FALL 2014

THE Common Denominator

UCLA DEPARTMENT OF MATHEMATICS NEWSLETTER

Stan Osher accepts the Gauss Prize from the President of South Korea.

Stanley Osher Receives Prestigious Gauss Prize

Stanley Osher, UCLA mathematics professor since 1977, is the proud recipient of the Carl Friedrich Gauss Prize, considered the highest honor in the field of applied mathematics. Named for 19th century mathematician Carl Friedrich Gauss and presented every four years, the prize was first awarded at the 2006 International Congress of Mathematics (ICM). Previous recipients were Kiyoshi Ito in 2006 and Yves Meyer in 2010, two of Stan's personal scientific heroes. The prize was awarded in Seoul, South Korea, during the opening ceremony for the 2014 ICM.

The Gauss Prize is awarded jointly by the International Mathematical Union and the German Mathematical Society for "outstanding mathematical contributions that have found significant applications outside of mathematics." Referred to as "a one-man bridge between advanced mathematics and practical real world problems," Stan has repeatedly created new tools and techniques that traverse barriers between research and the world in which we live.

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UCLA

> **"Mathematics is essential for driving human progress and innovation in this century. This year's Breakthrough Prize winners have made huge contributions to the field and we're excited to celebrate their efforts."**
> — Mark Zuckerberg

Terry Tao's Breakthrough Prize

UCLA Mathematics Professor Terence Tao is one of five recipients of the Inaugural Breakthrough Prize in Mathematics. Launched by Facebook founder Mark Zuckerberg and tech billionaire Yuri Milner in December 2013, the prizes "aim to recognize major advances in the field, honor the world's best mathematicians, support their future endeavors and communicate the excitement of mathematics to the general public." The laureates will be presented with trophies and a prize of $3 million each at a ceremony in November 2014.

Other 2014 recipients of the Breakthrough Prize in Mathematics are Simon Donaldson of New York's Stony Brook University and Imperial College London; Maxim Konstsevich of France's Institut des Hautes Études Scientifiques; Jacob Lurie of Harvard University; and Richard Taylor of the Institute

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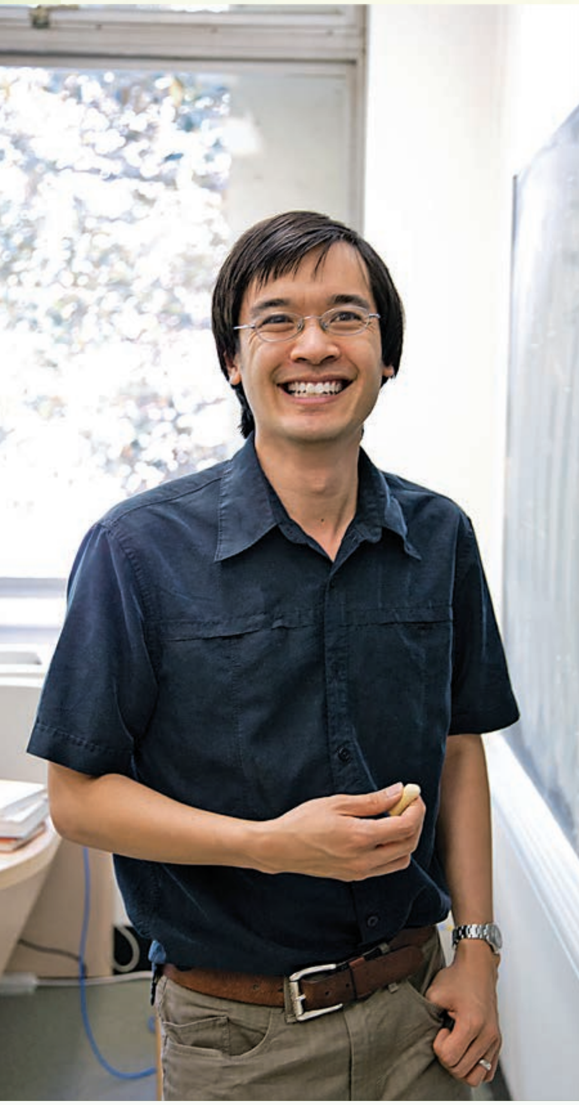

> **"Mathematics is the most fundamental of the sciences – the language they are all written in. The best mathematical minds benefit us all by expanding the sphere of human knowledge."**
> — Yuri Milner

Terry Tao's Breakthrough Prize

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for Advanced Study in Princeton, New Jersey. Recipients of the prize will serve on the foundation's selection committee, choosing the next winners from a group of contenders nominated by the mathematics community. In subsequent years, one Breakthrough Prize in Mathematics will be awarded annually.

Terry, along with the other recipients, has donated $100K of the prize money to establish a Breakout Graduate Fellowship. This initiative will support and develop graduate level education for talented mathematicians studying in developing countries. The award will be managed by the International Mathematical Union (IMU) with the hope of providing the basis for establishing new centers of excellence for mathematics in countries where none currently exist.

Upon finishing his PhD at Princeton at the age of 21, Terry joined the Department in 1998 and was soon dubbed the "Mozart of Math." Since then he has been the recipient of some of the most prestigious awards offered to mathematicians. Arguably, his most famous award was the 2006 Fields Medal, referred to as the "Nobel Prize in Mathematics."

Terry holds the James and Carol Collins Chair in the UCLA College and is a fellow of both the Royal Society and the Australian Academy of Sciences. He has received numerous national and international honors, including a MacArthur Fellowship, the National Science Foundation's Alan T. Waterman Award, the Royal Swedish Academy of Sciences' Crafoord Prize, a Simons Investigator Award, election to the American Philosophical Society, and, most recently, the Royal Medal.

UCLA Math Ranked Within Top 10 Across All Specialties

Rank	Department
#1	Analysis
#2	Applied Math
#2	Logic
#5	Algebra / Number Theory / Algebraic Geometry
#6	Discrete Mathematics and Combinatorics
#10	Geometry
#10	Topology

BEST U.S.News & WORLD REPORT RANKINGS

***U.S. News & World Report* ranked UCLA Math #7 overall** for top schools in the field of mathematics. The Department continues to be one of the best places in the world to study mathematics.

"I write the algorithms that make the computer sing. I'm the Barry Manilow of mathematics."
— Stanley Osher

Stanley Osher Receives Prestigious Gauss Prize

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Joseph Rudnick, senior dean of UCLA College and dean of physical sciences, remarked, "Stan Osher is a superb applied mathematician who has made major advances in the solution of important real-world problems. His work is marked by elegance and efficiency. He richly deserves this important honor."

MRIs, Law Enforcement, Weather Forecasting and More

Stan's work has contributed to major discoveries and improvements in areas such as medical image analysis, MRI scans, advanced computer chip design, law enforcement response to crime, enhanced computer vision, weather forecasting, earthquake source identification, and computer modeling in the design of supersonic jets. But his reach doesn't stop there. Stan has created innovative algorithms relying on solving partial differential equations and efficient numerical solution. His work on these algorithms has created many methods and applications used frequently today. One such example is level sets, a method that mathematically predicts and describes changes in shapes. Entertainment giants Pixar, Disney, ILM, and Dreamworks have adopted this method to create visually realistic animated images of fluids.

Another area revolutionized by Stan's research has allowed computers to transform blurred pictures into clearer, sharper images. Essentially, his methods recover missing information from photos by using algorithms to identify and reverse types of physical processes, such as an unsteady hand holding the camera, that lead to discontinuity (fuzz) in an image. In arguably the most famous application of these techniques, Stan's company, Cognitech, cofounded and co-owned with Leonid Rudin, assisted in identifying attackers during the 1992 Los Angeles Riots. Using mathematical algorithms, Cognitech employees were able to take footage of an attack against truck driver Reginald Denny and sharpen the images to identify the assaulters. One man, identified by a rose-shaped tattoo on his arm as Damian Monroe Williams, was convicted and sentenced to prison. Stan would go on to sell Cognitech to Rudin, but to this day the company continues to aid law enforcement departments throughout the country.

A Richly Acknowledged Career

Stan has been on the receiving end of many honors during his career as a mathematician. In 2014, he, along with Terence Tao, was named to Highly Cited Researchers — those whose papers have been cited so frequently that they fall within the top 1 percent of papers in their subject fields. Stan was elected to the National Academy of Sciences in 2005 and to the American Academy of Arts and Sciences in 2009. He was selected to give a plenary address at the 2010 International Conference of Mathematicians and the John von Neumann Lecture at the 2013 meeting of the Society for Industrial and Applied Mathematics. He has been an Alfred P. Sloan Fellow and a Fulbright Fellow and was honored with three-day "Osher Fests" in 2004 and 2012. He has served as director of applied mathematics at UCLA and now serves as director of special projects at UCLA's NSF-funded Institute for Pure and Applied Mathematics (IPAM).

Stan has trained and mentored more than 50 PhD students and even more postdoctoral scholars – many of whom have become distinguished professors and researchers in applied mathematics. When asked about his experience in the Department, he replied, "The community around UCLA mathematics is truly unique. I cannot imagine a more supportive atmosphere for research and friendship. I have been happy here from day one. I am grateful to the UCLA administration and to my colleagues for their support in building up applied mathematics and to many colleagues outside of the Department for the incredibly pleasant interdisciplinary research atmosphere that exists here."

Academic Ranking of World Universities in Mathematics – 2014

World Rank	Institution	Country/ Region	Total Score	Score on Alumni
1	Princeton University	USA	100	72.8
2	Harvard University	USA	88.8	72.8
3	University of California, Berkeley	USA	88.0	48.5
4	Pierre & Marie Curie University (Paris 6)	France	84.8	59.4
5	Stanford University	USA	80.8	0
6	University of Cambridge	UK	77.1	76.7
7	University of Paris Sud (Paris II)	France	76.7	48.5
8	University of Oxford	UK	75.6	42.0
9	**University of California, Los Angeles**	USA	**74.7**	**0**

UCLA Mathematics Department rose to 9th place worldwide and 5th place in the U.S. in the 2014 Shanghai rating of World Universities in Mathematics.

faculty news

Mark Green Gives Chern Medal Laudation

Professor Emeritus **Mark Green** was selected by the president of the International Mathematical Union, to give a one-hour plenary address honoring Chern Medalist, Phillip Griffiths. Mark spoke in front of an audience of approximately 1,500 mathematicians from around the world at the ICM opening ceremony in Seoul, Korea.

This was the second time that the Chern Medal has been awarded since its inaugural release in 2010. In honor of Shiing-Shen Chern's (1991 – 2004) outstanding contributions to the field of mathematics, the award recognizes an individual whose lifelong achievements deserve the highest level of commendation. Phillip Griffiths was Mark's thesis adviser, and in recent years, one of his principal collaborators.

"Although Phillip has many important pieces of work to his credit, I decided to focus on two – one of Phillip's earliest successes in algebraic geometry, the proof that algebraic equivalence and homological equivalence of algebraic cycles are not the same and a beautiful piece of work with Robert Bryant and Deane Yang on isometric embeddings of 3-folds in six dimensional space. This latter is in differential geometry involving novel methods in partial differential equations and is related to some early work of our own Robert Greene."

Faculty News Highlights

Prizes, Awards, Fellowships, Honors & Service

The **Fellows of the American Mathematical Society (AMS)** program recognizes those who have made significant contributions to the creation, exposition, advancement, communication and utilization of mathematics. In 2014, three UCLA mathematics professors, including two emeriti, were elected to the society: **Donald Babbit** for contributions to mathematical physics, for the development of MathSciNet, and for his long service as publisher of the American Mathematical Society; **Edward G. Effros** for contributions to the study of quantized Banach spaces, classification of C*-algebras, and quantum information theory; and **Gregory Eskin** for contributions to linear partial differential equations and their applications. ■ The **American Mathematical Society** hosted a **Congressional Briefing** titled, How Math Fuels the Knowledge Economy, in December 2013. The event was hosted by Congressman Jerry McNerny, who holds a mathematics PhD. The invited speaker, **Mark L. Green**, co-founder and former director of IPAM, described how the role of the mathematical sciences has expanded dramatically in recent years. Mark offered examples from a range of dynamically growing industries, including internet startups, biotech industries, film production, computer games, and individualized medicine. He also discussed the implications of these changes for training America's future workforce. ■ **Tony Chan**, IPAM's co-founder, former director, and current trustee, was elected to the **National Academy of Engineering (NAE)** for his work on numerical techniques applied to image processing and scientific computing and for providing engineering leadership at the national and international levels. The NAE honors those who have made outstanding contributions to "engineering research, practice or education, including, where appropriate, significant contributions to the engineering literature." ■ 2014 Gauss Prize Winner (see front cover) **Stanley Osher** was selected to give a talk, "What Sparsity and L1 Optimization Can Do for You," at the **Inaugural Lecture Series of the Center of Mathematical Sciences and Applications** at Harvard University. ■ **Raphael Rouquier** was invited to deliver lectures on higher representation theory at the **2014 NSF – CBMS Regional Research Conferences in the Mathematical Sciences**. The conferences are intended to stimulate interest and activity in mathematical research. ■ **Marcus Roper** was awarded an **NSF CAREER award** for his research in myco-fluidics – mathematics at the interface of fluid dynamics and fungal biology, which combines mathematical modeling and physical experiments to study the dispersal and growth of fungi and how to predict its response to our changing earth. This mathematical work includes probability theory, optimization, dynamical systems, fluid mechanics and the synthesis of new models. ■ **Andrea Bertozzi**, inaugural holder of the Betsy Wood Knapp Chair for Innovation and Creativity, and director of applied mathematics at UCLA, was honored with an *honoris causa* degree from **Claremont Graduate University**. ■ Each year the **Society for Industrial and Applied Mathematics** awards three prizes for outstanding papers published in all SIAM journals over the previous three years. Included in this year's recipients is **Andrea Bertozzi** for her joint paper with Arjuna Flenner, "Diffuse interface models on graphs for classification of high dimensional data," published in *Multiscale Modeling and Simulation* 10(3), 2012. Since its publication, this work has led to PhD level work for four students at UCLA and Claremont Graduate University. ■ **Stanley Osher** and **Terence Tao** were named to **Highly Cited Researchers**, representing some of the world's leading scientific minds. In total, over 3,000 researchers have earned the distinction by writing the greatest numbers of reports officially designated by Essential Science Indicators as highly cited papers, ranking among the top 1% most cited for their subject field and year of publication. ■ 2014 Breakthrough Prize Winner (see front cover) **Terence Tao** was selected by the **Royal Society** to receive the 2014 Royal Medal for physical sciences for his "many deep and varied contributions to mathematics." Based in London and founded in 1660, the Royal Society is the oldest scientific academy in continuous existence. The organization awards three medals each year in the physical, biological and applied sciences.

The After Math

Donald (Tony) Martin

Tony Martin joined the Department in 1977 with an undergraduate mathematics degree from MIT and after three years of graduate study in philosophy at the University of Chicago, two years as a junior fellow at Harvard, and 10 years on the faculty at Rockefeller University. He moved to a joint appointment in mathematics and philosophy in 1992 and has been happily splitting his time and research between the two departments ever since.

While at Chicago studying Philosophy, Tony solved a difficult, basic problem in recursion theory and gained instant fame. It is fair to say, however, that from the very beginning, his research — in both mathematics and philosophy — has been motivated and dominated by foundational questions in the theory of sets, especially questions of *consistency and independence* from the classical (ZFC) axioms of set theory and the search for *strong axioms* which can answer questions independent of ZFC. Some of his best known mathematical results are:

- Martin's Axiom (MA), a fairly simple mathematical proposition consistent with both the continuum hypothesis (CH) and its negation. This was published jointly with Robert Solovay in a now classic 1970 paper, in which they showed that MA can solve a large number of classical open problems and so prove them independent of the Continuum Hypothesis. MA has been used countless times to derive such results in infinite combinatorics and set theoretic topology without directly using Paul Cohen's forcing method and the intricate metamathematical arguments that it requires.
- A uniformization theorem for Σ^1_3 sets of real numbers from the hypothesis that measurable cardinals exist, again with Solovay (1968). This was one of the first – and still one of the most important – uses of a large cardinal axiom to prove results about the real numbers.
- The discovery in 1968 that under the hypothesis of full determinacy (AD), *every set of Turing degrees, or its complement, contains a cone*. The resulting ultrafilter on the degrees is ubiquitous in the study of determinacy.

  AD is the claim that in every two-person perfect information game on the natural numbers, one of the two players has a winning strategy. It contradicts the axiom of choice, but definable versions of it, such as *projective determinacy* (PD), provide powerful *strong axioms* that are apparently consistent with ZFC. PD implies a very rich structure theory for the projective sets, much of it developed by Tony.
- The proof (in ZFC) that all Borel games are determined. Arguably his most famous result, Borel determinacy solved a classical open problem, and its publication in 1975 had an immense influence in legitimizing the use of determinacy hypotheses like PD.
- The proof of PD from suitable large cardinal axioms, jointly with John Steel (1989). This fundamental result related the two kinds of strong axioms that had been employed and provided evidence for accepting both. It earned its authors and Hugh Woodin (who extended it) the Karp Prize, the highest honor of the Association for Symbolic Logic.

Tony has supervised 11 PhDs in mathematics and four in philosophy. He has chaired the UCLA Department of Philosophy, directed the math department's Logic Center, and served as president of the Association for Symbolic Logic. He has received numerous honors, including membership in the American Academy of Arts and Sciences. His arrival in Los Angeles in 1977 turned what was already a fairly strong logic group into the Los Angeles School of Set Theory, more affectionately known as "the Cabal."

Veeravalli Varadarajan

Veeravalli (Raja) Varadarajan grew up in India and came to the U.S. as a postdoctoral fellow after getting his PhD in 1960 from the Indian Statistical Institute and the University of Calcutta. Mainly through the efforts of UCLA faculty members Tom Ferguson and the late Paul Hoel, he was offered a permanent faculty position in the Department, where he has remained.

Raja's work, spread over several fields, is unified by the overarching theme of symmetry in mathematics

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faculty news

The After Math

Veeravalli Varadarajan *continued from page 5*

and physics. He was fortunate to have had personal contacts with George Mackey, Harish-Chandra, Pierre Deligne, Robert Finkelstein and Sergio Ferrara. The inspiration from these major figures powered his lifelong quests in the foundations of quantum mechanics; representation theory of semi simple Lie groups; the group theoretic view of linear meromorphic differential equations and their moduli; and in recent years, his explorations of supersymmetry via the unitary representation theory of super Lie groups and research into p-adic physics. He has published a number of significant papers in these areas, most of them in collaboration with others. His books on the foundations of quantum mechanics and Lie theory have now become classics. His selected papers have been published in three volumes, one by the AMS and two by the Hindustan Book Agency (India). His diverse interests have led him to study the history of mathematics, resulting in a book on Euler, exploring the remarkable resonance of Euler's work in the modern era. It has been translated into several languages.

Raja has been deeply devoted to teaching at all levels throughout his career, supervising the dissertations of 18 students. During his tenure at UCLA, Raja was the managing editor of the *Pacific Journal of Mathematics* for 25 years, leading the journal to a very visible place among the hundreds of journals that are part of the contemporary mathematics scene. He has served on various departmental and university committees and on review committees of mathematical institutes abroad.

He received an honorary doctorate in physics bestowed by the University of Genova in 1992, on the occasion of the 500th anniversary of Christopher Columbus's voyage to America. In 1998, he was the Ordway Professor at the University of Minnesota and the Lars Onsager Professor at the University of Trondheim, Norway; he was awarded the Lars Onsager medal at that time. His speaking engagements include the International Congress of Mathematicians in 1974, and with collaborator Donald Babbitt, the Taniguchi Symposium in Kyoto in 1986.

As a result of his wide-ranging interests, Raja has many friends in all areas of the Department. His 70th birthday was celebrated with an international conference in 2008, and his students are organizing another in November 2014 to mark his retirement. He is currently involved in a project jointly with Ramesh Gangolli, editing the posthumous papers of Harish-Chandra.

Geoffrey Mess

Professor of Mathematics

In memoriam, 1960 – 2014

Geoffrey Mess was born in Montreal in 1960. He entered the University of Waterloo at age 16, graduating with a bachelor's degree in mathematics in 1980. Following the completion of a brilliant PhD thesis at UC Berkeley on Torelli subgroups of mapping class groups, supervised by Andrew J. Casson and John R. Stallings Jr., he came to the Department as a Hedrick Assistant Professor, a visiting position reserved for top young PhDs from around the world. He joined the regular faculty in 1988 and rose to prominence in the areas of topology and geometric group theory by making a number of deep contributions to these fields. He laid the basis for the solution of the Seifert conjecture by Casson and Gabai. His joint work with Bestvina on torsion-free Gromov hyperbolic groups has produced what is now known as the Bestvina-Mess formula, relating the cohomological dimension of such a group to that of its boundary. Another of his celebrated results on symmetries of Lorentz spacetimes of constant curvature is a theorem that bears his name. He left a legacy of seven graduate students who completed their PhDs under his supervision.

Beyond mathematics, Geoff's interests included physics, world history, languages, kayaking, hiking and backpacking. He hiked Vermont's Long Trail, as well as hundreds of miles in the Sawtooth Mountains and the Canadian Rockies.

Geoff battled illness for much of the last 20 years of his life. The illness first stole away his productivity, and then succeeded in stealing him from us. He will be remembered and missed. Geoff leaves behind a brother, Derek Mess, and a nephew, Dylan Mess, both of Cambridge, Massachusetts.

—Dimitri Shlyakhtenko and Derek Mess

Robert Steinberg

Professor of Mathematics Emeritus

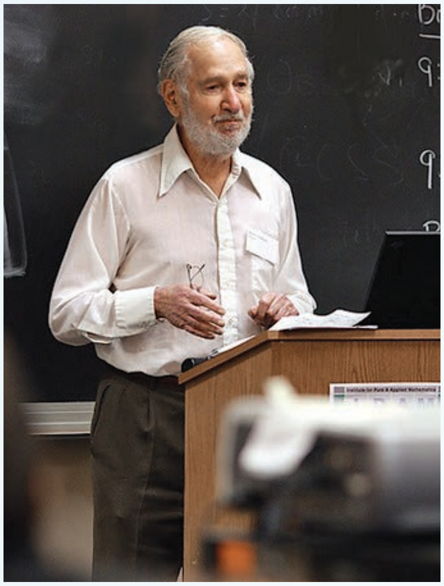
In memoriam, 1922 – 2014

I have had a good life
(Ik heb een goed leven gehad)

This quotation is exactly how Tonny Springer, a famous mathematician from Utrecht in Holland, and one of Robert Steinberg's closest friends, both personally and mathematically, wanted his own life described. It is also a perfect description of Robert Steinberg's life.

Bob was born in 1922 in Soroki, Bessarabia, Romania (present day Soroca, Moldavia), settling in Canada with his parents when he was very young. He was a student of Richard Brauer in Toronto, receiving his PhD in 1948 before joining UCLA that same year. He married Maria Alice née Weber in 1952. They were an inseparable unit, almost like two quarks. They led a simple life, opening their house and hearts to countless mathematicians and friends. Bob and I shared mathematical interests, and we became very good friends, as did our wives. Bob and Maria were avid hikers and campers, especially in Yosemite and Sequoia national parks, where they visited almost annually.

Bob must be regarded as one of the great mathematicians of our time. His main interest was in the theory of algebraic groups, especially semi simple groups. His discoveries in this area rank him among the subject's greatest innovators, like Armand Borel and Claude Chevalley. His results were profound and yet his methods were ultimately simple and transparent, a characteristic that only a truly great master can achieve. His famous lecture notes on Chevalley groups, written while he lectured on that topic at Yale in 1967, are a masterpiece of brevity, comprehensiveness and beauty. They are probably among the most famous unpublished notes in mathematics. The theory of groups and algebras is littered with concepts and ideas originating from him: Steinberg cocycles, Steinberg symbols, the Steinberg character, Steinberg triples, and Steinberg groups, to mention just a few. Twelve PhD students completed their dissertations with him.



Bob was elected to the National Academy of Sciences in 1985. In a letter to me on that occasion, he wrote more about the Lakers and Celtics than this honor; his one comment was that it proved he still had friends in the Academy! He won the AMS Leroy Steele prize for a distinguished career, the citation singling out several of his great papers, all of which can be found in *Robert Steinberg: Collected Papers*, AMS, 1997. He and Maria made generous gifts to the AMS throughout their lives, and they were members of the President's Associates of the AMS. He was awarded the Jeffery–Williams prize of the Canadian Mathematical Society in 1990. He was an invited speaker at the International Congress of Mathematicians in Moscow in 1966. In 2003, the *Journal of Algebra* published a special issue to celebrate his 80th birthday.

Maria was an avid gardener and grew the most wonderful roses. The photo below is of the daylily that their close friend and neighbor, Bill Wilk, discovered, grew, and registered in the American Hemerocallis Society in 2012 as "Hemerocallis, Maria and Bob." From Bill Wilk's letter to me: "It is growing in the Daylily Garden at the Los Angeles County Arboretum and is a good, sturdy plant that blooms well. Bob and Maria always had blooming flowers on their property and were pleased to have a daylily named after them. It meant a lot to them."

Maria's passing last year was a cruel blow to Bob. In the remaining months thereafter, I drew closer to him and visited him once every two weeks or so, discussing many things. I like to believe that these visits were pleasant and enjoyable for him.

I was fortunate to have been a friend of Bob's for almost 50 years, to admire, up close, his greatness, which was intertwined with simplicity and modesty. His was a gentle personality, full of humor and good sense. I will miss him very much, as will all his friends.

—V. S. Varadarajan

Daylily: Hemerocallis, Maria and Bob

focus on research

Scientific Computing in the Movies: Snow Simulation for Walt Disney's *Frozen*

By Joseph Teran

The Walt Disney blockbuster, *Frozen*, recently became the highest grossing animated film of all time, overtaking *Toy Story 3* and *The Lion King*. The Oscar winning 2012 feature is known for its stunning visuals, near fanatical support from youngsters, and of course, the soundtrack. It is also a triumph of scientific computing techniques for the special effects industry. While Disney Animation artists created breathtaking virtual snowscapes for the movie, convincing snow dynamics were only possible by approximating the governing partial differential equations (PDEs) with numerical methods specifically designed to treat the visual behavior of snow dynamics.

Together with Walt Disney Animation Studios, UCLA professors Craig Schroeder and Joseph Teran and UCLA alumnus and Walt Disney Animation Studios Senior Software Developer Alexey Stomakhin (PhD 2013) developed a numerical method for simulating the dynamics of snow **[1]**. These techniques were used to model a wide variety of visual effects in the film, including characters walking through deep snow, snow balls splitting and merging, and digging in heavy snow.

Computer generated imagery has become so convincing that it is almost impossible to distinguish virtual objects from images of the real world. However, for movie making, the dynamics of the virtual world must also be convincingly consistent with the real world. For example, a static image of a computer generated glass of water may look identical to the real thing, but if the dynamics of the water as it pours out of the glass are incorrectly animated, it could appear to have incorrect viscosity (looking like glycerin) or altogether look fake if such principles as conservation of mass and momentum are violated. It is here that scientific computing – more specifically, numerical methods for the continuum partial differential equations that govern solids and fluids – has become an indispensable tool for modern movie making.

It is common in the special effects industry to use the term "natural phenomena" to describe the dynamics of materials such as water, fire, clothing, hair, skin, smoke, rigid bodies, brittle/ductile materials, etc. Whether it's an exploding fireball in *Star War: Episode 3* or a swirling maelstrom in *Pirates of the Caribbean: At World's End*, numerical methods for natural phenomena can be seen in a wide range of Hollywood blockbusters **[2]**. As computers get faster and architectures evolve, traditional scientific computing

Figure 1: Anna interacts with a large snow covered tree, burying her in deep snow.

Figure 2: Kristoff hangs from a ledge, desperately clawing at the snow to keep from falling.

Figure 3: Anna is left buried in deep snow after falling from a cliff with Kristoff and Olof.

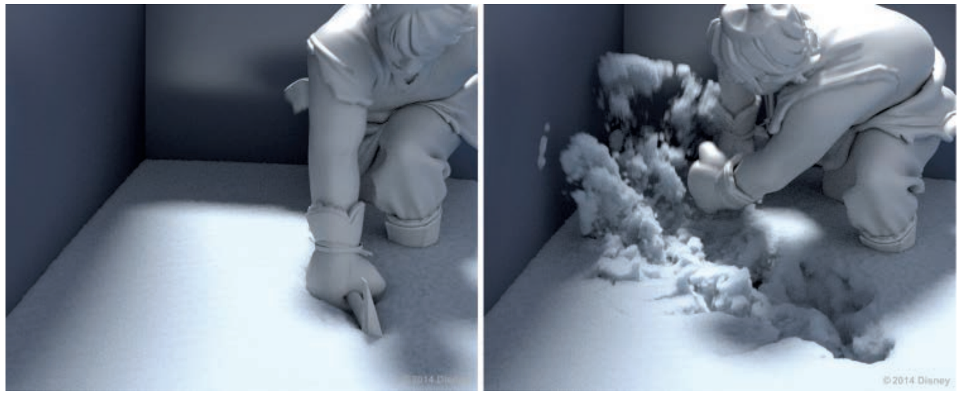


Figure 4: A test sequence from [1] demonstrates our algorithm's ability to simulate digging interactions with Kristoff.

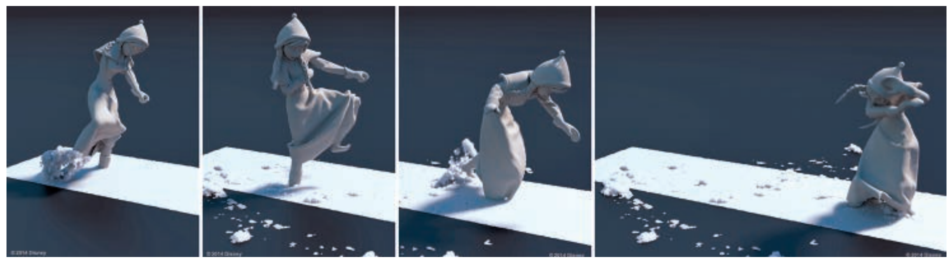


Figure 5: A test sequence from [1] shows our algorithm's ability to simulate characters walking in deep snow.

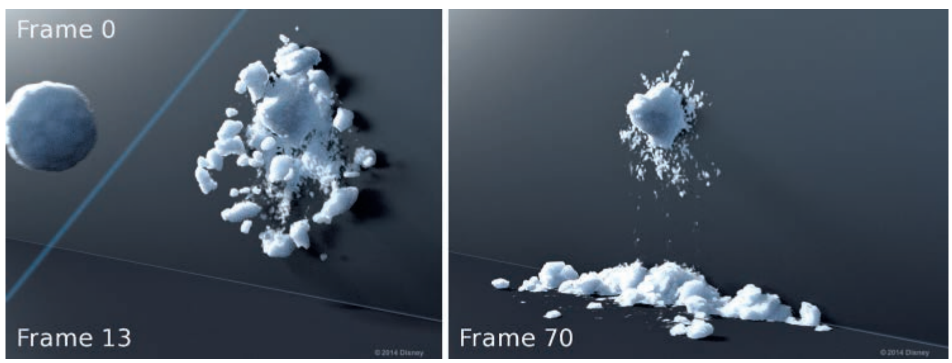


Figure 6: Topology change was essential to create the special effects needed in the movie. This image from [1] shows a test demonstrating this change with a snowball test.

that has historically required high-performance clusters can now be done on high-end commodity desktop workstations. Moreover, as the bar has been raised for increasingly realistic effects, physically based simulation has become not only tractable but an invaluable tool for creating realistic virtual worlds.

Until *Frozen*, snow dynamics had not been as important in the movies as other dynamics – clothing or smoke, for example. However, snow is an essential feature of this story and appears in nearly every scene. A novel numerical approach was required to produce dynamics that were convincingly realistic, especially as compared to the realism achievable in static snowscapes. The most challenging situations occur when characters are interacting with snow, for example, walking or digging in deep, wet snow. The importance of realistic dynamics in these scenarios is particularly evident when the camera zooms in on the character. A number of simplifications were used for snow dynamics viewed from far away (e.g. simple high field representations for foot prints augmented with rigid body dynamics and particle effects). However, a novel approach was required to produce sufficient realism for the "hero" shots in which the main characters interact with the snow in the center of the screen.

Character/snow interaction is ubiquitous in the film and often adds to the tension or comic relief in a scene. For example, in **Figure 1** Anna falls into deep snow and is buried after a large amount of snow falls from a tree. This was used for comic relief (and even appeared in the movie trailer). In **Figure 2**, Kristoff is being chased by a pack of wolves and is hanging from a ledge. The snow moves underneath him and he claws desperately at it to keep from falling. **In Figure 3**, Anna, Kristoff and Olof have all fallen off a cliff after being chased by an evil snowman, and Anna is left buried in deep snow.

Under typical conditions assumed in the movie, snow behaves as a granular material, obeying an elasto-plastic constitutive law. The material is elastic, up to plastic yield criteria, and it hardens under compression (e.g. packing a snowball makes it harder). This relationship closes a system of equations arising from classical continuum mechanics principles of conservation of mass and momentum. These equations are solved to reveal the time varying snow position and velocity used to animate the snow dynamics. Character and surrounding world interactions are imposed as boundary conditions. The system of PDEs is highly nonlinear and can only be approximated numerically. While there are dozens of methods for simulating granular materials in the computational solids and fluids literature, no previously existing technique was sufficiently suited to resolving the visual nature of snow dynamics in these conditions.

Some of the most important aspects of the snow dynamics involve topological change. Examples include such actions as digging in snow (**Figure 4**), characters walking through deep snow (**Figure 5**), and snowballs smashing against a wall (**Figure 6**). It was essential that we develop a numerical method capable of easily resolving such phenomena. Particle methods naturally treat topology change because the material is essentially always a disjointed collection of particles capable of interacting if they are in close enough proximity; there is no need to explicitly treat a split or merge scenario. Many particle methods exist in the computational physics literature. The

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focus on research

Scientific Computing in the Movies: Snow Simulation for Walt Disney's *Frozen*

The algorithm developed by UCLA mathematicians appeared in the 2013 proceedings of ACM SIGGRAPH conference on computer graphics. The SIGGRAPH meeting has thousands of attendees from the effects and video games industries as well as academia. Each year, its technical papers division showcases the most exciting new techniques in all of computer graphics. Notably, there is at least one session dedicated to computational fluid dynamics and one dedicated to computational solid dynamics every year.

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Material Point Method (MPM) [3], developed as a generalization of the Particle-in-Cell (PIC) [4] methods to solid mechanics, was a natural starting point. These techniques hybridize the particle representation with a grid-based representation to simplify numerical treatment of terms in the equations with spatial derivatives (other than those arising from advection).

For the scenes in the movie, our approach utilized a semi-implicit MPM technique capable of simulating millions of particles at a time. The implicit treatment of the elasticity in the material was necessary because explicit treatments required prohibitively small time steps (and therefore prohibitively long run times). Minimizing simulation time was critically important to the animators since they had to essentially art direct the numerical results. For a hero shot (like those in **Figures 1-3**), simulation times of up to a few days were tolerated. This was often aided with a few simulations at lower resolution used to predict the behavior of the simulator. Final high resolution simulations could then be done in a last pass.

Numerical methods often have a wide range of input parameters, including grid resolution, time step size, and material parameters. As mentioned previously, high resolution in space and large time steps are most desirable for producing visually detailed simulations; however, the space of simulations achievable by varying the material parameters is a little more complex. For our elasto-plastic model, there are essentially five parameters: Young's modulus, Poisson ratio, plastic yield thresholds (compressional and extensional), and hardening coefficient. The Young's modulus and Poisson ratio control the stiffness and incompressibility (respectively); the yield thresholds establish the critical amount of strain reachable before plastic flow; and the hardening coefficient controls how stiff the material gets under compression (equivalently, how weak it gets under extension). We explored a decent portion of this parameter space to treat a wide range of different snow types. We show a few possible behaviors achievable in **Figure 7**.

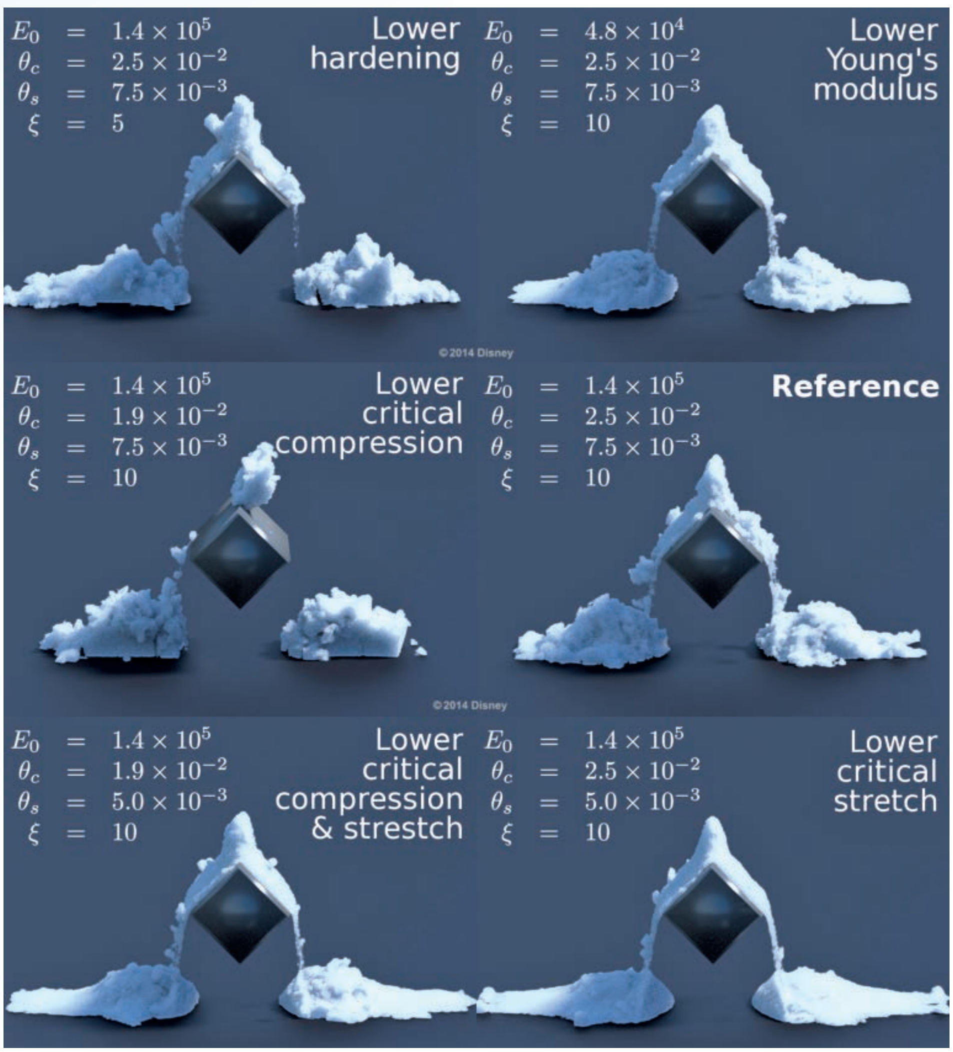

Figure 7: Snow under the conditions assumed in most of the movie is a granular material obeying an elasto-plastic constitutive law. The sequence above shows the types of snow achievable by varying the thresholds in our plastic yield criteria.

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[2] A. McAdams, J. Teran, S. Osher. "Crashing Waves, Awesome Explosions, Turbulent Smoke, and Beyond: Applied Mathematics and Scientific Computing in the Visual Effects Industry," *Notices of the AMS,* 57(5), pp.614-623, 2010.

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math education

IPAM Updates

"Math changes everything" is IPAM's new slogan, and in our programs over the past year and in programs scheduled for the upcoming year, you can see this slogan in action. The Fall 2013 program, Materials for a Sustainable Energy Future, brought together researchers from mathematics, science and engineering to design new materials for energy applications. A highlight was the combination of machine learning with quantum mechanics (i.e., density functional theory) resulting in better simulation methods at the atomistic scale. These methods are leading to better materials for demanding applications, such as waste heat recovery and more efficient photovoltaic solar cells.

At the other end of the pure – applied spectrum was the Spring 2014 program, Algebraic Techniques for Combinatorial and Computational Geometry, which assembled a remarkable group of mathematicians from many fields studying the new uses of algebraic methods for discrete geometry problems. A prime example is the Kakeya problem of finding the smallest set that contains a unit line segment in every direction.

The 2014-2015 academic year will offer two programs. One will focus on turbulence, an old and notoriously difficult subject. In mathematics, there has been some significant recent progress – for example on Lagrangian turbulence and formation of singularities for inviscid, incompressible flow. The second program on financial mathematics will examine new directions motivated by the financial crisis of 2007-2008. It will include topics such as systemic risk, high frequency trading, financialization of the commodities markets, and forensic analysis of financial data.

Russel Caflisch
Director, IPAM

THE CURTIS CENTER

With the adoption of Common Core Standards, California schools are changing the way they teach mathematics.

Training to Over 1,000 Mathematics Teachers

Curtis Center staff provided on-site mathematics training to over 20 school districts through the academic year and conducted targeted training at the annual conference, summer institutes and Saturday workshops. The annual conference gathered a record 420 teachers, math specialists, district math leads, university educators, and other mathematicians to the Department for a day of math, pedagogy, and educational research talks. Six four-day summer institutes offered introductory and advanced workshops on the Common Core Standards for elementary, middle and high school teachers, resulting in over 200 attendees increasing their understanding of the standards.

Helping to Develop New End-of-Year Mathematics Exams

The Curtis Center contracted with the Smarter Balanced Assessment Consortium (SBAC), which is producing end-of-year exams aligned with the Standards for about 19 million students across 22 states. The Center will be assisting with SBAC's Mathematics Reasoning Project to develop exam items that focus on justification and application, as opposed to solely computation.

California Mathematics Project

The California Mathematics Project (CMP) continues to develop and enhance K-12 teachers' content knowledge and instructional strategies in alignment with the math Standards and with English Language Development (ELD) Standards. In 2013, over 1,000 schools and nearly 7,000 teachers and other educators were served by CMP's 19 regional sites, including UCLA.

Mathematics Diagnostic Testing Project

As one of 10 Mathematics Diagnostic Testing Project (MDTP) sites in California, UCLA provides materials and services geared to informing secondary math educators about the strengths and weaknesses of their courses and students. Current efforts are supporting teachers' transition to the Standards.

Math Circle

■ Continuing its growth and popularity, the weekly UCLA Math Circle program attracted over 200 students of all ages to UCLA this academic year. Sessions were taught by over 20 UCLA graduate and undergraduate students. A highlight was the newly established Olympiad training, which targeted the most advanced students. This training was conducted by International Math Olympiad winner, Tudor Padurariu. ■ Special events for parents included a roundtable with long-term donors Judy and Roy Glickman. ■ During the summer session, the Math Circle opened its doors to over 100 new members in order to address its growing wait list. Several advanced math circle students enthusiastically volunteered to teach in the summer and became favorite instructors for many younger children.

All Curtis Center professional development focuses on improving mathematical knowledge of teachers and on providing pedagogically sound suggestions for sharing the content with their students.

Welcome From the New Graduate Vice Chair

It is my pleasure to thank my predecessor, Paul Balmer, for the excellent job he has done in the last two years. As the new graduate vice chair, I hope to contribute to maintaining our Department's reputation as one of the leading graduate programs in the country and worldwide. With an ever tightening and competitive funding situation, this will be challenging. I am confident, though, that the scholarly prominence of our faculty, aided by the administrative skill of our staff, will keep attracting some of the best and brightest students to our program.

We have much to offer: a vibrant research environment and a dedication to prepare our students for their future careers. Our success is measured by how our students thrive after graduation. My colleagues will agree with me that we are all looking forward to working with the incoming class, and we are eager to share with our new students what we are passionate about – mathematics.

2014 Graduate Students Take Flight

Beren Sanders *to University of Copenhagen*

Born overseas to Australian parents, Beren lived all over the world as an expatriate kid. Fortunately, he managed to survive the culture shock when, as a teenager, his family "returned" to Australia. Growing up, Beren loved three things: skateboarding, playing bass guitar, and programming his computer. After playing with the idea of becoming a jazz musician, he entered the University of New South Wales to study computer science. "I didn't even consider majoring in mathematics because I had some bizarre idea that math professors were geniuses. On the other hand, there was some awareness of mathematics in my household because way back in the day, my father had started a PhD in applied math. But he dropped out to go meditate in India."

While pursuing his computer science degree, Beren thought that in order to be successful at "hardcore" computer science research he had better know as much math as possible. By the time he got to the university courses on Banach spaces and Galois theory, the beauty of pure mathematics had Beren enthralled, and he knew it was time to leave the computers behind.

At UCLA, Beren took standard courses in number theory, algebraic geometry and homological algebra. He discovered that he liked the more categorical and Grothendieckian approaches to mathematics and ended up convincing Paul Balmer to take him on as a student. In this way, he was exposed to triangulated categories, tensor triangular geometry, and abstract homotopy theory. He is very happy to find himself at this particular place on the mathematical landscape, and looks forward to his postdoc at the University of Copenhagen.

Benjamin Hayes *to Vanderbilt University in Nashville*

Growing up in Mount Vernon, Washington, Ben was always interested in math, so it was no surprise when he decided to declare mathematics as his undergraduate major at the University of Washington. He worked for two years on an undergraduate research project with Doug Lind on algebraic problems applied to ergodic theory, which would eventually convince him to study analysis. "The research was very algebraic, and I was also taking many analysis courses in school. The algebra involved in the project was difficult to intuit, so I began to use analytic intuition to solve the problems. I decided that if all my intuition was coming from the analytic side of things, maybe I should just do analysis."

When Ben arrived at UCLA, he wasn't sure if he wanted to be in the harmonic or functional analysis group. After attending both seminars, he decided to join the latter. He took the operator algebras course over the last two quarters of his first year, despite having little background in the subject. Dimitri Shlyakhtenko (his future advisor) taught the last quarter, and they started a reading course together. “We read this paper by Lewis Bowen on sofic entropy, which vastly generalized previous work. I only knew a small amount about entropy from my undergraduate experience but could see that this was an important paper.” Ben continued to work on problems related to sofic entropy and the intersection of operator algebras and ergodic theory throughout graduate school. Ben is grateful for the support of the functional analysis group, as well as the welcoming attitude they bring to new students. He will be part of the operator algebras group at Vanderbilt University in Nashville and is excited to work with the excellent team of operator algebraists there.

Tijana Kostic *to Microsoft Bing at Sunnyvale*

Tijana first became interested in mathematics as a fourth grader growing up in Serbia when her father presented her with a book of math and logic puzzles. “Before that, math seemed like a dry subject – addition and subtraction devoid of any creativity. In the years that followed, my love and interest for mathematics grew.” Tijana eventually began competing in math and won a medal in the International Mathematical Olympiad.

She was introduced to applied math as a high school senior when she took a course in numerical mathematics. Tijana immediately fell in love with the power and elegance of the subject and one year later enrolled at the University of Belgrade, Serbia, as an applied math major. Numerical mathematics and optimization were the main focus of her undergraduate studies, but she enjoyed a variety of other math subjects as well. After graduation, she entered a master’s program and did a research project in operations research, ultimately deciding to pursue a PhD in applied mathematics.

While searching for a PhD program that would best fit her research goals, Tijana stumbled upon a paper by Andrea Bertozzi and a former grad student on image inpainting. “I realized that was the kind of mathematics I wanted to do – where interesting math meets a real world application, and the results are easy to explain to people with no mathematical background.”

As a graduate student under Andrea Bertozzi, Tijana’s work centered around devising numerical algorithms that would cut the computational cost of state-of-the-art techniques. Applications of her research work include image inpainting, data classification, and crime modeling.

Tijana is joining Microsoft Bing at Sunnyvale as a software development engineer on the ranking team. The expertise in optimization that she gained as a PhD student will be invaluable in tackling problems in her new position.

Math Student Receives Charles E. and Sue K. Young Graduate Student Award

Math graduate student Kaitlyn Hood, studying under Marcus Roper, has been awarded a prestigious 2013-2014 Charles E. and Sue K. Young Graduate Student Award by the UCLA College of Letters and Sciences. Given to six students annually (three graduate and three undergraduate), the award acknowledges students’ academic achievements, research and service to the University and community.

Says Kaitlyn:

My research involves modeling the effects of inertia in microfluidic devices. In collaboration with Dino di Carlo’s lab in bioengineering, we are trying to understand and predict particle movement in tiny channels. Our ultimate goal is to build software that can be used to design microfluidic chips. These chips have many medical applications, for example automating blood tests to diagnose cancer. This research is interesting because it is predictive and has promising applications, while at the same time it asks simple, fundamental questions.

Kaitlyn’s service activities focus on increasing the representation of minorities and women in the STEM fields (science, technology, engineering and mathematics). She was a cofounder of the (unofficial) women in mathematics group at UCLA. Other activities include AWiSE Empow-Her STEM Day, 2013 Exploring Your Universe, 2014 Intel International Science and Engineering Fair, and 2013 Ada Lovelace Wikipedia Edit-a-thon, in addition to Departmental recruitment and mentoring activities.

graduate news

Special Awards Honoring our graduate students

Every year the Department celebrates outstanding graduate students and faculty. Here are this year's awards and honored faculty and students:

■ **Sorgenfrey Distinguished Teaching Award** Kefeng Liu ■ **Department Teaching Award** William Conley, Stephen DeSalvo, Aliki Mavromoustaki ■ **Richard F. Arens Putnum Scholars Award** Tudor Padurarui ■ **Horn-Moez Prize for Excellence in First-Year Graduate Studies** Yilong Yang ■ **Beckenbach & Dissertation Year Fellowship Award** Giang Tran, Ashay Burungale, William Feldman, Huiyi Hu, Jukka Keranen, Yajing Liu, Ekaterina Merkurjev, Brent Nelson ■ **Heaviside Wealth Management Award** Benjamin Hayes ■ **Basil Gordon Prize** Peihao Sun

Pacific Journal of Mathematics Awards Go to Three UCLA Math Graduates

Founded in 1950 by professors Edwin Beckenbach of UCLA and Frantisek Wolf of UC Berkeley, the *Pacific Journal of Mathematics* (PJM) publishes original research in mathematics through a consortium of Pacific Rim universities. The managing editorship of the journal has always been held by a member of the UCLA faculty, the first being Edwin Beckenbach and currently, Don Blasius.

In recognition of the Department's long-term support of PJM and in pursuit of its mission to encourage research in mathematics, the journal awarded cash prizes to three of this year's PhD graduates for their outstanding research. The awardees of the 2014 Pacific Journal of Mathematics Dissertation Prize are Feng Guan, a student of Kefeng Liu, for the dissertation "Affine structures on the Teichmuller spaces and period maps for Calabi-Yau manifolds"; Lee Ricketson, a student of Russel Caflisch, for the dissertation, "Two approaches to accelerated Monte Carlo simulation of Coulomb collisions"; and Paul Skoufranis, a student of Dimitri Shlyakhtenko, for the dissertation, "Approximations in operator theory and free probability."

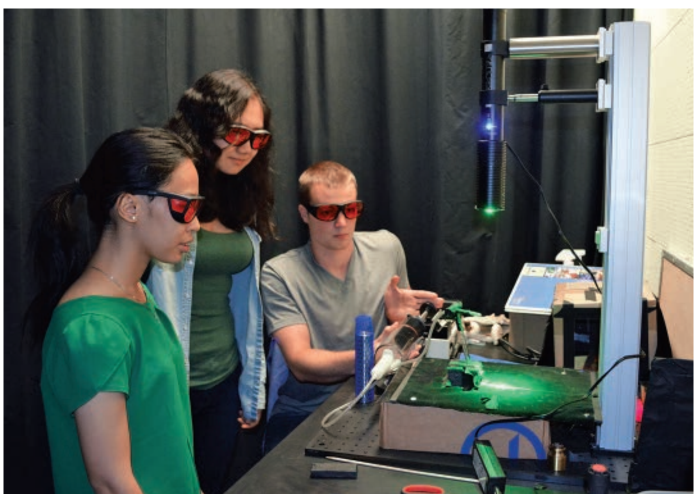
Congratulations to all three!

undergraduate news

2014 Summer REU Groups

The NSF Research Experiences for Undergraduates Students (REU) program engages students during the critical transition from undergraduate to PhD study in high quality university level research. Students have the opportunity to collaborate with faculty in mathematics, medicine, anthropology, engineering, chemistry, and other disciplines. At UCLA, students have participated in summer research modules on crime modeling, fluid dynamics experiments and modeling, robotics and control, medical imaging, cancer stem cells, bone growth, remote sensing applications, alcohol biosensors, photovoltaic cells, and algorithm design for microscopy. The following are three of several projects UCLA Math supported in 2014.

Modeling the Growth and Spread of New Fungal Diseases

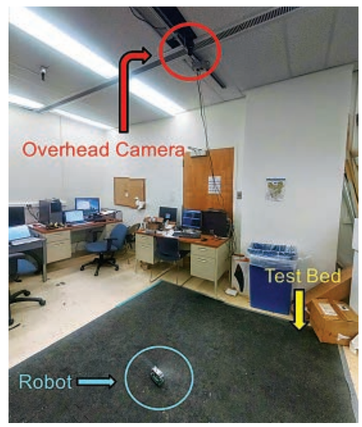


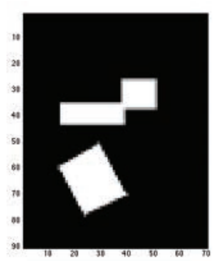
UCLA undergraduates Nhu Phong, Boya Song and Michael Tomasek use a laser and a syringe pump to recreate the air flows that disperse fungal spores.

In the bowels of the math sciences building, UCLA undergraduates subjected fungi to wind tunnels, lasers and genetic modification. As part of the Applied and Computational Math REU program (or alternatively working with Marcus Roper), students learned to harness microbiology and math to study how fungi grow, deal with environmental stress, and move across landscapes. Math majors worked with students drawn from across UCLA to do things such as write algorithms for interpreting fluorescence microscopy and dissect micron-sized spores of a genetically modified fungus to test a mathematical model.

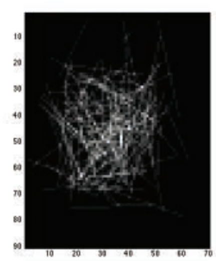
Why are mathematicians interested in these problems? Modeling the growth and spread of new fungal diseases requires developing new mathematical models and data analysis techniques. Mathematicians have a lot to contribute to efforts to control newly emergent fungal and fungal-like diseases, such as sudden oak death syndrome, which has infected over a million oak trees across California. The group's aims were to learn how, over a billion years of evolution, fungi have learned to solve mathematically challenging problems – like how to wire networks to reduce congestion and increase mixing – with an eye on co-opting these strategies to build better freeway networks and power-grids.

Environmental Mapping and Autonomous Robots

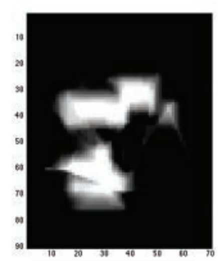




Actual test bed pattern



Paths traversed by robot. Note that only a single piece of data, the integral (weighted sum) of the sensor readings, was collected on each path.



Map of test bed pattern reconstructed from robot data

In recent years, the fields of robotics and signal processing have seen significant progress. In particular, the development of compressed sensing, a technique for recovering signals using relatively few measurements compared to the size of the signal being reconstructed. The Environmental Mapping and Autonomous Robots REU group set out to combine these advancements by building a simple robot that could map its own environment using compressed sensing.

Working in UCLA's Applied Mathematics Laboratory, students constructed a simple robot vehicle using commercially available parts. Tracked by

continued on page 16

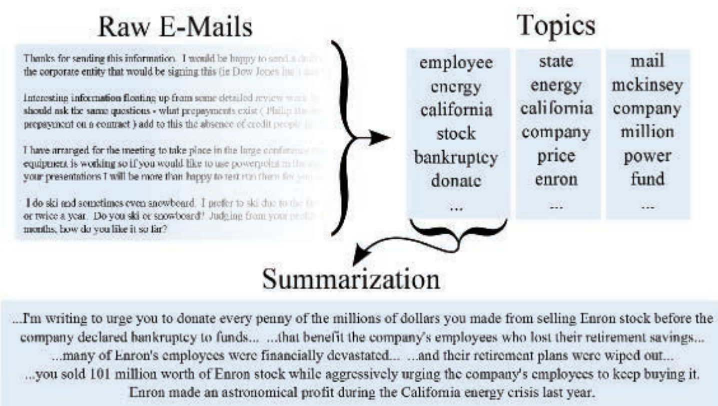
undergraduate news

2014 Summer REU Groups

continued from page 15

an overhead camera and with a sensor pointed down at the environment, the robot was programmed to travel in straight lines and collect data by integrating sensor readings. Compressed sensing was then applied to the data, reconstructing the environment from the robot's point of view with fewer measurements than would have been otherwise needed. The project's goal was to demonstrate, using real hardware, the viability of using compressed sensing to map environments. The results can be applied to robot submarines that map the ocean or robot swarms that map out a field of crops.

Designing Data Analysis Techniques



The large document collection can be summarized with two steps. First, the documents are decomposed into latent topic distributions over words. Each topic is then summarized by finding important sentences.

The collapse of the Enron Corporation in 2001, a result of the actions of a few key individuals' fraudulent financial practices, ended with one of the largest bankruptcies in U.S. history. The ensuing investigation led to the public release of over 500,000 company e-mails generated by over a hundred employees during the final years of the company's existence. This summer's Big Data II REU project utilized a multitude of powerful mathematical tools to better understand the detailed structure of this data. The students studied a modification of a probabilistic topic analysis algorithm revealing the complex temporal behavior of topics across the data set. These patterns included spikes of activity around events such as mergers and the California energy crisis. More work by the students produced topic summaries that vastly improved the interpretability of these topic modeling results. Additionally, by combining existing techniques, such as PageRank and point-process models in interesting ways, the students were able to model detailed social relationships. The students found that the temporal activity of these social structures further illustrated detailed events such as promotions and retirements. The complexity of the Enron e-mail collection is impressive, but even more so is the demonstrated effectiveness of properly designed data analysis techniques by this REU team.

Commencement Features Former Vice Chairman of General Motors

Steve Girsky (BS 1985) followed up his 2014 commencement address for graduating math students with a generous gift to the Department, establishing the Girsky Student Awards Fund. At the chair's discretion, the award will be used, Department-wide, for a wide range of undergraduate and graduate student needs, such as scholarships, TA support, and recruitment.

In addition to his undergraduate degree in math from UCLA, Steve earned an MBA from Harvard University. Over his notable career, he has accrued more than 25 years of automotive experience, culminating in the vice chairmanship of GM from March 2010 to January 2014. In this position, he had overall responsibility for global corporate strategy, new business development, global product planning and program management, and global research and development. He also had management responsibilities for GM's global connected consumer/OnStar and GM Ventures LLC and served as chairman of the Adam Opel AG Supervisory Board.

Thank you Girsky family!

To view his commencement address visit: http://www.math.ucla.edu/news/2014-ucla-math-commencement-keynote-speaker.

Awards for Outstanding Undergraduate Achievement

Daus Prize

Francisc Teodor Bozgan
Kun Dong
Derek Joseph Jung
Deven William Ware

Sherwood Prize

Wuhan Lin

Outstanding Actuarial Science Student Award

Honglun Wu
Panqian Xu

alumni news

Math Alumna and Author Launches New Web Series

Danica McKellar (center) is an actress, a *New York Times* bestselling author, a UCLA math graduate, and an advocate for math education. Danica has just launched a new web series, "Math Bites," on the Nerdist Channel, teaching viewers of all ages about math essentials in a fun and informative way.

What is your goal for the "MathBites" web series, and where did you get the idea?

Through my books I have enjoyed making math entertaining and accessible for years now. I thought it could be fun to do the same kind of thing on video. Chris Hardwick [CEO of Nerdist Industries] told me to do 'whatever kind of math show' I wanted. I had started to write a π song – yes a song including the many digits of π, 139 of them to be exact – sung to the tune of 'Dance of the Sugar Plum Fairies.' I thought, if I'm going to do a fun math show then this π song must be part of it, and it all grew from there.

Do you help write the material and lessons?

I wrote the first draft of all the episodes. Then comedy writers inserted jokes, and I did a final pass on all the scripts to make sure the math element was still being represented correctly.

How did you become a successful writer?

When I took a break from acting to get my math degree, I had no idea what I would do with it. I didn't know if I would ever use my math skills again. So I was thrilled when I got the opportunity to be an author of entertaining math books. It was like I'd been preparing to do that my entire life. I'm an entertainer, and I love math, so why not write entertaining math books? It was a natural fit.

Advice to current math students and recent graduates?

Math needs better press! I think it's our duty to show the world just how fun and outgoing math majors can be. Most people don't have nearly our knowledge of math, and it's a real advantage in the workplace, so make sure your potential employers know about your math degree.

If you have news to share with the Department, please contact Anna Ramos at anna@math.ucla.edu.

First Annual Math Alumni & Friends Mixer

This year the Math Department hosted its first ever Alumni & Friends Mixer. Roughly 50 people attended, enjoying cocktails and appetizers, networking, and reconnecting with the Department. Be on the lookout for more alumni activities to come!

Vannevar Bush Award to UCLA Alumnus

Richard Tapia (PhD 1967) was awarded the 2014 Vannevar Bush Award by the National Science Board (NSB). Richard is currently a mathematician in Rice University's Computational and Applied Mathematics Department. His research on computational optimization is highly regarded, as is his strong mentorship of women and minorities in engineering and mathematics.

alumni news

The Ferriss Project: Imagining the 21st Century Metropolis

A major philosophical tenet held by designers of 20th century metropoleis was the assumption that through sufficient process and quality control, one could build infrastructure systems that would not fail – or it was implicitly assumed that future thinkers would solve the problem of failure. In the 21st century, this approach must be questioned as it has encouraged us to build some very high risk systems with no blueprints for handling catastrophic failure.

Now that we know we have to plan for failure, the 21st century is likely to be dominated by the management of risk. The time frame may be 100 years, but all critical systems fail with finite probability and potentially calamitous effects. We must question the propriety of developing high risk systems that have no failure resolution.

The Ferris Project was launched in order to generate ideas and stimulate discussion on the future of cities. Such issues may take decades or even generations to solve, and they are often pushed aside indefinitely in favor of more present concerns. One key topic is the potential failure of our infrastructure. A central question that we must ask and answer: Have these systems outstripped the capacity of human intelligence to manage and control them? Are systems becoming more complex than our minds?

Our infrastructure systems are increasing in complexity with every decade. Yet the average human intelligence may not be increasing, at least not at the same rate. These two divergent trends point to a future where a vanishingly small portion of our population will be capable of intelligently planning our future city infrastructures, fixing the failures, and managing the risks. This will lead to unresolved arguments and debate among decision-makers who may not be able to grasp the necessary information to solve the problem.

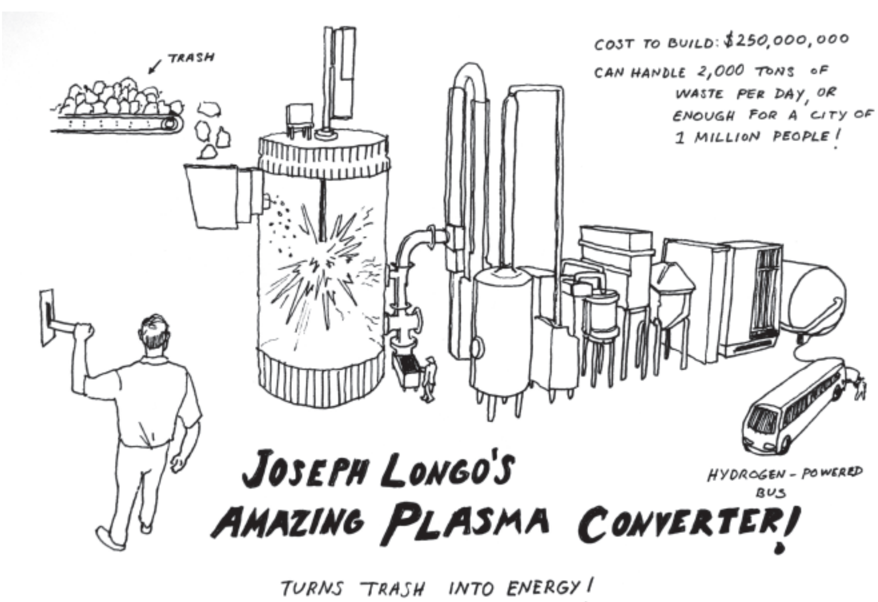
In order to address the complexities of infrastructure systems, our arguments are also becoming more complex. To resolve them, the parties involved must have an understanding of the relevant data, an increasingly challenging endeavor. Adding complexity is the fact that human emotional response can impair logical thought in certain arguments. What if there are debates that human populations will never solve, given that we cannot comprehend the data or even remain calm enough to process the information needed for resolution? This specter of interminable conflict already exists for us in other ways in the 21st century, raising the potential for our civilization to regress by hundreds of years.

With the growth of technology, the power of a single individual to create or destroy increases. One average person (by accident or intent) could incapacitate an entire metropolis. We need to ensure that this does not happen. What limitations to privacy, freedom and quality of life are we prepared to accept in order to effectively manage this risk?

In the face of these eventualities, are there ways that populations can become more intelligent or at least more successful at conflict resolution? Perhaps a goal may be to train people for complex argument. Consider what is at stake: Even one extra problem resolution per day per person could benefit a population of millions.

It would seem advisable that some effort should be spent brainstorming the problems that will arise in the future metropolis. The purpose of the Ferriss Project is to use artwork and literature to start conversations that may someday end in solutions that avert a future dystopia.

For more information about The Ferriss Project or to contact Alan Gillette, please email Anna Ramos at anna@math.ucla.edu.



Hugh Ferriss – Imagining a City of Tomorrow

In 1929, architectural illustrator Hugh Ferriss published *The Metropolis of Tomorrow*. His dreamlike renderings of futuristic cityscapes and his thoughtful commentary became an artistic visage of a city of the future. During the 1930s and '40s, as architects searched for source material, Ferriss' book and his ideas were never far from hand. So pervasive was his influence that by the 1940s, New York and Chicago had come to closely resemble many of the sketches in the book. Ferris effectively seeded the architectural idea space with his vision of future cities, and his influence continues to this day.

Alan Gillette (PhD 2006) is the founder of The Ferris Project as well as founder and Chief Investment Strategist for Heaviside Wealth Management, LLC, a bond investment and income planning firm.

our donors

July 1, 2013 – June 30, 2014*

We are pleased to thank and acknowledge our many supporters.

Gifts of three digits and above made after June 30, 2014, will appear in our fall 2015 newsletter

**Does not include payments on existing pledges*

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Dear Friends, Colleagues, Students and Alumni:

I am very happy to be sharing with you the latest issue of our departmental newsletter. UCLA Math has continued its steep upward trajectory. The latest *U.S. News and World Report* rankings put our graduate program as #7 in the country, and in the top 10 in every sub-field of mathematics, including #1 in analysis and #2 in logic and applied mathematics. In the 2014 Academic Ranking of World Universities, our Department was ranked #5 in the U.S. and #9 in the world. These rankings confirm what we all knew all along: UCLA is the place to be in mathematics!

This year, our faculty members received multiple honors and distinctions. Let me single out just two. Professor Terence Tao was named a winner of the $3 million dollar inaugural Breakthrough Prize in Mathematics. And Professor Stanley Osher received the Gauss Prize, the most prestigious prize in applied mathematics. Congratulations to both of them!

This year also marked the loss of two of our faculty members. Professor Emeritus Robert Steinberg, one of the great mathematicians of our time, passed away in May. He had enormous impact on generations of students and faculty in our Department. And in August, we lost another colleague, Professor Geoffrey Mess. They will both live in our memories.

Two of our colleagues, professors Veeravalli Varadarajan and Tony Martin, retired this year. Next summer, we will be joined by two new faculty members, Andrew Marks and Michael Hill, in our logic and geometry/topology groups, respectively.

Let me conclude by thanking Paul Balmer, our outgoing graduate vice-chair, for his very successful two years of service. I am also very grateful to Mario Bonk who agreed to step in as Paul's replacement.

Finally, I want to express our deep gratitude and appreciation to many of you, whose kind support has been instrumental to our success.

Sincerely,

Dimitri Shlyakhtenko

UCLA Department of Mathematics
Fall 2014 Newsletter

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