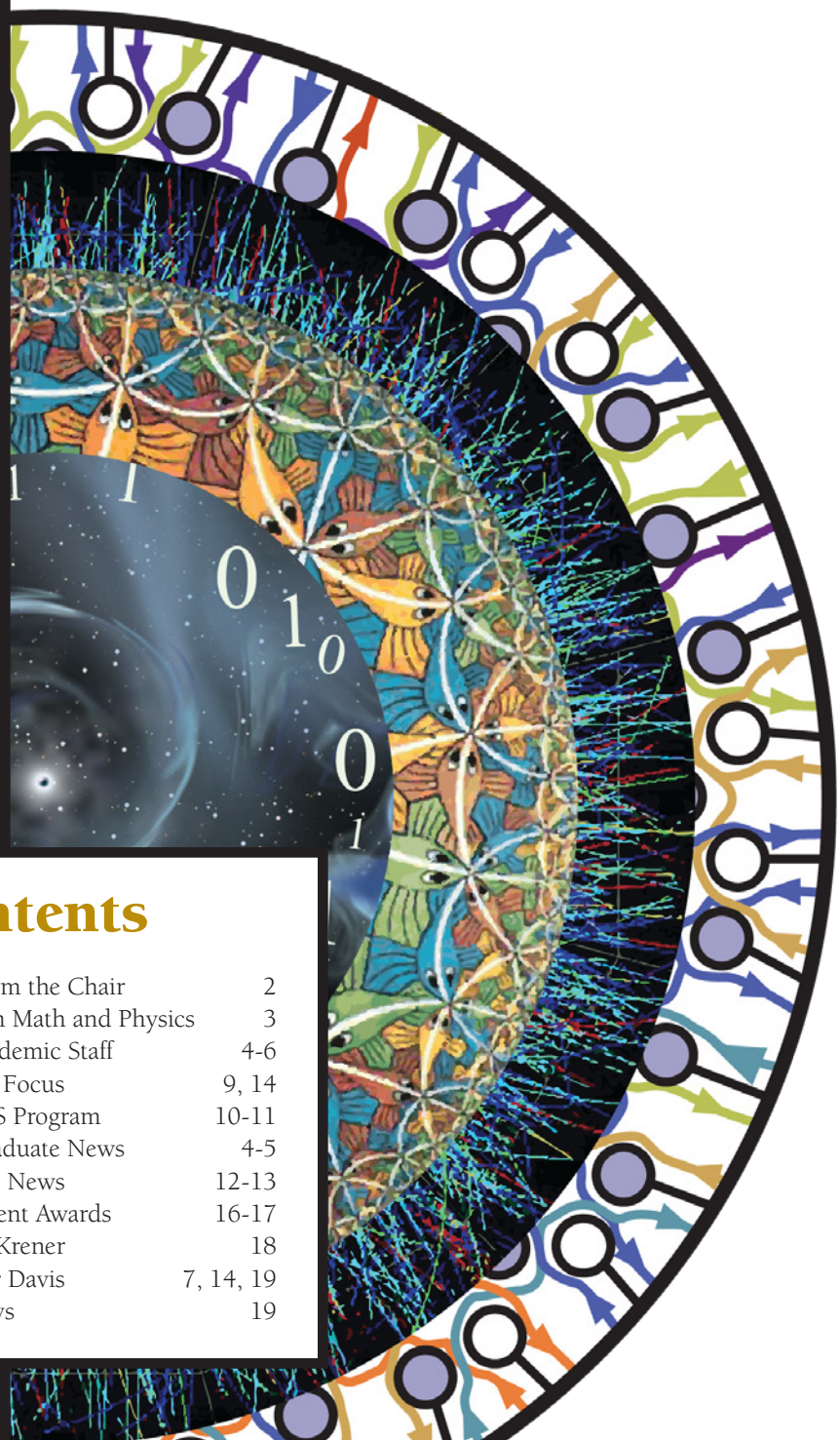
UCDAVIS

MATHEMATICS NEWSLETTER



Contents

Letter from the Chair

by Dan Romik

In a column in the New York Times published earlier this year and titled *Are You Smarter than an 8th Grader?*, columnist Nicholas Kristof tests the reader's knowledge of algebra and other simple mathematical concepts. The questions he lists are taken from TIMSS, an international study assessing the knowledge and problem-solving abilities of students from countries around the world. Kristof notes (which of course was the real point of the article) that American students ranked rather poorly in this survey; for example, one of the questions he cites was answered correctly by 37% of U.S. eighth-graders, compared to, for example, 47% of students from Ghana, 57% from Khazakhstan, and 78% from South Korea.

I was reminded of this recently when I ran across a discussion on an online forum[1] about the following question from a third-grade math exam:

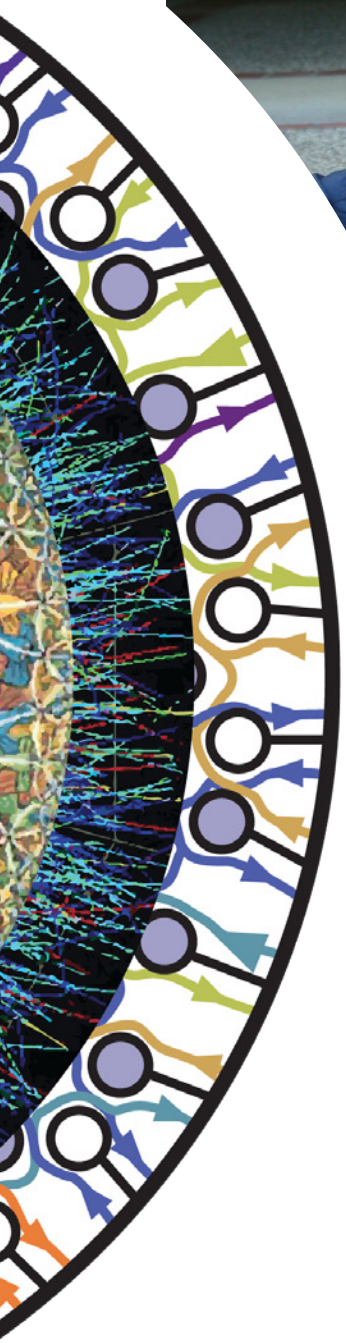
"It took Marie 10 minutes to saw a board into 2 pieces. If she works just as fast, how long will it take for her to saw another board into 3 pieces?"

Astonishingly, a photo of the exam notebook showed that the third-grader had answered the question correctly, only to have his answer marked down by the teacher, who incorrectly filled in "*Answer: 15*" and added the incorrect explanation: "*10=2 pieces, 15=3 pieces, 20=4 pieces.*"

While the problem of poor mathematics education in the United States is of course a vexing one, the best antidote to a bad education is a good education. We at the UC Davis Department of Mathematics are part of the solution, and spend much of our time and energy on fulfilling our core mission of teaching and training tomorrow's scientists, engineers, and citizens of all walks of life who will use the knowledge and thinking skills they acquired at UC Davis to improve our society's future as well as their own. We are very passionate about the work we do and proud of the contribution we make. In this newsletter you will read all about our latest activities, of which teaching is one important part, and the fantastic people who make them happen. I hope reading about our work will brighten your holiday season and inspire you, whether you are a student, alumnus, or current or former Department member, to make your own contribution. One way you can make it is with a small donation; see the insert in this newsletter for details.

1 See: http://math.stackexchange.com/questions/379927/a-simple-3rd-grade-problem-or-is-it

The Center for Quantum Mathematics and Physics



The disciplines of Physics and Mathematics are joined at the hip. Mathematics is filled with ideas and theories that were inspired by physics, while formulations of physical theories often require advanced mathematical tools. Riemann's geometry became the language of general relativity, while the developers of quantum mechanics required group representations to describe quantum symmetries.

In recognition of this tight connection, the UC Davis Departments of Physics and Mathematics together have embarked on the development of the Center for Quantum Mathematics and Physics (QMAP). The Center will foster research focused in four areas where mathematics and physics have particularly strong and productive overlaps in the study of the universe. These are: 1) Fields, Strings, and Gravity; 2) High Energy Physics; 3) Mathematical Physics, and 4) Theoretical Cosmology. One aim of the Center is to bring a coherent group of some of the best researchers in these areas to our campus, augmenting our existing strengths.

The new Center will have dedicated space in the Physics building. Its membership will draw from both the Mathematics and Physics faculties, as well as having postdoctoral fellows and graduate students. To date this initiative has hired five new faculty, two of whom have arrived. An official reception to open the QMAP Center took place on October 29, 2015. The Center's website is http://mukund.physics.ucdavis.edu/qmap

Updates from
The Undergraduate Program

by Tim Lewis, Undergraduate Program Chair

Photos by third year undergrad Filsun Jama

The Department awarded 90 undergraduate degrees this year, a 50% increase from last year! 56 students graduated in Mathematics, 28 in Applied Mathematics, and 6 in Mathematical and Scientific Computation. Seven of these graduates received citations for outstanding performance. In addition, Ruian Chen, Matthew Halbasch, Carter Johnson, Megan Liska and Gweneth McKinley graduated with high or highest honors. Furthermore, many of our graduating students went on to graduate school at prestigious institutions, including MIT, Princeton, and Harvard. Their achievements testify to the commitment and dedication of our majors.

We began the 2015-2016 academic year by welcoming the largest incoming class in the history of the Department of Mathematics. With this large influx, the total number of students in our four majors is now 664, which is an increase of almost 100 students from last year. 56 of these students are in our new Mathematical Analytics & Operations Research major, which will have its first graduate, Morgan Imel, at the end of the Fall quarter.

The Department places great importance on providing our students with a supportive and encouraging environment throughout their time with us. A variety of activities are designed to foster this atmosphere.

Two important mathematics interest groups are focused on undergraduates. The Math Club meets weekly (Wednesdays 5:30-7:30pm 1147 MSB). It provides a place where students with common interests in mathematics can meet and socialize, and learn about a variety of topics in current mathematics research. Also, all mathematics students are welcome at the Math Café, where faculty and graduate student volunteers are available to tutor any student in any course.

All of our students were invited to attend our Undergrad Welcome Event, which took place on October 9th. There we discussed the importance of students starting early to work with the staff and faculty advisers to plan their programs of study. We stressed that we are here to help all our students succeed. We described the multiple sources of support that are available when needed.

At the welcome event, we also introduced our students to several new resources:

- A weekly Math Undergraduate Newsletter will keep students informed of upcoming events and all the great resources offered through the Department and around campus, as well as provide reminders of important dates.
- A Math Department Online Suggestion Box whose purpose is to invite Math students to share their opinions and experiences regarding the Department or their major. This input will help us to evaluate our undergraduate programs and aid us in our improvement efforts. Visit

  http://tinyurl.com/ucdmathsuggest
- Group Advising Meetings. These meetings are low-pressure ways to meet faculty and learn about different math majors, degree requirements, and opportunities. Our goal is that every student who attends walks away with an academic plan that has been reviewed by a faculty member.

The Department of Mathematics continues to expand our course offerings and to hone our curriculum to enhance the experience of our undergraduate students and to attract more students to mathematics. Last year, a newly-established Advance Problem Solving course (the "new MAT 189") was taught by Professor Jesus De Loera. This will be a capstone course for all our undergraduate programs. To paraphrase Professor De Loera, "Students in the course do a quarter-long project that brings together several themes covered in the courses in their particular major. Students will be exposed to a role played by mathematicians in solving problems (not just doing homework sets!) and how mathematical thinking is translated into action. Students will also develop skills for communicating mathematics, both in writing and verbally, in formal and informal environments."

We continue our commitment to offer special topics courses for undergraduates (MAT 180). This year's special topics courses are The Mathematics of Theoretical Physics (Professor Andrew Waldron) in the fall quarter, The

Power of Analysis (Professor Kevin Luli) in the winter quarter, and Pursuit Games on Graphs (Dr. Erik Slivken) in the spring quarter.

We have increased the flexibility of the upper-division course requirements for all of our programs. The distinction between pure mathematics and applied mathematics is blurry and dynamic. Applied mathematics continually inspires new ("pure") mathematics, and traditionally pure math is increasingly being used in applied mathematics. More flexibility in enrichment courses will allow students to better follow their individual interests within their discipline.

Once again, the Department ran a vigorous Research Experience for Undergraduates (REU) program over the summer. Students worked on a variety of projects spanning pure and applied mathematics. Many of the students who participated in this Summer REU will present their research in the Undergraduate Research and Exploration seminar. Any student interested in getting involved in undergraduate research is encouraged to visit the following site for more information:
http://math.ucdavis.edu/undergrad/research

Undergraduate research is a great way to jump-start a mathematics career!

There are many opportunities available in the Department for enrichment of the undergraduate experience. Everyone is welcome; please join us!

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.

Incoming Academic Staff

New Faculty
Evgeny Gorsky

Evgeny completed his undergraduate and graduate studies at Moscow State University under the supervision of Sabir Gusein-Zade. He received his undergraduate degree (M.Sc.) in 2006, and his Ph.D. in 2009. Before coming to Davis, he held postdoctoral positions at Stony Brook University and at Columbia University.

Evgeny's research interests focus on the algebraic geometry of singular curves and surfaces, and their connections to low-dimensional topology and representation theory. In 2013 his research on knot homology was awarded the prize of the Moscow Mathematical Society. Albert Schwarz won this prize in 1960, and Alexander Soshnikov won it in 1999.

Outside of mathematics, Evgeny's interests include art and opera.

New Faculty
Adam Jacob

Adam Jacob grew up in Santa Barbara, CA. In 2007 he received a dual B.A. in Mathematics and Art Practice from UC Berkeley. He received his Ph.D. from Columbia University in 2012 under the direction of D.H. Phong, where he learned the key importance of computing everything in indices. After graduate school, he received an NSF postdoctoral scholarship to work at Harvard University under the mentorship of S.-T. Yau. Following 110 inches of snow in Boston this past winter, Adam decided to move back to the west coast.

Working in the field of differential geometry, Adam is especially interested in gauge theory and complex geometry. Much of his work has revolved around the Yang-Mills equations, and recently he has become interested in special Lagrangian submanifolds and their relationship with mirror symmetry. Although he primarily uses elliptic and parabolic PDE techniques for his work, Adam is also interested in connections with algebraic and symplectic geometry.

Adam lives in Davis. When he is not doing math, he enjoys spending time with his wife Lauren, and visiting friends and family in the Bay Area. He loves being outdoors, whether hiking, biking, skiing, playing golf, or visiting the beach. Adam also enjoys art, music, and cooking.

Incoming Academic Staff

New Krener Asst. Professor
Mimi Tsuruga

I hail from the East. No, not *that* East. I'm from the East Village, in New York City. But more recently I lived in Germany for nearly a decade, where I got my Ph.D. in mathematics from the Technical University in Berlin. I loved working and living in Berlin; it's an amazing city - full of culture, history, and mathematics! I encourage everyone to visit, if you haven't yet. But I was eager to get back home, so eager that I overshot by 3 time zones.

I work in computational topology, which merges combinatorial topology with programming and data science. At UC Davis I will work with Professor Javier Arsuaga, and like him, I am a member of two departments: Mathematics and Molecular & Cellular Biology. I will be developing topological software to analyze genomic data with the goal of aiding breast cancer research.

I also look forward to finding ways to participate in and contribute to the broader UCD community.

New Krener Asst. Professor
Peter Koroteev

Before moving to North America in 2008, Peter studied physics in the Moscow Institute of Physics and Technology. In 2012 he received his Ph.D. in Physics from the University of Minnesota. His thesis adviser was Professor Arkady Vainshtein.

Peter's current research interests include supersymmetric gauge theories in various dimensions (and their string theory origins), exactly solvable many-body systems, and geometric representation theory.

Outside of mathematics, Peter is active in several outdoor sports—running, biking, hiking, scuba diving, and skiing. He also enjoys reading.

New Krener Asst. Professor
Andre Kornell

I am a longtime Californian, and am happy to continue my mathematical life without leaving my home state. Before coming to Davis, I obtained my Ph.D. in mathematics from Berkeley, where I studied operator algebras.

My primary research interest is quantum logic -- the weird logical rules that govern very small objects. Mathematicians sometimes study objects called quantum groups and quantum metrics; I would like to know, what is a quantum set? Operator algebras are my main tool, but unsurprisingly sometimes a bit of mathematical logic shows up as well!

In conversation I veer towards mathematics, and I like to get a mathematical tidbit from each mathematician I meet.

New Krener Asst. Professor
Maria Trnkova

Maria was an M.Sc. student in Kazan, Russia. Although she did her Ph.D. study largely in the Czech Republic, her work was joint with David Gabai of Princeton University. Before joining UC Davis as a Krener Assistant Professor, she was a postdoc at Caltech.

Maria's research interests are focused in hyperbolic geometry; her favorite geometric objects are hyperbolic 3-manifolds. The goal of her work is to understand the topological and geometric properties of these manifolds, such as their ideal triangulations or length spectra. In her research she uses computer programs SnapPy, Snap, Mathematica and Python. Most of all she likes to visualize and draw models of 3-D objects. Her mentor at UC Davis will be Joel Hass.

Maria spends her free time with her husband and son. Her favorite activities are cooking and traveling. She also likes to study child development and education, do yoga, and dance.

New Krener Asst. Professor
Daniel DeWoskin

Daniel grew up in San Diego and is now returning to California after a 5-year stint in the Midwest. Daniel received his Ph.D. in applied math from the University of Michigan under the supervision of Danny Forger. In his thesis work, he developed and analyzed multiscale models of the neuronal network that controls the mammalian circadian clock.

Daniel's research activities center on dynamical systems, motivated primarily by his interest in coupled biological oscillators. He studies the role of coupling within networks to create emergent behaviors and encode information at the network level that can not be understood by looking at individual components. While at UC Davis Daniel plans to work on related problems with Professor Tim Lewis.

In his free time, Daniel enjoys playing basketball and squash, hiking, travelling, and learning new languages.

Alumni Update

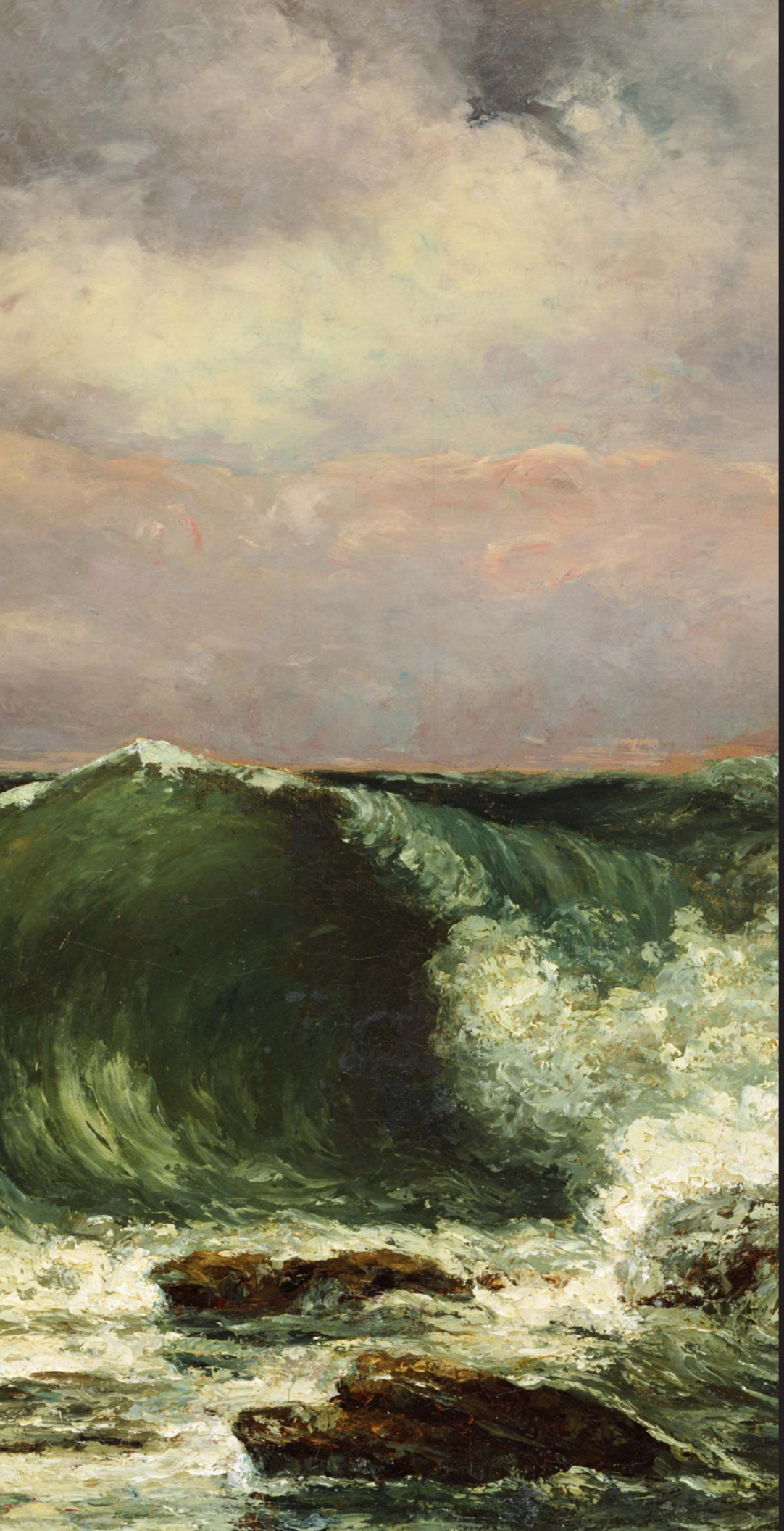
Irving Lubliner

M.A.T., 1988

Although Irving completed his coursework at UC Davis in 1976, he fulfilled the last requirement for his M.A.T. degree in 1988. Throughout that time he taught at middle schools in Novato, Berkeley and Oakland. In 2006, he accepted a professorship at Southern Oregon University, where he recently was granted tenure. After working with younger students for 31 years, in 2006 Irving joined the Department of Mathematics faculty at Southern Oregon University, focusing primarily on mathematics education and teacher preparation. In 2014 he retired and was awarded emeritus status.

During his career in mathematics education, Irving has delivered more than 350 presentations at conferences and in-service training events. In October of 2014 he delivered the keynote closing presentation at the Northwest Mathematics Conference, an annual conference for math teachers from Oregon, Washington, and British Columbia. In a sense this was an encore presentation, as he also was the featured closing speaker in 2011.

Throughout his consulting career the people he encountered were struck by his ability to develop and question strategies, to promote student participation, and increase their cognitive demand. Irving credits the training and mentoring he received in the M.A.T. program at UC Davis, which he has found to be invaluable to him as a mathematics educator. Evelyn Silvia has had a particularly profound and enduring influence on him.



"One might think that proving an apparent fact with full mathematical rigor, such as that water waves break, is an empty exercise. However, this kind of question is basic for every mathematical model of reality."

Rafael Granero Belinchon

Read More

The confined Muskat problem:
differences with the deep water regime
http://arxiv.org/abs/1209.1575

An approximate treatment
of gravitational collapse
http://arxiv.org/abs/1211.5392

Still Waters Run Deep

Research Highlight

Rafael Granero Belinchón

Dr. Granero Belinchón is an Arthur J. Krener Assistant Professor at UC Davis. In June 2015 his research was awarded the Vincent Caselles prize from the Royal Spanish Mathematical Society (RSME).

As Shakespeare wrote in 1592, 'smooth runs the water where the brook is deep' (Henry VI Part II). Conversely, one expects the flow to get rough where water is shallow. Although this apparent fact can be seen by anyone who observes waves break as they approach a beach, until recently it lacked a proper mathematical understanding. The first rigorous mathematical proof that water waves break (see Figure) was published in 2012[1]. The authors of that paper only considered an unbounded water region; the effects of an impervious bottom were not studied.

One might think that proving an apparent fact with full mathematical rigor, such as that water waves break, is an empty exercise. However, this kind of question is basic for every mathematical model of reality. In fact, for a complete mathematical model of fluid dynamics to be correct it must reproduce the real behavior of water waves. So, how good would our model system be if we could not prove what we see at the beach? Even if this kind of question seems closer to theoretical physics than to mathematics, the mathematical tools and techniques required to gain insight in these fluid dynamics problems are so charming that they have substantial mathematical interest on their own.

In my work I study a simplified case of water flow in which the fluid is confined between two parallel, vertical plates separated by a small distance. This is known as the Hele-Shaw cell problem and, mathematically, is equivalent to Darcy's law, which studies the flow inside porous media (e.g. sand). Both are classical problems that were formulated in the second half of the XIX century[2].

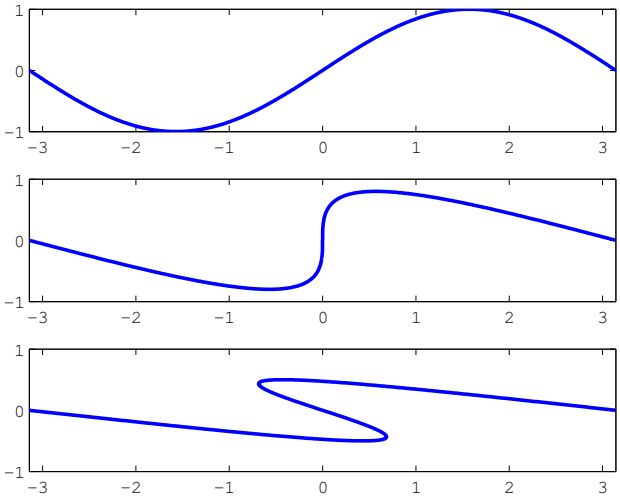
I am particularly interested in developing a better mathematical understanding of the consequences of having a bounded water region. Originally I planned to check whether the intuitive truth that Shakespeare described in 1592 was mathematically correct. With that goal in mind, I proved analytical results showing that waves in a confined medium turn more often than if there were no boundaries. In particular, with the help of my collaborators, I developed a computer-assisted proof [3] that the nearness of the wall makes some initial waves turn (i.e. break), while, when no wall is considered, the same initial wave does not turn. Thus, both William Shakespeare and our own intuition are right - the presence of impervious walls changes wave behavior.

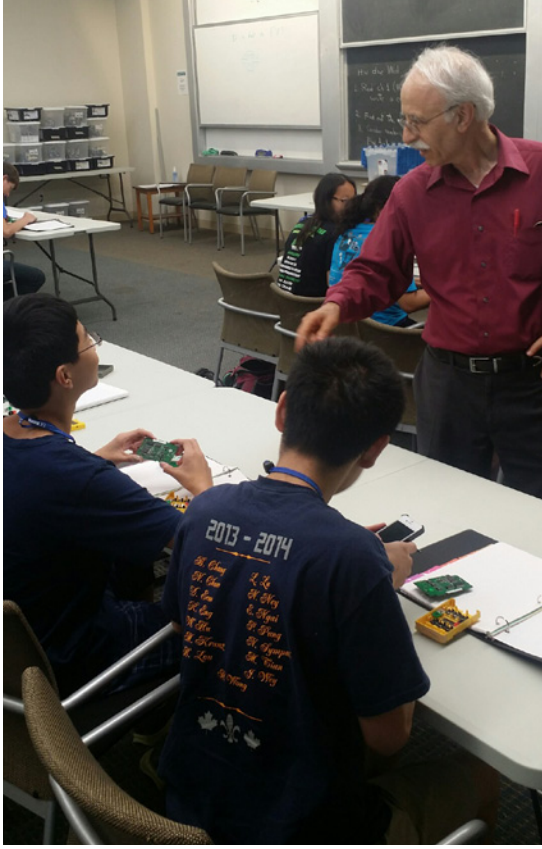
Even if now we understand better the mathematical problem of waves in a fluid, there are plenty of other intriguing questions waiting for us to solve.

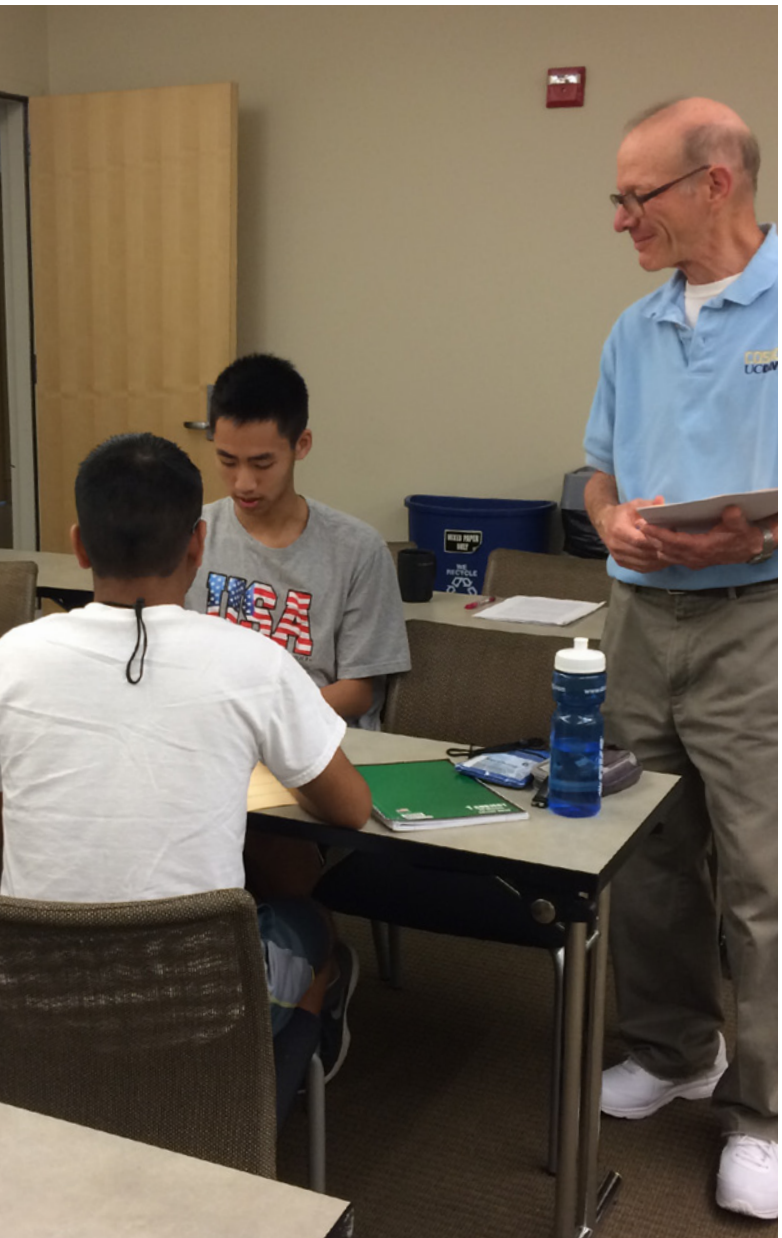
[1] A. Castro, D. Córdoba, C. Fefferman, F. Gancedo, M. López-Fernández, Annals of Mathematics, 2012.

[2] The Hele-Shaw cell problem was formulated in 1898 while Darcy derived his law in 1856.

[3] J. Gómez-Serrano and RGB, Nonlinearity, 2014.




2013 - 2014


USA

COSMOS California State Summer School for Mathematics and Science

The California State Summer School for Mathematics and Science (COSMOS) is a statewide, merit-based, residential outreach program of the University of California, bringing high-achieving high school students from around the state for four weeks of study with UC faculty and researchers. The program started in 2000 with sessions held on the Irvine and Santa Cruz campuses. Davis became engaged in 2001 and, due to high demand, San Diego joined in 2004.

The Department of Mathematics leads COSMOS on our campus. Professor Abigail Thompson has served as the UC Davis Director since inception. Several departmental faculty members, including Professor Thompson, are heavily engaged with its instructional activities.

The UC Davis COSMOS program consists of about ten topical units called clusters, each having approximately 20 students. Individual clusters are instructed, guided, and mentored by dedicated faculty, teaching assistants, and a high school teaching fellow. Each cluster focuses on a topic from mathematics, the physical sciences, engineering, biotechnology, or related fields. All students have the opportunity to interact closely with the research faculty who direct their cluster. Through COSMOS, the students make new connections among the topics they are studying in high school. They learn to apply their mathematics and science training to address problems of interest, while experiencing the residential camaraderie of fellow STEM-minded students from around the state.

The University of California has administered the COSMOS program since its creation by the State Legislature in 1998. Until recently the statewide management of the program was housed at the Office of the President. But in 2014 it was transitioned to the UC Davis Provost's Office, a move that required building an entirely new administrative structure for coordinating and enabling COSMOS' many multi-campus activities. Professor Niels Grønbech-Jensen of the Department of Mathematics has been selected to be the Executive Faculty Director of the Systemwide COSMOS program, a role he had filled on an interim basis since 2014. Grønbech-Jensen has long experience with COSMOS, having taught in the program since 2004.

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.

Graduate Highlight

Yuji Nakatsukasa

A Dissertation with Recognition

"I remember feeling daunted as a student trying to do research, but in Davis I always had people to turn to for advice..."

Yuji Nakatsukasa

Yuji Nakatsukasa received his Ph.D. from Davis four years ago. As a graduate student in our program in Applied Mathematics, he developed novel, efficient, communication-minimizing algorithms for the eigenvalue decomposition of symmetric matrices and the singular value decomposition of general matrices. His algorithms use a spectral divide-and-conquer approach, which is fundamentally different from the transformation to tridiagonal or bidiagonal form used in standard algorithms. In essence, his method transforms the original matrix into two matrices of roughly half the size in such a way that the eigenvalues of each of the two matrices are the eigenvalues of the original matrix that lie below and above their median, respectively. This process is repeated until one has reached all 1×1 matrices, whose entries are the eigenvalues of the original matrix.

Yuji's novel communication-minimizing algorithms form Part 1 of his Ph.D. Dissertation, "Algorithms and Perturbation Theory for Matrix Eigenvalue Problems and the Singular Value Decomposition". Part 2 contains an equally impressive collection of new contributions to eigenvalue perturbation theory.

In 2014, Yuji, received the prestigious Alston S. Householder Award XV for the best dissertation in numerical linear algebra. The Householder Award is given every three years to recognize outstanding contributions in this field.

Since completing his Ph.D. Thesis, Yuji and Dr. Roland Freund, his thesis adviser, have continued their collaboration. Recently, they used higher-order Zolotarev rational functions to develop a new class of communication-minimizing algorithms for computing both symmetric eigendecomposition and singular value decompositions. These have arithmetic costs that are comparable to the standard non-communication-minimizing algorithms. A paper describing these new algorithms has been accepted for publication in the Research Spotlights section of SIAM Review.

Since receiving his Ph.D., Yuji spent two years as a Postdoctoral Fellow at the University of Manchester in the UK, then moved to Tokyo, where he currently is located. He writes of his time with us:

"Davis will always be a special place for me. The experience and education I received there is the foundation of the research that I currently pursue. I love and miss the safe, free and friendly environment of Davis, the excellent faculty members (especially in my field of numerical linear algebra), and the staff who were willing to help whenever needed, often beyond the call of duty.

"Looking back it was really a precious time in my life, when I could focus on research with few other responsibilities. I suspect that such time will never come back. I remember feeling daunted as a student trying to do research, but in Davis I always had people to turn to for advice, and seminars and interactions with leading researchers from other Universities also were invaluable.

"I feel I was lucky to realize early in my graduate studies that my passion lay in numerical linear algebra. I started working on a specific problem at the end of my first year, and although it took a few years, that work formed the core of my Ph.D. dissertation. I encourage current graduate students to find out what fascinates you as early as possible.

"I am grateful and honored to have received the Alston S. Householder Award XV for my dissertation. I keep in touch with my colleagues from Davis, and I feel fortunate to continue to collaborate with my Ph.D. supervisor Roland Freund, and proud of the joint paper that we wrote, which I regard as the culmination of the research I started in Davis."

Updates from
The Graduate Programs

by Sasha Soshnikov, Graduate Program Chair
and Matthias Köppe, GGAM Chair

This year the Graduate Program in Mathematics welcomed 17 new graduate students. The total number of students in the program is 67. The Graduate Program in Applied Mathematics (run by GGAM) welcomed 11 new graduate students this Fall, 10 to the Ph.D. program and 1 to the M.S. program. They were selected from a highly competitive pool of applicants. This brings our number of graduate students currently in the program to 53.

Several graduate students received prestigious prizes during the 2014–2015 academic year. We are very pleased that Axel Saenz Rodriguez (Math) won the University's Dissertation Fellowship and Travis Scrimshaw (Math) received a prestigious postdoc appointment at the University of Minnesota, a top place for Combinatorics). Swati Patel (GGAM) won a 2015–2016 American Dissertation Fellowship from the American Association of University Women.

The 5th Annual Davis Math Conference, organized by the Galois Group, took place on October 16, 2014. The Conference aims to present current research conducted in the Department to graduate students and faculty. This year's conference covered a diverse range of topics from geometry, topology, algebra, analysis, applied math, mathematical physics and other disciplines.

The Department and its graduate programs hosted numerous distinguished visiting speakers during the year. Notable highlights include Colloquium presentations by Joseph Bernstein, Gunnar Carlsson, Edward Witten and Art Krener.

The annual GGAM mini-conference took place on Saturday, January 31, 2015, and was a great success. This annual day-long event brings together the faculty and students of GGAM to share research problems and results. This year's program included talks from faculty, postdocs, and Ph.D. students.

Steve Shkoller completed his term as the GGAM Chair, handing the gavel to Matthias Köppe in July, 2015. Under Steve's leadership a tradition of GGAM Colloquia was established. Invited speakers include both GGAM members and distinguished speakers from the outside. Notable external speakers include Thomas Hou (Caltech) and David Levermore (U. Maryland). Each colloquium was followed by a reception in the courtyard for faculty and students, which facilitated lively interactions.

The new Graduate Group of Applied Mathematics website went live in October, 2015 at
http://appliedmath.ucdavis.edu/

2014 - 2015
Graduate Degree Recipients

Brummitt, Charles : Ph.D., Applied : "Models of Systemic Events: Interdependence, Contagion, and Innovation," D'Souza : Postdoctoral Researcher, Columbia University

Lewis, Owen : Ph.D., Applied : "Mathematical Investigation of Hydrodynamic Contributions to Amoeboid Cell Motility in Physarum Polycephalum," Guy

Lu, Steven : Ph.D., Math : "No Quantum Brooks' Theorem," Kuperburg

Scrimshaw, Travis : Ph.D., Math : "Crystals and Rigged Configurations," Schilling : Postdoctoral Associate, University of Minnesota

Tavernetti, Edward (William) : Ph.D., Applied : "Modeling and Simulation of Thermal Ignition, Flame Fronts, Reactive Flows and Transonic Combustion," Hafez : Lecturer, UC Davis

Waagen, Alexander : Ph.D., Applied : "Phase Transitions on Static and Evolving Networks: Effects of Competition, Zealotry, and Growth," D'Souza

Watson, Richard : Ph.D., Applied : "The Structure of Transient Memory in a Simple Model of Inhibitory Neural Feedback," Crutchfield

Wertz, Timothy : Ph.D., Math : "Localized operators and eigenvector localization," Strohmer : Postdoctoral Teaching Fellow, Division of Science, Yale-NUS College

Bassett, Robert : M.S., Math

Buck-Moyer, Paige : M.A., Math

Chan, Virgil : M.A., Math : Strohmer

Clark, John : M.A., Math

Glaros, Michael : M.S., Applied

Petchprom, Mick : M.A., Math

Schiffman, Benjamin : M.S., Math

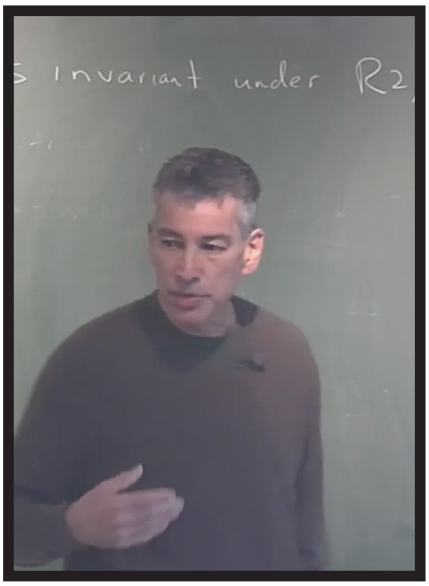
Starr, Rebecca : M.S., Applied : DeLoera

Yang, Yudi : M.S., Applied

Comparing Shapes

Research Highlight

Joel Hass



A neuroscientist compares brain images derived from MRIs taken six months apart. How much change has occurred, and where is the change most pronounced?

An anthropologist examines a fossilized toe bone from an extinct species of monkey. What is the evolutionary connection to current species? Which currently existing species has a toe bone closest in shape to the fossil?

A crystallographer determines the shape of a new protein. Which known proteins does this protein most closely resemble?

These are a few examples of the problem of aligning or comparing two shapes, known as the *surface registration* problem. This problem is encountered in many fields, from radiology to computer vision, molecular biology to brain mapping, target recognition to satellite image analysis, and many others.

Joel Hass and his colleague Patrice Koehl (CS) have proposed new methods for measuring the similarities and differences between pairs of geometric surfaces, and for finding an optimal correspondence between two surfaces. These methods are based on techniques of geometry and topology that are just starting to be applied to real world problems. Briefly, a conformal map f between an arbitrary pair of genus zero surfaces S_1 and S_2 (sphere-like surfaces with no holes, like an egg or a chicken) is a map that preserves local angles, though not distances. Hass and Koehl introduced a new energy functional on the space of conformal maps, called the *symmetric distortion energy*, and showed that there exists a conformal diffeomorphism minimizing this energy. The symmetric distortion energy defines a metric on the space of piecewise smooth, genus zero surfaces, which Hass and Koehl called the symmetric distortion distance.

This conformal surface alignment and its associated distance have properties that are highly desirable for many applications. The distance is sensitive to global changes in shape, but not to random perturbations or noise. It does not depend on choice of mesh or parametrization. The metric it defines is based on the intrinsic geometry of the surface, so is not affected by motions that preserve lengths of curves on the surface. This allows for recognition of objects that take multiple configurations, such as flexible proteins, human hands, or faces with varying expressions.

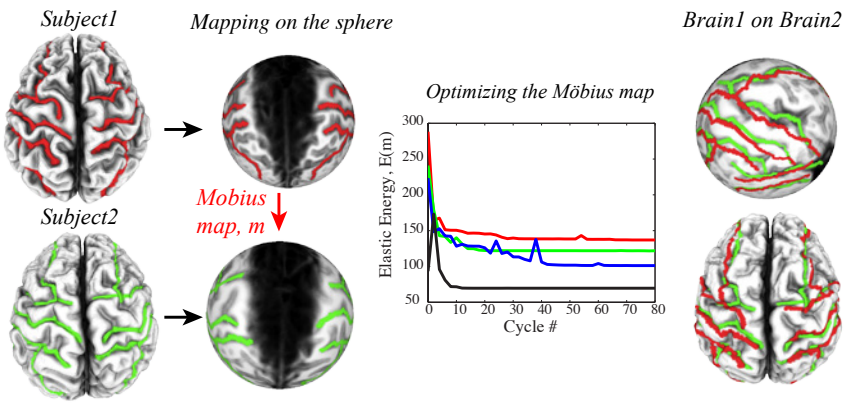
Hass and Koehl have performed a series of experiments on mathematical and biological surfaces that document the promise of this approach in several applications. They find that the appropriate shape comparison to make depends on the application being pursued. In some settings, for instance, there are clearly marked points that should be aligned (tip of the nose, corner of the eye), while in others there are no clear landmarks that require correspondence.

Brain alignment is one important application to which the techniques of this proposal are directed. Because the surface of the brain can be modeled as a surface with the topology of a sphere, pairs of brains can be compared using the symmetric distortion energy and its associated distance. When applied to two specific brain surfaces, the alignment shown in Figure 1 is obtained. This alignment is angle preserving, and the process to obtain it is completely automated and computationally fast, requiring no markings of key points or human expertise. Experiments indicate that minimizing the symmetric distortion energy leads to alignments of sulci (i.e. infoldings) that are comparable in accuracy with the methods commonly used in the neuroscience community, but without human input. Ultimately, the utility of this method in this and other areas will be established when a widely available software package allows scientists to apply a variety of alignment schemes.

Read More by Hass

How round is a protein? Exploring protein structures for globularity using conformal mapping
http://tinyurl.com/roundproteins

Automatic Alignment of Genus-Zero Surfaces
http://tinyurl.com/genuszero



Life After Davis

Tom Denton

Ph.D., 2011

Oh, Davis! It's hard to even know where to begin: I spent five wondrous years in Davis, enjoying the community, playing music, riding bikes, and working on my Ph.D. with Professor Anne Schilling. When I graduated, I thanked the owner of Mishka's Cafe for providing the space where I wrote the majority of my thesis. On my less productive days, I would set up shop at the Delta of Venus, scribble some Young diagrams with multicolored pens, and inevitably get drawn into conversations on agriculture, ecology, dance, and our many strategies to keep the Domes open.

Near the end of my time in Davis my girlfriend started a project in Kenya, so I thought I might have a look around myself. I sent out fifty emails and got exactly one response, from a crazy Mzungu named David Stern who had been teaching at a small university outside of Kisumu for the past three years. About two months later, I took my first trip to East Africa, got the lay of the land, and helped some of the local grad students get a better understanding of Banach spaces. After a couple more trips I was awarded a Fulbright, and spent 2012-13 working on math and computer science education in Kenya, with some side projects in Ethiopia and South Africa. With David and his graduate students (and anyone else we could convince to visit), we ran math camps for secondary students, taught undergraduate courses, ran graduate workshops, and more. Near the end of my Fulbright year, I helped start LakeHub, a hackerspace in Kisumu that is still going strong.

A strong background in math paired with a bit of imagination can take you very far indeed. When I was applying for the Fulbright a program officer told me not to bother, since they usually don't award them to people less than five years out of their Ph.D.. However, almost no mathematicians apply for Fulbright in sub-Saharan Africa, almost no one proposes any projects in Kenya outside of Nairobi, and our proposal had direct benefits for the country. Constraints (like my then-girlfriend's project in Kenya) can provide an opportunity to find a road less travelled.

My mathematical interests have shifted considerably because of my experiences in Kenya. Working with the hackers at LakeHub awakened my interest in building things, and in understanding how to use mathematics to solve problems that directly impact people's lives. This doesn't mean simply forgetting what I've learned, though: Statistics and machine learning provide ways for my background in combinatorics to interface with the world.

2013-2014
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.

Recipients – Hy Lam and Try Khov

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 – Indrajit Jana

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 – Minmin Fu

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.

Recipients – Nathaniel Gallup and Christopher Westenberger

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 – John Hunter, Ph.D.

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.

Recipients – Trevor Glynn and Gweneth McKinley

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 – Jaclyn Dewitt

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 – Eric Samperton

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.

Recipients – Carter Johnson and Travis Scrimshaw

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 – Becca Thomases, Ph.D.

Departmental Citation Awards

The Department recognizes undergraduate students of exceptional ability who have taken both a very strong selection of mathematics courses and have made substantial contributions to the Department or their program. In addition, they have all received strong recommendations from the faculty.

Recipient – Gweneth McKinley

Citation for Outstanding Performance

These citations honor undergraduates who have taken a very strong selection of mathematics courses and distinguished themselves with exceptionally high grade point averages.

Recipients of Highest Honors – Aviv Behar, Ruian Chen, Matthew Halbasch, Carter Johnson, Megan Liska, Gweneth McKinley, and Ryan Reynolds

Departmental Honors Awards

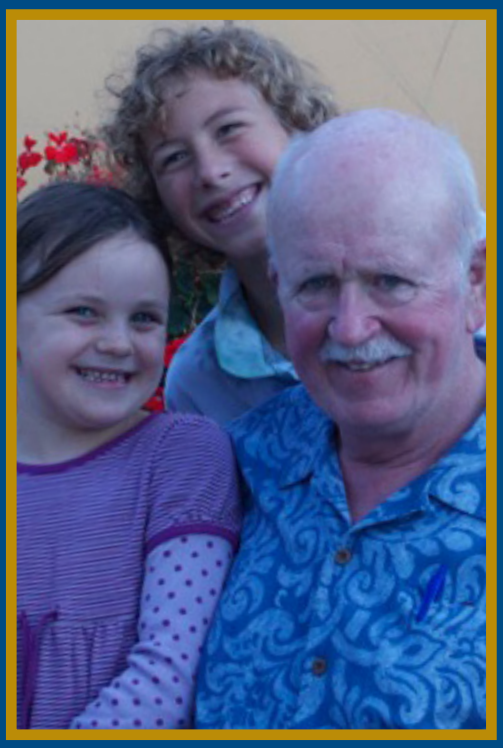
Every year, undergraduate students have the opportunity to participate in mathematical research, culminating in a senior thesis. Students typically work under the guidance of a faculty mentor to complete original research. The results are reviewed, and pending on the quality and substance, the student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

Recipients of Highest Honors – Ruian Chen, Matthew Halbasch, Carter Johnson, Megan Liska, and Gweneth McKinley

A Causal Relationship to Mathematic Contributions

Emeritus Focus

Art Krener



Throughout his career Arthur Krener's research focus has been on the control and estimation of nonlinear dynamical systems and stochastic processes. Over the years he has made many important contributions to this field. He is being honored for this lifetime of accomplishments by being awarded the 2016 Institute of Electrical and Electronic Engineers (IEEE) Control Systems Award.

On receiving his Ph.D. in Mathematics from Berkeley in 1971 Dr Krener joined the faculty of the University of California, Davis, where he remained until his retirement in 2006. He currently is a Distinguished Visiting Professor at the Naval Postgraduate School.

The modern theory of linear control and estimation began around 1960 when R. Kalman defined controllability and observability. But at the time a similar theory for nonlinear systems was lacking. In his Ph.D. thesis, Krener attacked this problem, showing that the Lie bracket played an important role in nonlinear controllability by proving a time-directed version of Chow's Theorem. Several years later, in joint work with Hermann he gave the definitive treatment of controllability and observability for nonlinear systems. This work was cited by the IEEE Control Systems Society as one of the 25 Seminal Papers in Control that were published in the 20th century. It made possible the tremendous progress that has occurred since that time in nonlinear systems theory.

Also around 1960 the well-known Pontryagin Maximum Principle was developed for optimal control problems. These are the first order necessary conditions that a control must satisfy to be optimal. But they are not always decisive, particularly for problems where the control enters linearly. Krener developed the High Order Maximum Principle, which give additional necessary conditions for optimality. This work stimulated tremendous interest, and has been generalized and extended by many authors.

Perhaps the two most important approaches to controlling a nonlinear system are feedback linearization and backstepping. Krener played a key role in the development of both. He gave necessary and sufficient conditions for a nonlinear system to be a change of state coordinates away from a linear system. Working with Isidori, Gori-Giorgi and Monaco, he also found conditions for the existence and construction of decoupling and noninteracting control laws for nonlinear systems. This led to the concept of the zero of a nonlinear system, which was subsequently extended by others to the backstepping technique of control.

The dual of control is estimation, and for nonlinear systems this is usually quite difficult. But Krener and Respondek showed how this could be accomplished for systems that could be linearized by change of coordinates and input/output injection. Their approach is the dual of feedback linearization.

Although many systems are causal (the current output is unaffected by future inputs), some are not. Examples are systems that satisfy boundary instead of initial conditions. Krener developed the complete set of conditions for the controllability, observability and minimality of linear acausal systems.

The development of controllers and estimators that are robust to noise and parameter variations was the motivation for linear H-Infinity control. Krener generalized this approach to nonlinear systems in a particularly simple fashion.

The theory of Markov diffusions is a beautiful area of mathematics, involving a rich interplay between Ito stochastic differential equations and parabolic partial differential equations. Krener developed a corresponding theory for reciprocal diffusions. (A reciprocal process is a Markov random field with a one-dimensional parameter.) He showed that reciprocal diffusions satisfy stochastic differential equations of second order that he discovered, and the conditional moments of their velocity satisfy a sequence of conservation laws that can be hyperbolic or of mixed type.

Dr. Krener's lifetime of accomplishments have earned him many accolades. He is a Fellow of the American Mathematical Association, of the Society for Industrial and Applied Mathematics, and of the International Federation for Automatic Control, and he is a Life Fellow of the IEEE. He has been a John Simon Guggenheim Fellow, and a Statistical and Applied Mathematical Sciences Institute University Fellow. His work has won the W. T. and Idalia Reid Prize from SIAM, the IEEE Control System Society Bode Prize, and the Richard Bellman Control Heritage Award from the American Automatic Control Council. The 2016 IEEE Control Systems Award is a fitting capstone to a career filled with major accomplishments.

Read More by Krener

The Accessible Sets
of Free Nilpotent Control Systems
http://tinyurl.com/krenernilpotent

Observability of viscoelastic fluids
http://tinyurl.com/krenervisco

Staff News

by Gladis Lopez

This has been a very good year. We have seen growth in the Department through increased faculty and student enrollment. We have also experienced staff changes this year. While it is sad to see staff members leave the Department, it is very exciting to see them move forward in their career goals and get promotional opportunities on campus. Letia Graening, undergraduate student adviser accepted a new position in the L&S Dean's Office and Danielle Sherwood accepted a position in Accounting & Financial Services. On the flip side, we are happy to welcome Keith Anglin as our contracts and grants coordinator and Malina Gilles-Doherty as the new undergraduate adviser. In addition, Denise Myrick, who is a shared employee with NEAT, is assisting with Department events and other administrative duties. We are fully staffed and ready to serve you.

Congratulations to Zach Johnson who was selected as the MPS IT representative. This assignment requires a very small time commitment and should not impact his appointment in Math. We are very happy for him.

The Math Project is now housed in the Math Department and we are happy to work with their staff members: Pam Hutchison, Thu Pham and Diana Zaragoza.

Another piece of goods news! Sarah Driver's baby, Addison, arrived on February 11, 2015. Congratulations Sarah and Cynthia!

We are looking forward to having another productive year.

Alumni Update

Joan Peters Ogden

B.S., 1966

After receiving her B.S. from UC Davis, Joan continued in mathematics, earning her Master's degree at Michigan State. There she discovered that her undergraduate education had been better than the bulk of her colleagues'. This gave her an appreciation for the superb teaching provided by Professors Alder, Stein, Jacobson, Tuma, and countless others at Davis.

After graduating, Joan worked first for NASA, where she was assigned as a mathematician to the Apollo Program. After that she taught math, first at Albion College, then at the University of Missouri, Bowdoin College, and Bloomsburg State University. Then she shifted into the actuarial field. She worked for Blue Cross of Utah then for Wilcox & Co.in Salt Lake City before starting her own actuarial consulting firm.

Joan now is married and semi-retired, with a daughter and grandchildren. Between camping, hiking, skiing, wine tasting (thank you, UC Davis), gardening, travel, church and community activities, she is so busy that she wonders how she ever had time to work.

Glen Michtom

B.S., Math and Computer Science, 1978

After receiving his B.S. with majors in Mathematics and Computer Science, Glen earned a Master's degree in Computer Science from Purdue University. He then moved back to California to take a job at the Intel Corporation. Since that time he has worked for Gavilan and Hewlett Packard. Currently he is a software engineer for the State Street Bank. Glenn met his wife, Angela, when they both performed at ComedySportz. They have two children, Rachel (14) and Daniel (12). They moved to Oregon 2001 so Glen could take his current position. Glenn still enjoys playing the piano and guitar, and has been in a couple of bands.

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:

https://www.facebook.com/

Get News by Email

Would you like to help the environment and save the Department of Mathematics money by receiving future newsletters by email? If so, just indicate your preference on the newsletter subscription page on our web site:

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

As always, you can also view past newsletters on the Newsletter Archive located on our web site:

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

UC DAVIS
MATHEMATICS

1015 Department of Mathematics
University of California, Davis
One Shields Avenue
Davis, CA 95616-8633

Address Service Requested

Nonprofit Org
U.S. Postage
PAID
UC Davis

Thanks for Your Support

The Department of Mathematics wishes to gratefully acknowledge the generosity of the following donors, who have contributed to its support over the past three years.

Rex V. & Mary Elizabeth Allen
Martha L. Bailey
Cheryl L. & Scott F. Beaver, Ph.Ds.
Christopher E. Broski
Sean P. Buggy
Youn-Sha Chan, Ph.D. & Ms. Jennifer Lee
Chau-Hsiung & Yueh-Jing Chuang
Doyle O. Cutler, Ph.D.
Jishu Das
Sarah M. Donovan
Gennis D. Emerson
Daniel M. & Joy H. Faletti
Gary F. Gruenhage, Ph.D.
Carol & Fields C. Gunsett, Ph.D.
Robert Guy
David R. & Lauren B. Hall
Joel Hass, Ph.D. & Abigail A. Thompson, Ph.D.
Stephen C. Hennagin, Ph.D.
Herbert L. Holden
Robert E. Jaffa
Jeanne M. Reese & Arthur J. Krener, Ph.D.
Jack F. Latimer
Eric K. Lee
Jeffrey S. Martell
Mika K. & Nelson L. Max, Ph.D.
Marion E. McCurdy
Charles N. Morris, III
Sayuri & Motohico Mulase, Ph.D.
Tan M. Nguyen
Sandra S. Ruliffson
Amre S. Saadeh
Joan S. & G. Thomas Sallee, Ph.D.
Brent Schultz
Bryan & Erica Schultz
Sai L. Shao, Ph.D.
Jennifer L. Sharples, Psy.D
Jim & Marilyn Simons
Roy W. Simpson
Jennifer & Seth A. Stevelman
Allan J. Thompson
Ngangiang N. & John B. Thoo, Ph.D.
Curtis C. Travis, Jr., Ph.D.
Jessica Utts, Ph.D.
Carolyn M. Weist
Robert D. & Sally Weist
James O. & Sybil B. Wells
Earl Q. Wong, Ph.D.
Sidney R. Wong

Featuring the 2014-15 Academic Year

Newsletter Committee:
Craig Benham, Editor
Gladis Lopez, Management Services Officer
Marianne Waage, Designer