

By Faye Yeager

The Math Safety Team would like to thank all who responded to our Skills and Special Needs Survey. Your skills will be of great value when the time comes to put them to use. Those of you with special needs can now rest easy in the knowledge that those needs will be addressed when necessary.

We would also like to congratulate those of the mathematics community who had the foresight to order (or create their own) emergency kits. Some of you have even thought to include loved ones in your decision to prepare by seeing that they have emergency kits as well. What a unique and wonderful expression of caring! You can now take comfort in knowing that you are prepared for a disaster and have a greater chance of surviving those days following a disaster when outside help may be limited or nonexistent. CONGRATULATIONS!!

For those of you who are interested in information regarding emergency kits, please contact Safety Team Leader Dave Hernes (Room 966, 2-9104). He did extensive research to find the best value for these kits and can tell you how to purchase them.

The Math Safety Team would also like to collect and stock some emergency supplies at Evans Hall. If you are interested in donating such items as heavy work gloves, tools, rope, blankets, sheets, etc. please contact Dave Hernes for a list of these and other items we need.

# More Congratulations !!!

## NICOLAI RESHETIKHIN
## Recipient of the Sloan Research Fellowship

By Bibi Rosa Basha

Professor Nicolai Reshetikhin of our department is an honored recipient of the Sloan Research Fellowship. Professor Reshetikhin was born in Moscow, received his Ph.D. in Mathematics at the Leningrad University in 1984, and joined the faculty here at UC Berkeley in 1991. His research focuses on mathematical physics, low-dimensional topology, and statistical mechanics.

The Sloan Research Fellowship was established in 1955 to provide support and to stimulate fundamental research by young scholars of superior promise. This fellowship recognizes young scientists, often in their first appointment to the university faculty, who are endeavoring to establish their own independent research project. Selection procedures for the Sloan Research Fellowships are designed to identify those who show the most outstanding potential of making important contributions to new knowledge.

*Ratner, cont. from pg. 1*

involved the discovery of various "rigidity" phenomena.

In her surprising work on horocycle flows, done in the early 80's, the objects under discussion are algebraic or geometric (depending on viewpoint). This structure carries along with it some measure-theoretic structure, but on the surface it would seem that the measure-theoretic description of these horocycle flows contains little information about them. The surprise is that, in fact, the measure-theoretic description contains **everything**! The prototypical result is that a measure-theoretic isomorphism between horocycle flows is in fact algebraic.

Marina's much acclaimed work of the last few years—the "Raghunathan conjectures"—are a far reaching generalization and application of these ideas to an important situation.

Briefly: There was an innocent looking question, sometimes called the "Oppenheim conjecture", about the values assumed by real quadratic forms in three integer variables. This question had proven remarkably recalcitrant. About 1980, M. S. Raghunathan observed that the expected answer would follow if a certain natural conjecture about actions of Lie groups were true. The question about quadratic forms required only a special case of Raghunathan's conjecture, and in 1986, G. Margulis proved this case. However, his proof was very intricate, and gave little insight into what was going on. Marina saw that her methods were the appropriate ones for this type of conjecture and eventually she was able to give much more natural proofs. Furthermore, her proofs worked in a very general context, and enable her to answer several related questions of Margulis and Raghunathan. This has led to further number-theoretic information about quadratic forms.

Here is a vaguely formulated version of one of this last group of results: a "measure-theoretic" version of Raghunathan's conjecture. Let $\Gamma$ and $H$ be appropriate sorts of subgroups of a Lie group $G$, and let $\mu$ be an arbitrary finite measure on $G/\Gamma$ which is invariant and ergodic under the left action of $H$ on $G/\Gamma$. Then $\mu$ has an algebraic nature: it is the Haar measure on some homogeneous space embedded in $G/\Gamma$. So again an apparently measure-theoretic object is revealed to be algebraic.

Marina's work has been acknowledged with a series of honors, of which the most recent ones are election to the American Academy of Arts and Sciences in 1992, election to the National Academy of Sciences in 1993, the award (jointly with M. Laczkovitch) of the Ostrowski prize[1] in 1993, and an invitation to deliver a plenary address at the 1994 International Congress of Mathematicians.

[1] This prize is awarded every two years, by the A. M. Ostrowski Foundation in Basel, for an outstanding contribution to higher mathematics. The previous recipients have been J. Bourgoin and L. de Branges. ■

# MATH and CPAM VISITORS

By Lou Maull and Haruko Bruce

**Adebisi Agboola** is a Morrey Assistant Professor in the Department for the second year. He concurrently holds a National Science Foundation Postdoctoral Fellowship. He spent 1991-92 as a Postdoctoral Fellow at the Mathematical Sciences Research Institute. He received his Ph.D.in 1991 from Columbia University where his research concerned algebraic number theory, especially abelian varieties and Galois module structure.

**Jørgen Andersen** is a second-year Morrey Assistant Professor in the Department. Originally from Denmark, he received his D.Phil. from Oxford University in 1992. His research deals with understanding and calculating the Witten invariants of 3-dimensional manifolds.

**Anne Bourlioux**, who has been associated with the Department since 1991 as a Miller Fellow, is an Adjunct Assistant Professor for the Fall '93 semester. From Belgium, Anne received her Ph.D. from Princeton in 1991 studying multidimensional instabilities of high Mach number combustion fronts, with particular emphasis on the structure of detonation cell patterns. Additionally, she has initiated research on low mach number combustion and droplet computation.

**Ming Gu** is in his first year in the Department with a two-year appointment as a Morrey Assistant Professor. From China, he has just completed his Ph.D from Yale. He is a numerical analyst with principle research interests in numerical linear algebra.

**Renling Jin**, also a native of China, returns for his second year with the Department as a Morrey Assistant Professor. He received his Ph.D. from the University of Wisconsin at Madison in 1992. His thesis topic was mathematical logic, especially set theory and nonstandard analysis.

**James Lewis** continues in the Department for the second year as an Adjunct Assistant Professor. He received his Ph.D. from the University of Chicago in 1989 and was a recipient of one of the prestigious NSF Postdoctoral Research Fellowships in 1991. Prior to joining us in 1992, he visited the Mathematical Sciences Research Institute as a postdoctoral research fellow. Lewis' mathematical interests have centered on infinitesimal rigidity.

**Dusa McDuff** is visiting the Center for the Fall '93 semester as a Visiting Research Mathematician under a grant from the National Science Foundation Visiting Professorship for Women program. In addition to her research on symplectic 4-manifolds, she is active in increasing the profile of women mathematicians, several of whom have been invited to speak at the Mathematics Colloquium. Dusa, who is from London and Edinburg, received her Ph.D. from Cambridge University in 1971 where her research involved operator algebras. However, after working with I. M. Gelfand in Moscow, she converted to topology. She has held lecturerships at the Universities of York and Warwick in England. She has been a member of the mathematics faculty at the State University of New York at Stony Brook since 1978. She has had visiting positions at MIT, Princeton and MSRI.

**John Milnor**, Professor and Director of the Institute for Mathematical Sciences at the State University of New York at Stony Brook, is the recipient of a Miller Visiting Professorship for 1993-94. He received his Ph.D. from Princeton in 1954. John is the recipient of many honors including the Steele Prize from the American Mathematical Society in 1982 and the Wolf Prize in 1989. He is a fellow of the National Academy of Sciences. His fields of research are the topology of manifolds, differential geometry, and dynamical systems.

**Michael Polyak** is both an Adjunct Assistant Professor in the Department and a National Science Foundation Research Associate in Modern Analysis in the Center for the 1993-94 academic year. Michael, born in Moscow, received his Ph.D. from Tel-Aviv University in 1992 and has been at Berkeley on a Rothshild Research Fellowship. His research concerns the interplay between low-dimensional topology, especially knot theory and 3-manifolds, and quantum groups.

**Tatiana Toro** is beginning a two-year appointment as a Morrey Assistant Professor in the Department. During the 1992-93 academic year she took part in a program on differential geometry held at the Institute for Advanced Study at Princeton. She received her Ph.D. from Stanford University in 1992 after completing undergraduate work in her native Colombia. Her research solved an important problem in harmonic analysis, with applications to differential geometry and partial differential equations.

**Zhimin Yan** has completed two years as a Morrey Assistant Professor and is an Adjunct Assistant Professor in the Department this year. Concurrently he is an NSF Assistant Research Mathematician at the Center. He received his Ph.D. from the City University of New York in October 1990. A native of China, he spent two months in 90-91 visiting the Mittag-Lefflere Institute in Stockholm and was a Lecturer at U C Irvine. He is a published researcher on generalized hypergeometric functions, bounded symmetric domains and related topics in Modern Analysis. His research also overlaps the fields of differential geometry, hard analysis and special function theory. ■

## MANAGER'S REPORT

By Carolyn Katz

I was delighted at the wonderful reception given to our first newsletter. We'll do our best to strike the right balance in coverage to reach all members of our mathematics community. Our alumni sent many wonderful and creative ideas which we hope to implement over time.

This past summer was atypical for staff; not a dull or boring summer moment was to be found! Indeed, it was filled with special training about the team process and analytic tools and techniques to use in analyzing processes and procedures. In late summer, we began teamwork on three major departmental projects, which are still ongoing:

*Service Excellence Team* – Our joint project with English is close to reaching it's first goal, to identify and clarify what "service excellence" actually means to us and those we serve. With extensive help from all staff, the team is working now on a document which describes specific expectations of the giver of services, and also of the beneficiary of services. The team is excited to have reached this point and we plan to contact faculty and students for their input next semester.

*Mathematics Safety Team* – We have made steady progress toward achieving this team's goals. So far, the team has (1) developed and conducted a survey to determine special emergency skills and needs among our Math community in Evans Hall; (2) purchased basic medical supplies for departmental use during emergencies; (3) identified needs and made recommendations for office and personal purchases of emergency items (and located the least-cost vendor); (4) identified needs and solicited donations for general supplies which might be needed by the Department in the event of a major disaster; and (5) shared information and documents with other departments in Evans Hall.

*Administrative Computing Team* – This team's charge is to identify needs for our administrative computing operations and to make recommendations for ways to better address those needs and create efficiencies and time-savings in our operations.

I am pleased with the progress of these teams, and it is gratifying to see principles and concepts we learned during the summer now being used. I wish to acknowledge the diligent efforts of team members Dave Hernes, Julianna Lopez, Lou Maull, Rondi Phillips, Faye Yeager, and Janet Yonan. And I especially thank the staff and faculty who have offered their valuable ideas and comments for these teams, as well as service on other teams reviewing different aspects of our operations. We appreciate it!

## NEW SCULPTURE AT MSRI

By Bill Thurston

MSRI ("Emissary") has unveiled a new mathematical sculpture, "The eightfold way", by Helaman Ferguson. This sculpture is a depiction of the Klein quartic, a famous object of mathematical study for more than a century. The abstract surface is a 3-holed torus that incredibly has a group of symmetries of order 336. This group cannot act isometrically in 3-space. The sculpture shows the symmetry topologically, using a pattern of 24 heptagons. Abstractly, each heptagon is equivalent to each other heptagon and each heptagon can be rotated and reflected on itself in 14 ways. The sculpture is made of white marble, and it rests on a 7-sided black column that rises out of a model of the hyperbolic plane, tiled by regular heptagons

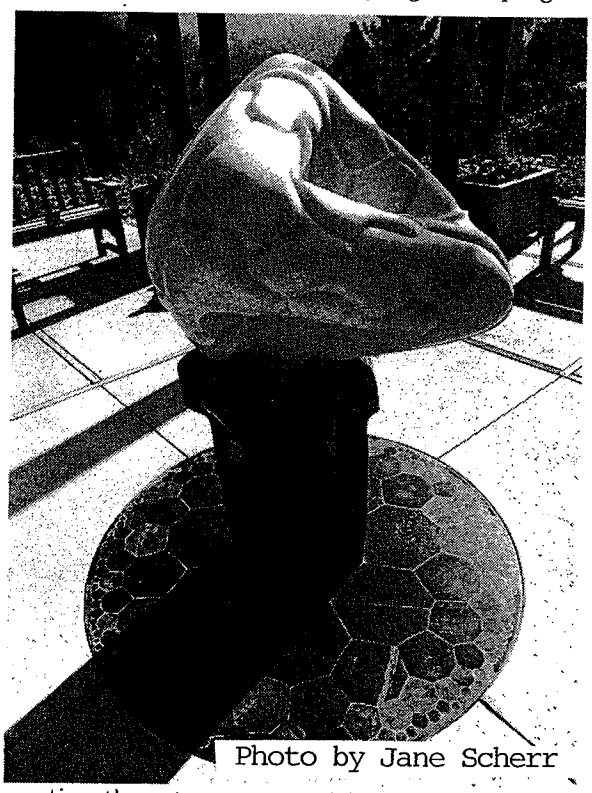


Photo by Jane Scherr

meeting three to a vertex. The surface itself is a quotient space of the hyperbolic plane by a subgroup of index 336 in the group of isometries that preserves the heptagonal tiling.

There are many different ways that the Klein quartic can be viewed. It can be given by an equation,

$$x^3y + y^3z + z^3x = 0,$$

which defines a two-complex-dimensional subset of $C^3$. This maps into a one-complex-dimensional or two-real-dimensional subset of the complex projective plane, which is topologically a 3-holed torus, the Klein quartic. There is a group of order 168 of linear transformations of $C^3$ that preserve the equation. (How many can you find? It is easy to

*see pg. 13*

## SPECIAL PERFORMANCE AWARD

By Lou Maull, Faye Yeager and Doris Smith

**Melanie Seepol**, accounts assistant in the Personnel and Finance Unit, received a Special Performance Award for the highest level of continuous performance and special one-time contribution of a superior nature to the Department. Melanie is an outstanding employee. Because of her abilities to organize and streamline, she is able to manage a work load that, over the last two years, has considerably increased and would exceed her half-time

position. She created a new monthly financial report which provides useful and timely information and accurately projects year-end expenses. Her efforts have been instrumental in helping us monitor our expenses very closely and have facilitated the annual fiscal closing process. The Department values Melanie as a dedicated, hard-working, and productive employee.

In the College of Letters and Science, 173 employees were eligible for Special Performance Award. Only 43 (25% of those eligible) won. It was an extremely competitive process.

**Gail Yoshimoto** was nominated for the Special Performance Award in May of this year. She is an employee of the Faculty Services Unit in the Department of Mathematics. Gail has exceeded the standard of her position regarding service to faculty on many occasions. She consistently helps international visiting faculty rewrite letters to correct spelling and grammatical errors and is quick to assist other faculty with any requests they may have. She is a very dedicated and loyal employee who is thought of very highly by faculty and staff alike. It is an honor to have Gail as part of our staff.

**Janet Yonan** was also nominated for the Special Performance Award. Her position as Graduate Assistant has two major components: helping our 300-ish graduate students thread their way through University and department requirements and regulations and managing the admission process for more than 300 applicants. Janet manages both of these functions with an impressive degree of efficiency, accuracy, and grace. She is highly knowledgeable about University procedures and is adept at reminding students about maintaining satisfactory degree progress. Janet's job performance has been consistently notable not only for the quality and quantity of work she does, but for her obvious dedication to her job.

*cont. from MSRI Sculpture, pg. 12*

see a linear transformation of order 3, and it is not hard to find one of order 7. It is considerably harder to find an automorphism of order 2.) This goes over to a group of order 168 of holomorphic automorphisms of the Klein quartic. The rest of the automorphisms are anti-holomorphic.

Hurwitz proved that a Riemann surface of genus $g > 1$ can have at most $84(g-1)$ holomorphic automorphisms. The Klein quartic is the first example attaining this bound.

The sculpture is the centerpiece of our newly remodeled patio, which has become a very pleasant place to sit and contemplate mathematics. The patio has been extended and an overhead trellis constructed. A handout with more information about the Klein curve is available from the receptionist. Come see it! ■

# ASTRONOMY/MATHEMATICS/ STATISTICS LIBRARY

By Jo Butterworth

The Astronomy/Mathematics/Statistics Library has gone through some major changes in the past year. Patrons have probably noticed that Ralph Moon can no longer be found in his office at 100 Evans. In response to budget cuts and capital improvement projects, there has been a major reorganization within the Library system which resulted in Ralph being promoted to Acting Associate University Librarian for Public Services. I was appointed temporary Managing Librarian in September. My appointment is half-time; in the afternoons I am the librarian at the Mathematical Sciences Research Institute (MSRI). The close affiliation MSRI has with the campus Mathematics Department is making the coordination of the two jobs very pleasant and, I hope, beneficial to both clientele. Sharing our collections is one of the many benefits this arrangement is providing.

Unfortunately, the Astronomy/Mathematics/ Statistics Library is being affected by budget cuts. The library committee (J. Addison, M. Wodzicki and J. Butterworth) will be looking over all of the issues involved in this grim task.

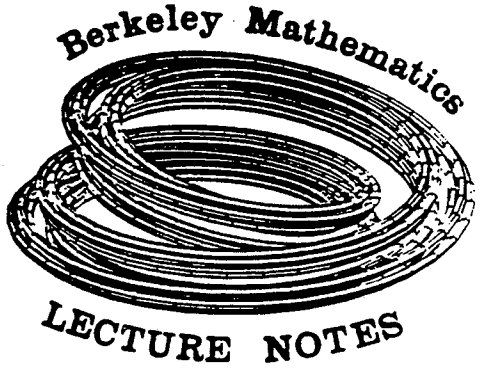
For your information, here is our Library Directory:

Library Hours:

9 am–7 pm Monday–Thursday
9 am–5 pm Friday
1 pm–5 pm Saturday
Closed Sunday

Circulation Desk: 2-3381

Please stop in and say hello, or introduce yourself. Alumni are welcome. We look forward to meeting you and providing you with the best service possible.




The Berkeley Mathematics Lecture Notes Series is published by the Center for Pure and Applied Mathematics, University of California, Berkeley, CA 94720.

This series provides an opportunity for the mathematics faculty at UCB to make informal, graduate-level class lecture notes available to the mathematics community. The aim is to provide as well an opportunity for keeping graduate class notes updated and for trying out preliminary versions of new texts.

Please contact Gail Yoshimoto (962 Evans Hall, (510) 642-6426, e-mail: gail@math.berkeley.edu) to place orders.

### Berkeley Mathematics Lecture Notes Currently Available

- Vol. 1: *Numerical Linear Algebra*, by James Demmel
- Vol. 2: *Lectures on Turbulence Theory*[1], by Alexandre Chorin
- Vol. 3A: *Partial Differential Equations*, by Lawrence C. Evans (Chapters 1–5)
- Vol. 3B: *Partial Differential Equations*, by Lawrence C. Evans (Chapters 6–11)
- Vol. 4: *Lectures on Topology and Analysis*, by Paul Chernoff, and *Notes on Measure and Integration in Locally Compact Spaces*, by William Arveson
- Vol. 5: *Prelim Workshop Lecture Notes*, by David Cruz-Uribe
- Vol. 6: *Applications of Global Analysis in Mathematical Physics*[2], by Jerrold Marsden

[1]This volume is a reprint of the 1977 Publish-or-Perish Press text.
[2]This volume is a reprint of the 1974 Publish-or-Perish Press text.

## IN MEMORY OF NORA LEE

By Catalina Córdoba Boniffaccini

Nora Lee Walters, a member of the Mathematics Staff for 17 years, died in London on December 3rd after a long and courageous battle against cancer. A cheerful person, her jovial and contagious laugh often filled the hallways. She was a woman of many talents who enjoyed gardening, cooking, and cross-stitching. Nora "retired" in 1986 to marry Peter Walters and move to England. In declining health, she was able to make one final, memorable visit last summer to the friends and the department she loved. To the end she lived her trademark of concern and caring for family and friends and was the epitomy of great inner strength. She will be well-remembered and missed by all those in Mathematics who knew her.

### ALUMNI AND FRIENDS NEWS AND UPDATE FORM

(Please type or print)

NAME:
Last _____ First _____ MI _____

DEGREE & YEAR GRADUATED: _____

ADDRESS CORRECTION:

WORK: Position:
Institution or Company:
Location:

PERSONAL AND PROFESSIONAL NEWS (Type or print on a separate sheet.)

IDEAS FOR OUR NEWSLETTER:
What items in this issue were of particular interest to you?

What other types of articles or information would you like included in future issues?

COMMENTS: (Please type or print on a separate sheet.)

Thank you for taking the time to help us plan for our next issue. Please return this form to Editor Rondi Phillips, Department of Mathematics, Rm. 968 Evans Hall, University of California, Berkeley, CA 94720. (FAX number (510) 642-8204; TELEPHONE number (510) 642-4024)

*Alumni, cont. from pg. 2*

**Sister Catherine Curry** (Class of '48) currently is an historical researcher for SISTERS OF THE PRESENTATION in San Francisco. In 1987 she was awarded a Ph.D. in History from the Graduate Theological Union in Berkeley. Recently she returned to UC Berkeley's OPEN HOUSE (Sp.'93) and enjoyed hearing Vaughn Jones' lecture. Her best remembrances from her Cal Mathematics major are her studies under Alfred D. Tarski who taught Differential Calculus.

**Lee DeCola** (Class of '67) is a research physical scientist at the USGS and a lecturer at George Mason University in Virginia. He's just co-published a book with Nina Lam entitled FRACTALS IN GEOGRAPHY. After accomplishing his BA in Mathematics in 1967, Lee received a Masters in City Planning at UCB in '69 and then was awarded his Ph.D. in Geography at the University of Ibada, Nigeria in 1984.

**Florence Smith Horton** received her BA in a double major of Math & Physics in 1939 and her MA in Mathematics in 1941. She taught at Campbell High & Whittier High Schools from 1941 - 1981. Currently retired, Florence is interested in any news from Math students from the Classes of '37-'42. ■

*BEST WISHES FOR A PROSPEROUS NEW YEAR!*

**From the Department of Mathematics at UC Berkeley**

**PRODUCTION TEAM**

**Editor:** Rondi Phillips

**Copy Editor:** Doris Smith, Faye Yeager

**Production Artist:** Deborah Craig

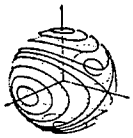
**Consultant:** Carolyn Katz

**Photographers:** George Bergman, Arlene Baxter, Catherine Karnow, Rondi Phillips

**Contributors:** Bibi Rosa Basha, Jo Butterworth, Alexandre Chorin, L. Craig Evans, Jack Feldman, Carolyn Katz, Lou Maull, Graham Randall, Stephanie Reynolds, Kenneth Ribet, Don Sarason, Doris Smith, William Thurston, Jack Wagoner, Alan Weinstein, Joseph Wolf, Faye Yeager, Janet Yonan

Printing done by PRINT MINT PRESS

Submit articles to: Rondi Phillips,
Department of Mathematics, UCB,
Berkeley, CA 94720, or
email: rondi@math.berkeley.edu



Berkeley
*Mathematics*
Newsletter

Department of Mathematics
970 Evans Hall
University of California
Berkeley, CA 94720
(510) 642-4024

Nonprofit Org.
U.S. Postage
PAID
Berkeley, CA
Permit No. 1