Geometry seminar forum for diverse research interests

The Geometry, Groups, and Dynamics/GEAR seminar (or GGD/GEAR, for short) is currently in its second year of operation, although the seminar has a rich history. The name reflects the many intertwined interests of the seminar's participants. GEAR stands for the "GEometric structures And Representation varieties," a grant which is a co-sponsor of the seminar.

From at least the 1950s there was a regular Group Theory seminar—in fact, there were at least two of them. The participants included Bill Boone, Robert Craggs, Everett Dade, Graham Higman, Arnold Learner, Avinoam Mann, Leon McCulloh, Irv Reiner, Derek Robinson, Joseph Rotman, Paul Schupp, Michio Suzuki, John Walter, and Paul Weichsel. During that same time period, the department's Differential Geometry seminar was also highly active, with regular members including Stephanie Alexander, Felix Albrecht, Richard Bishop, Kuo-Tsai Chen, Sam Goldberg, John Gray, and Howard Osborne.

A parallel geometry seminar, the Geometric Potpourri seminar (much later renamed simply the Geometry seminar) with interest in general geometric problems, often complementary to differential geometry, was started by Ralph Alexander with help from John Wetzel, and included participants from the Differential Geometry seminar as well as David Berg, George Francis, Gregory Galpern, M.E. Hamstrom, Richard Jerrard, Bruce Reznick, and many others. In recent past, dynamics as an area was primarily covered as a part of the Analysis seminar.

Geometry and group theory have always been intimately connected, but Gromov's work on geometric group theory in the 1980s saw these subjects merging in new, fundamental ways. Likewise, Margulis's work on rigidity drew together geometry, group theory, and dynamics making them fundamentally inseparable.

As the department evolved, so did the focus of its members' research. By 2010, the regular attendees of the Differential Geometry, Group Theory, and Geometry seminars had a substantial overlap in their focus. In 2011 Jayadev Athreya and Joseph Rosenblatt started the Ergodic Theory seminar, which was frequented by the participants of the existing three seminars. Also at this time, Steve Bradlow spearheaded a grant proposal to facilitate collaboration, especially among researchers in geometry, group theory, and dynamics. Bradlow's efforts, together with his co-PIs, resulted in the five million dollar GEAR grant shared by the University of Illinois, University of Maryland, and Stanford University.

It was clearly time to consolidate. The Group Theory seminar organizer Ilya Kapovich and the Geometry seminar and Differential Geometry seminar co-organizer Chris Leininger collaborated with Athreya and Bradlow, and together with input from many other members of the department, combined the four seminars into the single GGD/GEAR mega-seminar meeting twice a week. This schedule allows for a broad range of speakers, from local faculty, postdocs and graduate students, to various visitors from other universities.

The seminar includes new features, such as live streaming lectures on YouTube, but also holds to the traditions of the constituent seminars, for example maintaining a weekly lunch (photo above). Most importantly, the seminar provides the perfect forum for the department's diverse research interests in geometry, group theory, and dynamics.

The GGD/GEAR seminar is currently co-organized by Steve Bradlow, Ilya Kapovich and Chris Leininger.

College of
Liberal Arts & Sciences
AT ILLINOIS

From the Chair

Dear friends,

The Department achieved an important milestone this fall, for the first time enrolling more than 1,200 undergraduate majors, an increase of 50 percent in just the last five years. Mathematics is now the home of more than one-tenth of the undergraduate majors in the College of Liberal Arts and Sciences and 3.7 percent of the undergraduate majors of the Urbana-Champaign campus. Enrollment in our classes continues to increase—we teach more than 10 percent of the credit hours of the College, and 5.5 percent of the credit hours of the campus. An equally impressive statistic is that we produce roughly 1.5 percent of the PhDs in mathematics nationally.

With all this going on, we are a model of how to innovate in graduate and undergraduate education on a very large scale. Two examples: we teach 3,000 students multivariable calculus each year, and over the last five years we have introduced student group work in all of the discussion sections for this course.

At the graduate level, our PhD program has garnered national attention for connecting PhD students with summer internship opportunities: last summer, 27 PhD students worked in internships with government labs or scientific labs on campus, or with private companies. You can read about the impressive range of their activities at http://www.math.illinois.edu/GraduateProgram/internship-experiences.pdf.

With all this growth and activity, we are bursting at the seams. As we reported in the Fall 2013 issue of the *Math Times* (www.math.illinois.edu/mathtimes/mathtimes-fall2013.pdf), we have ambitious plans to renovate both Altgeld and Illini Halls. We have been working with supportive campus leadership on moving this project forward. I have been happy to hear Interim Chancellor Wilson talk publicly about the importance of renovating Altgeld and Illini Halls for the future of the campus.

Please contact me if you would like to hear more about the Altgeld/Illini Halls project, or indeed about any other matters related to the Department of Mathematics.

Matthew Ando
Professor and Chair
Department of Mathematics

Judy Holdener

by Jim Dey

Not many mathematicians can say that a labor dispute helped spark their career choice. But who knows what Judy Holdener's future would have been if her teachers had not gone out on a five-month strike during her sophomore year in high school?

Stuck in geometry class with an unprepared substitute teacher during the longest teachers' strike in Ohio history, Holdener said she "taught herself geometry just to keep (the sub) on track."

"Before that, I was not into academics," she said. "I don't even remember math before 10th grade."

The 50-year-old mathematics professor at Kenyon College in Gambier, Ohio, went on to get her bachelor's degree in mathematics at Kent State University before earning her master's and doctoral degrees at the University of Illinois.

Even then, she took a circuitous route. Initially majoring in art as an undergraduate, her performance in a series of math classes impressed one of her professors. One day, the professor asked Holdener what her major was. When she replied it was art, the professor disagreed. "No, it's not. You're a mathematician," he replied.

Holdener's professor not only persuaded her to study math as an undergraduate but recommended she attend the UI for graduate school. Since wrapping up her studies here in 1994, she's enjoyed teaching and research while continuing to dabble in art.

"I've been really happy with my career," she said. "I feel fortunate to have all these opportunities."

Holdener grew up in Ravenna, Ohio, a community near Akron, one of four children born to a steelworker father and an artist mother. She recalls attending art gatherings with her mother and said "art was a big part of my life growing up."

Holdener worked her way through Kent State, at one point simultaneously working three jobs. One involved painting murals for the interiors of airplanes. "I was pretty good at time management even at an early age," she said.

After enrolling at the UI, Holdener initially felt "like a fish out of water" but, after acclimating herself to a new, more competitive environment, said she "really enjoyed my graduate classes."

Struck by his precision and devotion to students, Holdener said she particularly enjoyed an Abstract Algebra class taught by the late Professor Michio Suzuki. Working with her advisor, Dan Grayson, she wrote her thesis on Algebraic K-Theory.

Like other math students, Holdener said she enjoys solving problems. "It's fun because it's challenging," she said. "It's fun to work on a problem no one knows the answer to and explore the unknown."

Judy Holdener (PhD 1994), John B. McCoy Distinguished Teaching Chair and Associate Professor, Kenyon College, Gambier, OH.

While studying at the UI, Holdener met her future husband Eric. He was studying for a doctorate in paleontology and, like her, now is a faculty member at Kenyon College, a prestigious liberal arts college. They are the parents of two sons —14-year-old Chase and 9-year-old Max. Holdener describes them as "two red-haired boys" who "both play soccer."

Holdener said because "my boys have introduced me to the world of sports," she now roots for Ohio State University in football and the NBA's Cleveland Cavaliers. "I love LeBron James," she said of the Cavaliers' all-star forward.

Before joining the Kenyon faculty in 1997, Holdener taught for three years at the U.S. Air Force Academy in Colorado Springs, Colo. She was the first civilian to teach in the math department, enjoying the work but chafing under the military bureaucracy. "The cadets were phenomenal people. Plus, I like the idea of serving your country," she said.

Since joining the Kenyon faculty, Holdener has had the opportunity to hold visiting professorships at the University of Colorado in Boulder and Carnegie-Mellon University in Pittsburgh, Pa. She likes to go new places and do new things.

"The more you put yourself outside your comfort zone, the more you learn," Holdener said.

In that vein, one of Holdener's latest pursuits is combining math and art. She said that since the "general public can't really read the language," it can't appreciate the "beauty of mathematics." To address that issue, Holdener said she's "starting to merge the two."

Holdener said she lives a busy life with "a lot of balls in the air." But she loves living in the small community of Gambier, has topnotch students, enjoys a "very supportive" work environment and has time to garden, read and go to aerobics class.

"I can walk to my office with a cup of coffee in my hand and when I get to my office it's still hot. So it's a great commute," Holdener said.

Judy will speak about her recent work in digital mathematical art in an invited address at the annual Mathematical Association of America MathFest in August 2016. The piece pictured here is titled "Immersion."

Jim Dey is a columnist and editorial writer for The News-Gazette *in Champaign-Urbana.*

Analysis and geometry in interaction

by Pierre Albin

Analysis, as a field of mathematics, is the language in which we describe processes that change; a language that is essential for the study of physics, biology, chemistry, and many other fields. Modern science requires analysis not just in multiple dimensions but also on curved spaces. For example Einstein's theory of general relativity is succinctly expressed as a partial differential equation relating the presence of mass with curvature of the underlying space, and thus gravity.

The study of differential equations on curved spaces reveals intricate relationships between the analysis of the equations and the geometry of the space. For example the wave equation models how sound and light evolve on a curved space. The behavior of waves turns out to be closely related to the geodesics of the space: curves that locally minimize distance such as lines in the plane and great circles on the sphere. This relationship is striking because quantum particles (like photons) are described by solutions of a wave equation, while classical particles (like marbles) follow geodesics. Understanding this requires the sophisticated techniques of 'microlocal analysis', so named because it studies functions closely enough to say if they are smooth not only at a point, but also how smooth in each direction. In the case of the wave equation, microlocal analysis shows that the solutions are waves and their singularities follow geodesics.

Examples of smooth manifolds.
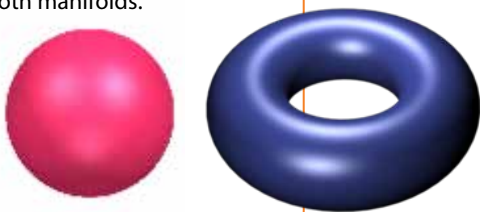
Pierre Albin is an Assistant Professor in the Department of Mathematics at the University of Illinois at Urbana-Champaign. Despite the French name, Pierre was born in California and grew up in Texas and Mexico. He got his undergraduate degree at ITAM in Mexico City while working as a financial risk analyst in one of Mexico's largest banks. After completing his PhD at Stanford working with Rafe Mazzeo, Pierre did postdocs at MIT, NYU/IAS, and Jussieu before joining the department in 2011.

Analysis and geometry also interact in the famous question of Mark Kac: Can you hear the shape of a drum? The movements of drumheads or violin strings are modeled by differential equations. Each object has 'overtones' corresponding to eigenvalues of the differential operator. Just as a bigger drum has lower tones, the geometry of the object affects these eigenvalues and conversely the eigenvalues constrain the geometry (e.g., the eigenvalue growth tells us the volume of the drum). There is no other drum that sounds like a perfect disk, but there are examples of differently-shaped drumheads with the same eigenvalues. The answer to Kac's question is thus 'no' but continues to inspire interesting mathematics about the interplay between analysis and geometry.

A striking real world application of microlocal techniques is through medical imaging and particularly early breast cancer detection: cancerous cells absorb more energy from electromagnetic waves than healthy cells. Medical imaging exploits this by exposing tissue to radiation and determining the composition of the tissue from the resulting waves. Mathematically, this radiation solves a differential equation whose coefficients reflect the composition of the tissue, and so we need to solve an 'inverse problem': given the initial data and the solution of the equation, can we reconstruct the equation? Sometimes we can, and this has led to cancer detection devices; sometime we can't, and this has led to primitive 'invisibility cloaks.'

Examples of singular spaces.

My research develops and applies microlocal tools to singular and noncompact spaces, spaces showing up naturally even from studying smooth spaces. For example, polynomials are smooth but their zero sets (algebraic varieties) are usually singular. Microlocal analysis requires understanding how the geometric singularities interact with the analytic singularities.

I am particularly interested in problems that relate analysis on a space to the underlying topology (the coarsest geometry). Analysis is in some ways rigid: changing an equation a bit may remove solutions, or it might add some. On the other hand, topology is flabby: changing a space a bit will not change the topology, as long the space is not 'torn' or 'smashed.' When a problem involves two such disparate fields, each approach brings its own tools and applications, making the results powerful.

Patrick Allen
Assistant Professor
PhD 2012, UCLA

Patrick Allen grew up in Frankville, Ontario, Canada. After getting his bachelor and masters degrees from the University of Waterloo, he received his PhD from UCLA in 2012 under the supervision of Chandrashekhar Khare. Before coming to the University of Illinois, he spent three years as a Boas Assistant Professor at Northwestern University. His research interests lie in number theory, specifically the connection between Galois representations and automorphic forms. Outside of math, he enjoys spending time with his wife Anush, reading, running, and being outdoors.

Patrick Allen

Jeremiah Heller
Assistant Professor
PhD 2006, Northwestern University

Jeremiah Heller grew up in Oregon and misses the mountains, ocean, and rivers, but not the dreary grey drizzle of a Pacific Northwest winter. Since then he has studied and worked in the midwest (Northwestern), Canada (Western Ontario), and Germany (Wuppertal, Bonn). His research is in motivic homotopy theory and in general he is interested in applications of homotopy theory to the study of algebraic cycles and algebraic K-theory. In his spare time he likes to cycle, garden, cook and bake.

Jeremiah Heller
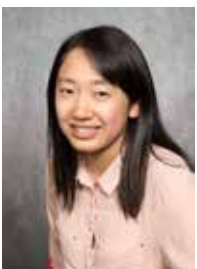
Shu Li
Assistant Professor
PhD 2015, University of Waterloo

Shu Li grew up in Harbin, China. She moved to Canada in 2010 and started her journey in the area of actuarial science, which strikes a good balance between her pursuit of mathematics and desire of managing uncertainty. She completed her PhD in 2015 from the University of Waterloo under the supervision of Dr. David Landriault and Dr. Christiane Lemieux. Her research interests include risk theory, the quantitative analysis of various insurance risk processes and financial models, as well as their applications in risk management.

Shu Li

Vesna Stojanoska
Assistant Professor
PhD 2011, Northwestern University

Vesna Stojanoska is an algebraic topologist with an interest in the interactions between homotopy theory and arithmetic. Before coming to the University of Illinois, she worked in Germany, California, and Massachusetts, and studied in Illinois and Bulgaria, but before that was born and grew up in Macedonia. She knits whenever she can, and loves cycling long distances.

Vesna Stojanoska

Anush Tserunyan
Assistant Professor
PhD 2013, UCLA

Anush Tserunyan grew up in Yerevan, Armenia, where she received her undergraduate and Masters degrees in computer science from Yerevan State University. She completed her PhD in mathematics at UCLA in 2013 under the supervision of Alexander Kechris (Caltech). Her research lies in descriptive set theory and measurable dynamics, with parts in ergodic Ramsey theory and combinatorics. When procrastinating, she tries to make her husband Patrick procrastinate too, and, if unsuccessful, she plays piano/fails to compose, practices fencing (beware!), or solves cooking optimization problems of maximizing taste given calorie constraints.

Anush Tserunyan
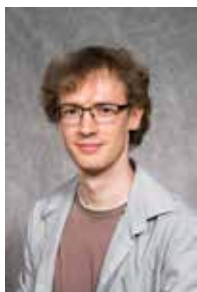
Mark Bell
J.L. Doob Research Assistant Professor
PhD 2015, University of Warwick

Before coming to Illinois, Mark Bell completed his PhD at the University of Warwick under the supervision of Saul Schleimer. His research interests are in computational topology and geometric group theory. Specifically, he is interested in decision problems in low dimensional topology involving knots, surfaces and 3-manifolds. In his free time, Mark enjoys rock climbing and swimming.

Mark Bell

Daniel Berwick-Evans
J.L. Doob Research Assistant Professor
PhD 2013, University of California, Berkeley

Dan Berwick-Evans got his PhD in 2013 from University of California Berkeley under the supervision of Peter Teichner, and then spent two years at Stanford University as a Szego Assistant Professor. His research uses methods from quantum field theory to construct invariants of manifolds. An ideal vacation for him involves rock climbing and/or kayaking.

Daniel Berwick-Evans

Ivan Contreras
J.L. Doob Research Assistant Professor
PhD 2013, University of Zürich

Ivan grew up in Bogota, Colombia. He obtained his undergraduate degree in mathematics in 2008 at Los Andes University, Colombia. In 2008 he moved to Utrecht, The Netherlands, to join the master class program "Aspects of Calabi-Yau geometries." In 2009 he moved to Switzerland and in 2013 he completed his PhD under the guidance of Alberto Cattaneo at the University of Zürich. Before moving to our department, Ivan was appointed as a postdoctoral fellow at UC Berkeley for two years. His research interest is mathematical physics and differential geometry. In particular, he studies the interplay between symplectic, Poisson geometry, and classical, quantum field theories.

Ivan Contreras
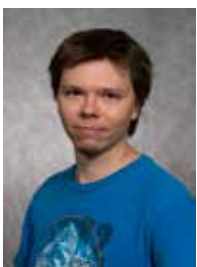
Sergey Dyachenko
J.L. Doob Research Assistant Professor
PhD 2014, University of New Mexico

Sergey Dyachenko completed his undergraduate degree in PhysTech (MIPT) in Dolgoprudny, Moscow and got his PhD in applied mathematics from the University of New Mexico under the guidance of Pavel Lushnikov and Alexander Korokevich. Before coming to Illinois he was a Visiting Assistant Professor at the University of Arizona where he worked with Vladimir Zakharov and Alan Newell. His research is concentrated on numerical simulations of systems that admit singular solutions, in particular evolution of water waves that lead to overturning, and simulations of blowing up solutions in nonlinear optical media.

Sergey Dyachenko

Laura Escobar
J.L. Doob Research Assistant Professor
PhD 2015, Cornell University

Laura Escobar grew up in Colombia, where she did her undergraduate degree in mathematics. She completed her PhD in 2015 at Cornell University under the supervision of Allen Knutson. Her research interests are combinatorics, algebraic geometry and the interactions between these areas. In particular she studies Schubert varieties. In her spare time she enjoys reading, hiking and traveling.

Laura Escobar

Nicolas M. Robles
J.L. Doob Research Assistant Professor
PhD 2015, Universität Zürich

Nicolas studied mathematics and physics at Imperial College and Cambridge. He also worked in investment banking in London and Zurich (JPMorgan, Nomura and UBS), before deciding to go back to graduate school for a doctorate in analytic number theory under the joint supervision of Alberto Cattaneo and Ashkan Nikeghbali. Away from work, he likes golf, skiing, soccer, history, board games and movies.

Nicolas Robles

Rebecca Tramel
J.L. Doob Research Assistant Professor
PhD 2015, University of Edinburgh

Becca Tramel grew up in Massachusetts, and did her undergraduate degree at Smith College as a double major in mathematics and French language. She then completed her Masters at the University of Connecticut, and her PhD from the University of Edinburgh, where she studied under Arend Bayer. Her research interests are algebraic geometry and derived categories. In particular, she is interested in connections between algebraic geometry and Bridgeland stability conditions. Her hobbies include cooking, running, and exploring the Urbana-Champaign area with her husband and their Australian shepherd, Sabrina.

Rebecca Tramel

Jing Wang
J.L. Doob Research Assistant Professor
PhD 2014, Purdue University

Jing Wang completed her PhD in 2014 at Purdue University under the supervision of Fabrice Baudoin. Before coming to Illinois, she spent one year as a postdoc fellow at IMA, University of Minnesota. Her research interest lies in the intersection of probability and sub-Riemannian geometry. In particular she works on diffusions on sub-Riemann manifolds; and heat kernel estimates of degenerate hypoelliptic diffusions. During her spare time, she enjoys dancing and teaching Salsa (a Latin social dance) and Argentina tango.

Jing Wang

Ming Xiao
J.L. Doob Research Assistant Professor
PhD 2015, Rutgers University

Before coming to the U.S., Ming Xiao did his undergraduate degree in mathematics from the University of Science and Technology of China. He completed his PhD at Rutgers University in May 2015. He works in the fields of several complex variables, Cauchy-Riemann geometry, complex geometry. His current research includes mapping problems in CR geometry and several complex variables, complex geometry of bounded domains in complex Euclidean spaces, applications of PDEs to complex analysis. Outside of mathematics, he is a fan of soccer and likes watching soccer matches.

Ming Xiao
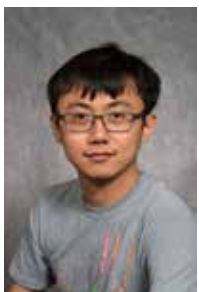
Xin Zhang
J.L. Doob Research Assistant Professor
PhD 2014, Stony Brook University

Xin Zhang obtained his PhD from Stony Brook University in 2014, under the guidance of Prof. Alex Kontorovich. He spent one year at Tel Aviv University before coming to Illinois. His current research lies in analytic number theory, spectral theory, homogeneous dynamics and the interplay between them. In his spare time, he likes to play tennis, badminton and ping pong.

Xin Zhang

McCarthy named Director of Undergraduate Studies

In August 2015, Randy McCarthy was appointed by the department as Director of Undergraduate Studies. Randy has been a faculty member in the department since 1994 and served as Director of Graduate Studies 2009-2012 and Director of Undergraduate Studies 2004-2007. He holds two other appointments in the department: Associate Chair for Instructional Technologies and Director of the NetMath program. He also serves as the Faculty Director in ATLAS (information technology services for the College of LAS) where he will be providing input for the direction of ATLAS.

Jockusch and van den Dries to give invited addresses at 2016 joint math meetings

Two faculty from the University of Illinois will give invited addresses at the Joint Math Meetings being held in January 2016 in Seattle, WA. Carl G. Jockusch, Professor Emeritus, will present "Imperfect algorithms, asymptotic density, and Turing degrees." Professor Lou van den Dries will present "Transseries: algebra and model theory."

GAANN grant received for graduate program

The Mathematics Department has been awarded a $885,000 grant from the U.S. Department of Education to support fellowships for students pursuing a doctoral degree in mathematics. As part of the GAANN (Graduate Assistance in Areas of National Need) program, the grant will fund at least six full three-year fellowships for US citizens or permanent residents who demonstrate superior academic ability, have an excellent academic record, and have financial need.

The GAANN program, established as part of the Higher Education Act of 1965, strives to sustain and enhance the capacity for teaching and research in areas of national need. The specific objectives of the GAANN program in Mathematics at Illinois are to increase the number of eligible students who obtain doctorates in mathematics, to shorten the time required to obtain the Ph.D. degree, to increase the number of students from traditionally underrepresented groups who obtain doctorates in mathematics, and to provide a high quality teacher training program for GAANN fellows.

Tropical mathematics and Poisson geometry

By Rui Loja Fernandes

If you google the term "tropical geometry" you will find that it is a version of algebraic geometry over the tropical semi-field, where the addition of two real numbers is defined as the minimum of the two numbers, and the product is defined as the usual sum of numbers (one formally completes the

Rui Loja Fernandes, Lois M. Lackner Professor in Mathematics, holds a Ciências sem Fronteiras grant.

real numbers by including -∞). The term tropical geometry was in homage to Hungarian-born Brazilian mathematician and computer scientist Imre Simon (1943-2009), who was a pioneer in the study of such min-plus algebraic systems.

The title of this note does not come, however, from some extension of tropical geometry to Poisson geometry (although I believe there is one!). It refers rather to my recent collaboration with a network of Brazilian mathematicians, working in Poisson geometry and related subjects. This collaboration is possible by a grant from the Brazilian Program "Ciências sem Fronteiras", which has supported so far a dozen of short-term visits by Brazilian mathematicians to Illinois, a one semester stay of a Brazilian PhD student, and has "forced" me to go on a regular basis to IMPA for one month visits. By the way, the name of this Brazilian program literally means "Science without Borders", although Brazilian people like to keep the original name, so that there is no confusion with a well-known NGO.

There are many good reasons to look into Brazilian mathematics. IMPA is, of course, a world-class institution, as attested by Artur Avila's recent Fields Medal. But it goes much beyond that: Brazil has been investing in Science and Technology and the Brazilian university system has been growing faster than any other system in the world. Nowadays, there are many other institutions in Brazil, with high quality research and researchers. Moreover, the grants from "Ciências sem Fronteiras" are generous, paying all travel and lodging expenses, including per-diems amounting to a one month of summer salary. On the top of that, it is not so unpleasant to spend a month each year in the cidade maravilhosa.

Besides "Ciências sem Fronteiras" the Lemann Institute of Brazilian Studies at UIUC also has collaboration grants with Brazil, which include mathematics. There is also a specific NSF program with CNPq, its Brazilian counterpart. So if you know Brazilian mathematicians and you are willing to try some tropical mathematics, there are some good opportunities out there!

National geometry lab conference showcases outreach and undergraduate research

Faculty, graduate students and undergraduates from across the U.S. converged on the department to participate in the inaugural Geometry Labs United conference, held August 28-30, 2015, in Altgeld Hall on the University of Illinois at Urbana-Champaign campus. The 50 conference participants enjoyed a weekend of engaging public lectures, hands-on workshops, poster presentations and panel discussions highlighting the vital role of undergraduate research within mathematics departments.

Geometry Labs United is the parent organization of a group of research labs hosted in mathematics departments around the country. The mission of GLU is to promote undergraduate mathematics research and public and community engagement. Labs currently affiliated with GLU include the Experimental Geometry Lab (EGL) at the University of Maryland, the Mason Experimental Geometry Lab (MEGL) at George Mason University, the Experimental Algebra and Geometry Lab (EAGL) at the University of Texas Pan-American, our own department's Illinois Geometry Lab (IGL) and the brand new Mathematical Computing Laboratory (MCL) at the University of Illinois at Chicago. The GLU conference included past and current members of all of these labs, as well as numerous other individuals from around the country interested in learning more about the organization, administration and impact of undergraduate mathematics research labs.

The conference started on Friday evening with a public lecture by Henry Segerman of Oklahoma State University on four-dimensional sculpture. Segerman, who is both a research mathematician and a well-recognized mathematical artist, gave an engaging and highly `illuminating' talk on visualization of high-dimensional geometric objects via projection and animation.

Saturday morning, attendees participated in an animated and interactive poster presentation. Twelve different teams presented posters describing their work on a variety of research projects, including statistical tests for randomness, complexity theory and Turing machines, dynamics of free group morphisms, and video games on Riemannian surfaces.

Two more public lectures, by Hugo Parlier of the University of Fribourg (Switzerland) and Saul Schleimer of the University of Warwick (U.K.), as well as outreach demonstrations for local schoolkids and separate panel discussions for faculty and undergraduate students filled out the afternoon schedule. The conference concluded on Sunday with a panel discussion on 3D printing technology and an awards ceremony honoring the top ranked poster presentations.

Conference participants included visitors from nine U.S. states, Puerto Rico and three European countries, representing a total of fifteen universities. The conference was supported by the National Science Foundation and the Department of Mathematics at the University of Illinois at Urbana-Champaign. The public lectures are all available on YouTube.

Michiels attends prestigious Heidelberg Laureate Forum

Daan Michiels was invited to attend the third Heidelberg Laureate Forum (HLF) in Germany this past summer. At this prestigious event, young computer scientists and mathematicians meet with laureates of the Abel Prize, the Fields Medal and the Turing Award. This year 26 laureates participated alongside 100 junior computer scientists and 100 junior mathematicians from all over the world. The program consisted of lectures by the laureates, plenty of coffee breaks to discuss ideas in an informal atmosphere, and some cultural trips to local research institutions.

Michiels, a third-year PhD student working with Rui Loja Fernandes, said "You don't get to meet people like the laureates every day, so having relaxed conversation with them and listening to their lectures was very special. One day you're talking to somebody who won an Abel prize and a Fields medal, the next you're having dinner with one of the people who decided a byte should be 8 bits while building the first computers."

Daan Michiels (far right) with colleagues at HLF. Photo © Heidelberg Laureate Forum Foundation / C. Flemming.

"Meeting the other young researchers was also extremely interesting," Daan continued. "Every single one of them had good ideas, and a passion for their work. Some of them did very abstract logic, others investigated data using machine learning, and still others designed hardware for better caching in computer networks."

Number theory conference highlights cutting edge research

Continuing the long tradition of number theory conferences at Illinois, the Illinois Number Theory Conference was held at the University of Illinois at Urbana-Champaign August 13-14, 2015, organized by Kevin Ford and Elena Fuchs. The goal of the conference was to represent the vast range of interests in our department's number theory group including topics such modular forms, Galois representations, elliptic curves, arithmetic of thin groups, L-functions, partitions, multiplicative functions, Diophantine equations, and much more.

There were 14 invited speakers from all around North America, including plenary speakers Jeff Lagarias of the University of Michigan and William Duke of UCLA. They all gave stimulating lectures which spanned a great amount of cutting edge research being conducted in number theory today.

The conference had a turnout of close to 100 participants, of whom approximately 50 percent were graduate students, 30 percent were junior faculty, and 20 percent were senior faculty, making the social events of the conference lively and stimulating. One of the main events of the conference was an open problem solving session, which turned out to be not only a particularly enjoyable and dynamic affair, but also a great opportunity for the younger participants to share problems they had been working on. In fact, one great aspect of the conference was that young people had the chance to give short 15-minute contributed talks on their work. There were 16 contributed talks in total, all of which were very well attended.

Another success of the conference was the high female to male ratio, both among participants of the conference, and among invited speakers: in both cases this ratio was around 1 to 2. While we cannot say with certainty which aspect of the conference contributed to this success the most, it is very likely that the combination of an invited speaker list with a high percentage of women (five out of 14) and a number of well-advertised resources for participants with young children, including play and nap/nursing rooms, as well as funding opportunities for caregivers and small children accompanying conference participants, played a role.

With the help of many of our graduate students and staff the conference was a huge success, with great talks and an atmosphere of enthusiasm and inclusivity. Learn more about the conference at www.math.illinois.edu/nt2015/.

Conference attendees on steps of Altgeld Hall on the University of Illinois campus.

Summer Illinois Math Camp

On August 3-7, 2015, the Department of Mathematics held the Summer Illinois Mathematics (SIM) Camp—a mathematics day camp for high school students developed to encourage proficiency in mathematics and science by introducing students to proofs and applications of math. Campers were encouraged to view mathematics as a broader and more interesting subject than just formula memorization. By showing students some of the ways mathematicians approach problems, we hope to encourage them to continue studying mathematics beyond the high school level.

Twenty-three students attended, mostly from the Champaign-Urbana area, with several students coming from out of state. SIM Camp was free for students and included lunch every day. Funds for travel reimbursement were also available to students. Funding was made possible thanks to grants from the Office of Public Engagement, Department of Mathematics, Illinois Geometry Lab, Association of Women in Mathematics, and the National Science Foundation.

In the mornings, students studied low-dimensional topology: they proved the classification of compact surfaces, developed strategies for tic-tac-toe on a torus and Klein bottle, and tried to visualize higher dimensional cubes. Afternoons were spent on number theory and cryptology. Students learned the basics of proofs and modular arithmetic and enjoyed encrypting and decrypting messages using ciphers. Students also spent a day applying mathematics to chemistry by building models of chiral molecules and encrypting messages in disappearing ink.

Mathematics graduate students Claire Merriman, Hannah Burson, Michelle Delcourt, Melinda Lanius, and Simone Sisneros-Thiry organized the 2015 SIM Camp. Dr. Olivia Lee, a Postdoctoral Research Associate in the Chemistry Department, organized the chemistry sessions. Mathematics graduate students Santiago Camacho, Elizabeth Field, Nicholas Kosar, Kyle Pratt, and Vanessa Rivera Quiñones provided vital help with teaching classes and supervising students.

Following the success of this first summer camp, the department plans to expand the program for the summer of 2016. We will offer two week-long camps: one for students entering 8th or 9th grade and one for students entering 9th-12th grade. Visit the SIM Camp website http://www.math.illinois.edu/SIM/ for more information.

Follow us on Facebook and LinkedIn

Look for "Illinois Department of Mathematics" on Facebook and LinkedIn and find out about upcoming events, news items, and other events on campus. And take a look at our photo albums!

Illinois reception in Seattle

The 2016 Joint Mathematics Meetings will be held January 6-9, 2016, in Seattle, WA. The Department of Mathematics at the University of Illinois at Urbana-Champaign will host a reception at the Joint Mathematics meetings from 5:30 to 7:30 pm on Friday, January 8, 2016 in the Ravenna AB room located on the 3rd floor of the Sheraton Seattle Hotel.

Everyone ever connected with the department is encouraged to get together for conversation and to hear about mathematics at the University of Illinois.

Homecoming 2015

Alumni and friends enjoyed a lunch buffet, games and comaraderie on a blustery fall day at the Department of Mathematics Homecoming Party held Saturday, October 24, 2015, in front of Altgeld Hall.

A special treat this year was having the *Altgeld Ringers*, a new registered student organization on campus, play the chimes during our homecoming party. Alumni were able to pick their favorite songs by having their requests radioed up to the ringers in the tower. From the Beatles, to classical, and the traditional, the bells were heard across campus!

Mark your calendar for next year's homecoming party on October 29, 2016 (Illinois vs Minnesota) and be sure to make plans to join us!

Follow us on facebook or go to math.illinois.edu/homecoming/ for more information.

Alumni together in Thailand

Ten alumni were in attendance at the Annual Meeting in Mathematics in May 27-29, 2015 held at Silpakorn University, Thailand. Bruce Berndt, a professor in the department, gave a plenary lecture at the conference and was able to get this photo of alumni!

Pictured (from left) are Jantana Ayaragarnchanakul (PhD, Advisor: Rosenblatt), Chariya Uiyyasathian (MS Illinois; PhD Colorado), Boonrod Yuttanan (PhD, Advisor: Berndt), Wipawee Tangjai (PhD, Advisor: Reznick), Malinee Sinthaveelert Chaiya (PhD, Advisor: Hinkkanen), Bruce Berndt (Professor UI), Ruth J. Skulkhu (PhD, Advisor: Kirr), Sineenuch Suwannaphichat (PhD, Advisor: Hinkkanen), Sarachai Kongsiriwong (PhD, Advisor: Berndt), and Somjate Chaiya (PhD, Advisor: Hinkkanen).

Braunfeld receives ICTM lifetime achievement award

Professor Emeritus Peter Braunfeld has been chosen by the Illinois Council of Teachers of Mathematics (ICTM) as the 2015 recipient of the Distinguished Lifetime Achievement Award. This award is the highest honor that can be bestowed on a mathematics educator by Illinois mathematics teachers. It is given each year to an individual who has given distinguished and honorable service and made significant contributions to the field of mathematics education in Illinois. Braunfeld is the 58th recipient of the award.

Not only is Braunfeld a retired professor from the department, but he is an alumnus of the department, receiving his PhD in mathematics from the University of Illinois in 1959.

This is not Braunfeld's first award from ICTM: In October 1979, he was awarded the Max Beberman award "for exceptional contributions to the field of teacher education in mathematics." Braunfeld's achievements include

- His development of the initial software for PLATO, the first computer-based, multiple-site teaching system

- His authorship of *Stretchers and Shrinkers*, an innovative text for at-risk 7th grade students.

- His development of a wide variety of innovative teacher preparation courses at the University of Illinois, including a course tracing the historical development of basic ideas in calculus.

- His development of numerous professional development programs for teachers, including Academic Year Institutes (AYIs) and Summer Institutes. These NSF-supported programs impacted hundreds of elementary, middle school, high school and college teachers of mathematics and computer science nationwide.

- His work with the Illinois Office of Extramural Courses to bring professional development to teachers throughout Illinois. This work earned him an Excellence in Teaching Award.

- His contributions as senior mathematics adviser to a dozen or so major national curriculum projects (including CSMP (Carbondale, IL), BUMP (Boston University), MSTE (Illinois), etc.

- The numerous projects in teacher professional development preparation and enhancement that he managed and nurtured during his tenure as an NSF program officer.

- The hundreds of talks, seminars, and workshops for teachers that he has given in the United States and Europe.

According to a former student of his, "Being around Peter Braunfeld makes one eager to learn more." Braunfeld says, "For a teacher, it doesn't get any better than that!"

Our most recent PhD alumni:

Who they are and where they are now

- Stephen Berning, Information Analyst, Caterpillar

- Seckin Demirbas, Research Instructor, Northeastern University; Postdoctoral Researcher, University of British Columbia

- Michael DiPasquale, Visiting Assistant Professor, Oklahoma State University

- Lisa Hickok, Applied Research Mathematician, Department of Defense

- Daniel Hockensmith, Visiting Lecturer & Director of the Mathematics Assistance Center, University of Pittsburgh

- Donghoon Jang, Postdoctoral Research Fellow, Korea Institute for Advanced Study

- Jian Liang, Senior Analyst, Quantitative Advisory Services, Ernst & Young

- Thomas Mahoney, Assistant Professor, Emporia State University, Kansas

- Daniel McDonald, Civilian Contractor, Space and Naval Warfare Systems Center Pacific

- Benjamin Reiniger, Postdoctoral Fellow, Ryerson University

- Victoria Reuter, Assistant Professor, Univ. of Wisconsin-Platteville

- Arindam Roy, G.C. Evans Instructor, Rice University

- Dominic Searles, Assistant Professor (NTT) of Mathematics, University of Southern California

- Jianyun Shan, Senior Analyst, Quantitative Advisory Services, Ernst and Young

- Han Wang, Postdoc Research Scholar, Dept. of ECE, North Carolina State Univ.

- Elyse Yeager, Tenure-Track Instructor, Univ. of British Columbia

- Min Zhao, Revenue Science Analyst, Fedex

- Sishen Zhou, Associate, Risk Management Group, Finance Division, Goldman Sachs

Students from Kazakhstan participate in summer REU

In summer 2015, three undergraduate students at Nazarbayev University (NU) in Kazakhstan, Narken Aimambet, Chingiz Matayev, and Alisher Urazbekov, traveled to the University of Illinois to participate in a six week REU program in mathematics. The program was conceived by Professor Rick Laugesen and Kira Adaricheva, Chair of the Mathematics Department at NU, and directed by Professor A.J. Hildebrand and graduate student Michael Santana.

The program included a short course on asymptotic analysis; workshops on LaTeX and *Mathematica*; an REU Seminar in which current graduate students talked about their areas of research; and other activities such as tours of the NCSA Petascale Supercomputing facility and Wolfram Research headquarters.
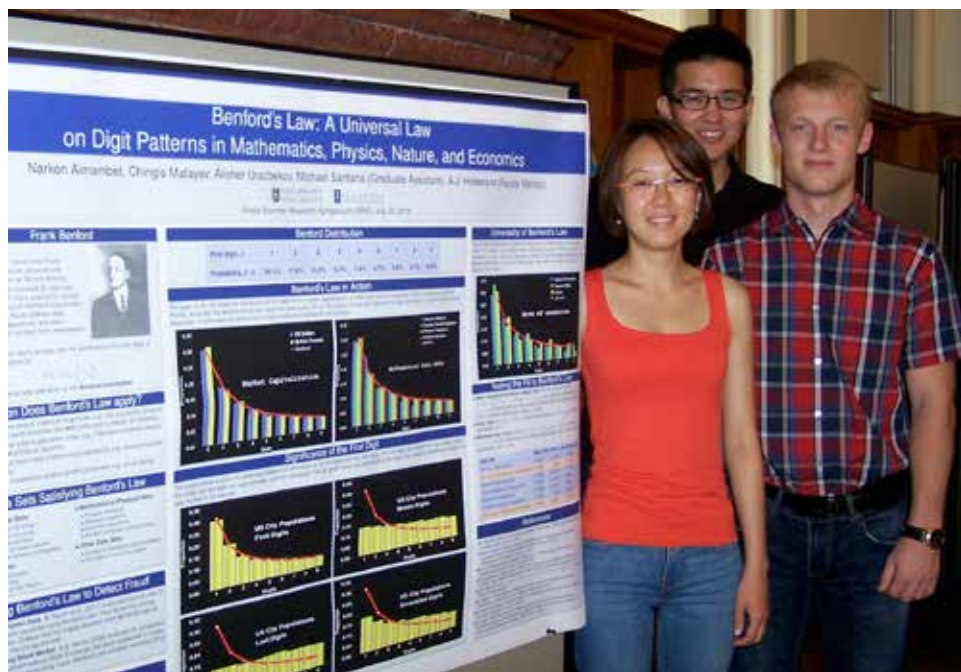
From left: Narken Aimambet, Chingis Matayev, and Alisher Urazbekov from Nazarbayev University in Kazakhstan.

For their research project, the students selected Benford's Law, a topic that lies at the interface of number theory, probability, and analysis, with applications to finance, economics, and other areas. They presented a poster on their work at the Illinois Summer Research Symposium on July 23, 2015. and they gave a 30 minute oral presentation to the mathematics department at the conclusion of the program. The students have since given additional presentations to student and faculty audiences at their home institution. In addition, *Mathematica* animations created by Narken Aimambet and Chingis Matayev as part of the program have since been published at the Wolfram Demonstrations website, www.demonstrations.wolfram.com.

Students compete in fall 2015 UI math contests

A combined 53 students participated in the first contest event of the academic year, the UI Freshman Math Contest, and the UI Mock Putnam Exam, held back-to-back on September 26, 2015.

The UI Freshman Math Contest is an entry level contest that provides freshmen an opportunity to show their problem solving skills in direct competition against their peers. This year's contest was won by Yunyi Zhang, a Freshman in Engineering Physics. In second place was Shiliang Gao, a Freshman in Mathematics, while Yuchen Li, a Freshman in Computer Engineering, placed third.

The UI Mock Putnam Exam is a long-running local version of the Putnam Exam, a nationwide math contest for undergraduates that has been dubbed the "world's toughest math test". The exam consists of seven challenging math problems, similar in nature to problems on Putnam contests, but a bit easier. Haidong Gong, a Junior in Mathematics, continued his dominance of the local math contest scene by winning the contest outright. Haidong has now won five out of six local math contests he had participated in since entering the University in Fall 2013. Second Prize went to Zehan Chao, a Senior in Mathematics, and the top local scorer (tied with Haidong Gong) on the 2014 Putnam Exam. Yewen Fan, a Junior in Mathematics, won Third Prize.

The contests are part of the University of Illinois' extensive Math Contest Program organized by Professors A.J. Hildebrand and Timur Oikhberg, with the assistance of graduate students Anton Bernshteyn and Hiram Golze, and undergraduate student Yifei Li.

For more information about math contests and training, visit www.math.illinois.edu/contests.html.

Yang Xu

by Jim Dey

It's a long way from Shaanxi Province in northwest China to the University of Illinois campus in Urbana-Champaign. But the distance didn't discourage 21-year-old Yang Xu from pursuing her dream of a mathematics education in the United States.

Yang Xu is a UI senior majoring in mathematics and statistics with a minor in computer science.

"I decided the people here (in the United States) have more passion about their careers," said Yang, a UI senior majoring in mathematics and statistics and minoring in computer science.

Passion comes naturally to Yang. She's been playing the piano since she was a little girl, hopes to someday become fluent in French and calls mathematics "the deepest and longest interest" in her life. Her long-term plan is to earn advanced degrees in a mathematics-related field and use her skills to advance science.

"I want to be involved with data analysis. You can always find the core reason behind the data," she said. "Currently, I want to be involved in medical research. I want to do something really helpful."

Yang describes her interest in mathematics as "innate," a subject that fascinated her before she understood "its relevance to economics or engineering."

"When I study math, I can prove it," she said, contrasting the certainty and step-by-step logic in mathematics with the imprecision of other subjects like history.

Yang has had plenty of opportunities to pursue her interests at the UI. She's president RSI — Research as Students at Illinois, a student organization founded to help support undergraduates pursue research — and a vice president of the UI math department's MATRIX Math Club.

She's also an undergraduate teaching assistant and a veteran researcher who's already worked with Professors Bruce Reznick and Runhuan Feng.

"If you like a topic, you can always find an opportunity to do research with your professors," she said.

Professor Reznick said Yang has worked with him on two undergraduate research projects. He calls her a "very smart person with a warm personality" who is determined to finish what she starts. "She was persistent in both of her research projects. My experience has been that in mathematics, as well as a lot of other fields, hard work is more important in the long run than talent. It is important not to give up," he said.

Unduly modest about her academic prowess, Yang said that "once I pick up something I don't want to give it up."

"Some students have more talent than I do. But when I have a goal, I want to finish it. I don't do anything halfway," she said.

Proof of her determination is the language barrier that Yang, as well as many other foreign students on campus, must clear each day. She said she has been studying English since primary school, but that her efforts to pick up the language became more intense as she got older. Her father is a businessman while her mother works for the Bank of China. She has a younger brother and carries a cell phone video of him playing in a swing.

"I miss China. I miss my family," Yang acknowledged.

But she's enjoying her time at the UI and is grateful for what she calls the "freedom to learn." Yang said earning a doctoral degree is her long-term goal. Right now, she's studying for the Graduate Record Exam and trying to decide where to apply for graduate school.

Although she doesn't aspire to be a professor, Yang said she enjoys her work as a teaching assistant and that it has helped make her a better mathematician.

"If you teach others a theory, it means you understand the theory," she said.

Although Yang spends a lot of time on her studies, she also enjoys shooting pool. Next semester, she's hoping to have more free time to devote to piano and perhaps her study of French.

Professor Reznick said that kind of dogged approach to advancing her education will serve her well in the future.

"She is in the group of our math majors that I would expect to succeed because they have the combination of talent with the inner qualities to make the most of their talent. If she wants to apply her mathematical skills in medical research, I'm confident that she'll be successful and make the most of her opportunities," he said.

Jim Dey is a columnist and editorial writer for The News-Gazette in Champaign-Urbana.

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(see page 2 for contact information).

In Memoriam

James Lee Hafner
1954-2015

Jim Hafner, who received his PhD at the University of Illinois under Professor Bruce Berndt in 1980, died from cancer on October 24, 2015. Jim was born in Monterey, CA on October 21, 1954. He attended Santa Clara University before coming to Illinois for his graduate work.

Upon completing his doctorate, he held a one-year appointment at the Institute for Advanced Study. He then taught at CalTech for two years. Jim then obtained an NSF postdoctoral fellowship which he spent at the University of California at San Diego for three years, where he was guided by Berndt's first doctoral student, Ron Evans, and Harold Stark.

Jim then joined the IBM Almaden Research Center in San Jose, where he served for the remainder of his career. Although Jim still occasionally did research in analytic number theory, his focus switched to theoretical computer science, where he worked in complexity theory, image data bases, storage systems, and storage protocols. During Jim's 29 year career at IBM, he was awarded at least 47 patents and was designated a Master Inventor.

Jim's older brother was with him at the end of his year-long battle with cancer. He is also survived by two sons, David and Paul.

Retirements

Lori Dick retires

Lori Dick

After 30 years with the department, Lori Dick retired on November 20, 2015. Lori began work in the department on November 11, 1985, as a Clerk Typist II, typing letters and keeping roster information by hand in the main office. She was promoted to Clerk Typist III in 1987 and to Secretary IV in 1989, when she moved from the main office to the graduate office, where she worked for the next 20 years.

She began in the graduate office with routine secretarial work, but as the years went by, her willingness to take on additional duties resulted in a promotion to Staff Secretary in 1997. From 1998–2000 she served on the Grad Connect committee; this committee designed a web-based grad student application system which was used from 2000 to 2004. Between 2000 and 2005 she served on the Graduate College Administrative Advisory Committee, whose focus was to improve the operations of the Graduate College.

In 2001 she was promoted to Administrative Secretary. Since she now had duties both in the main office and the grad office, an assistant was hired to work under her supervision. Lori attended Human Resource training to improve her skills,

receiving certification in the Fast Track Program and the Professional Supervisor program in 2002 and 2003, respectively. This drive toward self-improvement became a hallmark of her career. In 2008 she began taking classes at Parkland College working toward her Bachelor's degree which she will complete at Eastern Illinois University in May 2016.

Lori was promoted to Administrative Aide in 2004 as her responsibilities gradually shifted out of the graduate office and into the office of the Associate Chair, which is responsible for the teaching mission of the mathematics department. In 2009 she began to work full-time in the Associate Chair office, and in 2011 she was promoted to Administrative Assistant I, serving as assistant to the Associate Chair. She managed textbooks, room reservations, and scheduling for all of our courses, and arranged rooms for our hundreds of seminars, review sessions and conferences.

Lori's service has been characterized by hard work, an ongoing commitment to improve departmental operations and a consistent willingness to go the extra mile for the faculty, the staff, and the generations of graduate students who have been fortunate enough to work with her. Lori's career of distinguished service was celebrated when she received the Nancy J. McCowen Distinguished Service Award from the College of Liberal Arts and Sciences in 2013.

In Memoriam

Maurice H. Heins, 1915-2015

Professor Maurice H. Heins of Deephaven, MN passed away on June 4, 2015 at the age of 99. He was born in Boston, MA on November 19, 1915. He retired from the Department of Mathematics at the University of Illinois in 1974.

As a boy, he attended Boston Latin School where he began his lifelong enjoyment of Greek and Latin literature, then attended Harvard College where he majored in Mathematics, graduated first in his class in 1937, and won a fellowship for a year of travel to mathematical centers in Europe. He received his PhD from Harvard in 1940. His research interests were varied, but focused primarily on complex and harmonic analysis. He was the author of close to 100 research papers, published in the most prestigious journals, and three textbooks on complex analysis.

He is especially known for his work on so-called Hardy classes of functions defined on Riemann surfaces and on conformal metrics. Known for his kind and gentle demeanor, Professor Heins was widely sought as a mentor and advisor. He was the thesis advisor for some nineteen students over the course of his long career. In 1940, he married Hadassah Wagman (Radcliffe 1939), and they moved to Princeton, New Jersey where Maurice conducted research at the Institute for Advanced Study as an

assistant to Marston Morse, one of his teachers at Harvard. He returned to the Institute to conduct his own research in 1956.

Professor Heins held academic positions at three major research universities: Brown University (1945-1958), the University of Illinois at Urbana-Champaign (1958-1974) and the University of Maryland at College Park, where he was recruited to a distinguished chair professorship. His long career also included stints at the Illinois Institute of Technology; a period at the Pentagon; and research and teaching for brief periods in Helsinki, Stockholm, Wurzberg, and Zurich. After retiring from his professorship at the University of Maryland, he continued to pursue his research interests, publishing papers into the 1990s.

He was an invited speaker at the 1958 International Congress of Mathematicians in Edinburgh, was elected as a Fellow of the American Academy of Arts and Sciences, and to the initial class of Fellows of the American Mathematical Society.

Memorials can be made to Planned Parenthood Minnesota, North Dakota, South Dakota in St. Paul; The Ploughshares Fund in San Francisco; or the Advocates for Human Rights in Minneapolis, MN.

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IJM issue to honor Wolfgang Haken

In 1976, Wolfgang Haken and Kenneth Appel, two professors at the University of Illinois at Urbana-Champaign, solved one of the most famous problems in mathematics, the "Four Color Problem." They proved that any two-dimensional map, under natural hypotheses, can be filled in with four colors without any adjacent "countries" sharing the same color.

The article based on their research was published in two parts, "Every planar map is four colorable. Part I: Discharging", and "Every planar map is four colorable. Part II: Reducibility", in Volume 21, Number 3 (Fall 1977) of the *Illinois Journal of Mathematics* and has been one of the most well-known papers ever published in IJM.

To celebrate the 40th anniversary of the paper, we are pleased to announce the upcoming publication of a special volume of invited papers in honor of Professor Haken, scheduled to appear in late 2016 or early 2017 as a regular issue of IJM. In addition to invited contributions, the special volume will also include a biographical article about Haken and a reprint of one of his papers.

Apart from the solution of the Four Color Problem, Wolfgang Haken is known for fundamental contributions to low-dimensional topology, including the solution of the Unknot Problem, the development of theory of normal surfaces, and introducing the notion that came to be known as a Haken manifold. The "Virtual Haken Conjecture," recently solved by Agol and Wise, has been a major open problem in the study of 3-manifolds for over 40 years and greatly informed the development of the subject.

We would like to give a special thank you to guest editors for the issue, Ilya Kapovich, Christopher Leininger, and Walter Neumann, for their efforts in bringing the issue to fruition.

A special postmark (above) was used by the UI Mathematics Department for several years in the late 1970's bearing the slogan "Four Colors Suffice," based on the work by Haken (pictured above seated) and Appel.

FOUR COLORS SUFFICE