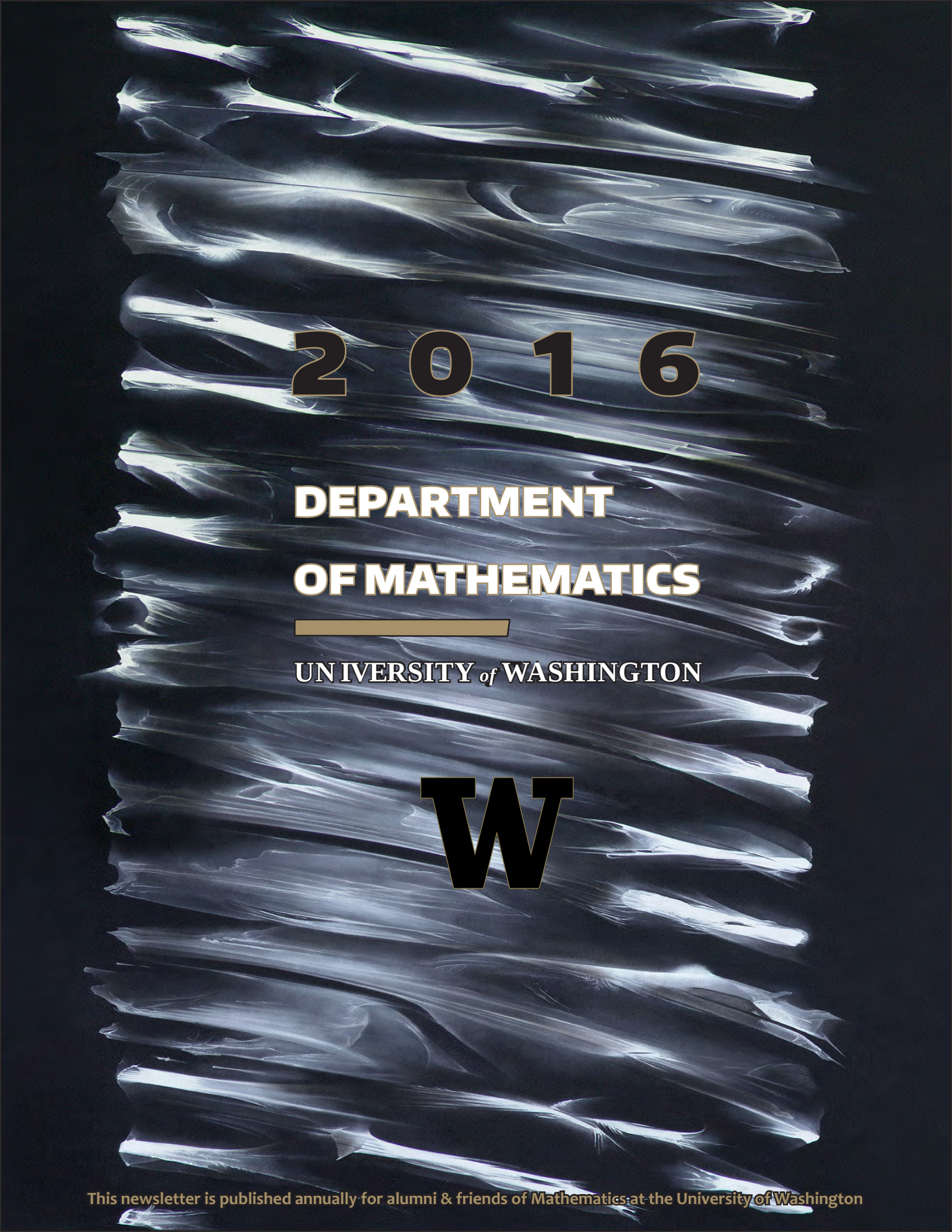


2016

DEPARTMENT OF MATHEMATICS

UNIVERSITY *of* WASHINGTON

This newsletter is published annually for alumni & friends of Mathematics at the University of Washington

Message from the Chair

I've got sunshine on a cloudy day.

Half a century ago, the Temptations' David Ruffin opened the nation's number one song with that line. I happily sang along, even if the source of that sunshine, "My Girl," was not yet on the horizon. After all, I did have mathematics, and for me, as for mathematicians around the world, this indeed makes every day sunny, for we inhabit a world of wondrous objects and ideas. We are blessed.

With this blessing comes responsibility, the responsibility to share our luminous world with others and strive to ensure that anyone with interest and motivation has access to it. Members of our department do this daily, through our teaching. And we do it as well through the many outreach programs that we offer within the community, such as the annual Mathday Jim Morrow has long overseen that brings 1500 students and their teachers to campus each year and the Math Circle program Julia Pevtsova runs for middle schoolers in the region.

Our newest outreach program—the Washington Experimental Mathematics Lab, or WXML—is rapidly becoming an integral part of department life. Established by Jayadev Athreya when he joined our faculty last year, WXML centers on quarterly lab projects for undergraduates. Little background is required. Calculus suffices. And the participants need not be math majors. They need only have an interest in mathematical exploration. Lab projects, each suggested by one of our faculty, involve research and mathematical visualization. The faculty member leads a small team of undergraduates with the assistance of a graduate student, and each team is asked to contribute to mathematical research while also making their work accessible to the general public. This dual nature of research and public outreach gives WXML its distinctive character. As WXML grows, it will expand its efforts to work with schools and the community in order to bring mathematical exploration to diverse groups.

Bringing mathematics to diverse groups is built into the department's Diversity Commitment, a statement prepared three years ago by our Diversity Committee under the leadership of Tatiana Toro and approved by the faculty. The statement, which is posted on our website, concludes with, "A mix of individuals contributes diverse perspectives which enrich the intellectual environment. Science in general and mathematics in particular benefit when confronted with input from different sources. Moreover, a department whose constituency reflects society is in a better position to serve the community at large. We acknowledge the important need to overcome barriers to the recruitment, retention, and advancement of talented students and faculty from historically underrepresented groups."

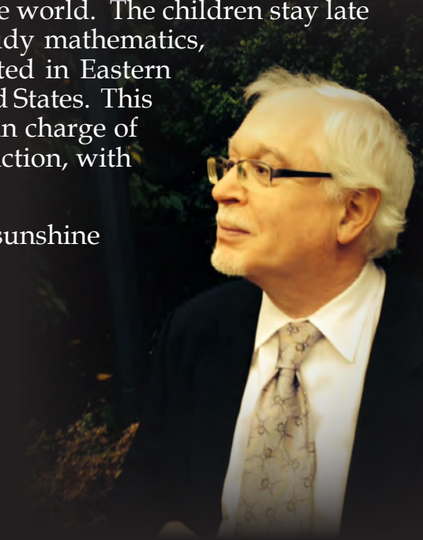
When it comes to introducing people to mathematics' radiant beauty, we have the good fortune that the cost is low. Little or no equipment is required. One inevitably thinks in this regard of the Indian mathematical genius Ramanujan, largely self taught, who had the good luck of choosing to write to the English mathematician G.H. Hardy in 1913. Hardy was so taken by Ramanujan's novel ideas that he had Ramanujan come to Cambridge the next year to collaborate. (For more on this, see the recent movie *The Man Who Knew Infinity* or read Robert Kanigel's book on which it was based.) Ramanujan was unique, but the larger lesson is that potential mathematicians are everywhere. It is our responsibility not just to teach those who come to our door, but also to provide opportunities for those less visible.

And so we do. Neal Koblitz has traveled the world—Vietnam, Peru, South Africa, and more—to bring mathematics to schoolchildren. Tatiana works with UW's College Assistance Migrant Program, which is funded by the US Department of Education, as an advisory board member and student advisor. This quarter, she is teaching calculus so that she can welcome students from the newest CAMP cohort to her class. She is also beginning preparations for the 2018 successor to the Latinos in the Mathematical Sciences Conference she ran last year at the Institute for Pure and Applied Mathematics (an NSF Math Institute at UCLA) that showcased achievements of Latinas and Latinos in the mathematical sciences.

I mentioned Julia Pevtsova's Math Circle. You may enjoy learning more about an allied program, the Navajo Math Circles, which attracts mathematicians to schools in the Navajo Nation to work with students and their teachers. One component of the program is a two-week summer camp, in which Jayadev participated last summer. I recommend viewing the film Navajo Math Circles, which had its world premiere here in Seattle last January at the annual Joint Math Meetings and was shown on PBS in September. As the blurb for the film explains, "Hundreds of Navajo children in recent years have found themselves at the center of a lively collaboration with mathematicians from around the world. The children stay late after school and assemble over the summer to study mathematics, using a model called math circles, which originated in Eastern Europe and which has proliferated across the United States. This notion of student-centered learning puts children in charge of exploring mathematics to their own joy and satisfaction, with potentially long-lasting results."

We really are blessed. What a delight it is to bring sunshine to others!

-Ron Irving



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Editors: Ron Irving and John Sullivan Layout: Rose Choi

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Milliman Lectures

Each year, the Department invites a distinguished mathematician to deliver a series of three lectures and participate for a week in department life. Support for the visit is from a departmental endowment in the name of Wendell Alfred Milliman, founder of one of the largest actuarial firms in the country. Below are descriptions of our two most recent Milliman Lecturers and their talks.

May 2016
CURTIS T. McMULLEN
Cabot Professor of Mathematics
Harvard University

Curt McMullen works across many fields of mathematics, including complex dynamics, hyperbolic geometry, and Teichmüller theory. He gave a series of three lectures on unexpected interactions between low-dimensional dynamics, complex analysis, and algebraic geometry. Their titles were Billiards and Moduli Spaces; Entropy, Integers and Algebraic Dynamics; and Surfaces in the Space of Surfaces. His many awards include the Salem Prize, a Fields Medal, and election to the National Academy of Sciences.

October 2016
FAN CHUNG
Distinguished Professor of Mathematics & Computer Science
University of California, San Diego

Fan Chung did research at Bell Labs for many years, heading the Mathematics, Information Sciences and Operations Research Division at its successor Bellcore before moving back to academia. She recently retired from her position at UC San Diego as a professor in Mathematics and in Computer Science and Engineering, and holder of the Akamai Chair in Internet Mathematics. Her research interests are primarily in graph theory, combinatorics, and algorithmic design. Professor Chung's three lectures were titled Can you hear the shape of a network—New directions in spectral graph theory; Sequences: random, structured or something in between; and Semigroup spectral theory and graph coloring games. She received the Allendoerfer Award of the Mathematical Association of America and is a member of the American Academy of Arts and Sciences.

Walker-Ames Lecture

The UW Graduate School sponsors several public lecture series each year, including the Walker-Ames lectures, which bring many outstanding scholars in the academic profession to campus. These scholars present lectures about their respective fields of expertise and work with groups of graduate students during their stay. The series is funded by a bequest established in 1936 from the estates of Maud Walker Ames and Edwin Gardner Ames.

In November, the series featured a dynamic father-son duo: Martin and Erik Demaine. Martin started the first private hot glass studio in Canada and has been called the "Father of Canadian Glass." Since 2005, he has been an artist-in-residence at the Massachusetts Institute of Technology. Erik is also at MIT, as a professor of computer science. He received a MacArthur Fellowship in 2003 as a "computational geometer tackling and solving difficult problems related to folding and bending—moving readily between the theoretical and the playful, with a keen eye to revealing the former in the latter."

The Demaines like to blur the lines between art and mathematics, by freely moving from designing sculpture to proving theorems and back again. Paper folding is a great setting for this approach, as it mixes a rich geometric structure with a beautiful art form. Mathematically, they are continually developing algorithms to fold paper into any desired shape. Sculpturally, the duo has been exploring curved creases, which remain poorly understood mathematically, but have potential applications in robotics, deployable structures, manufacturing, and self-assembly. By integrating science and art, they constantly find new inspirations, problems, and ideas: proving that sculptures do or don't exist, or illustrating mathematical beauty through physical beauty. Collaboration, particularly as a father-son team, has been a powerful way for them to bridge these fields.

MathAcrossCampus

Founded in 2008, MathAcrossCampus (MAC) is a quarterly lecture series sponsored by the Department that showcases applications of mathematics to a campus-wide audience. It is run by Professors Ioana Dumitriu, Christopher Hoffman, and Rekha Thomas, with help from a rotating group of graduate students.

The goals of the series are to expose students and faculty to applications of mathematics in a wide array of disciplines and to build a community of mathematics users at UW by creating awareness of mathematical work done by colleagues and students on campus. Each year, three speakers are featured, with one typically from UW. Topics have ranged from the mathematical sciences to the social sciences and the arts. MAC talks routinely attract an audience of 150 to 200, including a large number of undergraduate students as well as faculty from multiple departments.

This past autumn, Cornell's David Shmoys spoke about the mathematical models behind Citi Bike, the bike sharing system in New York City. Other researchers who have spoken in the series include David Baker (Biochemistry, UW), Tom Daniel (Biology, UW), Dave Kung (Mathematics and Music, St. Mary's College), Simon Levine (Mathematical Ecology, Princeton), Roger Myerson (Economics, University of Chicago), Taylor Perron (Earth, Atmospheric and Planetary Sciences, MIT), Dan Spielman (Computer Science, Yale), Elizabeth Thompson (Statistics, UW), and Margaret Wright (Optimization, NYU).

MAC has been funded by the Department of Mathematics, the College of Arts and Sciences, the National Science Foundation, the National Security Agency, and the Pacific Institute for the Mathematical Sciences.

Remembering
Harry Corson

FEBRUARY 2, 1931 – DECEMBER 20, 2015

Harry Corson died on December 20, 2015, after a long struggle with Parkinson's disease. Harry was born in Nashville and earned his undergraduate and Master's degrees in physics from Vanderbilt University, going on to Duke for his PhD in mathematics. After spending a short time at Tulane, he came to UW in 1959. As described in his obituary, "Harry was a raconteur, inspired mathematician, gardener, superb tennis player, golfer, runner, biker, walker, and he could do a perfect head stand. He could be seen biking, running or walking all over Laurelhurst and Seattle long before outdoor exercise became generally popular. He was a southern gentleman who adopted Seattle as his home, living there happily for 50 years. Harry was a brilliant and lovable eccentric and his family and friends will miss all aspects of his personality and presence."

Below are reflections on Harry from colleague Jim Morrow:

Harry Corson was my first and best friend in the UW Math Department. Harry received his PhD in 1957 at Duke University. His thesis advisor was Leonard Carlitz, who I believe helped instill in Harry the importance of originality. Harry's thesis was on systems of equations in a finite field, but he soon became interested in a variety of problems, most of them in analysis. He wrote papers with many of our colleagues: Bob Blumenthal, Irv Glicksberg, Ernie Michael, and others. He loved to talk mathematics with anyone. He and I didn't share a common research interest, but we had daily conversations about all of mathematics.

My fondest memories of Harry were as a family friend. He and his wife Carolyn essentially found a house for us in Laurelhurst. He lived nearby and for most of his active life we walked to and from the department together. Harry was a superb athlete. He was a nationally ranked tennis player when young and returned to tennis later in life. He was a very astute observer. In my clumsy attempts to learn that difficult game, he was always helpful with a key comment. He was a natural at many sports and generous with his advice. At about the age of fifty he began to play golf regularly with neighbors and family. He loved to walk everywhere, and in his eighties he was often seen walking to the UW golf driving range carrying his clubs. He regularly walked in the morning to have coffee with friends.

He contributed much to his community and cared for it greatly. He bought several houses that were not being kept up, landscaped and remodeled them by himself, and then sold them to families that were a wonderful addition to the neighborhood. He was a devoted gardener, doing all of the hard labor himself.

I talked with Harry every day for many years. He sometimes appeared to have a contentious nature, but never with me. He and I could disagree but it never spoiled our special friendship.

Chris Burdzy
named Carver Medalist

Chris Burdzy is the Institute of Mathematical Statistics' 2016 Carver Medalist. The medal, created by the IMS to honor Harry C. Carver, Founding Editor of the Annals of Mathematical Statistics and one of the founders of the IMS, is for exceptional service to the IMS. Chris's award recognizes his "leadership in the development and curation of electronic publications for the IMS probability community, especially for co-founding the Electronic Journal of Probability and Electronic Communications in Probability, and the Probability Abstract Service, and for sustained vigilance and dedication to ensuring the stability and open access for these publications and for serving as an informed resource for IMS on electronic issues." Chris also served as Editor of the IMS's Annals of Probability from 2012 to 2014, joining a distinguished list of mathematicians.

Bianca Viray
awarded NSF CAREER grant

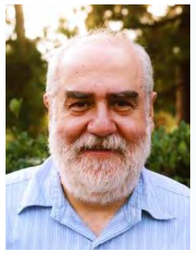
Bianca Viray is the recipient of a five-year NSF CAREER grant, which funds the integration of research and education.

Viray completed her Ph.D. at the University of California, Berkeley in 2010. She joined the department in 2014 after holding an NSF postdoctoral fellowship and a Tamarkin assistant professorship at Brown University.

Viray's CAREER proposal, "Rational points and 0-cycles via asymptotics and geometry," is motivated by the following fundamental question: Given a system of polynomials with rational coefficients, how can one determine whether there is a rational solution? Viray's research blends geometric and cohomological approaches to this question. For example, one of her past results, joint with Anthony Várilly-Alvarado, is a geometric interpretation of a cohomological obstruction to a rational solution on quartic del Pezzo surfaces.

The educational component of Viray's award centers on early career mentoring and broadening participation of traditionally underrepresented groups. As part of the proposal, Viray will organize a workshop in 2018 for mid-to-late career graduate students that is focused on communication skills.

Gunther Uhlmann
Royal Swedish Academy Lecturer

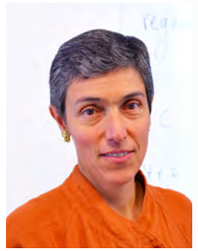


In October, the Royal Swedish Academy of Sciences took a break from awarding Nobel Prizes in physics, chemistry, and medicine to hear Gunther Uhlmann lecture on Inverse problems and Harry Potter's cloak. Gunther's talk was part of the Academy Lectures, a series of open lectures covering the most exciting fields of science in which the Academy is active. Gunther spoke about inverse problems, which arise in all fields of science and technology where causes for a desired or observed effect are to be determined. It is through solving inverse problems that we obtain a large part of our information about the world. He then turned to the question of whether we can make objects invisible, a subject that has fascinated humans for millennia, most recently in popular movies and fiction such as Star Trek and Harry Potter. Gunther described a simple and powerful proposal, transformation optics, and the progress it has yielded in achieving invisibility.

Chris Hoffman
named Simons Fellow

Chris Hoffman is a 2016 Simons Fellow. The Simons Foundation's fellowship program, which began in 2012, is designed to provide awardees with additional sabbatical funding that can "lead to increased creativity and productivity in research." Tatiana Toro was one of the inaugural fellows four years ago, followed by Hart Smith, Gunther Uhlmann, and Sándor Kovács in subsequent years.

Tatiana Toro
named Chancellor's Professor at UC Berkeley



Tatiana Toro has been awarded the Chancellor's Visiting Professorship in Mathematics at UC Berkeley, which she will hold while participating during the Spring Semester of 2017 in the Harmonic Analysis program at the Mathematical Sciences Research Institute, or MSRI. MSRI is an independent mathematics center partially funded by the National Science Foundation as one of its family of Mathematical Sciences Institutes. Each year, MSRI runs up to four semester- or year-long programs that attract visiting mathematicians from around the world. Prior to the given year, the organizing committee for each program nominates a distinguished researcher in the field to be the Chancellor's Professor in the UC Berkeley Math department, based on teaching excellence as well as research excellence, with the department selecting one of the nominees to serve in the position.

Each year's Chancellor's Professor teaches a graduate course at Berkeley in an advanced research topic, thereby providing Berkeley students and faculty with the opportunity to hear from a world-class expert who would not ordinarily be present in the department. Tatiana's course will focus on recent developments lying at the interface of harmonic analysis, partial differential equations, and geometric measure theory. At MSRI, she will mentor some of the postdoctoral fellows who are part of the Harmonic Analysis program.

Thomas Rothvoss named 2016 Packard Fellow

THE David & Lucile Packard Foundation has awarded a prestigious fellowship to University of Washington assistant professor Thomas Rothvoss to fuel his passion to balance precision and efficiency in complex mathematical calculations. The Packard Foundation Fellowships for Science and Engineering honor early-career academics pursuing innovative research in all fields of science and engineering.

"It's a great honor — and frankly, I'm still digesting the news," said Rothvoss, who has joint appointments with the Department of Mathematics and the Department of Computer Science & Engineering, or CSE.

Rothvoss' research probes the theoretical limits of computer algorithms designed to analyze large, complex datasets. He wants to understand when these algorithms operate quickly and efficiently and when they cannot. In situations where efficiency craters, he develops alternative mathematical methods that can approximate an optimal answer.

"This is really a problem of optimization," said Rothvoss. "Let's say you have a lot of objects of different weights and sizes — and boxes to pack them in. You want to optimize the packing process, grouping the objects into the smallest number of boxes as possible as quickly as possible."

It could be possible to write an algorithm to perform this calculation and produce a plan for packing the objects in boxes, Rothvoss said. But, the scenario is so complex that the algorithm would be sluggish and inefficient. "A better approach is to recognize these limitations and come up with algorithms that approximate an ideal answer," said Rothvoss. "Find an efficient algorithm that gets you close to that optimum. That's my specialty."

Efficiency problems plague the era of big data. For example, today's best DNA sequencers produce trillions of short sequences of DNA letters. It falls to computer scientists to write algorithms that can query these giant libraries of letters and assemble complete genome sequences of an individual or organism.

"This field is called 'combinatorial optimization,'" said Rothvoss. "And it lies at the intersection of theoretical computer science and mathematics."

A German native, Rothvoss became interested in the theoretical limits of computer science as an undergraduate at the Technical University of Dortmund. That meant spending more time in mathematics courses than the average computer science student, and he quickly became "hooked" on approximation methods.

Rothvoss earned his doctorate in 2009 from the Swiss Federal Institute of Technology at Lausanne, and later worked as a postdoctoral researcher both there and at the Massachusetts Institute of Technology. He came to the UW Department of Mathematics in 2014 as an assistant professor, and received a joint appointment with CSE in 2015.

As a Packard fellow, Rothvoss will receive $875,000 over five years. The Packard Foundation selects just 18 fellows each year from an initial pool of 100 nominees — two each from 50 universities. A 12-member panel of scientists and engineers selects the winners.

The fellows program began in 1988 to give early-career researchers — that is, those within the first three years of their first academic appointment — flexibility to pursue "risky" research avenues. As research funds atrophy from traditional sources, these fellowships become increasingly important for unlocking innovation.

"Basically, this means for the next five years that I can spend less time writing grants and more time doing research with my students," said Rothvoss. "And that is wonderful news."

Rothvoss is the UW's 10th Packard fellow, eight of whom are still affiliated with the university. He is the first from the UW Department of Mathematics, but the third for CSE. Past Packard fellows from CSE are Rajesh Rao and Christopher Diorio, who is now CEO of Impinj, a UW spinoff.

James Urton for UW Today (October 21, 2016)

Faculty Promotions

Professor Julia Pevtsova

has been a faculty member since arriving in 2005 in a postdoctoral position, having previously had positions at the Institute for Advanced Study in Princeton and the University of Oregon. Her research is in representation theory, especially over fields of positive characteristic such as the finite field of p elements. She is particularly interested in understanding connections with other areas of mathematics, such as commutative algebra, topology, geometry, and combinatorics. Julia also studies an unexpected sibling of characteristic p representation theory: representations and cohomology of quantum groups and, more generally, finite-dimensional Hopf algebras.

One of the central themes underpinning Julia's work is finding connections between representation theory and developments in algebraic geometry and algebraic topology. For example, in a recent collaboration with three others, she was able to solve a representation-theoretic classification problem for finite group schemes by introducing new ideas from both these fields.

Jointly with Ioana Dumitriu, Julia teaches an undergraduate course each autumn on The Art of Problem Solving. This offers students wishing to improve their problem-solving and proof-writing skills the opportunity to work on problems from diverse areas of mathematics. In parallel, Julia and Ioana prepare students for the annual Putnam Competition, offered each December to students across the US and Canada.

Julia also is the founder of several popular outreach programs offered to students throughout the Seattle area. These have the goal of promoting interactions and collaboration among students discovering mathematics at different stages of their educational experiences, from elementary school to graduate students, even engaging other faculty and technology professionals. Among these activities is a Math Circle for 7th, 8th, and 9th graders meeting one evening a week on campus in which students learn about logic, graph theory, combinatorics, geometry, and more. A monthly Math Hour each spring offers lectures by mathematicians to students, parents, siblings, and teachers. The Math Hour series culminates with a Math Olympiad, designed to be a learning opportunity in which friendly volunteer mathematicians reviewing solutions with individual participants.

Professor Ioana Dumitriu

received her BA in Mathematics from New York University in 1999 and her PhD in Applied Mathematics from MIT in 2003. After a three-year research fellowship with the Miller Institute at UC Berkeley, she became an assistant professor at UW, receiving tenure in 2010 and being promoted to Professor this year.

Ioana's primary area of mathematical research is random matrix theory, a vast field at the intersection of probability, linear algebra, statistical physics (as well as statistics), and combinatorics. Any matrix has a set of invariant parameters, its eigenvalues, that describe or predict certain desirable properties of the object that generated the matrix. Random matrices, for which each entry is drawn from a given distribution, have random eigenvalues, leading us to study eigenvalue statistics. Calculating eigenvalue statistics for various models of random matrices (or showing that they do not depend on the entry distribution) has wide applicability in numerical analysis, statistical mechanics, theoretical computer science, and even big data and network science.

From random matrix theory, Ioana has enjoyed making incursions into neighboring fields, such as random graphs, numerical linear algebra, scientific computing, and probabilistic and algorithmic combinatorics. Despite her adventures elsewhere, her intellectual home remains eigenvalue statistics, with a bias toward global statistics for eigenvalue functionals, like the Law of Large Numbers and the Central Limit Theorem.

In addition to pursuing her research, Ioana has developed new curricula, co-designing with Julia Pevtsova an advanced undergraduate class in problem-solving and designing a graduate class on Advanced Linear Algebra that she is offering this year for the first time. Ioana has also partnered with Julia in training UW's Putnam Competition team, which in 2009 had the honor to register UW's first Putnam winner (Will Johnson), and which, year after year, scores consistently high in the team rankings. Ioana is also an organizer of the popular UW lecture series MathAcrossCampus, which showcases applications of mathematics to students and faculty from many fields, helping to create a community of mathematicians and users of mathematics on campus.

Ioana has offered her services within UW and for a number of professional organizations, such as the American Mathematical Society, the Association for Women in Mathematics, and the Mathematical Association of America. She has also had the honor in the past three years to serve as advisor or co-advisor to two graduate students who received National Science Foundation Postdoctoral Research Fellowships, Elliot Paquette and Tobias Johnson, and one who was awarded a Miller Research Fellowship at Berkeley, Shirshendu Ganguly.

The Math Department at UW has been a wonderful and nurturing home for Ioana, and she is looking forward to continuing to enjoy her work with undergraduate and graduate students and with her colleagues.

New Appointments

Associate Professor Jarod Alper

Jarod Alper will join the department in January 2017 as a tenured associate professor. Jarod, who works in algebraic geometry, received his PhD under Ravi Vakil at Stanford in 2008. He spent three years at Columbia as an NSF postdoctoral fellow and a year at Universidad de los Andes in Bogota as an assistant professor before moving to Canberra, Australia, to join the faculty of the Australian National University as Lecturer and then Senior Lecturer. At Canberra, he held an Australian Research Council Discovery Early Career Researcher Award. Here at UW, he will join fellow algebraic geometers Sándor Kovács, Max Lieblich, and Bianca Viray.

Acting Assistant Professors

Jonathan Beardsley

Jonathan Beardsley received his PhD at Johns Hopkins under the supervision of Jack Morava. He works in algebraic topology, and will be collaborating with Ethan Devinatz and John Palmieri.

Noah Forman

Noah Forman received his PhD at UC Berkeley under the supervision of Jim Pitman. He recently held a postdoc at Oxford University where he worked with Matthias Winkel. He works in combinatorial stochastic processes and will be collaborating with Soumik Pal.

Mariana Smit Vega Garcia

Mariana Smit Vega Garcia received her PhD at Purdue under the supervision of Arshak Petrosyan. She recently held a post-doc at the University of Duisburg-Essen and Heinrich Heine University, where she worked with Georg Weiss. She works in geometric analysis and partial differential equations, and will be collaborating with Tatiana Toro.

Amos Turchet

Amos Turchet received his PhD at the University of Udine under the supervision of Pietro Corvaja. He recently held a post-doc at Chalmers University of Technology, where he worked with Per Salberger. He works in arithmetic and algebraic geometry, and will be collaborating with Bianca Viray.

Malik Younsi

Malik Younsi received his PhD at Laval University under the supervision of Thomas Ransford. He recently held an NSERC post-doc at Stony Brook, where he worked with Chris Bishop. He works in complex analysis, and will be collaborating with Don Marshall.

Elena Pezzoli

Part-Time Lecturer

In addition to regular faculty and graduate students, the department relies on an invaluable corps of part-time lecturers to provide instruction to our undergraduates. Our longest-serving part-time lecturer, Elena Pezzoli, talks below about her background and teaching experience:

I graduated from the University of Bologna in Italy with a degree in Mathematics, summa cum laude, then went to Stanford, where I obtained a PhD in Mathematics under the direction of Solomon Feferman and Phokion Kolaitis (a professor at UC Santa Cruz). My research was in the areas of Computational Complexity and Logic. While I was a graduate student, I also worked for the Education Program for Gifted Youth, a program at Stanford that provides innovative personalized courses to help students become advanced learners. I tutored students in Linear Algebra, Differential Equations, and Number Theory. After Stanford, I moved to Boston with my husband and son and taught at Boston College for two years. In 2000 we moved to Seattle and I joined the UW Math department as a visiting assistant professor, leaving in 2002 after the birth of my second son and returning in 2005 as a part-time lecturer.

In the past eleven years, I have taught a variety of courses, including Calculus and Precalculus, Linear Algebra, Real Analysis, and Mathematical Reasoning, one of my favorites. I like to interact with students and see the enthusiasm in their eyes when they discover a new concept or master a new skill. I am also encouraged by the many students who thank me at the end of the quarter, even though they say their grade was not as high as they had hoped for, or tell me they used to find Math hard and never liked it, but my examples helped them understand the subject better. It is difficult to adapt to different audiences, challenging the more advanced students while trying to make sure other students develop basic skills. But it is also very rewarding, forcing me to try to understand how different people learn and to strive to present new material, to adapt to new technology, and to keep learning myself. I hope to have the opportunity to keep teaching for many years to come.

Director of Student Services

Brooke Miller retired at the end of March after 25 years of distinguished service to the department, first as an advisor and for most of her time here as the Director of Student Services. She assisted many thousands of undergraduates, generations of graduate students, and a greatly appreciative faculty. As much as Brooke enjoyed working closely with us, she decided that the time had come to realize her dream of starting a gardening business. Now she has the pleasure of working outdoors every day.

Sarah Garner succeeded Brooke Miller as the department's Director of Student Services in April. Sarah is passionate about public higher education, with a particular interest in the recruitment and retention of underrepresented students in STEM fields. She is excited to join the Department, with the opportunities it provides to work with the wide range of students we teach in our large service courses, the undergraduate majors in Mathematics and the Applied and Computational Mathematical Sciences program, and our graduate students.

Sarah began her career at UW in 2006 in the Department of Astronomy, immediately after receiving her BA in Anthropology from UW. Her many duties in Astronomy included advising undergraduate and graduate students as well as helping run the department's Pre-Major in Astronomy Program, which is designed for entering UW students who are interested in math and science and who are traditionally underrepresented in astronomy. While in Astronomy, she continued her studies at UW in the College of Education, receiving her M.Ed. in Educational Leadership and Policy Studies in 2010. Sarah later served as Program Director for a Master's program in the Foster School of Business before joining the Department. Her background and interests are a perfect match for us.

Research Highlight

Sara Billey

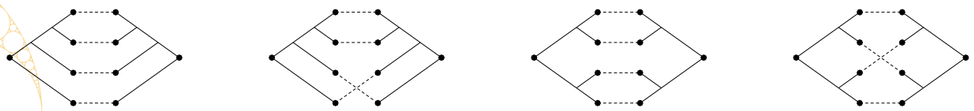
John Rainwater Faculty Fellow

My passion for mathematical research began the first time I heard about an unsolved problem. It was in my undergraduate probability class at MIT, taught by Gian-Carlo Rota. Until then, I thought mathematics was a stagnant body of results mostly finished by the Greeks two thousand years ago. If there were still open problems to solve, then I was ready to solve them!

My career benefited by doing undergraduate research in math, physics and computer science with Rota, Don O'Shea, Richard Yamamoto, Gerry Sussman, and Rod Brooks. When I went to graduate school at UC San Diego, I was ready to focus on research and quickly found my niche working with Adriano Garsia and Mark Haiman. I was very fortunate to get a graduate fellowship from the National Physical Science Consortium, supported by IBM. I now specialize in a field called algebraic combinatorics.

Combinatorics embodies the philosophy that every aspect of mathematics can be made more precise, more concrete, and more computationally feasible by identifying the key discrete structures. This allows combinatorics to be applied in both pure mathematical research and scientic applications. As an example, let me introduce the notion of a tanglegram.

A tanglegram is a graph obtained by placing two binary rooted trees with the same number of leaves side by side and matching each leaf from the tree on the left with a unique leaf from the tree on the right. We refer to the number of matched vertices in a tanglegram as its *size*. Furthermore, two tanglegrams are considered to be equivalent if one is obtained from the other by replacing the tree on the left or the tree on the right by isomorphic trees. It is not difficult to count all tanglegrams of size 4. One finds 13 of them, of which four are drawn below.



Tanglegrams are used in biology in the study of cospeciation and coevolution. A binary rooted tree may represent the phylogenetic or evolutionary history of a species. Given a pair of organisms with a symbiotic relationship, cospeciation is the result of mutations in one or both pair of organisms with a symbiotic relationship, that lead to the creation of a new species. One important problem in biology is to reconstruct the historical associations between the phylogenies of host and parasite under a model of parasites switching hosts, which is an instance of the more general problem of *cophylogeny estimation*. Consider, for instance, mice and lice, with the left tree of a tanglegram representing the mouse's phylogenetic history and the one on the right the louse's.

Tanglegrams can be useful when computing the distance between possible variations on a species via a model called the subtree-prune-regraft (SPR) graph. An SPR move cuts one edge of the tree and then reattaches the resulting rooted subtree at another edge. The SPR distance between two phylogenetic, or leaf-labeled, trees T_1 and T_2 is the minimum number of SPR moves required to transform T_1 into T_2. Counting distinct tanglegrams is equivalent to counting distinct double cosets of the form $A(T_1)wA(T_2)$ where $A(T_1)$ and $A(T_2)$ are the automorphism groups of fixed binary trees T_1 and T_2 with n leaves and w is a permutation of n objects.

In a recent paper with two others, I give a formula for the exact enumeration of tanglegrams of size n along with an algorithm for choosing a tanglegram uniformly at random and a simple asymptotic formula, which was our goal for the purpose of biological applications. Furthermore, we obtained a generalization of the tanglegram formula that counts *tangled chains*. These are ordered sequences of k binary trees with matchings between neighboring trees in the sequence. This yields for $k = 1$ a new formula for binary trees and for $k = 2$ the formula for tanglegrams. Here is our result:

Theorem 1. *The number of ordered tangled chains of length k and size n is*

$$\sum_{\lambda} \frac{\prod_{i=2}^{\ell} (2(\lambda_i + \cdots + \lambda_\ell) - 1)^k}{z_\lambda},$$

where the sum is over binary partitions $\lambda = (\lambda_1, \ldots, \lambda_\ell)$ *of* n.

The z_λ's that occur in the denominator are a family of positive integers familiar from a famous formula counting permutations of a given cycle structure.

Other areas in which tanglegrams appear are computer science, when considering two interacting pieces of code and reliability of networks, and anthropology, when comparing ancient humans and objects they constructed.

In light of our recent success in counting tanglegrams, which represent certain double cosets of the symmetric group, we are considering other families of double cosets of permutations and of Coxeter groups having interesting structure and enumeration. In a forthcoming paper, I and coauthors have described a canonical representative for each parabolic double coset that we call the lex-minimal presentation. Lex-minimal presentations are then used to enumerate double cosets via a finite automaton depending on the Coxeter graph of the group. These double cosets have interesting applications in the Solomon descent algebra, the ring of quasisymmetric functions, and in the theory of Schubert and Richardson varieties.

I'll conclude with one of my favorite long-term projects: building a large repertoire of computer-assisted proofs. Some of the most interesting new proof techniques in research include computer-verified proofs. This is an active area of research in computer science, but applications of computer proofs in pure mathematics are still rare. Every new computer proof can add to our understanding of this effective tool. How is a computer proof used? When is it applicable? What do we learn from a computer proof? These are all open problems. I am committed to developing computer algorithms and proof techniques in pure mathematics and teaching these techniques to others.

Student Awards & Honors

GRADUATE AWARDS

Academic Excellence
Max Goering, Tuomas Tajakka, Elizabeth Wicks

ARCS Foundation Fellowship
Sean Griffin, Juan Camilo Posso Escobar, Anthony Sanchez, Elizabeth Wicks

Excellence *in* Teaching
Gabriel Dorfsman-Hopkins *and* Caleb Geiger

McFarlan Fellowship
Nathan Saritzky *and* Amy Wiebe

McKibben *and* Merner Fellowship
Samantha Fairchild *and* Tuomas Tajakka

NSF Graduate Fellowship
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Robert & Elaine Phelps Fellowship
Abdalla Nimer

John Rainwater Fellowship
Hailun Zheng

Tanzi-Egerton Fellowship
Courtney Paquette

Top Scholar
Chi-Yu Cheng

UNDERGRADUATE AWARDS

Gullicksen Award *for* Outstanding Junior
William Dana *and* Austin Stromme

First Year Honors Calculus
Haim Grebnev

Second Year Honors Calculus
Jasper Hugunin

Outstanding Graduating ACMS Major
Kristina Chen

Outstanding Graduating Senior
(B.S. Comprehensive Major)
Austin Tran

Outstanding Graduating Senior
(B.S. Standard Major)
Zhenghao Fu

Outstanding Graduating Senior
(B.A. Teacher Preparation)
Robert Lambertz

Putnam Exam Outstanding UW Score
William Dana

Shirshendu Ganguly
Graduate Medalist in the Natural Sciences

"If Shirshendu Ganguly had arrived at the UW five years ago as an assistant professor instead of as a graduate student, his body of work would surely have been enough to have earned him tenure," says Christopher Hoffman, professor of mathematics and Victor Klee Faculty Fellow, referring to the more than one dozen papers authored or co-authored by PhD student Ganguly that have been accepted for publication in top journals.

Though Ganguly's papers cover topics ranging from random matrix theory to Markov chains to spin systems in theoretical physics, they all tackle probabilistic questions coming from statistical physics. "I have no doubt that in a few years, Shirshendu will be a world leader in probability," says Hoffman. "He is stunningly quick and has shown an amazing breadth and depth."

Ganguly, whose academic awards include a Douglas Lind Fellowship from the Department of Mathematics, has also shown generosity of spirit. During his years at the UW he mentored his fellow graduate students, teaching them new material, providing tips on doing research, and helping them write up results. Ganguly's next step? He's headed for the University of California, Berkeley, where he will be a Miller Fellow in statistics and mathematics.

Nancy Joseph for A& S Perspectives (June 2016)

Austin Stromme
Goldwater Scholarship

Austin Stromme, a Mathematics and Computer Science double major, has been awarded a Goldwater Scholarship from the Barry Goldwater Scholarship and Excellence in Education Foundation. The Goldwater Scholarship program is designed to foster and encourage outstanding students to pursue careers in the fields of mathematics, the natural sciences, and engineering, and Austin is the latest in a long list of Math Department recipients. He was also co-recipient last spring of the Department's Gullicksen Award for outstanding junior math major. His interests are broad, and he has worked with several students and faculty in both Math and Computer Science. For the scholarship, he proposed to do research on discrete harmonic cohomology and random models on graphs. He is currently working with Jim Morrow and with David Jekel, a recent alumnus who is now a graduate student at UCLA.

Graduating Class: 2015-2016

Doctorate:

Yernat Assylbekov *(Gunther Uhlmann, advisor)*
Some inverse problems in analysis and geometry
Zelevinsky Research Instructor at Northeastern University.

Alan Bartlett *(Boris Solomyak)*
Spectral Theory of $\mathbb{Z}^d$ Substitutions
Lecturer at the University of Washington, Tacoma.

Hao Chen *(William Stein)*
Computational aspects of modular parametrizations of elliptic curves
Postdoctoral Researcher at Microsoft Research, Redmond.

Graham Clenaghan *(Sándor Kovács)*
Grothendieck duality on diagrams of schemes
Data Scientist at eBay.

Shirshendu Ganguly *(Ioana Dumitriu, Chris Hoffman)*
Interacting particle systems: mixing, phase transition and scaling limits
Miller Fellow at the University of California, Berkeley.

Cody Holdaway *(Paul Smith)*
Deformation Invariance of Rational Pairs

Matthew Junge *(Chris Hoffman)*
Random Recursion
William W. Elliott Research Assistant Professor at Duke University.

Hon Leung Lee *(Rekha Thomas)*
Problems in Algebraic Vision
Software Engineer at Tesla.

Stephen McKeown *(Robin Graham)*
Cornered Asymptotically Hyperbolic Metrics
Postdoctoral Research Associate at Princeton University.

Christopher McMurdie *(Paul Smith)*
The C-algebra of a finite T_0 topological space*
Actuarial Analyst at Farmers Insurance Group.

Jessica Merhej *(Tatiana Toro)*
On the Geometry of Rectifiable Sets with Carleson and Poincare Type Conditions
Assistant Professor at Notre Dame University-Louaize, Lebanon.

Cris Negron *(James Zhang)*
Alternate approaches to the cup product and Gerstenhaber bracket on Hochschild cohomology
C. L. E. Moore instructor at Massachusetts Institute of Technology.

Bharathwaj Palvannan *(Ralph Greenberg)*
On Selmer groups and factoring p-adic L-functions
Hans Rademacher Instructor at the University of Pennsylvania.

Lorenzo Prelli *(Sándor Kovács)*
Results on singularities of pairs
Google

Christian Rudnick *(Zhenqing Chen)*
Boundary Harnack Principle for some symmetric stable-like processes and censored stable-like processes

José Alejandro Samper Casas *(Isabella Novik)*
On f-vectors of polytopes and matroids
Fuqua Research Assistant Professor at the University of Miami.

David Sprehn *(Steve Mitchell)*
Some cohomology of finite general linear groups
Postdoc at the University of Copenhagen.

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Sheaves on support varieties and varieties of elementary subalgebras
National Security Agency

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Formal group laws and hypergraph colorings

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On T-Semisimplicity of Iwasawa Modules and Some Computations with $\mathbb{Z}_3$-Extensions

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Matrix free methods for large scale optimization
Senior Data Scientist at LinkedIn.

Ting-Kam Leonard Wong *(Soumik Pal)*
Geometry and Optimization of Relative Arbitrage
Postdoc at the University of Southern California.

Hanming Zhou *(Gunther Uhlmann)*
Some linear and non-linear geometric inverse problems
Postdoctoral Research Associate at the University of Cambridge.

Master's:

James Cameron *(Steve Mitchell)*
Rebecca Hoberg *(Thomas Rothvoss)*
Karthik Iyer *(Gunther Uhlmann)*

Bachelor's:

272 ***in*** **Mathematics**
83 ***in*** **Applied & Computational Mathematical Sciences**

New Gifts

Washington Research Foundation

Last spring, the Washington Research Foundation made a generous gift to the department in honor of Barry Forman, who had served on their Board of Directors for two decades. Barry—a brilliant polymath with degrees in philosophy, physics, and law and a valued department friend—is now using some of his spare time to pursue research questions in number theory.

The Washington Research Foundation is an early-stage investor that works with entrepreneurs, research institutions, and industry partners to transform ideas into successful businesses in the life sciences, physical sciences and information sciences. By capturing the value of intellectual property arising from the state's research institutions, WRF is then able to reinvest profits to support additional research and scholarship. Their gift to us is such an investment. It will be used to promote excellence in the work of our faculty, graduate students, and undergraduates.

Faculty funded by the WRF gift will be supported through faculty fellowships named for John Rainwater, our pseudonymous long-time colleague, who represents the department's collaborative spirit at its finest. Sara Billey is the inaugural Rainwater Faculty Fellow. Graduate student awards are to be given to outstanding applicants or graduate students and named for Gloria Hewitt, who is among the first African-American women in the US to receive a PhD in mathematics. She did so in 1962 with a thesis in algebra written under the supervision of Richard Pierce, then went on to a long and distinguished career at the University of Montana, where she served as department chair from 1995 until her retirement in 1999. Undergraduate awards will be named for Ernie Esser.

Brian and Tiffinie Pang Faculty Fellowship

The Brian and Tiffinie Pang Faculty Fellowship in Mathematics was established last spring thanks to a new gift from the Pangs, who in 2013 funded the Brian and Tiffinie Pang Endowment in Mathematics. The endowment supports the department's academic programs, including the needs of graduate students. In contrast, the new faculty fellowship will support the work of our faculty. In July, Robin Graham began a three-year term as the Pang Faculty Fellow.

Brian Pang came to UW from South Korea in 1984 as a mathematics graduate student. He and Tiffinie met at UW, where she was studying accounting, and they married in 1986. Brian received his PhD in 1989 under the supervision of Tom Duchamp with a thesis in differential geometry, taking a course from Robin along the way. He stayed at UW one more year as a lecturer, moved on to other academic positions, and then shifted to a career in mathematical finance, working in the areas of credit, energy, and high frequency trading as a qualitative analyst. Brian noted in 2013 that he and Tiffinie initiated the Pang endowment "in appreciation for the University and Department providing life changing opportunities for and financial support to Brian to learn a mathematical way of thinking." For their continuing support, we in turn are most appreciative.

Ernie Esser Undergraduate Support Fund

The Ernie Esser Undergraduate Support Fund was established in September, thanks to gifts from Ernie's family and friends, in order to support the work of the department's majors. Ernie, a beloved alumnus, died in March 2015 in Reykjavik, Iceland, on his way home from Europe. He graduated from UW in 2003 with degrees in mathematics, applied and computational mathematical sciences, and Italian. After obtaining his PhD in mathematics at UCLA and doing postdoctoral research at UC Irvine, Ernie moved to the University of British Columbia as a postdoctoral fellow at the Seismic Laboratory for Imaging and Modeling.

Ernie impressed everyone with his wit, kindness, athleticism, and originality. He was always laughing and ready to tell the latest joke. He cycled more than thirty miles each day while a student at UW, beat everyone he played at tennis, and loved soccer. He also made wine and shared it widely. Ernie returned to UW every March to participate in Mathday, entertaining high school students from across the state with his lecture, *Why boomerangs come back*.

Tatiana Toro was named a Craig McKibben and Sara Merner Professor this past September, along with Sándor Kovács.
Also in September, Isabella Novik was named the Robert R. & Elaine F. Phelps Professor.

Our Donors: Individual Contributors

Each year the Department receives gifts from its alumni and friends. These gifts are of immense value to us and permit us to carry on important activities for our students and our scholarly work. They provide money for scholarships, fellowships, and prizes for our students; support events like Mathday and the REU program; fund visits to our department by distinguished mathematicians from around the country and the world; and give the Department a much-needed element of flexibility to meet special needs as they arise. For these contributions we are truly thankful to our donors.

If you are thinking of making a gift to the Department, or remembering the Department in your will, we invite you to discuss the matter with the chair, Ron Irving, or Alex Haslam of the Advancement Office in the College of Arts and Sciences (alexeck3@uw.edu). You can also visit our web site at www.math.washington.edu and click on "Give to Math."

The following friends have contributed to the Department between September 2014 and October 2016.
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