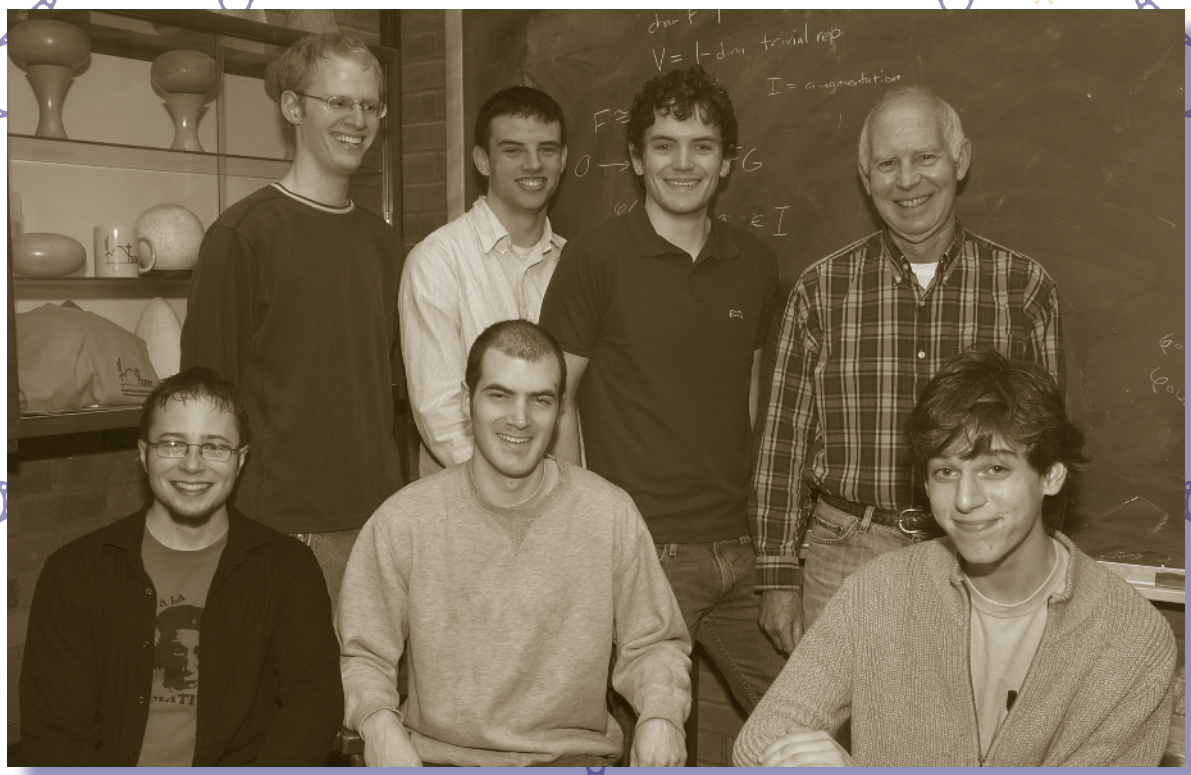
AUTUMN 2007

NEWSLETTER OF THE DEPARTMENT OF MATHEMATICS AT THE UNIVERSITY OF WASHINGTON

Mathematics NEWS



DEPARTMENT OF MATHEMATICS NEWS

MESSAGE FROM THE CHAIR

As you will read in the article by Tom Duchamp, a concerted effort by the Department has transformed our graduate program during the past decade. A record number of 14 students completed the Ph.D. last academic year, and ten students finished in the previous academic year. In fact, all indications are that we have entered a period in which we will continue to average over ten doctorates a year, compared to a historical average of about 6.5. One of our goals during the past decade has been the broadening of the experience and preparation of our students. While the majority of our doctoral graduates go on to postdoctoral positions at research institutions, several choose to work in industry or to teach at two-year or four-year colleges. All have a better understanding of the scientific and educational responsibilities that mathematicians must assume.

The past decade has also seen major revisions to our undergraduate degree programs and instruction, resulting in the doubling of the number of Mathematics majors to above 300. In addition, there are over 100 students in the joint ACMS program that was introduced ten years ago. The graduates of both of our programs, Mathematics and ACMS, are prepared to pursue a wide range of careers in all areas of science, engineering, and mathematics, and in other fields.

The following pages describe some of the achievements of our students and the recognitions they continue to receive, for example two wins in the Mathematical Contest in Modeling, a Dean's Medal, and two National Science Foundation Postdoctoral Fellowships during the past year. We are pleased to acknowledge the strong (and increasing) support of our alumni and friends, including a number of professorships and fellowships. This support beyond state funding and federal grants adds greatly to our effectiveness in research, education and outreach.

I would also like to acknowledge a group of colleagues who contribute to every aspect of our work: the Department's ten members of staff. They deserve a large share of the credit for the Department's successes.

Our educational activities go hand in hand with our research, each part of our mission benefiting from and strengthening the other. And everything we do rests on the efforts of the Department's faculty. During the past decade we have built research groups in algebraic geometry, combinatorics and number theory. In addition we have recognized the important role computation now plays in mathematics; with the appointments we made in recent years, we now have several faculty members whose interests include computation. We plan to continue to build in these areas, and at the same time maintain the Department's long-standing strengths in probability, optimization and several areas of analysis. More generally, we hope to build upon the advances the Department has made in undergraduate and graduate education as well as in research. Thanks to the commitment of the Department's faculty, staff, students, alumni and friends, we are in an excellent position to do so.

– SELIM TUNCEL

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Pictured (front cover):

Lower left: Virginia Warfield – See article page 14.

Lower middle: Nicholas Reichert – See article page 4.

Lower right: Ioana Dumitriu – See article page 16.

Top: 2007 Mathematical Contest in Modeling 2007 Outstanding Winners from UW Mathematics; (back row from left) Sam Whittle, Aaron Dilley, Sam Burden and instructor Jim Morrow, (front row from left) Lukas Svec, Wes Essig and Nate Bottman – See article page 6. *Photo by Kathy Sauber.*

DEAN'S MEDALISTS: A LOOK BACK

The Sixth Dean's Medalist in Eight Years

In 2006, Nick Reichert achieved the honor of being the first Mathematics major from UW to earn an Astronaut Scholarship from the Astronaut Scholarship Foundation. (Established by the Mercury 7 astronauts, the foundation awards a fellowship to one student in each of 18 universities. Seldom is the fellowship awarded to an undergraduate!) Just last June, Nick achieved another first in the history of the Department: he graduated from UW with simultaneous Bachelor's and Master's degrees in Mathematics. Yet there was something else Nick achieved last spring that we in the Department are proud to say was not a first: he was also awarded the Dean's Medal in the Natural Sciences.

Nick is the latest in a distinguished line of six Mathematics majors who have received the Dean's Medal in the last eight years. Preceding Nick in this honor were Eliana Hechter, Terri Moore, Jeff Giansiracusa, Thomas Carlson, and Kathy Temple. This year we take a look back at these exceptional students, and check in with them to see where their careers have taken them since their time at UW Mathematics.

2007 Dean's Medalist in the Natural Sciences Nick Reichert

Nick Reichert

Nick was admitted to UW via the Robinson Center's Early Entrance Program, a path that led him to the pursuit of mathematics. "There are so many great things that happened while I was at the UW Mathematics Department," Nick recalls. Even prior to the Dean's Medal and Astronaut Scholarship, he was one of the Department's star students. He twice was the top scorer at UW in the Putnam Mathematical Competition, and studied inverse problems in electrical networks as part of the NSF Research Experience for Undergraduates (REU) Program. Nick was also an undergraduate teaching assistant for the Honors Calculus series—a position held by many previous medalists.

"The administration was incredibly accommodating," says Nick, "letting me complete a Master's degree simultaneously with my undergraduate degree."

After leaving UW, Nick's first stop was the Kennedy Space Center at Cape Canaveral, Florida, where he worked for six weeks this summer as a consultant for NASA. Here he used techniques from partial differential equations to model diffraction patterns for sound waves in order to optimize an ultrasonic detector. Once the summer had ended, Nick moved on to Princeton University where he now pursues a Ph.D. in Mathematics.

Eliana Hechter

2006 Dean's Medalist and Rhodes Scholar Eliana Hechter, the featured graduate in last year's newsletter, also became a Goldwater Scholar and Marshall Scholar after coming to UW via the Early Entrance Program. Her interests also ran to biology and genetics, leading to her spending a year at the Center for Cell Dynamics at Friday Harbor Labs. Like Nick Reichert, during her time at UW Eliana was involved in the REU Program and served as an undergraduate TA for the Honors Calculus series.

As a Rhodes Scholar, Eliana now studies at Oxford University with Peter Donnelly toward a Ph.D. in Statistical Genetics. In addition, she has formed her own mathematical problem-solving firm, eBourbaki, whose mission is to "help leading corporations become more efficient and competitive while increasing interest in mathematics in the global community."

Terri Moore

Graduating magna cum laude in 2004 with a double major in Mathematics and Computer Science, Terri's undergraduate career was flavored by research both here and abroad. After participating in the Budapest Semesters in Mathematics program, she took part in a VIGRE-funded research project titled "Non-Unique Factorization in Integral Domains." Following graduation, Terri began her graduate career at the University of Nebraska where she won an Outstanding Qualifying Exam Award in 2005-06. She now pursues her Ph.D. as part of the Commutative Algebra Group under Roger Wiegand.

Jeff Giansiracusa

In 2003, Jeff won the Dean's Medal—a cap to an undergraduate career that also involved the Goldwater Scholarship, REU, and TAing for Honors Calculus. Jeff was also on the first ever Outstanding Winner Mathematical Contest in Modeling (MCM) team from UW Mathematics, and would earn the Outstanding Winner designation a second time the following year.

The recipient of an NSF graduate fellowship, Jeff entered the mathematics Ph.D. program at Oxford. There he studied with Ulrike Tillman in the area of algebraic topology and also met his wife, Rebecca Clifford. Jeff spent the 2006-07 academic year in Paris, visiting the Institut des Hautes Etudes Scientifiques on a postdoctoral fellowship and finishing his thesis during this time, which he defended last April. He is currently a junior research fellow with Magdalen College, Oxford, and has given research talks in many countries throughout Europe and North America. Jeff's work involves tools and problems at the intersection of three areas: moduli spaces, diffeomorphism groups, and algebraic K-theory.

Looking back at his undergraduate career, Jeff notes that he appreciates the opportunities at UW Mathematics even more now that he has seen other departments around the world. "I think that UW Math offers undergrads a far wider array of choices and much more diverse education experiences than any European university. I've been trying, with what influence I can wield, to move Oxford more in the direction of UW."

Thomas Carlson

Graduating in 2002 with a B.S. in both Mathematics and Computer Science, as well as a B.A. in English, Thomas was another student who came to UW via the Early Entrance Program. His undergraduate career involved not only beginning graduate courses in his junior year and TAing Honors Calculus, but also directing and starring in plays and publishing and editing a newspaper.

Thomas worked the first year after graduation as an actor before completing a Master of Divinity at Trinity Evangelical Divinity School. He went on to earn a Master of Studies in Syriac at Oxford in 2006, and is currently working toward a Ph.D. in history at Princeton.

Kathy Temple

A double-major in Mathematics and Economics, Kathy was also a double-medalist, winning both the Dean's and President's medal before graduating in 1999. Exposed to probability theory at UW through Krzysztof Burdzy and Rich Bass, she made it her specialty when attaining her Ph.D. at the University of Wisconsin-Madison. Kathy returned to the Pacific Northwest and is now an Assistant Professor at Central Washington University where she also works with her husband and fellow UW Mathematics alumnus Jim Bisgard. Part of her job is to advise students in the actuarial science program, melding her original majors at UW.

Kathy credits part of her success in graduate school to the supportive faculty and variety of courses (both undergraduate and graduate) available to her here at UW. "There's a stereotype that it can be easy to get lost in large departments...but I didn't feel that way at all about the Math Department," she recalls. "I had faculty who were genuinely interested in their students and willing to put in extra time and effort to help us."

It is a trend worth noting that medalists teach medalists: Eliana Hechter was taught by Jeff Giansiracusa, while Nick Reichert was once taught by Thomas Carlson, who in turn was taught by Kathy Temple.

Congratulations once again to all of the Dean's Medalists on their past and continued success!

– MIKE MUNZ

The following article was published in *University Week*, the faculty and staff newspaper for the University of Washington. We thank *University Week* and Hannah Hickey for permission to include the article here.

See front cover for a photo of the Outstanding Winner teams.

UW Undergrads Dominate International Math Competition

They thought they had already had their proudest moment. But then this year they did even better.

Results of the 2007 Mathematical Contest in Modeling surpassed even the adviser's high expectations. The 14 winning teams included entries from Harvard, Duke and MIT. And two teams from the University of Washington.

The undergraduate teams were chosen as Outstanding Winners of the grueling, 96-hour competition. And this year's field was tougher than ever. Of 949 entries, more than two-thirds of the teams were from outside the United States.

"We're extremely proud of our students. They're fantastic," said Selim Tuncel, chair of the UW's department of mathematics. "Two Outstanding Winners in one year is an incredible achievement." The members of the winning teams are Nate Bottman, Sam Burden, Aaron Dilley, Wes Essig, Lukas Svec and Sam Whittle.

The UW's math department now counts seven wins in six years—a feat Tuncel jokingly compares to Lance Armstrong's unprecedented seven Tour de France titles. "I think the excitement really builds," Tuncel said. "Students in one year see students in the previous year winning, and it just snowballs."

Coaching the teams was Jim Morrow, a professor of mathematics. Morrow began entering teams in the competition in 2001, when there were roughly half the number of entrants.

"Not only has winning not gotten old, but to me, it's gotten more and more surprising," Morrow said. "The competition has gotten far more difficult over time, as it's become more of a worldwide contest."

As always during the contest, sleep was in short supply. "I advise the students to get enough sleep and tell them it's a physical contest," Morrow said. "That's one of the reasons that I think young people are good at it."

The entrants, ranging from sophomore to senior years, receive a choice of two questions revealed on a Thursday at 5 p.m. Both winning teams answered this year's problem on gerrymandering: how to devise a fair, mathematical way to divide up states' congressional districts.

For the next four days the students could research the problem in libraries or online, but they were barred from communicating with friends, family or professors. Team members work closely together from dawn until long after dusk, sharing computer programming, mathematics research and report-writing duties. Asked to describe the experience, Dilley responded: "Two words: mentally exhausting." Names and affiliations are removed from the final submissions so they can't influence the judges' decisions.

"The skills that you learn are really marketable. Teamwork, problem-solving, how to communicate ideas," said Burden. Soon after the contest results were announced, a data analyst at Google e-mailed the winning members and encouraged them to apply for a position. Winning team members are often recruited by companies such as the National Security Agency, Microsoft and investment company D.E. Shaw, Morrow said.

Plaques displayed in the Department of Mathematics main office proudly showcase the Mathematical Contest in Modeling Outstanding Winner awards as well as INFORMS, MAA, and SIAM awards, also related to MCM. All of these awards were earned by UW Mathematics teams since 2002.

This is not only local teams but pure Northwest talent. All but one of this year's winners hail from Washington state. The exception, Essig, is from Idaho. "The local people ought to be pretty proud of them," Morrow said.

Burden, Dilley and Svec all attended the first Summer Institute in Mathematics at the UW, the department's outreach program for mathematically talented high school students, in 2003. In addition to the Outstanding Winner title, their solution also earned the Mathematical Association of America prize.

The Outstanding Winner teams are as follows:

Team 1:
Nate Bottman, sophomore, mathematics and applied math, Seattle, WA.
Sam Whittle, junior, computer science, Bellingham, WA.
Wes Essig, senior, mathematics, Boise, ID (two-time winner).

Team 2:
Sam Burden, junior, computer engineering and electrical engineering, Spokane, WA.
Aaron Dilley, sophomore, mathematics, Spokane, WA.
Lukas Svec, senior, physics and mathematics, Oroville, WA.

– HANNAH HICKEY, *UNIVERSITY WEEK*

UNDERGRADUATE STUDENT AWARDS

Undergraduate Scholarships in Mathematics

Tam Thanh has been selected to receive the Mathematics Undergraduate Endowed Scholarship this year. Tam is a sixteen-year-old student from Puyallup, and took many college-level mathematics courses while still in high school. Tam joins previous winners Amanda Jane Geddes and Zachary Sanford, who continue to excel. The scholarship is made possible by an endowment established by Byron and Sheila Bishop.

Lukas Svec has been selected to receive the first Thomas Bleakney Endowed Scholarship in Mathematics. Lukas, also an Outstanding Winner and MAA Award recipient in the 2007 Mathematical Contest in Modeling (see article page 6), is a senior and double-major in Mathematics and Physics.

American Mathematical Society Recognizes Undergraduates

Photo by Mike Munz

Susan Massey has won the Trjitzinsky Award of the American Mathematical Society. Six of these awards are given each year to mathematics students across the nation to assist them in pursuit of careers in mathematics.

A senior working toward her B.S. in mathematics, Susan spent the summer of 2007 working in the lab of Dr. Kristin Swanson developing a mathematical model of glioma (a type of brain tumor) genesis and evolution, through funding by the Amgen Scholars Foundation. This past winter she took care of her mother and ten-year-old brother during her mother's bone marrow transplant, taking off only one quarter from school, so that she could stay in school to achieve her dream of being the first in her family to graduate from college. She continues to support her family as her mother is still unable to return to work. Susan aims to pursue an M.D./Ph.D. with a focus in neurology to research causes of and treatments for neurological diseases.

Nate Bottman won a Math in Moscow Scholarship Award from the American Mathematical Society, continuing in the tradition of previous winners Wes Essig, Justin Vincent (both 2006) and Noah Giansiracusa (2005). This scholarship helps to fund awardees' study at the Independent University of Moscow, an institution specializing in research mathematics.

The Math in Moscow Scholarship is only one of the awards Nate has earned recently. In addition, Nate has won the UW Freshman Medal and was on one of the Outstanding Winner teams in the 2007 Mathematical Contest in Modeling (see article on page 6). Most recently, in August he was named a Davidson Fellow, an award given to seventeen students across the country under the age of 18 for significant contributions in science, mathematics, technology, literature, and music.

Photo by Kathy Sauber

VIGRE PROGRAM

Photo by Adam Berliner

Participants of the 2007 Graduate Student Combinatorics Conference at the University of Washington, made possible by support from VIGRE.

VIGRE Update

Only two mathematics departments nationwide have won back-to-back five-year VIGRE (Vertical Integration of Research and Education) grants from the National Science Foundation going back to the program's start in 1999, both at universities with the initials UW! (The other one is Wisconsin.) Our $4,000,000 VIGRE grant is a collaboration with the Departments of Applied Mathematics and Statistics. It funds undergraduate research projects, graduate traineeships, postdoctoral fellowships, student travel, and a range of activities meant to enrich and broaden the professional development of our students at all levels.

One of the highlights this past year was a visit by Professor Hendrik Lenstra of the University of Leiden as VIGRE Distinguished Lecturer in November 2006. As part of this visit, Professor Lenstra gave a spectacular public lecture on "Escher and the Droste Effect," about the deep mathematics underlying a lithograph by M. C. Escher called "Print Gallery," to over 200 people. His week-long visit was organized and run by VIGRE graduate fellows, who had many opportunities to interact with this internationally recognized scholar.

Our graduate students also used VIGRE funds to host a national conference on combinatorics one weekend in April, at which over 100 students from around the country participated in lively exchanges about their work and heard a keynote address by Professor Vic Reiner of the University of Minnesota (see photo above).

VIGRE continues to fund dozens of our undergraduates working on projects with faculty. Professor William Stein has been especially energetic in recruiting undergraduates to make crucial contributions to SAGE, the publicly available mathematical software system he is developing. In addition, VIGRE graduate fellows help run our Undergraduate Mathematical Sciences Seminar, recruiting speakers who explain subjects like "Blowing Stuff Up and Looking for Oil in Silly Putty: Seismic Inverse Problems," "Numerical Modeling of Tsunamis," and "Sphere Packing and Error Correcting Codes."

— DOUG LIND

GRADUATE PROGRAM NEWS

The Graduate Program

The Mathematics Department's graduate program has undergone a remarkable renaissance in the past decade. The number of doctoral degrees awarded by the Department has increased in each of the past three years to a thirty-year record number of fourteen in 2007, and job prospects for our graduates are better than ever. Many recent graduates have accepted positions at top research universities such as Columbia, Cornell, Michigan, Stanford, Purdue, Rice, and Wisconsin; others are working at leading companies such as Chevron and Samsung; and still others are teaching at local colleges and universities including Seattle University, UW Bothell, and Green River Community College.

It wasn't always this way. The current state of our graduate program is the result of a comprehensive recruitment and retention plan that we began to formulate in 1997 when it became apparent that our old approach was not working well. From the late 1990s up to the present, we have instituted a number of changes to our program which, together with other factors, are responsible for our success.

To improve the quality of our entering classes, we have revised our evaluation procedure for applicants and enhanced our recruitment efforts. Each application is carefully evaluated by three members of the Admissions Committee. We use funds from the Graduate School together with internal departmental funds to support visits of our top candidates. Our own students are the best publicity for our program, so each visiting applicant is chaperoned by an advanced graduate student.

Developing a comprehensive support package guaranteeing adequate financial support to our top students has been a central component of our recruitment strategy. Most of our top applicants receive offers from leading universities such as Michigan and Berkeley that include financial incentives beyond their base TA salary, which in turn is often significantly greater than ours. Beginning in the 2001-02 admissions season, we have been able to promise an attractive 11-month salary for a minimum of five years, subject to making satisfactory progress toward the Ph.D. To fund this plan we have to call upon all sources of funding available to us: outside sources such as the National Science Foundation, the ARCS Foundation, and the Microsoft Corporation, as well as internal funds. The majority of these sources are temporary, and our long-term goal is to stabilize the plan with permanent funding.

Our recruitment strategy has been a dramatic success. The number of applicants to our program has steadily increased from a low of a little over 110 applicants in 1998 to over 270 applicants last year, allowing us to be increasingly selective in our admissions policy. We typically admit fifteen doctoral students and five master's students. Our graduate enrollment has increased to 90 students, the maximum number we can fully support with our current resources.

Strengthening our advising and mentoring program has also been a multi-year effort. We have designed a three-day orientation program for new students and teaching assistants. Each new student meets individually with the Graduate Program Coordinator and with a faculty advisor to map out a course of study. In addition, new students participate in a TA training program, and they are mentored by an experienced TAs during their first quarter of teaching. Advising and mentoring of students (by multiple faculty members in numerous roles) continues throughout our program.

The Department sponsors numerous courses and activities designed to acquaint students with current research in mathematics, as well as with current topics related to the profession. The Department organizes regular colloquia and both formal and informal seminars and reading groups, and graduate students organize the Current Problems Seminar where faculty and advanced graduate students discuss their own research. In addition to formal talks, the Department sponsors lunches with colloquium speakers and "brown-bag lunches" to discuss issues related to the teaching of mathematics. Approximately twice each quarter the Department sponsors an informal dinner where a small group of students and faculty meets to explore ways to improve our graduate program.

We are proud of the success of our graduate program and students over the past few years, and we confidently expect not only to continue operating at the high level we have achieved, but to build further upon it.

– TOM DUCHAMP

Graduate Student Awards for 2007–08

Academic Excellence Awards
Joao Goeveia
Ting Kei Pong
Wenhan Wang

Teaching Excellence Awards
Michael Goff
Troy Winfree

ARCS Foundation Fellows
Christopher Jordan-Squire
Michael Gaul
James Vargo
Stephanie Vance

McFarlan Fellows
Andrey Novoseltsev
Zsolt Patakfalvi

McKibben and Merner Fellows
Sean Holman
Matthew Korson
Wenhan Wang
Ursula Whitcher

GO-MAP Research Assistantship
Megan McCormick

Microsoft Scholars
Mauricio Duarte
Julia Eaton
Joao Gouveia
Jacob Lewis
Andrey Novoseltsev
Zsolt Patakfalvi
Ting Kei Pong
Dake Wang
Xingting Wang
Carto Wong

Tanzi-Egerton Fellows *(see photo below)*
Anusha Sekar
Catherine Williams

Top Scholar Awards
Samuel J Buelk
Paul Carr
Alberto Chiecchio
Nathan Grigg
Gautam Sisodia
Justin Tittelfitz
Dake Wang

VIGRE Fellows
Nathaniel Blair-Stahn
Robert Bradshaw
Jonathan Cross
Ariana Dundon
Nathan Grigg
Luke Gutzwiller
Christopher Jordan-Squire
Ian Langmore
Dustin Moody
Anusha Sekar
Stephanie Vance
James Vargo

Inaugural Tanzi-Egerton Graduate Fellows: Anusha Sekar and Catherine Williams. This award is made possible by an endowment established by Lisa Tanzi and Charles Egerton. .

INVERSE PROBLEMS...

The following article was published in *University Week*, the faculty and staff newspaper for the University of Washington. We thank *University Week* and Hannah Hickey for permission to include the article here.

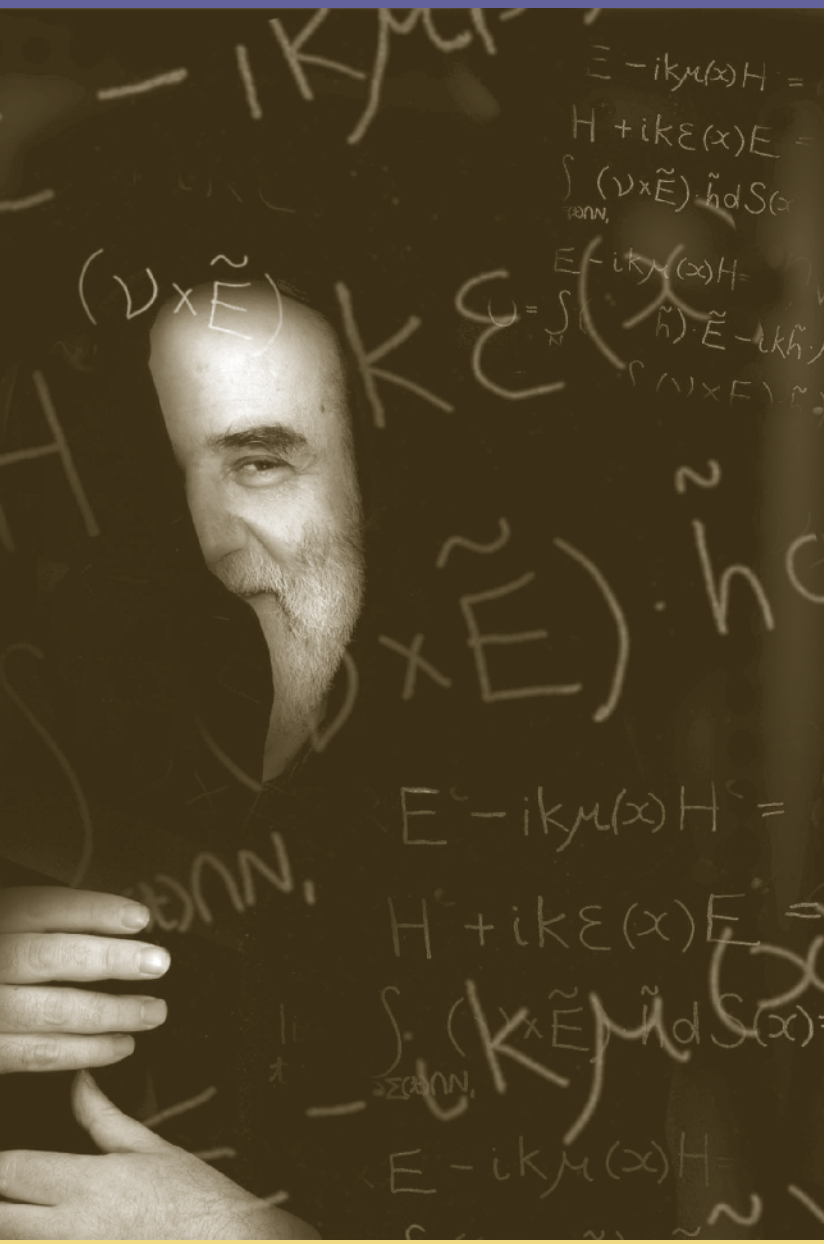


Photo illustration by Mary and Joel Levin

Gunther Uhlmann, the Walker Family Professor of Mathematics, solved mathematical equations used to build an invisibility cloak.

Mathematicians Conjure Up Invisibility Cloak

Every child's dream of becoming invisible leaped forward last year toward becoming a reality. A cloaking device has set the mathematical community buzzing about how to make invisibility not just possible, but practical.

"Who would have thought that people would be talking about invisibility in scientific terms?" said Gunther Uhlmann, the UW's Walker Family endowed professor of mathematics.

Invisibility is a recurring theme in human legend, from Perseus' helmet to Harry Potter's cloak. The recent scientific hubbub began in May when a team of American and British physicists, none affiliated with the UW, announced they had solved the equations for an invisibility cloak. Five months later the team had constructed a prototype. The news rocked popular and scientific circles. The cloak was named one of the year's top scientific achievements, and a video of a nearly invisible penny is posted on YouTube.

Uhlmann followed the news especially closely because he and his colleagues had discovered an invisibility cloak in 2003.

Yes, Uhlmann had unknowingly discovered the same equations three years earlier in another context. They were working on mathematical theory that underlies a way of detecting breast-cancer tumors by placing electrodes around the breast, measuring the voltage at different points, and then reconstructing the enclosed volume. Since tumors are more conductive than normal breast tissue, even small tumors would show up.

In their calculations, Uhlmann's group found one case that didn't work at all. For certain types of coatings they could not detect anything about the enclosed volume.

"This was the opposite of what we were looking for," Uhlmann recalled. "We were trying to make invisible things visible, and not the opposite." The group published its findings, including the mysterious case, in the journal *Mathematics Research Letters*.

And that was that. The breast-cancer research continued. The work is a type of inverse problem that uses measurements from the surface of a body—say a human body, or the Earth—to deduce what's inside. UW mathematicians have

...VISIBILITY AND INVISIBILITY

been active in this area for 20 years, Uhlmann said, developing basic theories and applications to discover underground oil reserves and pinpoint buried land mines. But in July, Uhlmann received an e-mail from a colleague alerting him that an article in the journal *Science* contained some familiar equations.

A group of physicists showed that for certain types of coatings, sensors could—guess what?—sense absolutely nothing about the enclosed volume. Looking at the surrounding waves it was as if nothing was there. The group from Duke University and other institutions discovered the results independently, Uhlmann said.

"We had not thought about the positive aspects of this result," he now admits. But he acknowledges that science doesn't always follow a straight path.

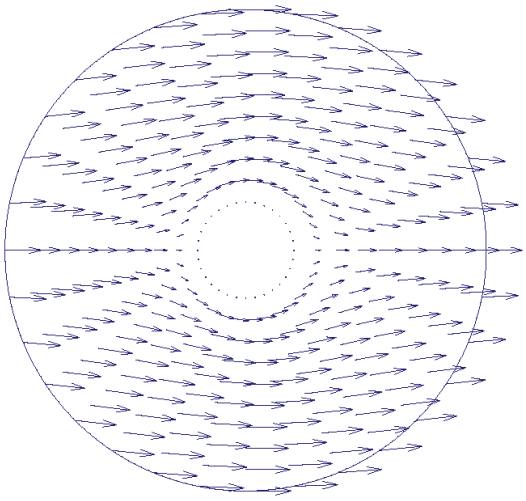
The Duke researchers' prototype cloak is a small cylinder, about the size of a donut, that can make a small object invisible to microwaves. Its creation was made possible by new materials, called metamaterials, that control electromagnetic waves and bend them through angles previously thought impossible. The existing invisibility cloak uses tiny copper wires embedded in fiberglass panels to manipulate incoming waves. Waves wrap around an object and return to their regular path.

Many drawbacks still exist. The current "cloak" is actually more of a thick shield. A person trapped inside the cloak would be completely cut off from the outside world. And so far, the cloak is invisible only to microwave frequencies. But many researchers are now clamoring to improve the design.

Uhlmann and his colleagues are revisiting their original equations. In a recently submitted paper, they solve equations showing how to make a cloak invisible to all incoming frequencies, including visible light. They also calculate how to shield living, glowing or electrically active objects. And although they hint at other surprises on the horizon, they're keeping readers in suspense.

"This is a very active field and many people are interested, so we'd rather not discuss our ideas in detail at the moment," Uhlmann said. He revealed, however, that they will look at "almost invisibility." What happens when conditions aren't quite the mathematical ideal? And what would be the consequence of cutting tiny peepholes into the cloak?

Applications for invisibility are endless. The military would have obvious interests. Surgeons might like metal instruments that were invisible to magnetic fields, so they could take magnetic resonance images on the operating table. Someday we might even be able to cloak buildings to make them invisible to seismic waves, Uhlmann said. But these applications—and any teenagers wanting to hide from their parents, employees wanting to occasionally disappear, or would-be thieves—will have to wait a few more years.



As waves hit the left side of the cloak they start to bend, so that waves leaving the cloak on the right appear as if they had never encountered an obstacle. An object hidden in the middle of the cloak would be unseen from any direction.

Uhlmann recently submitted the paper "Full wave invisibility of active devices at all frequencies" to the journal *Communications in Mathematical Physics*. Coauthors are Allan Greenleaf at the University of Rochester, a longtime collaborator; Matti Lassas at the Helsinki University of Technology, a former post-doctoral researcher at UW; and Yaroslav Kurylev at Loughborough University in the UK.

– HANNAH HICKEY, *UNIVERSITY WEEK*

HAY AWARD

Association for Women in Mathematics Hay Award Citation, reprinted with permission from the AWM Newsletter, Vol. 37, No. 2, March-April 2007, pp. 9-11.

Virginia Warfield Receives Louise Hay Award from the AWM

Ginger Warfield

In recognition of her long career of dedicated service to mathematics and mathematics education, the AWM is pleased to present the Seventeenth Annual Louise Hay Award to Virginia McShane Warfield of the University of Washington.

Virginia Warfield received her doctorate from Brown University in 1971 under the direction of Wendell Fleming and continued to contribute to the field of stochastic analysis for several years. At the same time she became increasingly absorbed by problems of mathematics education through her work with Project SEED, a highly regarded mathematics program whose goal was to promote sense-making mathematical activities for fourth through sixth grade students.

Her work with Project SEED led to her becoming the leader of the University of Washington Mathematics Department's entry-level mathematics courses, which she restructured in ways that have stood the test of time and which she continues to oversee. Eventually, teacher preparation and enhancement, both of K–12 teachers and mathematics graduate students, became a major focus of her activity. She significantly revised the courses for future elementary teachers and has served as a mentor for graduate students throughout her years at the university.

From 1994 to 2001, she was project director for "Preparing Future Faculty" in which, among other things, she arranged for graduate students to spend time at local community or four-year colleges, took them to conferences on educational issues, and arranged conferences with guest speakers. She also began a series of "brown bag lunches" for faculty and graduate students to talk over issues related to their teaching, and since 1994 she has posted electronic newsletters based on those discussions. A letter written jointly by eight recent students states: "Her vision of education and her sense of optimistic possibility have encouraged us to reflect upon our development as teachers of mathematics and to seek ways in which we might contribute to a stronger, more effective mathematics education. Most important, though, is our recognition that Ginger has been instrumental in fostering a supportive and exciting environment in which to investigate and explore the many dimensions of mathematics education."

In the broader community she was instrumental in creating Washington Teachers of Teachers of Mathematics (WAToToM), at which members of departments of mathematics and mathematics education from around the State get together for a week-end of conversation and idea-sharing. Vaughn Foster-Grahler of Evergreen State College wrote that "it has been her leadership that had kept [WAToToM] a vibrant and integral component of math education in Washington State. . . . Ginger is a tireless advocate for strengthening the level of preparation of K–12 math teachers and supporting the types of pedagogies that lead to success for all students."

During the past ten years she has played a leading role in three major NSF-funded teacher enhancement projects: Creating a Community of Mathematics Learners, Extending the Community of Mathematics Learners, and Graduate Teaching Fellows in K–12 Education (GK–12), all of which partner University of Washington faculty and graduate students with in-service teachers of mathematics. Warfield is described as a master in integrating various levels of math learners—creating relationships between grade school teachers and mathematicians—and as having special concern for students from economically disadvantaged backgrounds and underrepresented groups. At one GK–12 elementary school the percentage of students who passed the state mathematics standard rose in two years from under 10% to about 55%, which is above the state average. Currently, she is Co-PI of a new project, Teaching for the Environment: Active Mathematics on the Olympic Peninsula. In discussing the impact of her work, Selim Tuncel, chair of the University of Washington Mathematics Department, praised "her commitment to improving mathematics education at all educational levels, her clear vision of the key elements for achieving this goal, her gentle persistence, and her ability to work effectively within a research department as well as in collaboration with the K–16 education communities."

Warfield has also made significant contributions to mathematics education research through her collaboration with the French mathematician Guy Brousseau, a pioneer in the "didactics of mathematics," the scientific study of issues in mathematics teaching and learning. This collaboration has led to publication of several articles, translation and co-editorship of a book, and, most recently, a monograph about Brousseau's work and the nature of didactics.

Among her many professional activities, Warfield has been a member of the National Faculty (by election), of Sigma Xi, of the Association pour Recherche en Didactiques des Mathématiques, and of the Mathematical Association of America's committees on Professional Development and Mathematical Education of Teachers. For the Association for Women in Mathematics she has served in several capacities: Chair of the Education Committee, Member of the Association Review Group for the revision of the NCTM Standards, Member-at-large of the Executive Committee, and Education Column Editor for the AWM *Newsletter*.

To describe her work, Janet P. Ray, professor emeritus from the Seattle Central Community College wrote: "It would be difficult to overstate the contributions Ginger has made to mathematics education. Whether through the organizations she has founded, the events she's sponsored, or the connections she's forged, Ginger's work has had a huge impact. She has also made a difference in more subtle, though no less profound ways—through example and through innumerable small acts of kindness."

AWM is proud to honor Virginia M. Warfield for her contributions to education through her teaching, graduate student training and mentoring, work on the didactics of mathematics, and outreach and collaborations with K–16 communities.

DEPARTMENT NEWS

Ioana Dumitriu

Ioana Dumitriu Receives Leslie Fox Prize

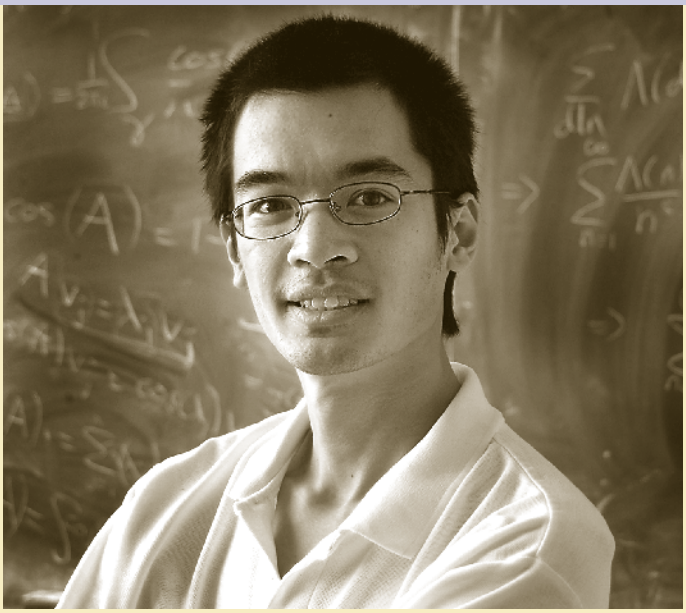
Ioana Dumitriu is one of the two First Prize winners of the 13th Leslie Fox Prize in Numerical Analysis. These prizes, administered by the Institute of Mathematics and its Applications in Southend-on-Sea, England, are awarded to young mathematicians (age 30 or less) on the basis of research papers submitted for the competition. The past winners include some of today's most eminent researchers in numerical analysis. Dumitriu's winning paper, written jointly with James Demmel and Olga Holtz, is entitled "Toward accurate polynomial evaluation in rounded arithmetic."

Ioana Dumitriu joined the Department as an assistant professor in 2006. In addition to numerical analysis, Dumitriu's areas of active research include random matrix theory and the probabilistic and combinatorial aspects of game theory.

Terence Tao to Give Milliman Lectures

In December the Department will welcome Terence Tao of UCLA as the 2007-08 Milliman Lecturer. Professor Tao received the Ph.D. in 1996 at the age of 21. Last year he was awarded the Fields Medal, the highest honor in mathematics, for a remarkable body of research that includes major contributions to several diverse areas: harmonic analysis, partial differential equations, combinatorics, and number theory. Among his best-known achievements is his proof, in joint work with Ben Green, that the set of prime numbers contains arbitrarily long arithmetic progressions. In his lectures, Professor Tao will discuss this result along with other recent developments in arithmetic combinatorics.

For more information about the Milliman Lecture series, see http://www.math.washington.edu/Seminars/milliman.php.



Terence Tao, 2007-08 Milliman Lecturer

PIMS: Partnering with Canada and France

The Pacific Institute of Mathematical Sciences (PIMS) was created in 1996 by a consortium of five universities in western Canada to foster the development of mathematics at all levels. The University of Washington joined as an affiliate in 2000 and became a full member in 2005, thus opening up a new era of scientific collaboration between the USA and Canada. Membership in PIMS enables the Departments of Mathematics, Applied Mathematics, and Statistics at the UW to participate in PIMS activities such as the formation of collaborative research groups and the planning and execution of conferences at the Banff International Research Station.

In celebration of its 10th anniversary, PIMS sponsored a program of lectures by distinguished mathematicians from all over the world at its member universities in 2006-07. Nine such lectures were held in the Department of Mathematics, plus seven more in Applied Mathematics and Statistics, making a valuable contribution to the intellectual life of the mathematical community here. A complete list of the lectures can be found on the web page: http://www.math.washington.edu/Seminars/PIMS10th.php.

The second decade at PIMS has started very successfully. The Natural Sciences and Engineering Research Council of Canada (NSERC) has renewed its grant to PIMS for the period 2008-13, and the Alberta government has doubled the size of its grant to PIMS. The most important development of the past year, which will have long-term benefits for UW and all the PIMS universities, is the establishment of an agreement between PIMS and the French Centre National de la Recherche Scientifique (CNRS). It has the purpose of advancing research and education in the mathematical sciences and developing international cooperation in science, industry, and education. Under the agreement, PIMS will become a "Unité Mixte Internationale" of the CNRS, the only one in North America.

PIMS and CNRS see the training of highly qualified personnel as an essential component of this mission. During the academic year 2007-08, the CNRS has sent two young mathematicians to PIMS, and PIMS has awarded a postdoctoral fellowship to a French mathematician. Yuxin Ge of the University of Paris will spend the year at UW working with Dan Pollack and other differential geometers.

– GUNTHER UHLMANN

PIMS 10th Anniversary Distinguished Lectures in Mathematics

Kari Astala, University of Helsinki

Carlos Kenig, University of Chicago

Frances Kirwan, University of Oxford

Shrawan Kumar, University of North Carolina

Gregory Lawler, University of Chicago

Peter Lax, Courant Institute

Klaus Schmidt, University of Vienna

Richard Schoen, Stanford University

Peter Winkler, Dartmouth College

ENDOWED PROFESSORSHIPS

McKibben and Merner Professorship

Sándor Kovács was appointed last year as the inaugural recipient of the Craig McKibben and Sarah Merner Professorship. Kovács's research is in the area of higher dimensional complex algebraic geometry. The ultimate goal of the field is to classify all algebraically defined geometric objects.

A celebration of the professorship was held on May 1, 2007 at the Henry Art Gallery. The celebration included a talk by Kovács entitled "Singularities" followed by a reception (see photo at right).

Selim Tuncel, Craig McKibben and Sarah Merner, and Sándor Kovács

Doug and Maggie Walker

Walker Family Professorship

Gunther Uhlmann was appointed last year as the inaugural recipient of the Walker Family Professorship. Uhlmann's research is in the area of partial differential equations and inverse problems arising in several applications including medical imaging and the geosciences.

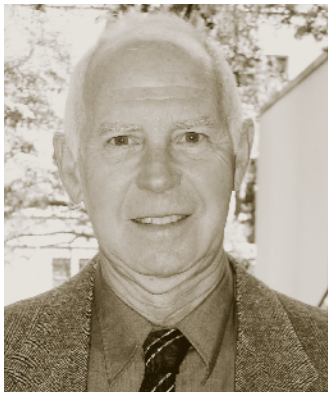
A celebration of the professorship was held on October 23, 2007 at the Henry Art Gallery. The celebration included a talk by Uhlmann entitled "Inverse Problems: Visibility and Invisibility" (see article on page 12) followed by a reception.

Phelps Professorship

In 1999 Robert and Elaine Phelps created the Robert R. and Elaine F. Phelps Endowed Fund to support and encourage graduate mathematics students and untenured mathematics faculty. Most recently, with gifts matched by the Department, they have added to the fund to create the Phelps Professorship of Mathematics. The Department plans to make the inaugural award of the Phelps Professorship this spring, the term for which will begin in the 2008-09 academic year.

Robert and Elaine Phelps

Kauffman and Rebassoo Professorship



Jim Morrow has been named the Kauffman and Rebassoo Professor in Mathematics for a three-year term. A member of the Department since 1969, Morrow has been a powerful force in mathematics eduation. Just some of his achievements include coordinating the Research Experience for Undergraduates program and mentoring teams in the Mathematical Contest in Modeling. Morrow has been recognized numerous times for his efforts with awards such as the Honors Excellence in Teaching Award and the Distinguished Teaching Award of the Pacific Northwest Section of the Mathematical Association of America.

The professorship was created through gifts from George B. Kauffman, Vaho Rebassoo, and Donald and Jeannette Fowler.

Mathematics Faculty Fellows

The Mathematics Faculty Fellowships are intended for research faculty below the rank of professor, or professors who are less than 15 years past the Ph.D., and recognize the importance and impact of research support for these colleagues. The Department has selected both Sara Billey and John Palmieri to be the inaugural recipients of this award.

Sara Billey

Sara Billey received her Ph.D. from UC San Diego in 1994 and received the Presidential Early Career Award for Scientists and Engineers in 2000 as an assistant professor at MIT. She joined the Department of Mathematics at UW in 2003. Her area of research is the combinatorics of structures arising in algebra, algebraic geometry, and the theory of Lie groups. She is an enthusiastic user of computers in her research, particularly for obtaining data for conjectures and for verifying proofs. She has enhanced our graduate program through special lectures and recruiting events and has directed five undergraduate research projects.

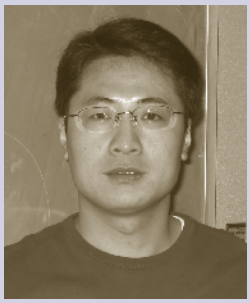
John Palmieri

John Palmieri received his Ph.D. from MIT in 1991, under the direction of our former colleague Haynes Miller, and joined the Department of Mathematics at UW in 1999. His research is in the field of algebraic topology. Traditionally this is the study of topological and geometric problems by algebraic methods, but much of Palmieri's work turns the tables by using techniques from topology to illuminate problems in algebra. Palmieri is also active in promoting the development of writing skills as an important component of advanced mathematics courses.

TRANSITIONS

Faculty News

This year, the Department made two new appointments:



Hongyu Liu (Acting Assistant Professor), Ph.D. Chinese University of Hong Kong, 2007. Professor Liu studies inverse problems, numerical analysis, and geometric numerical integration.

Clément Pernet (Acting Assistant Professor), Ph.D. Université Joseph Fourier, 2006. Professor Pernet studies linear algebra, exact computations, computer algebra, algorithmic complexity, and mathematics software development.

Isabella Novik was promoted from Assistant Professor to Associate Professor.

Zhen-Qing Chen was named Fellow of the Institute of Mathematical Statistics.

Steve Monk retired; he joined the Department in 1964.

Visiting Faculty

The following is a list of this year's supported long-term visitors, their affiliations, and areas of research:

Sergey Bezuglyi (Autumn), Institute for Low Temperature Physics. *Ergodic theory and topological dynamics.*

Timothy Chartier (Winter), Davidson College. *Applied mathematics and numerical analysis.*

Nurlan Dairbekov (Winter), Kazakh-British Technical University. *Function theory, partial differential equations, differential geometry, and integral geometry.*

Recent Degree Recipients

The following students completed their doctorates in Mathematics during the academic year 2006-07:

Yeongcheon Baek. His advisor was Jim Burke, and his thesis title was "An interior point approach to the constrained nonparametric mixture models." Yeongcheon is now a Senior Research Fellow with Samsung Life Insurance in Seoul.

Eric Bahuaud. His advisor was Jack Lee, and his thesis title was "Intrinsic characterization for asymptotically hyperbolic metrics." Eric is now an ANR Postdoc at Université de Montpellier II.

Tristram Bogart. His advisor was Rekha Thomas, and his thesis title was "Problems in computational algebra and integer programming." Tristram is now a Postdoctoral Fellow at Queen's University.

Matias Courdurier. His advisor was Gunther Uhlmann, and his thesis title was "Restricted measurements for the X-ray transform." Matias is now an Assistant Professor at Columbia University.

Anton Dochtermann. His advisor was Isabella Novik, and his thesis title was "The topology of graph homomorphisms." Anton is now a Postdoctoral Researcher at Technische Universität in Berlin.

K. Ilgar Eroglu. His advisor was Boris Solomyak, and his thesis title was "Self-similar sets, projections and arithmetic sums." Ilgar is now an Assistant Professor at Anadolu University.

Kelly Jabbusch. Her advisor was Sándor Kovács, and her thesis title was "Notions of positivity for vector bundles." Kelly is now a Postdoctoral Researcher at Universität zu Köln.

Brant Jones. His advisor was Sara Billey, and his thesis title was "Some combinatorics on Hecke algebras of reflection groups." Brant is now a VIGRE Postdoctoral Fellow at UC Davis.

Matthew Kahle. His advisor was Chris Hoffman, and his thesis title was "Topology of random simplicial complexes and phase transitions for homology." Matthew is now a Samelson Postdoctoral Fellow at Stanford.

(continued on next page)

Elizabeth Kelly. Her advisor was Sara Billey, and her thesis title was "Connections between Schubert objects." Elizabeth is now a Mathematics Instructor at Edmonds Community College.

Kris Kissel. His advisor was Tatiana Toro, and his thesis title was "Generalizations of a result of Lewis and Vogel." Kris is now a Mathematics Instructor at Green River Community College.

Venkateswaran Krishnan. His advisor was Gunther Uhlmann, and his thesis title was "A support theorem and an inversion formula for the geodesic ray transform." Venkateswaran is now a Part-time Lecturer at Tufts University.

Leo Tzou. His advisor was Gunther Uhlmann, and his thesis title was "Linear and nonlinear analysis and applications to mathematical physics." Leo is now a Szegö Assistant Professor at Stanford.

Sangwoon Yun. His advisor was Paul Tseng, and his thesis title was "A coordinate gradient descent method for structured nonsmooth optimization." Sangwoon is now a Research Fellow at the National University of Singapore.

Karl Schwede *(not listed in last year's Newsletter due to error)*. His advisor was Sándor Kovács, and his thesis title was "On F-injective and DuBois singularities." Karl is now an NSF Postdoc at the University of Michigan.

Below is a list of those who finished their work at the UW with a Master's degree in Mathematics, with each student's advisor listed in parentheses:

Christopher Anderson (Mitchell)

Piotr Jagiello (Burke)

Laura Matrajt-Arbetman (Uhlmann)

Mong Kon Mo (Arms)

Angelo Polo (Greenbaum)

Nicholas Reichert (Uhlmann)

Oana Rus (Toro)

Ross Williams (Billey)

Bachelor's Degrees

145 Bachelor's degrees were awarded during the 2006-07 academic year: 97 in Mathematics and 48 in ACMS.

NSF Postdoctoral Fellowships

National Science Foundation (NSF) postdoctoral fellowships are among the most prestigious for mathematicians. Two UW Mathematics Ph.D. recipients were awarded NSF postdoctoral fellowships in 2007:

Karl Schwede (*pictured, left*), who received his Ph.D. in Summer 2006, is now an NSF Postdoc at the University of Michigan. Karl's research is in the area of algebraic geometry.

Matthew Kahle (*pictured, right*), who received his Ph.D. in Spring 2007, was offered an NSF postdoctoral fellowship, but instead accepted his current position as a Samelson Postdoctoral Fellow at Stanford University.

Victor Klee, 1925–2007

The Mathematics Department lost one of its most distinguished members on August 17 when Victor L. Klee passed away a few weeks short of his 82nd birthday.

Born in San Francisco in 1925, Klee obtained his Ph.D. from the University of Virginia in 1949. He stayed on there as an assistant professor for four years before moving to the University of Washington, where he quickly rose through the ranks to become a full professor in 1957. He spent the remainder of his career here, except for several years on leave as a research fellow or visiting professor at various universities around the world, and he retired in 1998.

Klee's mathematical interests were wide-ranging. He wrote well over two hundred papers on topics in the fields of geometry, functional analysis, optimization, graph theory, and combinatorics; the unifying theme that runs through most of this work is the study of convex sets. According to his longtime colleague Branko Grünbaum, "his most valuable mathematical achievement was in the theory of convex polytopes. Klee's path-breaking and seminal papers on polytopes, published in the 1960s, mark the beginning of the theory that flourishes at present, and he has to be considered the father of the whole field." Klee's work is also marked by an appreciation of both the pure and applied aspects of his fields of interest.

Klee made many other contributions to the Department and to the mathematical community. On the local level, he was the founder, and for many years the leader, of the Geometry and Combinatorics Seminar, which remains a vital part of the life of the Department to this day. On the wider stage, he held several official positions in professional organizations, including the presidency of the Mathematical Association of America in 1971–73, and served on numerous editorial boards and committees.

Klee's dealings with people were always characterized by a friendly, unassuming, and helpful attitude. He was an enthusiastic mentor of young mathematicians, and there are many people now who remember his advice and encouragement with gratitude. Thirty-six students wrote their doctoral dissertations under his direction, including our own Bob Phelps. (There are other "family connections": Klee's own doctoral advisor, E. J. McShane, was the father of Virginia Warfield, who is featured in another article on page 14, while Bernd Sturmfels, advisor to our own Rekha Thomas, was one of Klee's students.)

Klee's achievements received worldwide recognition, including honorary doctorates from universities in California, Belgium, and Germany. He received the MAA Award for Distinguished Service to Mathematics in 1977 and was a fellow of the American Academy of Arts and Sciences and the American Association for the Advancement of Science.

The Department has been fortunate to hire several young people recently in the areas of mathematics that were dear to Klee's heart, thus ensuring that the legacy he created will endure. But Vic Klee was one of a kind, and he will be sorely missed.

— GERALD FOLLAND

OUR DONORS

The following is a list of our friends who have contributed to the Department between September 1, 2005, and October 18, 2007. Should you notice an error or omission in this list, please draw it to our attention by a telephone call or e-mail message to Mike Munz (206-543-1151 or munz@math.washington.edu).

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CONTACT INFORMATION

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

Selim Tuncel, Chair, chair@math.washington.edu
Gerald Folland, Editor, folland@math.washington.edu
Michael Munz, Layout, munz@math.washington.edu

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