UC DAVIS

MATHEMATICS NEWSLETTER

Fellows of Math

AMS Recognizing Achievement

Contents

Letter from the Chair

by Joel Hass

Picnic Day outside the Math Sciences Building

Good news continues for the UC Davis Department of Mathematics. Our faculty extended its record of extraordinary productivity, bringing in numerous research grants and awards. The growing reputation of the campus and the Department has led to increasing enrollments, at both the graduate and undergraduate levels. We welcome an outstanding new faculty member this year, Kevin Luli, who joins us from Yale University.

The Department starts the new academic year with 516 majors, up over 100 from last year. Our challenge will be to continue providing high quality classes, inspired advising, career guidance, research opportunities, and a welcoming environment. We have created a new meeting room for our undergraduate majors, which sees constant activity during the week. We are also sponsoring an active Math Club that hosts well attended weekly meetings. Large numbers of undergraduates are participating in research projects with a variety of faculty. I want to mention the long overdue recognition given to Prof. Jesús de Loera this year. His tireless work supporting the undergraduate research programs of the Department over many years were recognized with the 2013 Chancellor's Award for Excellence in Mentoring Undergraduate Research.

We have set up additional drop-in consultation rooms for our calculus students, staffed for six or more hours each day. A major source of new students has been from overseas, due to the UC Davis 2020 Initiative, which is leading to a substantial expansion in student numbers. While we have always had international graduate students, the campus is now attracting international undergraduate students in significant numbers. Mathematics is proving to be a big draw for these students, ranking behind only Economics as a target major. This year 49 international students begin as Math majors at Davis, most of them from China. They are excellent students and we look forward to their presence in the Department this year.

This year we will host several national and international research conferences at Davis, including one over the coming Spring break in honor of faculty member Albert Schwarz. Professor Schwarz has a long and distinguished career that began in Moscow in mathematics, then took a diversion into physics. For the last twenty years he has played a key role in the Department. His early career is featured in this newsletter.

Our faculty is continuing to produce outstanding new results in a wide range of mathematical areas. I know this not just from my own knowledge of their work, but also from the offers that they have been getting from the world's leading universities. We have been fortunate that our faculty are committed to excellence at Davis. The campus is planning a significant expansion, roughly 20% enrollment growth over the next seven years, and this offers us a chance to hire a new generation of mathematicians.

I am continuously impressed by the extensive and deep mathematical activity that I see happening around me. Whether it is faculty working in their offices, graduate students talking to each other or to their advisers, undergraduates in office hours or talking in the halls, or visitors giving seminars, there is a buzz of mathematical activity. In the Departmental offices I see the staff providing friendly and efficient services. The faculty teaching evaluations, which I read each quarter, are a pleasure to review. Mathematics is a key to a better world, and at Davis the future is bright.

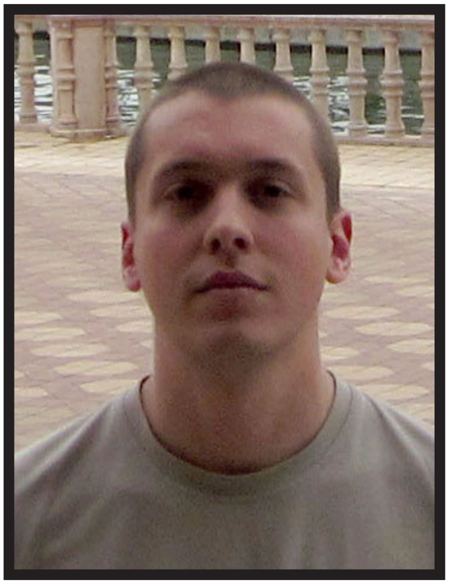
New Krener Asst. Professor Anastasiia Tsvietkova

Anastasiia Tsvietkova was born in Lithuania and received her undergraduate degree from Kyiv National University in Ukraine. She was a doctoral student at the University of Tennessee, working with Morwen Thistlethwaite. After receiving her Ph.D. degree in 2012, she spent a year as a VIGRE Postdoctoral Fellow at Louisiana State and then a semester as a Postdoctoral Fellow in the Program on Topology, Geometry and Dynamics at ICERM, Brown University.

Anastasiia's research interests lie in the area of knot theory and low-dimensional topology, with a particular emphasis on intrinsic geometric properties of hyperbolic 3-manifolds. Currently she explores relationships between the geometry of finite-volume hyperbolic 3-manifolds and quantum or arithmetic invariants, and—for links—to the combinatorial picture given by the link diagram. Additionally, Anastasiia has a side interest in geometric group theory.

Anastasiia is looking forward to joining the UC Davis geometry and topology group and the Department in January 2014.

Incoming Academic Staff



New Krener Asst. Professor
Rafa Granero Belinchón

Originally from Villaverde y Pasaconsol, a small village in Cuenca, Spain, Rafa Granero Belinchón completed his M.Sc. at the Autonomous University of Madrid and Paris-Dauphine University, and his Ph.D. at the Institute of Mathematical Sciences in Madrid. His thesis advisers were Professor Diego Córdoba and Professor Rafael Orive. In his dissertation research he investigated the effects of inhomogeneities in porous media on the dynamics of internal waves. In his last year as a Ph.D. student he spent several months at the University of Pisa in Italy, working with Professor Luigi Berselli.

At UC Davis, he will continue his study of the partial differential equations that arise in fluid mechanics, biology, astrophysics and other disciplines. His focus will be on free boundary problems and one dimensional models.

In addition to his research, Rafa enjoys hiking with his wife, Elena, playing sports and reading.

New Krener Asst. Professor
Michael Bishop

Michael Bishop is returning to Davis after an eight-year hiatus. In 2005 he graduated from UC Davis with a B.S. degree in Mathematics. In 2013 he received his Ph.D. in Mathematics from the University of Arizona. His thesis adviser was Professor Jan Wehr.

In his dissertation Michael studied the low energy states of both non-interacting and interacting quantum systems in random Bernoulli-distributed environments. These states model the behavior of Bose-Einstein condensates, an aggregated state of matter that requires very cold temperatures and can show quantum effects on a macroscopic scale. His current research studies the existence and nature of Bose-Einstein condensation in random environments. At Davis he will work with Professor Bruno Nachtergaele.

When not doing mathematics, Michael enjoys reading history, economics, current events and literature. He plays ultimate Frisbee and follows professional sports.

New Faculty
Kevin Luli

The Department is pleased to welcome Kevin Luli into our faculty. Kevin received his Ph.D. from Princeton University in 2010. His thesis adviser was Charles Fefferman. After serving as a Gibbs Assistant Professor in Mathematics at Yale University for three years (2010-2013), he joins the Department as an Assistant Professor.

Kevin's research focuses primarily on harmonic analysis and the partial differential equations that arise in fluid mechanics. In particular, he has been working on several aspects of the Whitney extension problems, developing related algorithms and pursuing applications of these problems to other fields. Examples include the organization of large data sets and computational commutative algebra.

Kevin is very happy to return to northern California where he has strong roots. He obtained his secondary school education at Drew College Preparatory School in San Francisco and his undergraduate training at Stanford University. When not working on mathematics, he enjoys hanging out with friends, reading novels and listening to classical music (sometimes even while working!). He likes hiking and swimming, and plays basketball and tennis. Kevin has been trying to learn to play the piano by watching YouTube videos, so far with mixed success. It seems that playing the piano is harder than proving a theorem.

Fellows of Math: Recognition from the American Mathematical Society

In 2012 the American Mathematical Society elected its inaugural class of Society Fellows. The Department is proud that five of our faculty members received this signal honor. The mathematical interests and achievements of each new Fellow are described here.

Joel Hass

Joel's research focuses on problems in three-dimensional geometry and topology. His initial contributions were in minimal surfaces and 3-dimensional manifolds. In a paper co-authored with Michael Freedman and Peter Scott, he showed that surfaces of smallest area have the fewest possible self-intersections. This result has found many applications in the study of 3-manifolds.

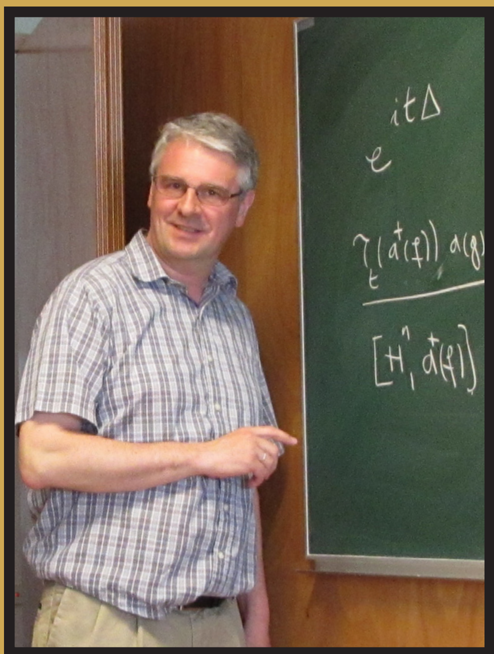
He also has worked on problems relating to the computational complexity of algorithms in topology and geometry. Specifically, with Lagarias and Pippenger, he has shown that the problem of determining whether a curve is not knotted is in NP. With Agol and Thurston, he showed that determining the genus of a surface in a 3-manifold also is NP complete. Recent work with Greg Kuperberg has shown that determining whether a manifold is the 3-sphere lies in the complexity class NP intersect coNP, assuming the Generalized Riemann Hypothesis..

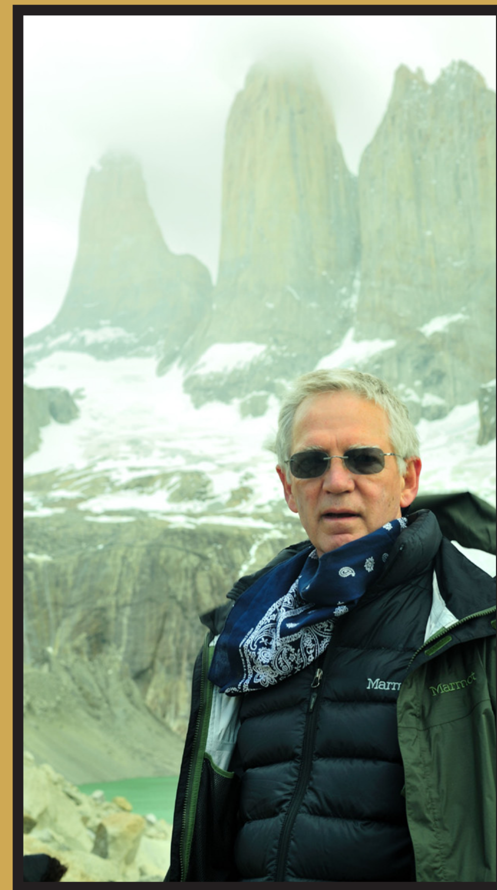
More recent work explores the use of hyperbolic geometry and, in particular, hyperbolic orbifolds, to study a variety of complex biological surfaces, such as the cortical folds of the brain, and the shapes of bones and protein molecules.

Greg Kuperberg

Over the course of his career Greg has made contributions in many areas of mathematics, including quantum algebra, quantum computation, combinatorics, geometric topology, convex geometry and differential geometry. A recurring focus of his research is quantum mathematics, where the word "quantum" means non-commutative generalizations of mathematical objects that are usually described by commutative algebras. Thus, quantum probability is the study of non-commutative algebras and random variables, while quantum groups are like Lie groups, but with non-commuting coordinates.

Greg is best known for short proofs and elegant constructions in his various areas of research. These include a short proof of the alternating-sign matrix conjecture using quantum algebra, a skein theory for the quantum link invariant associated to the exceptional Lie group G2, a quantum algorithm for the dihedral hidden subgroup problem and a new proof of the Bourgain-Milman theorem in convex geometry using Gauss linking integrals.





Bruno Nachtergaele

Bruno's research focus is on mathematical physics. Perhaps his best known work is in quantum spin systems. A series of joint papers with Mark Fannes (Leuven) and Reinhard Werner (Hannover) introduced and developed the theory of Finitely Correlated States for quantum spin chains. These have been used in a wide variety of applications. Working jointly with Horng-Tzer Yau (Harvard), he derived the compressible Euler equations from quantum many-body dynamics. This achievement earned him an invitation to speak at the 2002 International Congress of Mathematicians in Beijing.

Bruno's recent interests focus on understanding the dynamics, ground states and elementary excitations of quantum many-body systems. The Lieb-Robinson bounds, an essential tool that lies at the basis of most of the recent advances in this area, were developed by Nachtergaele and Sims (Arizona) over the past seven years.

Bruno has been the vice president of the International Association of Mathematical Physics (2009-2011), the editor of the Journal of Mathematical Physics (2005-present), and Department Chair (2007-2009). He currently serves as chair of the UC Davis Division of the Academic Senate.

Abigail Thompson

Abby works in the area of low-dimensional (2,3 and 4 dimensions) topology and knot theory. A 3-dimensional manifold is an object that looks, to a local observer, like regular 3-dimensional Euclidean space. That is, it looks like the room in which you are likely to be sitting. Tremendous progress has been made in recent years in understanding 3-manifolds. There is hope that the full range of possibilities soon will be known. Abby works to resolve some of the longstanding structural questions in this field. Her ultimate aim is to contribute to uncovering the elegant framework which underlies the structure of these low dimensional manifolds.

In 2003 Abby received the American Mathematical Society's Satter Prize for her research. She won the 2010 UC Davis distinguished teaching award for graduate teaching. Since 2002 she has directed the UC Davis Cosmos program, a residential summer program for talented high school students in math and science. Currently she chairs the American Mathematical Society's Committee on the Profession.

Craig Tracy

Craig's research is in mathematical physics and probability theory with an emphasis on stochastic integrable models. His work has earned many accolades. He was awarded the 2002 George Polya Prize from the Society of Industrial and Applied Mathematics (SIAM), and the 2007 Norbert Wiener Prize from the American Mathematical Society. Both prizes were awarded jointly to Craig and to his long-time collaborator Harold Widom (UC Santa Cruz). In addition to being named a Fellow of the American Mathematical Society, Craig is a member of the American Academy of Arts and Sciences and a Fellow of the Society for Industrial and Applied Mathematics.

Updates from

The Undergraduate Program

During the academic year 2012-2013, the Mathematics Department awarded 72 undergraduate degrees. Of these, 58 were in Mathematics, 10 were in Applied Mathematics and 4 were in Mathematical and Scientific Computation.

In the 2013-2014 academic year that has just started, we have experienced another large increase in undergraduate admissions, enrolling 150 freshmen majors. The Department now has a total of 516 undergraduate majors in our three degree programs, the largest number ever.

The Department has a long-running and vigorous Research Experience for Undergraduates (REU) Program. This year 27 students participated in the Summer 2013 REU experience. They will present their research at the Undergraduate Research Conference later in the academic year.

No description of the Undergraduate Program would be complete without acknowledging the enthusiastic and highly effective work of our Vice-Chair for Undergraduate Affairs, Jesús De Loera. It is largely through his efforts that the numbers of majors and degree recipients have shown such robust growth; both numbers increased by 25% this year alone. This year Dr. De Loera's mentoring efforts and achievements were acknowledged by his receiving the 2013 Chancellor's Award for Excellence in Mentoring Undergraduate Research.

Two mathematics interest groups are focused on nurturing undergraduates. The Math Club meets weekly (Wednesdays 5-7pm in 1147 MSB). It provides a place where people with common interests in mathematics can meet, socialize and learn about a variety of topics in current mathematics research. Also, all mathematics students are welcome at the Math Cafe. Faculty and graduate student volunteers are available there to tutor any student in any course. Professor Monica Vazirani has worked hard to make this opportunity available to students. We are happy to report that it has been extremely successly.

You can join the friends of the UC Davis Math Department on Facebook at

https://www.facebook.com/DepartmentOfMathematicsUcDavis

We invite all math majors and other interested parties to joint our email list. This can be done at the Department website. This will provide announcements of forthcoming events and activities. All our majors also have the opportunity to have an email account in the Department.

http://www.math.ucdavis.edu/

Emeritus Focus

Thomas Sallee

Tom Sallee received his Ph.D. in 1966 from the University of Washington and joined the faculty of the UC Davis Mathematics Department immediately thereafter, primarily to work with Don Chakerian. He spent his entire career at UC Davis, retiring in 2009.

His mathematical research interests focus on convex geometry, an area in which he made numerous contributions over his career. He has solved a number of problems with elementary statements involving common geometric objects and constructions, such as Reuleaux triangles, Euler characteristic and convex bodies.

Professor Sallee has devoted considerable effort over the years to improving mathematics education, first working with the Northern California Mathematics Project and, in 1989, founding the College Prep Math Project (CPM) with Elaine Kasimatis (now at CSUS) and Judy Kysh (now at CSUSF). This program writes and publishes the CPM books for grades 6 through calculus that now are used by approximately 650,000 students across the U.S. and in various foreign countries. In recognition of these efforts, Tom was made a Fellow of the International Society for Design and Development in Education in 2011.

He still enjoys creating problems at all levels, especially those with surprising answers. Two of his current favorites are presented here:

1. How big is the number 4^(4^(4^4)))? If you write out its digits in numerals one centimeter in width, how far will they stretch? Across Davis? Across the U.S.? Across the solar system? Across the galaxy?

2. On a rainy day, 64 people hand their umbrellas to a clerk who puts each of them in an 8x8 square umbrella stand with spaces numbered from A1 to H8, and each person is given the appropriate ticket. Late in the morning, when the clerk is not present, a man rushes out to catch a plane and grabs an umbrella at random out of the stand. Later, when each departing person hands in their ticket, the clerk gives them their correct umbrella when possible; otherwise, he takes an umbrella at random and hands it to the person. What is the probability that the last person gets their correct umbrella?

For the solutions, see page 15.

Relativistic Shock Waves

by Blake Temple

Above: Image Copyright Angus Lau, Y Van, SS Tong (Jade Scope Observatory). Reproduced with permission.

Above: Blake Temple (left) with Moritz Reintjes (right). Below: Planetary Nebula NGC 2392. Copyright NASA.

The starting assumption of General Relativity is that spacetime is locally flat in the sense that at each event (i.e. point in spacetime) there are locally inertial coordinate systems in which the gravitational metric is Minkowskian, and its first derivatives vanish at the center. The failure of the second derivatives to vanish at the center is described by the Riemann curvature tensor, which represents the gravitational field.

Recent work of Blake Temple and former UC Davis student Moritz Reintjes has demonstrated that, in a perfect fluid, the gravitational metric is in fact not locally flat at points of shock wave collision. Instead, a new kind of singularity forms, which they have named a regularity singularity. At these points the first derivatives of the metric cannot be made to vanish at the center in any coordinate system. But Temple and Reintjes have shown that, even though the second derivatives of the metric contain delta function source terms in every coordinate system, these delta functions cancel out in the Riemann curvature tensor. Since it is generally assumed that all physical effects of the gravitational field arise from the curvature of spacetime, one may ask whether there are observable physical effects resulting from the failure of locally inertial frames at Regularity Singularities.

In recent work, Temple and Reintjes express the linearized Einstein equations describing gravity waves in an arbitrary coordinate system as a second order wave equation together with first order terms whose coefficients arise from nonzero first order derivatives of the background spacetime metric. These first order terms would vanish in any locally inertial coordinate frame if one existed. These terms give rise to effects analogous to Coriolis forces, fictitious forces that could be removed by transformation to locally inertial coordinates, if this can be done. But at the regularity singularities caused by colliding shock waves there are no locally inertial frames. So these Coriolis-type terms cannot be made to vanish in any coordinate system in their neighborhood. In fact, they are the dominant terms in the high frequency scattering of gravity waves, and therefore their effects in principle will be measureable by every local observer. This would be a new physical effect of the gravitational field that is not due to its curvature alone, but rather due to the essential lack of regularity in the underlying spacetime geometry.

Since shock wave collision in a perfect fluid can evolve generically from smooth initial data describing a sufficiently strong expansion, (like an explosion), inside a sufficiently strong contraction, (like a collapsing star), authors suggest that regularity singularities are worth exploring as a possibly significant physical effect for gravitational wave detection, perhaps by the LIGO gravity wave sensors currently under development. In any event, as far as we know, this is the first demonstration that the scattering of gravity waves can be localized by the dynamics of a perfect fluid to create first order effects.

A Mathematician's Road to Davis: A Personal Reminiscence

by Albert Schwarz

When I graduated from high school in 1951, I already knew some mathematics—calculus, and Lobachevsky geometry. So in my freshman year at the Ivanovo Pedagogical Institute, I was able to study topology. During my undergraduate years I wrote seven papers in this field. I proved that the volume invariant (a concept introduced by my adviser, V.A. Efremovitch) of a universal covering can be expressed in terms of the fundamental group of the original manifold. I also gave estimates for volume invariants of manifolds with non-positive and with negative curvature, results that were rediscovered by John Milnor thirteen years later. This work eventually gave rise to the new field of geometric group theory.

In 1955 I entered graduate school at Moscow University in the best Mathematics Department in Russia. I was very lucky; that was the best year for a Jew to enter the University. The discrimination of Stalin's time was abolished, and the new period of discrimination started later. My adviser, P. S. Alexandrov, gave me complete freedom to work independently, so my years in graduate school were quite productive. I published eight more papers, mostly in topology. In 1958 I defended my Candidate of Sciences (= Ph.D.) dissertation.

After graduation I accepted a position at Voronezh University. There I worked on the genus of fiber spaces, which would become the subject of my Doctoral dissertation. I also determined the topologies of several classes of operators and worked on other topological questions arising in functional analysis. Later, some of these results were replicated by Atiyah and by Smale. I also worked in category theory.

I received my Doctor of Sciences (> Ph.D.) degree from Moscow University in 1960. During the week I spent in Moscow after my dissertation defense, I met my future wife, Lucy Kissina, whom I married several months later. My wife was born in Moscow and did not want to leave her city, so I started to look for a job there. In 1964, at the age of 30, I was offered a position as Professor of Theoretical Physics at the Moscow Engineering Physics Institute.

I had been interested in physics for a long time, so the chance to work with physicists was very exciting to me. At the time the intensive and fruitful interaction between mathematics and theoretical physics had only just begun. A handful of Russian mathematicians, myself among them, started to study theoretical physics seriously, and to identify and work on related mathematical problems. My initial focus was on quantum field theory. The discovery in the 1970s that soliton solutions of classical equations of motion are related to quantum particles, and that topological considerations can be used to guarantee their stability, brought topology into this discipline. I worked to investigate topological integrals of motions and topologically non-trivial solutions. Gauge instantons (topologically non-trivial solutions of the equations of motion of Euclidean gauge theory) were demonstrated and first investigated in a joint paper with Belavin, Polyapkov and Tyupkin. These became very useful in quantum field theory. My research was interesting both to physicists, as it provided powerful new analytic tools, and to mathematicians, who discovered a rich source of exciting mathematical problems.

I was even happier in 1978 when I found a way to use ideas from physics in topology. I realized action functionals that do not depend explicitly on a metric should give rise to topological invariants. This idea led to the concept of topological quantum field theory, which became important in both physics and mathematics. It opened the way for applications of the methods of theoretical physics to topology, algebraic geometry, symplectic geometry and other branches of mathematics.

Over the years I had received many invitations from the West; previously I was not able to accept any of them. But Gorbachev's *perestroika* brought new freedoms and exciting possibilities. In 1989 I was able to spend six weeks at the International Center for Theoretical Physics in Trieste and to participate in their Supermembrane Conference. On July 17, 1989 my wife and I left the Soviet Union forever.

I spent the 1989-90 academic year visiting the Institute for Advanced Study at Princeton, Harvard and MIT. In 1990 I accepted a faculty position in the Department of Mathematics at UC Davis.

This article was adapted from Dr. Schwarz's autobiography, which is available at http://www.math.ucdavis.edu/~schwarz/bion.pdf

Research Highlight

Sam Walcott

Sam Walcott joined the Department in 2011 after earning a Ph.D. in theoretical and applied mechanics from Cornell University and doing postdocs in experimental and theoretical biophysics at the University of Vermont and Johns Hopkins. His research develops models that predict large-scale biological phenomena from single molecule mechanics. One important focus of his work is muscle mechanics.

The muscle contractions that underlie the heartbeat and other physiological processes involve ratchet-like interactions between myosin molecules and actin molecules. When myosin binds to the actin filament, it undergoes a conformational change that moves the filament. As it unbinds, this conformational change is reversed, making the myosin ready to rebind and ratchet again. When this cyclic process occurs at many molecules within a muscle cell, it causes that cell to contract.

Single myosin molecules can be isolated and their interactions with single actin filaments observed. In this way the rates of their reactions, the size of myosin's conformational change, and the mechanical properties of myosin and actin have all been measured. Recent experiments have shown that myosin's mechanics and chemistry are coupled through a chemical reaction whose rate depends on force. If myosin experiences a force resisting its conformation change, the reaction occurs more slowly than if myosin experiences an assistive force.

While these experiments define the actions of single molecules, groups of molecules working together behave differently. Sam's research addresses this problem. He uses mathematics to relate the behavior of single proteins to their functions in groups. In collaboration with experimentalists, he develops and tests models that make predictions at successively larger size scales.

In a recent paper, for example, he incorporated measurements of single myosin molecules into computer simulations to predict their collective, group behavior. Interestingly, these simulations and the corresponding experiments both find that myosin molecules working together move actin faster than one myosin working alone. The mathematical analysis shows why: Myosin molecules working together apply forces on each other. These increase their detachment rates from actin, which in turn increases the muscle contraction speed. This work shows how problems affecting myosin molecule interactions can lead to disease, insight single molecule measurements cannot provide.

This picture becomes more complex when one considers the other proteins that regulate myosin binding. These proteins make the binding of myosin to actin cooperative; one binding event facilitates the binding of other nearby myosin molecules. If two nearby myosins bind to actin, they accelerate the binding of additional myosins more than they would if they were far apart. Recently, Sam has derived the first differential equation model of myosin binding that includes cooperative myosin groups and shown it to accurately and efficiently reproduce experimental measurements.

Sam's long term goal is to develop a series of mathematical models describing muscle contraction that extend from single molecules to the complete organ. This work has the potential to transform our understanding of muscle contraction. His present work is laying the groundwork for a full, quantitative understanding of heart muscle contractions in particular. His research will illuminate both normal heart function and the molecular bases of several cardiac diseases and has the potential to lead to new medical treatments.

Mathematics for the Future

The Department of Mathematics wishes to thank all alumni, parents, students, faculty, staff and friends who support the Department each year. For a list of our endowed funds, please see our web site:

http://www.math.ucdavis.edu/about/donation/

Your gift to the Department is tax deductible, and you can choose to have your name published or remain anonymous.

Your gift can be used towards undergraduate and graduate support, faculty and research support, and/or Departmental priorities. Your gifts ensure our future success.

Give Online

If you would like to give, please go to the UC Davis secured giving site at:

http://giving.ucdavis.edu/DeptMath/General

Please choose "Mathematics General Support" for the gift designation and follow the prompts.

A list of donors can be found on the back cover of this newsletter. Thank you for your continuing support.

We appreciate the many donors who double or triple the impact of their gifts through their employers' matching gift program. For more information about matching gifts, you can go to:

http://matchinggifts.com/ucdavis/

For additional questions please contact the Development Office at (530) 752-3429.

Alumni Update

Carol Adjemian

M.A., 1967

After receiving her degree in Mathematics from UC Davis, Carol worked as an applied mathematician at Cornell Aeronautical Laboratory in Buffalo, NY, and at Xonics in Van Nuys, CA. She completed her Ph.D. in Applied Mathematics at UCLA in 1981. She became a professor at Seaver College of Pepperdine University beginning in 1980 and retired in 2012. In that time she has served two terms as the president of the Seaver faculty. She also was honored as a Luckman Distinguished Teaching Fellow of Pepperdine University. She has served terms as vice president, president and governor of the Southern California section of the MAA.

Robert E. Mrak

B.S., 1970

After receiving his B.S. in Mathematics, Robert switched to medicine. He received his M.D. at UC Davis in 1976.

Moving to Tennessee, Robert completed his residency and a postdoc at Vanderbilt University, ultimately joining their faculty in 1980, specializing in Pathology. In 1984, he joined the University of Arkansas for Medical Services. Since 2007, he has been faculty at the University of Toledo, College of Medicine, in Ohio. He's presently Chairman of Pathology.

Robert's research has focused on the cellular and molecular pathophysiology of Alzheimer disease. He believes that the analytical skills honed in mathematics at UC Davis have served well throughout his academic career. In 2009 his son, Eric, graduated from UC Davis with a B.S. in Computer Science.

Linda W. Hildreth

B.S., 1970 and M.A., 1971

After graduating with her Masters from UC Davis, Linda because a part-time teacher at Brigham Young University for a short time before moving on to Prudential Insurance for two years. In 1977, she began a programming career at Hughes Aircraft for twelve years. In 1990, she moved to Kaiser Permanente as a medical records clerk.

Linda is now married and retired. After enjoying math and science in her youth, she's now studying sociology, from marriage and family to gender in society.

Looking back at her time in Mathematics, she remembers her classes with Professor Milton.

Updates from
The Graduate Programs

by Thomas Strohmer, Graduate Program Chair and Albert Fannjiang, Acting GGAM Chair

This year the Graduate Program in Mathematics welcomes 18 new graduate students. They were selected from about 200 applicants, which is one of the largest applicant pools the Program has ever had.

Our graduate students were again quite successful in earning awards and fellowships. Wenjing Liao was awarded the 2013 Outstanding Graduate Student Teaching Award. This award, which is co-sponsored by the Graduate Council and the Office of Graduate Studies, recognizes excellence in teaching by graduate students on the UC Davis campus. Charlie Brummitt received the Alice Leung Scholarship in Mathematics. Tim Wertz was the recipient of the William K. Schwarze Scholarship. Joohee Hong received the Henry Alder Prize for excellence in teaching. Joseph Grimm won the University's Dissertation Year Fellowship.

The fourth installment of the Annual Davis Math Conference took place on October 10, 2013. The conference aims to present the current research conducted in the Department to graduate students and faculty. Organized by the graduate students under the auspices of the Galois Group, it showcased research by faculty and students from both the GPM and the GGAM graduate programs. The presentations covered a diverse range of topics including topology, random matrix theory and partial differential equations.

The quarterly Department Colloquia attracted large audiences. A highlight was the colloquium by Fields Medalist Shing-Tung Yau, which drew a standing-room-only audience. Dr. Yau's talk, entitled "String Theory and Geometry of the Universe's Hidden Dimension," was both very entertaining and highly informative.

The Graduate Group in Applied Mathematics welcomes nine new students into its program this year. This is one of the most selective cohorts of GGAM students in recent years.

In 2012 Steve Shkoller became the Chair of GGAM. Currently Albert Fannjiang is the Acting Chair while Steve is on leave at Oxford University. The group presently has 89 faculty from 22 Departments and 56 graduate students. currently enrolled in GGAM. This year we graduated nine students with Ph.D.'s, and eight with Master's degrees.

The eighth GGAM Mini-conference was held on January 26, 2013. This annual event brings the faculty and students of GGAM together in an informal forum to share research interests. This year's program was coordinated by Raisa D'Souza and Albert Fannjiang. Talks presented research on many topics, from optimization of power grids to cancer cells modeling, geo- and fluid- dynamics, ecology, coding and information theory. The Mini-conference provides students with a sense of the breadth of research opportunities available to them. As always, there were extensive informal discussions among the participants, which in the past have fostered productive collaborations.. More than 70 participants attended the dinner that followed the Mini-conference.

GGAM started a Distinguished Lecture Series last year. The inaugural speaker, Professor Tai-Ping Liu of Stanford, gave a series of three lectures on gas dynamics and kinetic theory. Professor George Papanicolaou of Stanford has accepted our invitation to give the second set of lectures in this series, on financial mathematics.

GGAM also started the GGAM Colloquium as a forum for GGAM members to present their research. The Colloquium normally is held monthly on a Friday, with a reception to follow.

Congratulations to GGAM faculty member Alan Hastings of Environmental Science and Policy for becoming a SIAM Fellow and to Brandon Dutra for winning an NSF graduate research fellowship.

2012 - 2013
Graduate Degree Recipients

Jeffrey Anderson, Ph.D., Math : Lecturer, Foothill College, "The Structure Exploiting Arnoldi Algorithm for Model Order Reduction of General Higher-Order Linear Dynamical Systems," Prof. Freund

Emi Arima, Ph.D., Math : Adjunct Professor, Prof. Thompson

Carlos Barrera-Rodriguez, Ph.D., Math : "A Collection of Multicurve Complexes," Prof. Hass

Adam Dobrin, Ph.D., Applied : "Exploring the Effects of Enforced Proximity in Enzyme Reaction Kinetics," Prof. Benham

Robert Hildebrand, Ph.D., Applied : Postdoctoral Researcher, Eidgenssische Technishe Hochschule (ETH) Zurich, "Algorithms and Cutting Planes for Mixed Integer Programs," Prof. Koeppe

Jason Hole, Ph.D., Math : "Well-posedness of the free-boundary Compressible 3-D Euler equations with surface tension and the zero surface tension," Prof. Shkoller

Joohee Hong, Ph.D., Applied : Lecturer, University of California, Davis, "Minimal Realization for Descriptor Systems: Applications to RCL Circuits," Prof. Freund

Yvonne Kemper, Ph.D., Math : Postdoctoral Researcher, National Institute of Standards and Technology, "Problems of Enumeration and Realizability on Matroids, Simplical Complexes, and Graphs," Prof. De Loera

Wenjing Liao, Ph.D., Applied : Postdoctoral Researcher, Statistical and Applied Mathematical Sciences Institute (SAMSI), jointly with Duke University, "Grid-Independent Compressive Imaging and Fourier Phase Retrieval," Prof. Fannjiang

Haoyang Liu, Ph.D., Applied : Continuing Ph.D. in Real Estate & Urban Economics, University of California, Berkeley, "Spectral Analysis of High Dimensional Time Series," Prof. Aue

Paul Mach, Ph.D., Applied : Software Engineer, Strava Inc., "Protein Sequence Design for Fold Recognition Using a New Quantification of Protein Geometry," Prof. Koehl

Nicholas Travers, Ph.D., Applied : Postdoctoral Researcher, Technion-Israel Institute of Technology, "Bounds on Convergence of Entropy Rate Approximations in Hidden Markov Processes," Prof. Crutchfield

Ernest Woei, Ph.D., Applied : "Characterization and Clustering of Dendritic Trees Using Morphological Features Extracted by Graph Spectra," Prof. Saito

Jing Xia, Ph.D., Applied : Research Analyst, Ebay, "Finding Disease Associated Genes from Microarray Data," Prof. Rocke

Jiawei (Calvin) Zhang, Ph.D., Applied : Assistant Professor/Courant Instructor, NYU: Courant Institute, "Limb Coordination in Crustacean Swimming: The Underlying Neural Mechanisms and Fluid Dynamics," Prof. Lewis

Robert Beck, M.A., Math : Prof. Koeppe
Jeff Bronson, M.S., Applied : Prof. Saito
Thomas Brounstein, M.A., Math : Prof. De Loera : Research Analyst, Sandia National Labs
Brandon Crain, M.S., Applied : Prof. Koeppe : Teaching Credential, UC Davis
Alicia Fiebig, M.S., Applied : Prof. Kellogg
Katrina Glaeser, M.A., Math : Prof. Morris
Omar Hafez, M.S., Applied : Prof. Saito
Ryan Halabi, M.S., Applied : Prof. Hunter
Jizhou Huang, M.S., Applied : Prof. Saito
Mark Junod, M.A., Math : Prof. De Loera
Bailey Meeker, M.S., Applied : Prof. Schreiber
Nathaniel Merrill, M.S., Applied
Benoit Richard, M.A., Math : Prof. Strohmer
Douglas Unger, M.A., Math : Prof. Xia

Alumni Update

Ezra Alicia Antonio Gonzales

B.A., 1996

After earning her degree at UC Davis, Ezra was awarded a Rackham Merit Fellowship to attend the University of Michigan, Ann Arbor. She earned her Masters in Education in 1997 and got a teaching credential in math and general science.

Ezra has been teaching high school mathematics for over 17 years in Michigan, California, and now in Florida. Throughout that time she's been writing and consulting for the Test Development Department at ACT, Inc.

Ezra credits her time at UC Davis for preparing her for the demands of graduate school, as well as her work with students in her own classroom.

She especially appreciates the late Professors Henry Alder and Evelyn Silva for the love of their craft and mathematics, which was evident in the classes they taught. Her experiences with them as a student helped her with interactions with her own students. She will forever be grateful for their inspiration.

Karen J. Thomason

B.S., 1981

Karen received her B.S. in 1981 and continued on her Masters in Math until 1982. She still has friends from her time in Math that she regularly contacts. Life as a mathematics major was great!

In 1982, she was admitted to the School of Veterinary Medicine here at UC Davis, a fact she attributes largely to her degree in Mathematics singling her out.

She now owns Blue Ridge Veterinary Hospital, a small animal hospital in rural Virginia.

She had the pleasure of learning from Drs. Alder, Mead, Chakerian and Sallee among others, and she'll never forget the outstanding education she got being a Mathematics major!

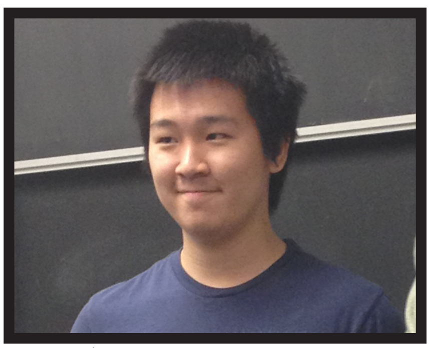
Are You a Graduate?

We want to hear from you! Please send us information about yourself so that we can stay in touch and share in your experiences outside of UC Davis.

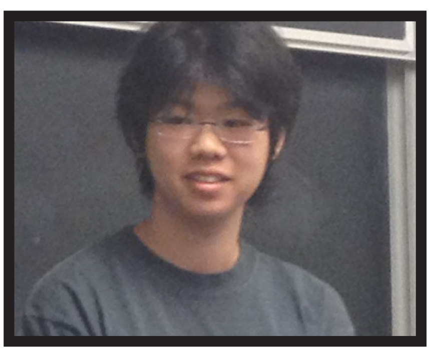
Please complete our Alumni Questionnaire:
http://www.math.ucdavis.edu/news/alumni_quest
or send e-mail to:
mso@math.ucdavis.edu
We will do our best to include it in the next newsletter.

Chun Yu Hong

Tim Wertz



Ruian Chen



Virgil Chan

Amitabh Basu with Prof. Emeritus Sallee

2012-2013 Department Awards Recipients

Eric C. Ruliffson Scholarship in Mathematics

Eric Canady Ruliffson attended UC Davis from 1964-1968, loved the study of math and excelled in it. He was first and foremost a problem solver, which helped him to achieve life-long personal and professional success. While attending UC Davis, Eric worked as a summer intern in the actuarial department of Pacific Mutual Insurance in Los Angeles and was hired by them upon graduation. After serving in the Navy, Eric attended graduate school in demography at UC Berkeley. In 1973 he resumed his actuarial career at Pacific Mutual Insurance. He became a partner at the San Francisco office of Coopers & Lybrand and named a Fellow in the Society of Actuaries. He was subsequently elected to the Board of Partners for Coopers and Lybrand, the first actuary to be so honored, and later served on the Board of Partners for PricewaterhouseCoopers, the world's largest consulting firm. The Eric C. Ruliffson Scholarship in Mathematics is awarded annually to students of junior or senior standing majoring in mathematics.

Recipient – Chun Yu Hong

William K. Schwarze Scholarship in Mathematics

William Karl Schwarze was born in 1942 in San Francisco. He excelled in mathematics in high school and at UC Davis, where he received a bachelor's degree. He went on to graduate school at Berkeley and a career as a mathematics teacher in San Francisco. Perhaps due to his mathematical insights, Bill also became a successful investor in real estate. After his death in 1988, a trust he established with the SF Foundation has donated to a variety of humanitarian purposes, in particular to the Schwarze Scholarship to be presented today. This award is given to graduate students in Mathematics who have demonstrated outstanding mathematical scholarship and exceptional promise of making a strong professional contribution as a mathematics teacher and educator at the pre-college or college level.

Recipient – Tim Wertz

Robert Lewis Wasser Memorial Scholarship

Robert Lewis Wasser was born in 1973 in Sacramento. He excelled in many areas—he was selected as a National Merit Scholar in 1991 and participated in the Academic Decathlon. Robert began at UC Davis in 1991. His academic achievements were numerous and impressive. He was one of the few students in our Department who had already taken as a sophomore some of our most challenging courses, such as Math 127. His instructor in that course, Professor Don Chakerian, said how much he was inspired by their discussions and that Robert's presence made the whole class much more lively and spirited. After his tragic death in an automobile accident in 1993, prior to his Junior year, his grandmother, Vera May Wasser, initiated the Robert Lewis Wasser Endowment in his memory, with contributions from family and friends. Its goal is to benefit promising mathematics students at UC Davis.

Recipient – Ruian Chen

Alice Leung Scholarship in Mathematics

Alice Siu-Fun Leung received a Master's degree in Mathematics in 1975 from UC Davis. She later worked as a global property management accountant in Hong Kong. She remembered with fondness her days at UC Davis. She enjoyed gardening and working as a volunteer helping animals.

In her will, Ms. Leung generously provided funding to award scholarships annually to graduate students in Mathematics. This award is given to students who have shown exceptional promise in all aspects of mathematics, including research, scholarship and teaching.

Recipient – Charlie Brummitt

G. Thomas Sallee Mathematics Teaching Award

The G. Thomas Sallee Mathematics Teaching Award honors Professor Emeritus Tom Sallee's 40-year career with the Department, his dedication to being an excellent teacher, and his life goal of developing and supporting talented mathematics educators.

An endowment was established in his name that allows the Department to recognize the best teaching of lower-division mathematics courses on an annual basis.

Recipient – Amitabh Basu

G. Thomas Sallee Mathematics Prize

This award is also given in recognition of Professor Emeritus Tom Sallee, and reaffirms his life goal of developing and supporting talented individuals in mathematics. This prize recognizes exceptional undergraduate students of junior or senior standing who competed in this year's Spring Mathematics Competition.

Recipient – Kyumin Kim

Henry L. Alder Award

Professor Henry L. Alder received his Ph.D. from UC Berkeley in 1947. After spending a year on the faculty in the Department of Mathematics at Berkeley, he joined the Davis faculty as an Instructor of Mathematics. He advanced to the rank of Professor in 1965, and officially retired in 1992. He then served as Department Chair from 1992 to 1994. After his retirement, Professor Alder continued to teach in the Department for many years.

Professor Alder was also active in other campus programs and was always a strong advocate for quality teaching. In 1999, Professor Alder gave a gift to the UC Davis Foundation to establish an endowment. This provides support to mathematics graduate students at UC Davis through the Henry L. Alder Prize for Excellence in Teaching, an award given each year to the graduate student who is deemed to be the top teacher among all graduate students in mathematics.

Recipient – Joohee Hong

Evelyn M. Silvia Scholarship for Future Mathematics Teachers

The Evelyn M. Silvia Scholarship for Future Mathematics Teachers was established by generous donations from family and friends of the late Professor Evelyn Silvia. Evelyn was hired by the Department in 1973 after receiving her Ph.D. from Clark University. The focus of Evelyn's passion and unwavering commitment was to develop talented mathematics teachers at the K-12 grade level. She was extremely generous with her time, whether it was as a campus committee member or as an adviser assisting students.

This scholarship honors Professor Silvia's memory by encouraging students who aspire to be future mathematics teachers. It recognizes a junior or senior with a major in mathematics, applied mathematics or statistics who has shown an interest in teaching mathematics.

Recipient – Lea Riedel

Yueh-Jing Lin Scholarship in Mathematics

Yueh-Jing (Jean) Lin and Chau-Hsiung (Mike) Chuang created the Yueh-Jing Lin Fund in 2009. This endowment provides scholarship support to one or more mathematics students each year. The scholarships are available to high-achieving mathematics students, either undergraduate or graduate. Mr. and Mrs. Chuang are alumni of UC Davis who met while they were graduate students on campus. Jean received her Master's degree in mathematics in 1971, and Mike received his master's degree in agricultural education in 1969.

Recipient – Melody Molander

Galois Group Service Award

The Galois Group is "the official voice of the graduate students in Mathematics." All graduate students in the Department of Mathematics are members of Galois; this is how graduate students in mathematics collectively communicate with Department faculty and staff. The group also coordinates and facilitates various activities, such as Monthly Game Nights and New Student Welcomes.

Every year, the Galois Group presents an award to recognize outstanding service and/or sustained commitment to the graduate group.

Recipient – Perry Gee

Departmental Citation Awards

These citations recognize undergraduate students of exceptional ability who have taken a very strong selection of mathematics courses and distinguished themselves with exceptionally high grade point averages. In addition, they have all received strong recommendations from the faculty.

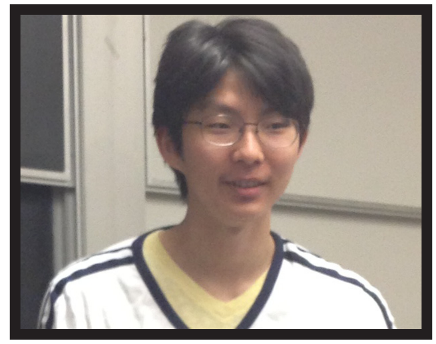
Recipients – Mincheng Zhou, Aaron Higgens, Brian Busemeyer, Kaitlyn Kortright, Devin Platt, Natalie Telis, Ran Xie

Departmental Honors Awards

Every year, undergraduate students have the opportunity to participate in mathematical research, culminating in a senior thesis. Students typically work under the guidance of a faculty mentor to complete original research. The results are reviewed, and pending on the quality and substance, the student can receive Departmental high or highest honors.

Recipients of Highest Honors –

Mincheng Zhou, Virgil Chan



Kyumin Kim

Lea Riedel

Melody Molander

Joohee Hong

Department Awards Recipients

Notable Awards

Abigail Thompson was featured on the California State Library website honoring "California women trailblazers in science, technology, engineering and mathematics."

Sam Walcott has been awarded a 2013-14 UC Davis Hellman Fellowship. This Fellows Program was created by the Hellman Family Foundation to promote the scholarly growth of faculty members at the Assistant Professor rank who exhibit the potential for great academic distinction.

The 2013 Chancellor's Award for Excellence in Mentoring Undergraduate Research has been awarded to Professor **Jesús de Loera**. He shares the prize with Mani Tripathi of Physics.

Wenjing Liao has been selected to receive a 2013 Outstanding Graduate Student Teaching Award. This award, which is co-sponsored by the Graduate Council and the Office of Graduate Studies, recognizes excellence in teaching by graduate students on the UC Davis campus.

Brandon Dutra, a graduate student in the Graduate Group in Applied Mathematics, has been awarded a highly competitive National Science Foundation Graduate Research Fellowship. Brandon's award, in the area of Algebra, Number Theory and Combinatorics, was one of five awarded in mathematics at a UC campus.

Former Krener Assistant Professor **Ian Agol** has been awarded the Oswald Veblen Prize in Geometry. The American Mathematical Society awards the Veblen Prize every three years in recognition of a notable research memoir in geometry or topology that was published in the preceding six years. The 2013 Veblen Prize was awarded to Ian Agol for his many fundamental contributions to hyperbolic geometry, 3-manifold topology and geometric group theory. Now a professor at UC Berkeley, Ian came to UC Davis following his Ph.D. at UCSD in 1998 to work with UC Davis professors Joel Hass and Bill Thurston.

Life After Davis

Allison O'Hair
B.S., 2009

After graduating from UC Davis in 2009 with a degree in Mathematics, I moved to Cambridge, Massachusetts, to start a Ph.D. at MIT. I'm currently a 4th year Ph.D. candidate in the Operations Research Center, working with Professor Dimitris Bertsimas.

My research is focused on applications of optimization and analytics. My thesis work is in health care, using optimization to improve personalized health management for diabetes. I also have done work on learning preferences, predictive policing and optimizing clinical trials for cancer.

As a graduate student, I assist in teaching, and work with an amazing group of colleagues. I have traveled to several interesting conferences in my research area. I am planning to defend my thesis this summer and will then pursue my work in healthcare analytics.

I am grateful for all of the experiences and opportunities I had at UC Davis, and especially to my undergraduate research mentor, Jesús De Loera, who encouraged me to pursue graduate studies in Operations Research.

Stephen E. Erfle
B.S., 1977

Stephen E. Erfle began his career as a managerial economist during a 1994-1995 sabbatical at Seagram Classics Wine Company. During those 14 months, he maintained offices at Sterling Vineyards and at Mumm Cuvée Napa where the finance and marketing departments of SCWC resided. Trained as a microeconomic theorist, he began to use his economist's toolkit to analyze concrete business questions such as, Should Mumm raise the price of Brut Prestige a dollar a bottle? Or, when does it make sense to have another tasting room associate on the floor in Sterling's tasting room?

Upon returning to Dickinson College, he decided to refocus his teaching in a more applied direction. He helped found the International Business and Management department and major during the late 1990s. One of the core courses in that major is his course, Managerial Economics. This course, which uses Excel as a teaching platform, is modeled after what he did during his SCWC sabbatical. In the past fifteen years he has taught more than a thousand undergraduates how to build economic models in order to do comparative statics analysis and how to do regression modeling in Excel.

He received a B.S. in mathematics and B.A. in economics from the University of California, Davis, and a master's and Ph.D. in economics from Harvard University. He has also taught in the Economics Department at Dickinson College and in the School of Social Sciences at the University of California, Irvine. He is also involved in wine education and has taught wine tasting classes and conducted wine tastings since his graduate school days as the resident economics and wine tutor for Harvard's Leverett House.

From front-piece of Keat, Young, and Erfle, Managerial Economics, 7th edition, Prentice Hall, 2013.
Photos by Carl Socolow '77.

Staff News

Welcoming Opportunities for Growth

by Gladis Lopez

I am very pleased to share the news that our administrative office is now fully staffed. Thank you for your patience during the time we had limited staff and were trying to wear multiple hats. We strive to provide excellent customer service to all our Department members and affiliates.

This year, we hired two new Student Advising Officers: Sarah Driver (Graduate) and Letia Groening (Undergraduate).

Our previous student adviser, Perry Gee, transferred to Chemistry. Tina Denena is now our Analyst-Supervisor and, among other duties, she has taken on some of the duties that Carol Crabill used to handle. Carol retired last December to spend more time with her daughter. We wish Carol and Perry the best!

We have experienced growth in our student enrollments, and our administrative staff welcomes the opportunity to embrace this growth.

I am happy to share with you that Marianne Waage is pregnant, and her due date is in January 2014. We are very excited for her and wish her well.

We look forward to another productive year!

Join us on Facebook!

The Department of Mathematics is on Facebook! Visit us there to get updates on current seminars, events and news. We'd be happy to include any memories or photos you have of the Department on our wall.

To "like" us, search for "Department of Mathematics - UC Davis" on the Facebook web page:

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http://www.math.ucdavis.edu/research/news/archive/

Solutions to Sallee's Puzzlers

Continued from page 6.

1. If z = positive integer, the number of digits needed to write z in base a is $\log_a(z)$. So the number of digits needed to write 4^(4^(4^(4))) in base 10 is (4^{256}) $\log_{10}(4)$ = 8×10^{153}. The number of subatomic particles (protons and neutrons) in the universe is estimated to be 10^{80}. So if you wrote one digit of this number on each subatomic particle in the universe, it would require all the particles in 8×10^{73} universes to do the job. It turns out that 4^(4^(4^(4))) is an extremely large number.

2. There is 1/64 chance that the first man to leave got the right umbrella, in which case everyone else also will get their right umbrellas. There is a 1/64 chance that the first man took the last man's umbrella, in which case the last man is certain not to get his right umbrella. Otherwise, without loss of generality, assume the first man's umbrella was in F3, that he took A1, and that the very last person to come will want H8. There is one orphaned umbrella (F3) whose owner is no longer in the museum, and one person in the museum whose umbrella is not in the rack. This situation does not change until that person departs, when they will be given an umbrella at random. If she is given F3, then all subsequent people will get their right umbrellas. If she is given H8, then the last person to exit will not get their right umbrella. These two events are equally likely. If the umbrella they are given is neither F3 nor H8, then the situation continues, iterating the same condition as before. So at each stage it is equally likely that the chain of wrong umbrellas will end either way.

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