THE UNIVERSITY OF ARIZONA
Department of Mathematics

The University of Arizona
Department of Mathematics
PO Box 210089
Tucson, AZ 85721-0089

Presentations, Symposia, Workshops

Marta Civil presented *Dialogues with Latino/a Parents: Implications for Leaders in Mathematics Education* at a Major Session at the 41st National Council of Supervisors of Mathematics (NCSM) Annual Conference, April 20-22, Washington D.C.

Jim Cushing is helping to organize Conference on Mathematical Biology, to be held in October at the University of Alabama in Huntsville. This will be the second installment of the Conference on Mathematical Biology, first held two years ago in honor of his 65th birthday.

Nicholas Ercolani will be the plenary speaker at the VIIIth Americas Conference on Differential Equations, to be held in October 2009 in Veracruz, Mexico

Lotfi Hermi was invited to spend two weeks in May at the Erwin Schroedinger International Institute for Mathematical Physics (ESI) in Vienna as part of the program *Selected Topics in Spectral Theory*. He gave a talk at ESI on a class of new inequalities for the eigenvalues of the Laplacian.

In February, he was invited to participate in the week-long mini-workshop on *Low Eigenvalues of Laplace and Schroedinger Operator*s at the Mathematisches Forschungsinstitut Oberwolfach, Germany.

Hermi was also one of the main speakers at the upcoming *Geometric Spectral Theory* conference on June 8 to 12 in Neuchâtel, Switzerland. He will deliver a mini-course on *Applications of Eigenvalues to Computer Vision.*

Rebecca McGraw was an invited colloquium speaker in April at the University of Akron, where she discussed *Making, Testing, and Proving Mathematical Conjectures in a Computer Environment: An Examination of How Students Use the Geometer's Sketchpad.*

Alan Newell was the keynote speaker March 23rd at the University of Georgia Conference on Nonlinear Evolution Equations, where he spoke on plant phyllotaxis. On April 8 at the Conference on Dynamos at the Institut Henri Poincare, Paris, Newell gave an invited lecture on Wave Turbulence. In June he gave Summer School lectures on Asymptotic methods, the Central Limit theorem and Black Scholes at the University College, Dublin, Ireland. He will give a William Benter Distinguished Lecture on plant phyllotaxis at the University of Hong Kong; and will give a plenary lecture at the ICIAM Conference in Shanghai, China. In August Newell was an invited speaker at the Landau Institute in Chernogolovka.

THE UNIVERSITY OF ARIZONA | College of Science

IN THIS ISSUE

page 2
View from the Chair

page 3
Grad Students Burn the Midnight Oil during Spring Break

page 4
If You Don't Notice Her Work, Then She's Done a Good Job

page 5
Faculty Awards

page 8
It Takes a Lot of Organization to Keep the Graduate Program on Track

page 10
Graduate Student Awards

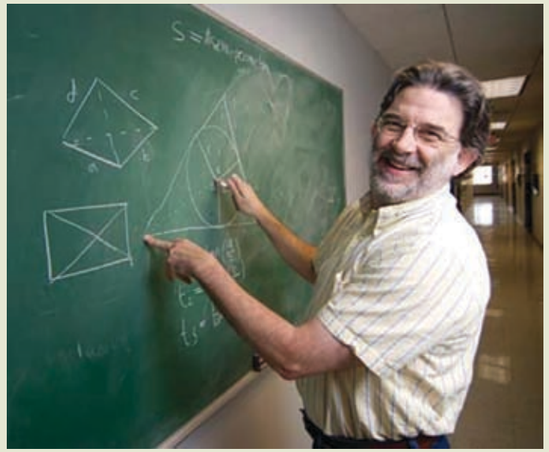
page 12
From Bose-Einstein Condensation to Probability Theory

page 14
Math Majors Prove Participation Important to Their Education Equation

Fall 2009
Volume IX, Issue I

MATHEMATICS

UA SCIENCE



A View from the Chair

William G. McCallum, Department Head and Professor of Mathematics

I'd like to start my first newsletter by thanking Nick Ercolani for his dedicated leadership over seven years, and Tom Kennedy for his heroic service as interim head during the first part of this year. We are heading into a stormy patch, and it is to their credit that we are doing so in such good shape and with such strong spirit.

I am very pleased to be able to say that the endowment for the Graesser Chair announced in the last newsletter, continues to grow through the generosity of Linda Lohse. Also, we remain on the path to a new building mapped out by Nick, in part through the courageous stand on the state budget taken by Governor Jan Brewer.

Despite a difficult year for the University, the department made two excellent hires at the assistant professor level: mathematics educator Jennifer Eli from the University of Kentucky and statistician Selena Niu from Princeton University. Both were top choices and crucial to two key programs in the department.

We have much to be proud of. Our faculty continues to win grants and awards, particularly our junior faculty, who carry the department's future in their hands. Our graduate students enliven our research seminars, fulfilling the promise of our two VIGRE grants. I would also like to call out the all-too-often unsung heroes of our success: our staff and our instructional faculty. Sandy Sutton, profiled in this newsletter, is the epitome of spirit and dedication that make this such a wonderful department to work in. Under the leadership of Tina Deemer, who has accepted a new position as Director of Academic and Support Services, our staff will continue to grow as a team. The leadership potential and vision of our instructional faculty are exemplified by Tina Schuster and Laurie Varecka, who have agreed to take on key roles in placement and advising.

I am delighted to have this opportunity to steer the department through the next few years. I am optimistic that, with the support of the department and the external community, we will come through stronger than ever.

Cover photo by: Angelica Elias

Editor/Writer:
Karen D. Schaffner, Department of Mathematics
kschaffner@math.arizona.edu

Designer:
Roma Krebs, AHSC Biomedical Communications

The Department of Mathematics Newsletter Spring/Summer 2009, Volume X, Issue I, is published twice yearly by The University of Arizona Department of Mathematics, PO Box 210089, Tucson, AZ 85721-0089.

Grad Students Burn the Midnight Oil during Spring Break

By Karen Schaffner, Admin. Assistant

Even if the halls in the Mathematics building were empty during Spring break, math was still on the minds of at least some students.

Across the street from The University of Arizona, in a one-story conference hall behind the Four Points Sheraton, Holly Krieger, a third-year graduate student from the University of Illinois at Chicago, puzzled over the genus of quadratic forms. She wasn't alone. Eight more graduate students joined her, all working on the questions posed by her group leader, renowned mathematician John Conway of Princeton University. At other tables set up in the noisy conference room, several other groups pondered the problems posed by their group leaders. It was getting late, and Krieger was going on only four-and-a-half hours of sleep, but she was not about to leave early. "The best part is the work sessions at night," Krieger said. Even so, "brain fry is definitely a danger."

> "The best part is the work sessions at night," Holly Krieger said. Even so, "brain fry is definitely a danger."

Welcome to the annual Arizona Winter School, where graduate students from around the country and the world spend their spring breaks, not at the beach but at The University of Arizona, delving deeper into advanced number theory. Designed specifically for graduate students studying number theory or a related field, the winter school gives students an opportunity to work with faculty considered by those in the field to be shining stars and those considered the "up-and-comings." There's also an opportunity to network with other graduate students and senior researchers. In the process, it keeps everyone excited about what they are doing.

"It's a way of building up those connections that will hopefully keep people in the field," David Savitt said. He's an Assistant Professor in the Department of Mathematics at the UA and one of this year's organizers. "It's very energizing, very rewarding for [the students] although they're worn out by the end of the week."

The school began in 1998, organized by a group of senior math faculty from around the Southwest, including Douglas Ulmer, Professor of Mathematics at the UA. He knew that students at state schools were receiving good educations, but were unlikely to cross paths with top-tier number theorists from schools such as Harvard and Princeton. To remedy this, he and seven others created a solution: The Southwest Center for Arithmetic Geometry, funded by the National Science Foundation. Its main function is to host the Arizona Winter School. It's been quite successful, according to Savitt, who said 15 to 20 papers have been impacted by the work done during those few days. *(See related article on page 4.)*

"We ask the speakers at the Winter School to suggest projects for the students to think about, and it often happens that their work with the students leads to original research," Savitt said.

Most of this year's 110 students came as the guests of the Center, which paid their expenses. To obtain funding, students have to have a demonstrated interest in number theory and a letter of recommendation from their advisor. They come from all over the U.S. and the world, from places like Germany, Japan, and Taiwan. The schedule is grueling. The days begin with breakfast, then it's off to morning talks. Lunch lasts no more than two hours, then it's time for the afternoon talks. After a two-hour dinner break, the evening work sessions begin, which easily last into the wee hours of the morning. All talks given by faculty are taped. Also, faculty notes are posted on the Winter School Web site. To give a break and show off Tucson's beautiful landscape, field trips are organized to such locations as the Arizona-Sonora Desert Museum and Sabino Canyon Recreation Area in the Coronado National Forest. On the last day of AWS, students present their findings.

The theme for the first AWS was the ABC Conjecture. Although it still resembles the first meeting, the school has evolved as new directors bring their own ideas. One of the new features of the Winter School is the speakers are asked to suggest a junior mathematician, usually a post-doc but sometimes one of their own grad students, to assist them with supervising the project.

continued on page 13

From her office on the ground floor of the math building, Annette Horn has spent the last three years planning all department events including workshops.

If You Don't Notice Her Work, Then She's Done a Good Job

By Karen Schaffner, Admin. Assistant

If you've attended a Department of Mathematics conference in the last three years, you know Annette Horn's work.

As the event planner for the Department of Mathematics from July 2006 to June 2009, Horn has wrangled every detail of department conferences and events down to the last detail. She has made decisions from where people will sleep to what napkins will be used during dinner; it's all in a day's work for her. Of course, if you don't notice her work, it means she's done a good job.

"There are just so many things behind the scenes nobody knows about," Horn said. "A successful conference would be when all participants arrive at the workshop, return from all the activities and make it home safe and sound. What more can the event planner ask for?"

Horn has planned the last three Arizona Winter schools with Assistant Professor David Savitt. They begin getting all the logistics worked out just one month after the last AWS ends. As soon as Savitt tells Horn the date for next year's school, she makes hotel and conference space reservations. In all, she plans for 80 rooms and all the meeting space the Four Points Sheraton has available. Then there's the space used on campus, which not only has to accommodate a crowd of up to 160 people, but also has to have the equipment available for computer presentations. This usually points to the Integrated Learning Center (ILC), across from The University of Arizona's library and a short walking distance from the hotel.

One of Horn's favorite tasks is communicating with AWS participants. This begins about three months before the school begins. Through email, she coordinates itineraries, and confirms school affiliations and home addresses. If participants are from somewhere other than the U.S., Horn also advises them what travel documents are needed. When the school begins, she feels she knows just about all who are participating.

"By the time they get here, we've been in contact for months. It's really cool to put a face with a name," she said.

In the meantime, there are folders to be labeled and stuffed with name tags and schedules, excursions to the Desert Museum or Sabino Canyon to be planned, vans and drivers to be hired and paid, and the menus to be selected for the final dinner.

Since there are so many little details that can go awry, Horn shows up to the conferences at least two hours ahead of time. For this year's AWS, 6:30 in the morning found her in Eller College of Business, checking on tables, chairs, doors and locks, projectors and bulbs, and most importantly, breakfast, ordered three months ahead.

"Everything that goes wrong, goes wrong before anybody shows up. Nine times out of ten, the tables don't show up," she said. "Or the food is set up in the wrong room." Often, she said, the doors are still locked—this happens a lot, especially if it's a Sunday—so she carries a card with emergency numbers."I've made three or four of those calls," she said. Both Facilities Management and the UA Police know her, "because those are the guys who usually let me in."

Even while AWS was taking place in Eller, about 100 other participants were at the ILC involved in another event, *Entropy and the Quantum* workshop. Horn began organizing this event in September

continued on page 7

Faculty Awards

William Yslas Vélez *has been selected to receive the Peter W. Likins Inclusive Excellence Award* (IEA) for the 2008-2009 academic year. The IEA recognizes individuals or groups who have demonstrated a significant contribution toward enhancing the academic distinction of The University of Arizona by creating a diverse and inclusive community.

Peter W. Likins was the inaugural recipient of the IEA in 2005. As UA President, he led by example, demonstrating that diversity is an indicator of academic quality. President Likins further demonstrated his commitment to diversity through the creation and support of numerous diversity initiatives. Vélez is being recognized for continuing and extending Dr. Likins' legacy of "excellence through diversity," and will be recognized at a reception in October.

Professor Vélez *has also been elected Fellow of the American Association for the Advancement of Science* (AAAS) for distinguished contributions to mentoring mathematics students and for leadership as President of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS).

Vélez is a founding member of SACNAS. The national organization was created to encourage Chicano/Latino and Native American students to pursue post-graduate education and obtain the advanced degrees necessary for science research, leadership and teaching careers at all levels.

Among his accomplishments is the implementation of the Calculus Advising Program for Minority Students here at The University of Arizona. The program not only helped students succeed, but Vélez found that it was a remarkable way to actively recruit math majors and minors. The program's success gave Vélez the tools to work with students and to help them understand the importance of this first calculus course.

He has also worked to obtain grants totaling more than $5 million, some of which were used to recruit and help undergraduate and graduate students pay for tuition and books.

In honor of Vélez's work and dedication, the UA College of Science has *created the William Y. Vélez Scholarship.* The award provides $1,000 to entering freshmen who show financial need and plan on majoring in a College of Science area of study.

David Savitt *was selected to receive the College of Science Early Career Teaching Award.*

In his recent award letter, Dean Joaquin Ruiz said, "[This award] acknowledges the dedication with which you have served students . . . in the Department of Mathematics."

While still an Assistant Professor, and while teaching the normal load (with excellent evaluations), Savitt has implemented several programs that cover the range from high school to graduate school.

He has been instrumental in starting a Math Circle, a weekly meeting of local high school students to work on challenging problems; and connecting with the national Math Circle movement (a Russian tradition being adopted nationwide).

At the undergraduate level, he took over the study group for the prestigious Putnam problem-solving competition with excellent results. He also participated with William Vélez in a summer transition program for minority students entering the University to help them prepare for calculus.

At the graduate level, he has taken over the running of the nationally-recognized Arizona Winter School, an annual school for advanced graduate students that introduces them to research and puts them in project teams with world-renowned researchers. *(See related article on page 3.)*

Savitt has accomplished all this in addition to the summer math camp for talented high school

continued on page 6

continued from page 5

students that he had already been running for a number of years before he arrived here.

The award will be formally announced at the annual College of Science Faculty Reception in September.

Savitt has also *received an NSF Grant* for p-adic and mod p Galois representations. Savitt's research areas are number theory and representation theory. In particular, he will focus on p-adic Galois representations and p-adic Hodge theory, with an eye towards applications to the modularity of Galois representations and the Langlands program.

Joceline Lega *is the principal investigator* on the new *"GK-12 Graduate Students and Teacher Engaging in Mathematical Sciences, or G-TEAMS, program.* The G-TEAMS Program provides an opportunity for graduate students and teachers to collaborate on the development of novel, rigorous, and relevant material for K-12 mathematics courses. The program, run by the Institute for Mathematics and Education and the Department of Mathematics at The University of Arizona, builds on a long-standing relationship between these two units and schools in the Tucson area. Fellows are recruited from the graduate programs in Mathematics and the interdisciplinary programs in Applied Mathematics and in Statistics at The University of Arizona. They work with high school teachers on the development of new courses, such as probability and statistics and mathematical modeling, on ways to promote algebraic thinking in K-8 grades, and on strategies to facilitate transitions between elementary, middle, and high school. The program is interdisciplinary and involves such new approaches as video conferencing between classrooms and the Applied Mathematics Laboratory, or the use of computer simulations and applets. G-TEAMS lessons and learning objects are made available to the community by means of a web portal.

The program promotes Science, Technology, Engineering, and Mathematics (STEM) disciplines to underrepresented K-12 student populations and fosters a synergetic relationship among fellows, teachers, and K-12 students. Fellows learn to communicate mathematical ideas to diverse audiences, implement a range of teaching techniques, and increase their understanding of K-12 educational issues. Teachers become familiar with cutting-edge research and broaden their understanding of mathematics. Students learn to appreciate the wide variety of possibilities offered by STEM disciplines.

Kevin Lin *was awarded an NSF Applied Math Grant for his proposal, Computational Analysis of Large Dynamical Systems.* The grant will support his efforts to understand the dynamics of systems involving the interaction of many components. The focus is on some model systems coming from biology and physics.

The grant will also support the development of efficient computer algorithms for the analysis of these systems.

Walter W. Piegorsch *has been named Editor of the journal, Environmetrics,* (http://www3.interscience.wiley.com/journal/6285/home), the oldest scientific journal presenting peer-reviewed research on development and application of quantitative methods in the environmental sciences. The journal is the official organ of The International Environmetrics Society (TIES) and is published by John Wiley & Sons. Piegorsch began his term in January.

He was also elected to the Regional Committee of The International Biometric Society's Western North American Region.

Romyar Sharifi *has been awarded a National Science Foundation (NSF) grant* for a research project on Iwasawa Theory and Galois Representations. The project involves a study of operations in the Galois cohomology of number fields and their application in Iwasawa theory. Sharifi conjectured an explicit relationship between the values of a cup product on cyclotomic p-units and p-adic L-values, taken modulo p, of newforms that satisfy congruences with Eisenstein series at a prime above p. The proposed research relates to this through a number of distinct but intertwined sub-projects, including an algebraic study of the structure of the Selmer groups of the associated modular representations, the exploration of relationships with Kato's Euler system and classical main conjectures, and the precise formulation of certain generalizations.

Pham Huu Tiep
His project "Group Representations and Applications" has been recently funded by the NSF. His proposal focuses on several important problems in representation theory of finite groups and its applications. It ties together different areas of mathematics, such as finite groups and algebraic groups, finite permutation group theory, group cohomology, combinatorics and finite geometry, algebraic geometry, and string theory, with the main unifying ingredient being representation theory. Many of the problems addressed in the proposal come up naturally—some long-standing and play a central role—in the group representation theory, and others are motivated by various important applications.

Joseph Watkins *has been named a 2009 Galileo Circle Fellow, one of the highest honors given to faculty in the College of Science.* The award recognizes outstanding accomplishments in academic scholarship. Each fellow receives $5,000 and lifetime membership in the Galileo Circle, a society of individuals who support the UA College of Science and activities that nurture the future of science.

Watkins brings his deep mathematic skills in probability and statistics to interdisciplinary research on an array of problems in the life sciences. Examples of his collaborative work include the application of statistical analysis and modeling to the study of language and gene evolution in Southeast Asian/Pacific communities and the use of sophisticated Markov processes to model the population growth of soil bacteria. He also directs the Native American Summer Institute, a program aimed at preparing American Indian students for higher education through a science and math curriculum based on biology, algebra and the economics of beekeeping.

Watkins was also named the winner of the 2008 Lovelock Award. The award, presented at the College of Science Fall Faculty Reception, seeks to recognize and reward innovation and creativity in mathematical education, and in the provision of mathematical experiences for undergraduates.

In her nomination letter, Anne McGettigan, Watkin's student, said Watkins "exemplifies the spirit of this award. For every topic we study, Professor Watkins strives to bring real world examples to the classroom. He integrates research in different fields and statistical programming into our daily lectures in a way that emphasizes the relevance of statistics. He is also very generous with his time outside of lectures, always making himself available to answer questions and help us review for tests. He is genuinely interested in the well being of his students, and he always asks about our plans after graduation and makes himself available to offer advice and assistance."

If You Don't Notice

continued from page 4

with Assistant Professor Bob Sims and Visiting Assistant Professor Daniel Ueltschi. Sims was very happy with the outcome.

"We were lucky enough to have Annette Horn help administrate many of the details associated with the conference. She helped reserve rooms for our guests, she made reservations for our dinner, she managed the cumbersome task of reimbursements, and perhaps most impressively, she answered the myriad of questions Daniel and I presented to her, always with a smile. I would be very happy to have Annette help me organize my next conference, should I ever decide to host one again," Sims said.

Sandy Sutton keeps watch over all the paperwork that makes the graduate program run smoothly

It Takes a Lot of Organization to Keep the Graduate Program on Track

By Karen Schaffner, Admin. Assistant

Seated behind her desk in her tidy corner office, Sandy Sutton is the picture of calm organization.

She looked around at all the documentation she faces every day. Besides the seven tall file cabinets filled with manila folders, there's a gray milk crate containing standing folders, four neat stacks of at least 15 folders each within arm's reach, at least three piles of fat, paper-filled binders, and two shelves weighed down with another 10 fat binders each.

"I have to make lists in order to be organized," Sutton, 52, said. And it's not just task lists Sutton makes. Among her lists: student identification numbers, student funding and where it comes from; which students belong to the Center of Mathematical Education of Latinos/as (CEMELA) and which belong to the Arizona Teachers Institute (ATI); who is going to be a teaching assistant, and how they will be paid. "There are so many lists of stuff you would not believe it." As Coordinator for the Mathematics Graduate Program, Sutton fills every workday with the tasks that keep the 75 faculty and 52 graduate students going.

Sutton says her year is divided into roughly two categories. First, she helps faculty recruit graduate students; and then, she helps keep the grad students on track. No matter what month or season it is, there are documents to be filed, deadlines to be met. "I keep tabs on the things students and faculty are supposed to do regarding a student's academic career. I check on things, I remind them to turn in paperwork, I keep records of their progress," Sutton said. "I really think most people don't know what I do up here."

"She knows everything about how the program is run," said Tom Kennedy, the Associate Head for the Graduate Program. A senior faculty member, Kennedy has been working as Associate Head for about six months. "The actual work that makes (the grad program) run is done by Sandy. One of the reasons I was willing to take this job is because she was in her job."

Graduate student recruiting is made up of two big tasks: processing graduate applications and planning the Recruitment Workshop.

Application processing begins in October for international students and in December for domestic students. Each international application contains at least 25 documents, while domestic applications are about 15 pages long. International applications require language tests and other documents. What isn't electronic—official transcripts for instance—have to be scanned. Once that's completed, Sutton posts all the documents to an in-house Web site so Graduate Committee members can view the materials. Last year, Sutton received and processed 90 applications.

The Recruitment Seminar is a three-day, intensive time in which prospective graduate students look over the program and faculty look over the prospects. Fortunately, Sutton shares the planning with Applied Math Program coordinators, Anne Keyl and Stacey Wiley. Between the three, logistics for the 30 prospects are arranged, students are shuttled about Tucson and the University, fed, toured, and introduced to the Department of Mathematics' brand of education.

The hardest part of the Recruitment Workshop process for Sutton is arranging grad student appointments with faculty members. Besides attending seminars and meetings, each of her 15 math prospects meet with at least four to six faculty members over the course of two days. Although prospective grad students may ask to see certain faculty whose research interests are similar, it is the Associate Head who mostly decides who will meet with whom. Sutton then arranges the meetings but it's not easy to coordinate and the schedule changes up to the last minute. Still, Sutton keeps at it. "I want to be able to give them a good impression of our program at The University of Arizona," she said. "I know this is not an easy decision for the prospective graduate students and I just want to be as helpful as I can to help them make their decision"

After the Recruitment Workshop, Sutton's next big task is to send admission offer letters. Since not everyone accepts, it takes about three rounds of letters to fill the class, but once it's done, Sutton is happy. "It's a relief when the incoming class is finally set. Then I can go on to the next phase," she said. To keep herself on track throughout the year, Sutton keeps a large journal, a kind of list divided into months and weeks, showing all the tasks that must be completed to keep things humming. July, Sutton said, is an easy month, with only 10 tasks on her list. Among those: "Make new files for incoming students;" and "Enter stipends and tuition waivers." She also has to finish those tasks that began in April and May but were moved aside when more pressing matters arose. And then she begins work on the Integration Workshop.

> "One of the reasons I was willing to take this job is because Sandy was in her job."
> — Tom Kennedy

The Integration Workshop is a kind of eye-opening, advanced math boot camp for incoming graduate students. It takes place the first week of August.

"You get a little intimidated when they start picking apart your problems," Jordan Schettler said of the workshop. A confident third-year graduate student studying number theory, Schettler said despite the fact that the workshop was hard, it was a really nice way to meet and begin to form a community with the other new grad students. "You're all in it together," he said.

Even before he was accepted to graduate school, however, Schettler said as he began the process of applying, it became very clear that Sutton was an integral part of things.

"I was impressed by the organization and Sandy had a lot to do with that," he said. "She's definitely a crucial cog. She's not a cog, she's like the axis, the hub."

In August, with the beginning of the semester just around the corner, there are about 20 tasks on her list for this month, and Sutton has to step up the pace. Each of the 20 large tasks requires many time-consuming smaller jobs. During the first week of the month for example, one of the tasks is to "Prepare for upcoming qualifying exams." The qualifying exams (or "quals") are a three-day ordeal grad students must take early in their academic program. For the exam, Sutton collects the problems from the faculty who are writing the exams. She makes sure there are enough exams, prepares a cover sheet for each day's exam, proctors the exam, tabulates the results, and prepares result sheets.

"Those lists are just reminders so you don't forget the deadlines. There are so many things to do in between those tasks," Sutton said.

No matter what season or month it is, Sutton's day begins with emails—and there are a lot of emails. "A big portion of my job is email. I do so much email correspondence it's ridiculous," Sutton said. During the spring alone, she said she responded to 1,535 emails. The messages come from students from all over the United States and the world. They want to know about the program, and most questions point to one thing: What are my chances of getting in?

Correspondents want to discuss application procedures and requirements, necessary documents, receipt of documents, and the status of their applications. Questions about coursework are forwarded to Kennedy. Sutton is careful to give each email a personal response and more than anything, this has made Sutton one of the most visible members within the Department of Mathematics.

continued on page 11

Graduate Student Awards

Yijun Shao *has been selected to receive the Daniel Bartlett Memorial Fellowship for summer 2009.* He entered the graduate program one year after Daniel Bartlett, took several courses with him, and remembers him as being "really smart" and able to absorb new material very quickly.

Belin Tsinnajinnie *has been selected as the recipient of the 2008-2009 Outstanding Graduate Academic Award, sponsored by the Native American Student Affairs (NASA) office.* He was also a recipient of the *Galileo Circle Scholarship* in the amount of $1,000. He specializes in math education.

Tsinnajinnie's dissertation focuses on the concept of mathematical norms in classrooms with a large number of Native American students. His outreach includes working with teachers in several local middle schools, working as a graduate mentor for the summer Computational Group Theory for undergraduates, and as a resident assistant for 8th and 9th grade participants in the Summer Math Camps in 2005 and 06.

Tommy Occhipinti *won a Galileo Circle Scholarship in the amount of $1,000.* He was recognized for his work in mathematics, where he was a leader in his research group. That group proved a result that their faculty mentor later discovered had been published in one of the top journals in the field in the 70s. In addition, he served as a student mentor for younger students studying for their qualification exams over the summer. He served as a mentor in the Integration Workshop for incoming graduate students and a mentor for undergraduate students in senior level math modeling courses.

Daniel Reich *was named a Department Outstanding Graduate Teaching Assistant for the Spring of 2009.* Classroom observers said he has a true gift for teaching. He knows all his students' names, students are still attending class late in the term, and he is patient and clear. A second observer, Lotfi Hermi, said Daniel is well organized, has impeccable board work, presents material with clarity of thought and is responsive to students' needs.

In the Fall of 2008, the Mathematics Graduate Committee recognized the following students:

Abhishek Bhattacharya *received the Scholarship Award for his research.*

Josh Chesler *was the recipient of the Service Award for his K-12 outreach.*

Selin Kalaycioglu was named winner of the Teaching Award for her work as a TA.

Chantel Blackburn *has been selected as the Outstanding Graduate Teaching Assistant.* She received $300 and her name is engraved on the plaque opposite Math 108.

Undergraduate Student Awards

Amanda Schaeffer has been awarded a *National Physical Science Consortium Fellowship.* This fellowship will provide up to six years of support while she pursues her PhD.

Angela Yazzie has been selected as the *recipient of the Outstanding Undergraduate Award* by the Native American Student Affairs office.

Mathematical Contest in Modeling

Two teams from the UA's Department of Mathematics received a "meritorious," the second highest ranking, in this year's Consortium for Mathematics and Its Applications (COMAP)'s Mathematical Contest in Modeling. Only 18 percent of the 1,695 teams did as well.

Team members Ivan Grubisic, Dustin Keys and Alex Blount selected problem A. Their paper was entitled *Comparative Analysis of Traffic Control Systems for Roundabouts, Including Enzyme Catalyst Reaction Based Scheme.*

Team members Livia Zarnescu, Emily Hartley and Ben Wilson chose problem B and the name of their paper was *Modeling the Energy Consequences of the Current Telecommunications Transition.*

COMAP (www.comap.com/index.html), whose mission is to improve mathematics education for students of all ages, conducts the *Mathematical Contest in Modeling* each year. The contest challenges teams of three students to clarify, analyze, and propose solutions to open-ended problems. Each team receives their problem at 8 p.m. Eastern Standard Time on a Thursday and is required to turn in their solution in the form of a research paper on the following Monday at 8 pm E.S.T. The contest attracts students and faculty advisors from more than 500 institutions around the world.

Nine teams received an "outstanding," the top award.

William Lowell Putnam Competition

Sean Howe, Kyle Marshall, and Derrick Sund—the UA's Department of Mathematics William Lowell Putnam team—ranked 31st from more than 1600 competing teams in the 2008 William Lowell Putnam Competition. Individually, Sund placed in the top 200 and Howe placed in the top 500, both for the second year in a row.

The Putnam competition (math.scu.edu/putnam) is constructed to test originality as well as technical competence. Contestants are expected to be familiar with the formal theories embodied in undergraduate mathematics. It is also expected that questions involving elementary concepts from group theory, set theory, graph theory, lattice theory, number theory, and cardinal arithmetic will not be entirely foreign to the contestants. In addition, questions may be included that cut across the bounds of various disciplines, and questions may be included that do not fit into any of the usual categories.

The examination is held on the first Saturday of December and consists of two periods of exactly three hours each with a two-hour break between the two sessions, under the official supervision of faculty member, David Savitt.

It Takes a Lot

continued from page 11

"She's the first impression," Kennedy said. "She is, in some sense, the face of this program."

Once Sutton responds to an email, she prints it out, creates a file for the correspondent, and makes a place for it in her well-organized file depository.

Sutton doesn't just move paper. Unofficially, she looks after the students in the program.

On any given day of the school year, Sutton said, she will have six or seven students visiting her office, mostly for department business but sometimes for personal issues. "I feel like their mom," she said. "If they want to come and talk about something, I want them to do that. . . and several of them have."

Lizhen Lin, 23, from Jinyun, China, and a graduate of Sichuan University, said Sutton was the first person she met at the UA. When there are problems, Lin knows where she needs to go.

"Ok, I'll go talk to [Sandy]," Lin said. "She has been helping me over the three years [I've been here]."

"She's very approachable. You can ask her any kind of question," said Grethe Hystad, a graduate of the University of Oslo. She will be defending her doctoral thesis in the fall semester. Hystad came to Tucson with nothing but two suitcases filled with winter clothes.

"[Sandy] is just amazing, so helpful and nice, always willing to help," Hystad said in a soft Norwegian accent.

At the end of the work day, Sutton puts away her lists and goes home. But it's those lists that help her get her work done.

"You do feel like you've accomplished things, especially if you have lists, you can mark them off," she said.

From Bose-Einstein Condensation to Probability Theory

By Daniel Ueltschi

The Bose-Einstein condensation is a phase transition that takes place in certain large systems of quantum particles. It is believed to give rise to such striking physical phenomena as superfluidity and superconductivity. Besides atomic physics and condensed matter theory, it is also present in turbulence and optics, two strong research areas at The University of Arizona. The theoretical discovery of the Bose-Einstein condensation is an intriguing tale in the history of science and I cannot resist the temptation to retrace it briefly.

In 1924, the unknown Indian physicist Satyendra Nath Bose (pronounced "Bosh") submits an article to the Proceedings of the Royal Society, which rejects it. Nothing unusual, and Bose should have accepted the opinions of established academics. He did not, however, going so far as to send his manuscript to Albert Einstein, the leading physicist of his time... and Einstein took the time to study it, and even translated it himself into German and recommended its publication in the journal *Zeitschrift für Physik.* The article of Bose showed that, by using certain rules for counting "particle configurations"—rules that are referred to nowadays as the "symmetry principle" for identical bosonic particles—it is possible to get the equation of black-body radiation. Shortly afterwards, Einstein wrote his own articles, pointing out that an ideal (i.e. non-interacting) gas of bosonic particles undergoes a "condensation" where the quantum state of lower energy becomes macroscopically occupied. In addition, he gave an exact formula for the critical temperature, namely $T_c = \frac{2\pi\hbar^2}{m k_B}\left(\rho/\zeta\left(\frac{3}{2}\right)\right)^{\frac{2}{3}}$ where m is the particle mass, $\hbar$ is Planck's constant, k_B is Boltzmann's constant, ρ is the density, and $\zeta\left(\frac{3}{2}\right) \approx 2.612$ is Riemann zeta function at $\frac{3}{2}$.

The concept of Bose-Einstein condensation was born. It took many years for physicists to believe that these calculations reflect a genuine physical phenomenon. And it took a full 70 years for experimental physicists to catch up and create a "Bose condensate" in a laboratory, in 1995. Clearly, theoretical physics scored here an impressive success, and this is why the 2001 Nobel prize of physics was awarded to the experimentalists as a second-place consolation prize.[1]

My current study of interacting bosonic systems is motivated by Feynman's path integral approach, which dates back from the 1950s. Quantum particles are not represented by points in the space, but by "Brownian motions," i.e. by an erratic random walk that keeps changing its direction. Bringing in the symmetry principle, one is led to a representation that involves points in the space, permutations of these points, and Brownian bridges between the points. If we neglect the particle interactions, we can integrate the contribution of Brownian bridges and we obtain "spatial permutations." This notion seems interesting in its own right and I want to describe it in more detail.

Usually, a permutation of n elements is a bijection from {1, : : :, n} to {1, . . . , n}. But here, a *spatial* permutation involves a set of points $x_1, : : :, x_2 \in \mathbb{R}^d$ and a permutation π of n elements. See Fig. 1 for an illustration. We now consider a probability distribution on these spatial permutations. Let us fix the point locations. The probability of the permutation π is proportional to

$$\prod_{i=1}^{n} e^{-\xi(x_i - x_{\pi(i)})}.$$

That is, to each permutation jump $x_i \mapsto x_{\pi(i)}$ there is a factor $e^{-\xi(x_i - x_{\pi(i)})}$. The most relevant choice for ξ, the one that shows up in the quantum Bose gas, is $\xi(x) = \frac{1}{4\beta}|x|^2$.

Here, $\beta = 1/k_B T$ is proportional to the inverse temperature of the system. The effect of these factors is to force all jumps to be small—a point cannot jump to the other side of the box in one step. But although all permutation jumps are "local," the possibility exists for global behavior: a permutation cycle may involve a lot of points that cover a large portion of space. The main question is whether, as the size of the system and the number of points becomes infinite (with fixed density, i.e. with fixed mean-distance between points), some points find themselves in cycles of infinite length. It is expected that a transition to infinite cycles takes place when the density increases (or when the temperature is lowered) and this transition has something to do with the Bose-Einstein condensation described above.

[1]Of course, this remark should not be taken seriously. The two experimental realizations of Bose-Einstein condensation by Cornell and Wieman, and by Ketterle, were extremely difficult. They involved creating equilibrium systems of many bosons at very low temperatures (around 2000 ^{87}Rb atoms below 170 nK, and 5x10^5 ^{23}Na atoms below 2μK). These physicists fully deserve their Nobel Prize.

My interest in this topic goes back to 2001 when I was a postdoc in Princeton, but I really started working on it during my years at UA. I clarified and extended the very fine study of A. Sütő, a mathematical-physicist from Hungary, who had shown that the occurrence of infinite cycles coincides with Bose-Einstein condensation in the ideal gas. Since then I have been joined by several collaborators: D. Gandolfo and J. Ruiz of Marseille, my colleague V. Betz of Warwick University, and John Kerl of UA. John is currently working on lattice permutations as part of his PhD thesis, under the supervision of T. Kennedy.

> "It took many years for physicists to believe that these calculations reflect a genuine physical phenomenon."
> — Daniel Ueltschi

Thanks to the help of those collaborators, we have made good progress, especially in proving the existence of a critical density above which infinite (macroscopic) cycles appear. This holds for many jump functions, and also when certain simple interactions between permutation jumps are included. We noticed that some of the problems appeared in studies by mathematical biologists and probabilists. One ambitious goal is to calculate the effects of particle interactions on the critical density of Bose-Einstein condensation. This question has not been fully resolved by physicists; the present approach should allow for some useful analytical steps and more precise numerical simulations. At UA, John is developing numerical techniques that should help answering many questions in the future.

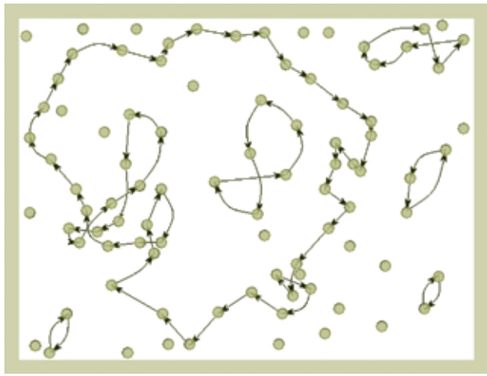


Figure 1. A typical "spatial permutation." There are seven cycles with more than one point (check it!). The box is supposed to be huge, but the permutation jumps have finite length. The main question is about the occurrence of infinitely long permutation cycles.

He also identified a few problems about transition probabilities between spatial permutations that belong to the area of discrete mathematics, and for which we hope to make good progress.

I am currently spending a useful and very pleasant semester in Arizona. My collaborators V. Betz, S. Poghosyan, and R. Seiringer, who came to Tucson, enjoyed the Arizona-Sonora Desert Museum and the Pima Air & Space Museum. My favorite activities include hiking (Sabino and Bear Canyon, Wasson Peak, and hopefully Mount Wrightson soon), playing street hockey (Want to join? We are looking for new players: www.pimastreethockey.com), and enjoying the beautiful campus of UA.

Daniel Ueltschi is Visiting Assistant Professor in the Department of Mathematics at The University of Arizona. He has been on sabbatical from the University of Warwick, England, where he is an Associate Professor.

Burn the Midnight Oil

continued from page 3

"Lecturing during the day and running a project during the evening is an exhausting amount of work for the speakers. Having some help with the project makes their job a little more manageable, provides the students an extra person to talk with about the project, and is an opportunity for the assistant to get some experience working with students in an advisory role," Savitt said.

Ulmer said the school has always been about change, adding that in the beginning especially, "there was a fair amount of experimentation." One idea, for instance, was a unit on professional development. "It was harder than we thought,"

continued on page 15

Math Majors Prove Participation Important to Their Education Equation

By William Yslas Velez, Mathematics Professor
and Associate Head for the Undergraduate Program

The mathematics major program continues to thrive. We ended the academic year with more than 550 mathematics majors and they continue to participate in a variety of activities.

Many of our undergraduates are involved in research activities, as evidenced by the article by Amanda Schaeffer. Our faculty members are most gracious in developing research projects for undergraduates to work on. These projects introduce undergraduate students to the many open problems mathematicians are addressing and serve to motivate undergraduates to take more advanced courses. Both Amanda and fellow math student Alan Mackey have already taken graduate mathematics courses. This kind of preparation, research and graduate-level mathematics courses make our students competitive when applying to graduate programs.

Mackey points out in the next article that he also is majoring in economics. Many of our mathematics majors have other interests and use their mathematical studies to prepare for graduate programs in other areas or to support their applications to join the workforce. Mathematics majors bring strong analytical skills with them to address the complex problems that confront society. If you are a graduate of our program, we would like to invite you to contact us. We would like to talk to you about our recent graduates, and then could encourage them to apply for positions with your firm. Establishing a linkage between our undergraduates and the mathematics graduates we have trained who are established professionally, would motivate the study of mathematics and highlight its applicability.

Professor William Velez may be reached at velez@math.arizona.edu.

A solid foundation leads to success

Alan Mackey, Mathemathics

Before I enrolled as a freshman at The University of Arizona, my primary interest was economics. I was also interested in taking more math courses as a complement to my degree, but I didn't know where to start. I had taken the Calculus BC (a full-year course in the calculus of functions of a single variable) Advanced Placement test, but I didn't know anything about math beyond calculus.

Before my first semester, William Velez, Mathematics Professor and Associate Head for the Undergraduate Program, contacted me about the math courses I was taking. I had planned on taking Vector Calculus, but Dr. Velez encouraged me to enroll in Linear Algebra—MATH 215—as well. I had some space in my schedule, so I decided to add the course.
As my first semester went by, I became more interested in mathematics. I declared a math major, and it wasn't long before I noticed that I was planning my schedule around math courses rather than economics. I took Formal Math Reasoning and Writing my second semester, and enrolled in the year-long courses in Algebra and Analysis my sophomore year.

> In retrospect, taking Linear Algebra—MATH 215 my first semester was one of the best scheduling choices I ever made.
> — Alan Mackey

I'm still an econ major, but math has become my main interest. In retrospect, taking MATH 215 my first semester was one of the best scheduling choices I ever made. The course serves as an introduction to math beyond calculus, but taking it early has other benefits. I didn't realize it at first, but MATH 215 is an important course in the major because it's either a direct or indirect prerequisite for all upper division classes. If I hadn't taken it my first semester, I would either have had to make up for it in summer courses or take the yearlong Algebra and Analysis courses a year later than I did.

That year has made a big difference. Having more experience with the subject early on has made me more competitive for summer research programs and internships. It has also given me more time to explore my options as a math major after I graduate.

For those reasons, I recommend taking MATH 215 early to any freshman with some curiosity about Mathematics. It's been a great asset for me, and I'm thankful the math department's advising was so proactive.

Faculty mentors help undergrad arc to graduate school

Amanda Schaeffer
Mathematics Graduate Program

My name is Amanda Schaeffer, and I am a senior undergraduate math major here in The University of Arizona Department of Mathematics. In my four years here, I have come to love the subject; and in the fall I will begin the Ph.D. program in mathematics here. With my graduation drawing near, I would like to share some of the experiences the department has made possible which have helped me to fall in love with mathematics.

I began my math coursework slowly. Being nervous about coming to college, I retook calculus II my first semester here. After taking MATH 323 (Introduction to Proofs) in the spring of my sophomore year, the fire was lit. I proceeded to take the rest of the required coursework my junior year, and graduate courses this year.

During my sophomore year I had the pleasure of participating in the Tutoring in the Schools Program, sponsored by the Center for the Recruitment and Retention of Mathematics Teachers and taught by Ann Modica and Sue Adams. I caught a glimpse of how difficult—but also how rewarding—teaching mathematics in high school can be. The instructors of the weekly seminar have been very supportive, helping me with some projects and always answering questions. They gave good advice or introduced me to faculty members that could advise me.

That year and again last semester, I was also an Undergraduate Teaching Assistant, thanks to a bit of National Science Foundation (NSF)-Vertical InteGrated Research and Education (VIGRE) funding. This was another great experience, where for the first time I graded, held office hours, and ran review sessions. As with the Tutoring in the Schools Program, it gave me some insight as to what it's like to teach, this time a college math course. The experience has made me look forward to the time I begin teaching in graduate school.

One of the best parts about my years as an undergraduate math major has been doing research. I spent a year as an Undergraduate Research Assistant (again through VIGRE), during which I worked with Professor Emeritus W.M. Greenlee, and Associate Professor Klaus Lux. I continued work with Professor Lux through this year for my honors thesis on number theory, Strong Reality in Coxeter Groups. Both professors Greenlee and Lux have inspired me to research and study mathematics, and to someday serve as a mentor as they have for me.
With the help of the UA Math Department's VIGRE funding, I was able to present the results from an NSF Research Experience for Undergraduates at the Mathematical Association of America's Mathfest last July in Madison, Wis. I was also able to present the research that I have been doing with Professor Lux at the Nebraska Conference for Undergraduate Women in Mathematics in February.

> "In my four years, I have come to love the subject; and in the fall I will begin the Ph.D. program in mathematics here."
> — Amanda Schaeffer

My experience here in the department has made me eager for the future. I am very excited for graduate school and my work as a mathematician.

Burn the Midnight Oil

continued from page 13

Ulmer said. "But we were willing to try things."

Fifteen years later, Ulmer likes what he sees. "I am extremely pleased that it's continued," he said. "It may well go beyond 15 years." The National Science Foundation must feel the same. The organization awarded a fourth grant to the cause in December of 2008.

Besides Savitt, today's directors include Matt Papanikolas, William Stein, Dinesh Thakur (one of the original Principal Investigators), and Fernando Rodriguez Villegas. Other original PIs are Ulmer, Bjorn Poonen, William G. McCallum, Alex Buium, Minhyong Kim, Wayne Raskind, and Felipe Voloch.