SAN FRANCISCO STATE UNIVERSITY

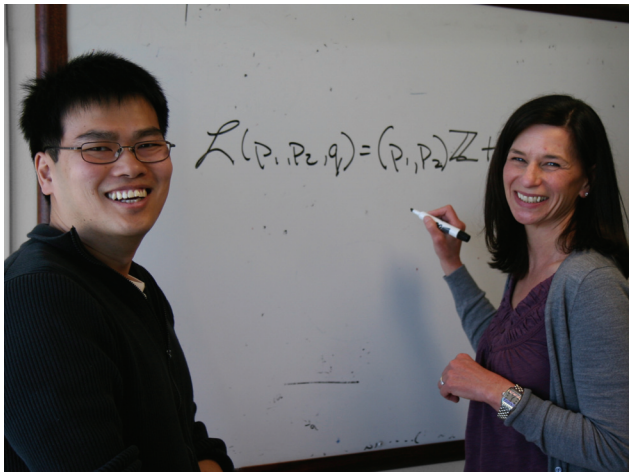
DEPARTMENT OF MATHEMATICS

MATH news

Spring 2014

We publish this newsletter to acquaint our community and graduates with developments here. Our faculty wish to emphasize the connection between their research and their work as teachers. *MATHnews* will include only a selection of available news items. For many others, consult news sections of our website, `http://math.sfsu.edu/`.

On later pages



Prof. Yitwah Cheung *Ms Deborah Damon*

Deborah Damon: Re-entry

Our alumna Deborah Damon was born in Scotts Valley, and educated in public schools there. She had a rough childhood; three sisters did not finish high school. But she won a scholarship to UC Berkeley: "I knew that if I wanted to escape I needed to concentrate on studies." She started preparing for an engineering career, but developed a love for our subject instead, and completed a double major: applied mathematics and economics. Deborah secured employment as a research analyst in financial services, and became a portfolio manager, expert on zero-coupon bonds. In due time, she left that profession to become a mother. Her three children are now college-educated and starting professional careers.

Deborah headed back to mathematics: "I'm terrified of losing the ability to think," she remarked. The only available mathematical job was at Marin Catholic High School, near her home. She found that she really liked teaching, and decided to relearn her mathematics and enter community-college teaching. While caring for her aged mother, she retook lower-level courses and regained her confidence. Deborah entered our program to complete the upper-division requirements, and then to earn a master's degree. Coming back was indeed difficult: "I don't think as quickly as others, or maybe I expect to understand more deeply. It was a little hard to be always the oldest person in class, a bit of an outsider. But I never felt any singularity as a woman, anywhere." At first intimidated by the thought of writing a thesis, she finally undertook a project with Prof. Yitwah Cheung related to his research on continued fractions. That subject is not covered in our standard courses, so she dived into a famous and difficult text, mastered the subject, and understood and solved the suggested problem, completing her thesis in **200?**. During this process Deborah's drive to achieve deep understanding led to her simplification of some of the proofs in Cheung's own work. He praised her professionalism and reports that she has proceeded considerably beyond the material in her thesis and has discovered how certain symmetries arise in his constructions: "This helped me, and let my research go forward." Deborah offers potential students this advice: "Read—force yourself to understand."

Department News

Prof. Matthias BECK is one of only three mathematicians nationwide to receive the Mathematical Association of America's celebrated Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching. It is given annually to college and university faculty members with an extraordinary record of teaching, whose influence has extended beyond their institutions. "Prof. Beck is not only an outstanding teacher but also has a distinguished record of scholarly research," said Sheldon Axler, Dean of Science and Engineering. "He is yet another example showing that our best teachers are usually our best researchers, and vice versa." Beck has dedicated his career to preparing students to teach mathematics effectively at the primary, secondary, or higher-education level. At SF State, he is known both as a tireless student mentor and for his ability to teach subjects ranging from teacher preparation to complex mathematics such as combinatorics and the theory of polytopes. His own research involves discrete and computational geometry and analytical number theory, and he is the author of two textbooks for intermediate and advanced undergraduate students.

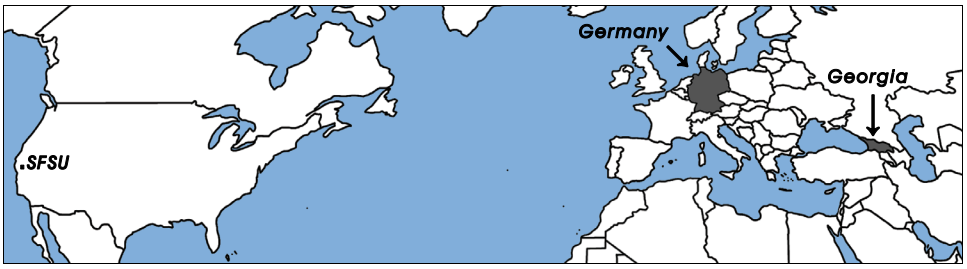
Dr. Joseph RICHARDS has joined our Department. A 2005 graduate of Pomona College, Richards completed the doctoral studies in statisics in 2010 at Carnegie Mellon University. His main area of interest is astrostatistics. Richards is on leave for 2013–2014 to complete a National Science Foundation fellowship at the University of California, Berkeley, which he was awarded in 2010 to study real-time classification of massive time-series data streams. Welcome, Dr. Richards!

Assoc. Prof. Mariel VAZQUEZ has received a prestigious National Science Foundation CAREER Award for her research, which applies pure mathematics to the biological mysteries of DNA. She is an expert in topology, a part of geometry that emphasizes shapes and transformations rather than distances and lines—particularly in the application of this theory to analyze knots. "When DNA is packed into a living cell it doesn't look like the straight double helix that we see in textbook pictures," Vazquez says. "In order to fit into the cell, the double helix is twisted and coiled around itself and around proteins." The two strands of the double helix must be separated and unwound in order to be copied, allowing the genome to replicate. Scientists have found enzymes which disentangle DNA, but much is still to be learned about how they work. These enzymes are vital for the functioning of healthy cells in all living organisms. They also play an important role in allowing bacteria and other malignant cells to multiply: those are targets for antibiotics and anti-cancer drugs. Vazquez is planning educational activities on DNA topology for the general public at the California Academy of Sciences. She will also introduce her work to local elementary school children, collaborating with the San Francisco Math Circle programs.

Prof. Emeritus David B. MEREDITH died in December 2012 from complications during heart surgery in San Francisco. He had just completed the SFSU early retirement program. Meredith spurred the development of our graduate program, and served as our Chair, 2002–2006. Always heavily involved in academic affairs, he served as Chair of the university Academic Senate, 2006–2007. The University is establishing a scholarship fund in his honor.

Joseph Gubeladze:

Transitions



Students in Joseph Gubeladze's SFSU classes are led into a complex mathematical world by a teacher who made his way there via an unusual and indirect path. With mental microscopes students follow him deep into fascinating theories. With wide-angle lenses, they can glimpse how some social forces fostered his progress, but others would impede it. Joseph took advantage of timely opportunites to overcome chaos, ensure intellectual growth, and allow his family to flourish. His initiative has led to advances in science and to increased opportunity for SFSU students to explore higher mathematics and make their own way into its depths and delights.

As the displayed map suggests, Joseph's story depicts a journey not just intellectual, but also cultural and geographical. He was born in 1961 in Tbilisi, capital of the Republic of Georgia, a mountainous country of five million on the Black Sea between Russia and Turkey. It had been part of the Russian empire for more than 150 years. Joseph's mathematical facility gained him a place in a special high school, a benefit of the Soviet emphasis on education in science. His parents, an agricultural instructor and a pediatrician, encouraged him to follow that talent, even though the economic promise of a career in science did not match its social prestige. Joseph's family life and schooling were entirely in the Georgian language: the Russians had never been able to impose theirs in Georgia. His school emphasized traditional Georgian culture, which remains a mainstay for him even today.

Joseph pursued university studies in Tbilisi, but many centralized administrative aspects were conducted at St. Petersburg, far to the north. His research supervisor was Hvedri Inassaridze, an algebraist specializing in K-theory—and a Georgian patriot and statesman. Joseph's doctoral research concerned the mathematics surrounding a famous conjecture in K-theory by the French mathematician Jean-Pierre Serre. After others confirmed the conjecture, David F. Anderson suggested an extension to it in his 1976 Chicago dissertation. Joseph generalized their methods, solved this extended problem, in his own 1986 thesis, and thus provided a route to further investigations.

Joseph's early research, from 1981 to 1989, was published in Russian in an obscure Georgian journal. But another Chicago mathematician, Richard G. Swan, noticed it and began publicizing and refining Joseph's work. That spurred Joseph to publish a major survey paper in English in 1990, and let him qualify that year for the highest Soviet degree, Doctor of Science. Swan's major report was published by the American Mathematical Society in 1992. The positive reception of Joseph's research in the West was decisive for his career.

In 1982 Joseph married a fellow mathematics student, Manana, and they started a family. As the Soviet empire collapsed in 1991, Georgia asserted its independence, and the country plunged into civil war, which lasted four years. During much of that time, its economy simply did not function. Many scientists gave up academic employment, but Joseph remained, employed solely as a researcher at the Georgian Academy of Sciences. His minimal salary didn't suffice for a family.

K-theory

The study of systems of equations in algebra and calculus includes that of their graphs in higher-dimensional analytic geometry. By 1890 these studies had begun to employ advanced algebra, far beyond the familiar high-school subject. The need to correlate results obtained by concrete geometric methods with those obtained via abstract advanced algebra led to complicated questions in algebraic topology and algebraic geometry. K-theory is an algebraic technique invented around 1950 to handle these. It employs structures more complex than those used to handle vectors in elementary geometry and physics. Gubeladze showed that in a certain large class of those structures, analogous coordinate methods are still possible.

Fortunately, Joseph's interest and expertise overlapped that of mathematicians in Germany who had noticed Swan's reports. Winfried Bruns invited Joseph to visit Osnabrück. Bruns's main interest was in applying algebraic methods to assess the complexity of polytopes—higher-dimensional analogs of polygons and polyhedra. Joseph obtained research fellowships to support his family in Germany for four years in Germany during 1995–2001. In collaboration ever since, he and Bruns have produced twenty research papers. Their work lies at the interface between algebra and geometry, and has expanded beyond their original individual emphases.

continued ...

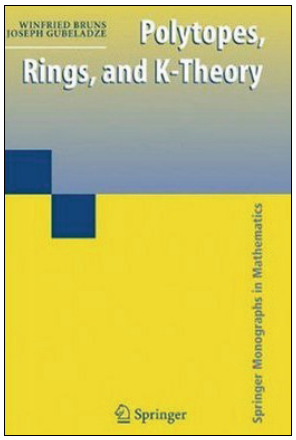
Manana and Joseph

By then Joseph's family had grown: three daughters, two sons. Athough he had been promoted to the highest rank at the Georgian Academy, his salary was impossibly low. Even after returning from Germany, he saw little improvement in life in Georgia. Joseph began exploring the possibility of employment in the United States. His application to SFSU caught the attention of Sheldon Axler, then chair of our Department. Joseph was appointed lecturer here in Fall 2002, and to a research fellowship at the Mathematical Sciences Research Institute in Berkeley during the Spring 2003 session devoted to topics in advanced algebra. The SFSU faculty felt that Joseph's interest in algebra and polytope theory would complement that of Serkhan Hosten, who had joined us two years before. Joseph was appointed Assistant Professor of Mathematics at SFSU in Fall 2003.

What was hardest about emigrating here? *Teaching classes!* Joseph had never before offered instruction below postdoctorate level; he had to start an essentially new career as a teacher. Seriously considering what he had to learn, he made major use of his recollections of his own teachers and tried hardest to avoid what had troubled him most as a student. What was that? "Acting like a monarch in class!"—certainly not part of any SFSU tradition. (Joseph has assured us that instruction in Georgia has greatly improved since then.) He reports, "I'm really happy to have ended up in the Bay Area. The atmosphere is cosmopolitan, and I feel at home."

Joseph teaches a heavy load: large calculus classes, graduate-level algebra, and lending help and a sympathetic ear to graduate students with thesis projects in higher algebra. He explains the complex ideas of mathematics in a way that is congenial to beginning students, and leads them to understanding and achievement. Joseph has been promoted to Associate Professor, and is a member of our Academic Senate. His family have redistributed themselves. Eldest daughter Nino has graduated from SFSU and is employed in this area. Her sisters Ana and Tamar have returned to Georgia, to marriage and motherhood, and to medical school. The two boys remain here: Jimsher studies at SF City College, and Lazare, a football enthusiast, will graduate this term from nearby Abraham Lincoln High School.

Since Joseph's arrival, two other faculty with similar research interests have joined us: Matthias Beck in 2004, and Federico Ardila in 2005. With Joseph and Prof. Hosten, they form the Algebra-Geometry-Combinatorics Group, which is providing our graduate students and advanced undergraduates unprecedented deep access to current research work in mathematics. They are collaborating on research, offer seminars almost weekly, and have numerous master's theses underway. Several graduates of this group have achieved major distinction in PhD programs and already in postdoctoral research.



Joseph recently published a research monograph with his collaborator, Prof. Bruns. Although he is decreasing his activity in that area now, others are taking up some of its open problems. Joseph has been pursuing computations that may eliminate some infeasible approaches. This work fits particularly well with his collaborative group at SFSU. Recently he has been considering possible applications of his algebraic methods to theoretical problems in quantum physics. He has a concrete working plan and looks forward to future interaction with physicists. But he predicts that finding collaborators in a different discipline will be harder.

Asked what he misses most after his transition to SFSU, Joseph responded, "Close relatives and really close friends, and the landscape of the Great Caucasus range." California's mountains remind him of that, but they're not the same. He compensates in part through serious participation in Georgian cultural and Church activities here. Asked what is most needed for him to help advance the SFSU mathematics program, Joseph responded that the increasing role of research here, far greater than that of a generation ago, collides with local budget realities. For faculty and students to continue their current high level of achievement in research and studies, some means must be found to restore the security of funding that is threatened by continuing fiscal crises.

James T. Smith, Professor Emeritus

Mathematical Note

Polish and Reverse Polish Notation

Reading about hand calculators or computer programming, you may have encountered these terms. What's this about?

During World War I Poland was emerging as an independent country. Polish mathematicians were determined to make it a research center of world rank. They emphasized a discipline where they were already strong: mathematical logic. During the 1920s, the logician Jan Łukasiewicz was investigating how to measure the complexity of formulas such as $(a+(b-1))\times d$ that you meet in algebra class. Does complexity have to do with the nesting of parentheses? Not directly: read on.

Łukasiewicz and his colleagues noticed that if we should always write the operation sign *before* the numbers it combines—for example, $-b1$ instead of $(b-1)$ —then we wouldn't need parentheses at all. Our formula $(a+(b-1))\times d$ would become first $(a+-b1)\times d$, then $(+a-b1)\times d$, then finally $\times+a-b1d$. Evidently, complexity stems from the number and arrangement of the operation signs, not the parentheses.

The Poles' achievements in several areas of logic quickly made them famous. They wrote many logic formulas this way in their research journal *Fundamenta Mathematicae*, probably to attract attention as much as to analyze complexity. That journal became tops in the world in its field, and this style widely known, as *Polish notation*.

Not easy to read, is it! But someone noticed that something suddenly rings a bell if you always write the operation sign *after* the numbers it combines—for example, $b1-$ instead of $b-1$. With this *reverse Polish* notation, that trial formula $(a+(b-1))\times d$ would become first $(a+b1-)\times d$ then $(ab1-+)\times d$, and finally $ab1-+d\times$.

No bell yet? Find someone familiar with Hewlett–Packard hand calculators. Read this formula from left to right, say "enter" before each symbol for a number and "punch" before each operation sign. The HP user will envision the machine's main-storage display showing first the entered value of a, then b, then 1, then $b-1$ (the result of combining the previous two entries), then $(a+(b-1))$ —same idea—then finally $(a+(b-1))\times d$. Ding: there's the answer!

Stack of plates, as in a cafeteria but staggered, with the top two plates overlaid by formulas to be combined.

This shows that reverse Polish notation is equivalent to the system you learned in algebra: whatever you do with one you can do with the other.

Here are some remarks that may intrigue you into inquiring further. Łukasiewicz was not just a mathematician: he served as a cabinet minister in the first independent Polish government, and as a professor of philosophy. Desktop calculators were introduced in the 1910 decade and this input technique developed for them soon after that; reverse Polish notation became familiar during the 1950s. The main storage unit of that sort of calculator is analogous to the pushdown stack of plates at the start of the serving lines in Polish cafeterias today; the display shows the top plate, and the operations always replace the top two plates with one containing the result. The idea of a pushdown stack is one of the most basic in computer architecture, and reverse Polish notation is the underlying idea of several very powerful computer languages, such as the *PostScript* language that a computer uses to describe this document to a printer.

James T. Smith

Selected Alum Notes

Steven NERNEY, BA 1966, earned an MS in Physics from SFSU in 1968, and a PhD in astro-geophysics from the University of Colorado in 1974. He pursued a scientific career at NASA Ames Research Center in Mountain View and at Ohio University, Lancaster. Now retired in Boulder, Colorado, Nerney is a performing musician. He has dedicated his recent folk-music CD to Lawrence CHANG, BA 1968, known in those years as Larry TRUONG. Larry died in 1983 after a distinguished but too brief career, including service as assistant professor in our Department; he is a member of the SFSU Alumni Wall of Fame.

Dennis MORITZ, BA 1971, visited the Department recently. He earned an MS in computer science from the University of California at Berkeley and has pursued a career in analysis and software development for financial services. In 2004 he founded his own company, the San Francisco firm Advantage for Analysts.

Mahyar AMOUZEGAR, BS 1987, is Dean of the College of Engineering at California State Polytechnic University, Pomona. He earned doctorates in electrical engineering and operations research at the University of California at Los Angeles in 1991 and 1994. Before coming to Pomona in 2011, he worked for the RAND Corporation and served on engineering faculties in California and New Zealand.

Seth BRAVER, BA 1999, teaches mathematics at South Puget Sound Community College in Olympia, Washington. Braver earned the PhD in history of mathematics at the University of Montana in 2007. The Mathematical Association of America has recently published his book *Lobachevsky Illustrated*, on non-Euclidean geometry.

Katherine Marie (Kaytee) BOCK, BS 2002, is now a senior manager of business development at the Nevro Corporation in Menlo Park. The company is introducing technology to improve the role of spinal cord stimulation in the treatment of chronic pain.

Candice PRICE, MA 2007, is now Assistant Professor of Mathematics at the United States Military Academy. She earned the PhD degree from the University of Iowa in 2012, with a dissertation entitled *A Biological Application for the Oriented Skein Relation*. She is organized a session on *Women Math Warriors* at the January 2014 Joint Mathematics Meetings in Baltimore, Maryland.

Emily McCULLOUGH, BA 2009, taught mathematics at Mission High School in San Francisco, serving as a partner teacher in the Department's NSF-sponsored (CM)2 program for enriching the mathematical experiences of our students in collaboration with teachers and students from San Francisco public schools. Now she has returned to the Department as a graduate student, and is continuing to work with students and teachers in that program.

Tia BAKER, MA 2013, is now a mathematician with the United States Navy.

For many other notes, go to `http://math.sfsu.edu/alum_news.php`

Supporting Us

Our Department prepares students for further studies in doctoral programs, for the teaching profession, and for careers in industry. A gift from you would go a long way to enhance the quality and impact of our work. There are several venues by which you can make a contribution: see the webpage

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We thank you for your generosity!

David Bao, Chair

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