The Quaternion

The Newsletter of the USF Department of Mathematics and Statistics
Volume 29, Number 1; Fall 2014

Les Skryzpek is New Department Chair

Dima Khavinson Promoted to Distinguished University Professor

Gan Ladde's Story of Determination

Nagle Lecturer Casts a Ray of Light over a Sea of Dark (Matter)

Also in this issue:

Faculty News
STEM Education Center News
Student News
Club News

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USF UNIVERSITY OF SOUTH FLORIDA

The Quaternion
Volume 29: Number 1; Fall, 2014

The Quaternion is an annual publication of the Department of Mathematics & Statistics at the University of South Florida-Tampa. The Quaternion is available online at

http://www.math.usf.edu/quaternion/

The department serves the community by teaching students, conducting research that will help build the future of Florida, and providing outreach services.

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We'd Like to Hear from YOU!

The Department of Mathematics & Statistics would like to hear from alumni, friends, collaborators, members of the community, and fellow explorers of and guides to the world of mathematics and statistics.

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Appeal for funds

We are a growing department, and we strive to develop new programs to meet the needs and provide opportunities for our students and our community to fulfill their aspirations. With all due respect to Benjamin Franklin, many of the best things in education and scholarship cost money. We would appreciate any assistance we can get from alumni and the community. Feel free to contact our chair, Les Skrzypek, at the above address for details.

In this Issue

Changing the Guard
The Department has a New Chair

After four terms as Chair of the Department of Mathematics & Statistics, Marcus McWaters has stepped down. He is succeeded by Lesław Skrzypek, who has served as Associate Chair since 2009.

Professor Skrzypek arrived at USF in 2003. He had received his M.S. and Ph.D. from Jagiellonian University in Cracow, Poland. He had also taught in workshops for gifted high school students seeking to compete in the Mathematics Olympiads. "The Olympiad isn't very big in America, but it is very big in Poland." He was a volunteer and did it for fun.

With the support of a Fulbright Grant and, later, a NATO Advanced Grant, he continued his research in functional analysis, Banach spaces, and approximation theory at UC Riverside. He later came to USF.

Professor McWaters appointed Skrzypek Associate Chair in 2009. The associate chair deals with much of the minutiae of running the department, from class assignments to student problems to dealing with the university bureaucracy. "You meet a lot of people and hear a lot of stories. You try to help people, or just give them good advice."

During the last few years, USF has focused much attention on getting students successfully through their programs. That includes enforcing prerequisites for lower division courses, reserving seats for freshmen so they can enroll in courses, and a university-wide redesign of the general education curriculum. In our Department, we have a new SMART lab for lower division students and several NSF-funded efforts to improve lower division teaching. "A lot of the job is solving problems: predicting the problems that will exist and making back-up plans."

Skrzypek also plays tournament bridge, and is a Life Master in the American Bridge Contract League.

Skrzypek succeeds Professor McWaters, one of the two longest serving faculty members at the University of South Florida. He arrived in 1966, and reports that "The most significant changes I have seen over the last 48 years at USF is in the size and complexity of the physical plant and the increased talent level of the departmental faculty."

McWaters did research in topology and co-authored ten textbooks. "[T]the core material taught in the lower level courses [i]s more or less standardized across the nation," so he and Professor Jogindar Ratti "focused on making that core material more accessible and appealing to undergraduates. This turned out to be much more challenging and time intensive than I anticipated." He also worked on technology in the classroom, and ultimately the SMART Lab now occupying half the second floor of the library (see the 2013 Quaternion, featuring Computer Guided Coursework: the SMART Lab.)

He also presided over the division of the department into two autonomous units, the Mathematics Unit and the Statistics Unit. "The chair's job is to facilitate the professional activities of the faculty, to advocate for the department to all units on campus, to secure all possible resources (from all possible sources) to advance the mission of the department, and to represent

the department in both internal and external venues. For me, the most rewarding activities involved helping individual faculty members achieve their goals." He will be returning to a non-administrative position this fall.

The new Associate Chair is Stephen Suen, who came to USF in 1993. Professor Suen had received his doctorate at the University of Bristol in the UK, and then taught at what is now the City University of Hong Kong, and then at Carnegie-Mellon University before coming to USF.

A Problem-Solver Becomes a Distinguished University Professor

Every year, the University of South Florida promotes two or three of its 2,000+ faculty to a special position, *Distinguished University Professor*. This year, USF Mathematics Professor Dmitry "Dima" Khavinson was one of three faculty chosen this year to join the Distinguished University Professors at USF.

Professor Khavinson was promoted for his research in mathematics. The promotion announcement stated, "He is one of the most prominent and influential scholars in the field of mathematical analysis, widely known for his work in function theory, partial differential equations, harmonic analysis, and potential theory." The announcement cited prior recognition of his work. "His research record has been recognized by USF with the Theodore and Venette Askounes-Ashford Distinguished Scholar Award in 2010 and internationally

through honorary appointments at the famous Mittag-Leffler Institute (Royal Swedish Academy of Sciences), the Royal Institute of Technology (Sweden), Bar Ilan University and Technion (Israel) and nationally at the University of Michigan and Indiana University."

Dima Khavinson was born and raised in the former Soviet Union, and he taught high school in Moscow after earning his M.S. there. He then came to the United States and got his Ph.D. from Brown in 1983. Since then, he has held several faculty positions, most notably at the University of Arkansas (where he was a Distinguished Professor of Mathematics), and the University of South Florida. He has supervised five doctoral dissertations and two masters' theses, and served as Program Director for Analysis at the National Science Foundation. He has received 29 grants, including fourteen from the National Science Foundation. He has published and co-edited three books and 94 papers, and serves on the editorial boards of five journals.

Professor Khavinson started in complex approximation theory but subsequently expanded to other areas of analysis. "I get interested in problems," he says. "Mathematics is problems." The problem cited by the promotion announcement was one the cosmologists were interested in. "A number of reviewers remark on Dr. Khavinson's breakthrough result on the number of zeros [sic] of harmonic polynomials in the complex plane because the result settles a long standing question in astrophysics going back to Einstein, namely, how many images of a star one would observe due to gravitational lensing..."

The 2011 **Quaternion** (posted online) described the impact of Khavinson's work on gravitational lensing. We outline the problem and his solution here. Time to recall a little mathematics...

The *Fundamental Theorem of Algebra* states that any polynomial of one variable of degree n with coefficients from the complex numbers has at most n zeroes (in fact, precisely n zeroes if we count multiplicities). This is not true of polynomials of more than one variable: for example, the polynomial $f(x, y) = x^2 - y^2$ equals 0 for any x, y with $y = \pm x$.

The generalized problem for the Fundamental Theorem of Algebra is: given a polynomial of some number of variables, how many zeroes does it have? This is a sprawling and complex problem. Mathematicians typically approach such a problem by focusing on one jigsaw piece of the problem at a time, gradually assembling the entire puzzle as pieces come into hand. The strategy is to focus on a collection of especially tractable polynomials, deal with them, and then with the knowledge gained, moving on to more challenging polynomials.

One may start with the "harmonic" polynomials. A polynomial f of two real variables x and y is *harmonic* if it satisfies Laplace's equation:

$$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0.$$

For example, $f(x, y) = x^2 - y^2$ is harmonic while $g(x, y) = x^2 + y^2$ is not. The harmonic polynomials have one nice property: they can be represented in terms of two polynomials of a single shared variable. Admittedly, this single variable ranges over *complex numbers* (that is, over numbers of the form $x + iy$, where $i = \sqrt{-1}$), but using one variable makes the problem more tractable.

Terence Sheil-Small, one of the people who popularized focusing on harmonic polynomials for generalizing the Fundamental Theorem, conjectured that when this two-polynomial representation was of a particular form, then there was a nice (finite) upper bound on the number of zeroes of the original polynomial. Khavinson and Grzegorz Świątek started with the simplest of these two-polynomial forms, which looks like this:

$$f(x + iy) = p(x + iy) - (x - iy)$$

where p is a polynomial (with "complex coefficients") and $x + iy$ is the complex variable. Khavinson and Świątek proved that if n was the degree of p, and if $n > 1$, then f would have at most $3n - 2$ zeroes.

Proving this was not easy, and they wound up using a tool that one wouldn't guess would be helpful. There is a kind of *discrete dynamics* popularized by fractals and automata theory: one has a starting point a and an operator F and one repeatedly applies the operator to watch where the trajectory a, $F(a)$, $F(F(a))$, $F(F(F(a)))$, ... goes. For example, if $F(x) = 2x$, then $a < 0$ implies that the trajectory zooms off to $-\infty$, while $a > 0$ implies that the trajectory zooms off to $+\infty$. Khavinson and Świątek looked at starting points of trajectories to count zeroes.

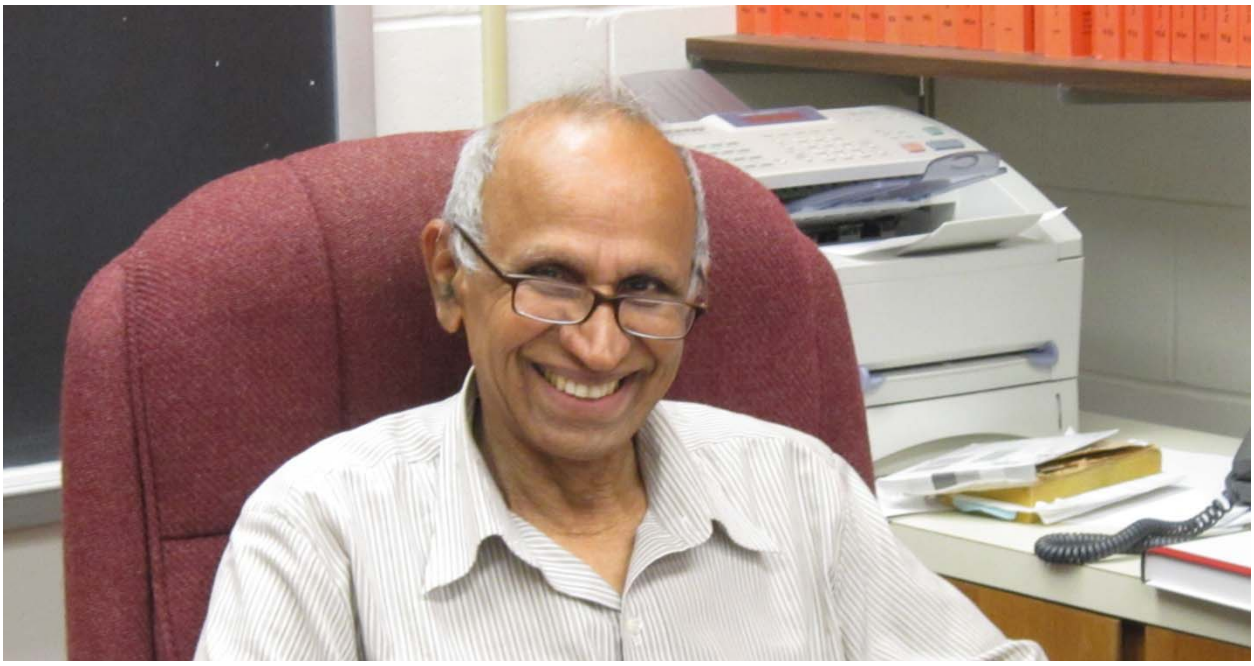
Sometimes, a solution to a problem suggests a solution to a related problem, and that's what happened here. Khavinson and Genevra Neumann used a similar technique on functions of the form $r(x + iy) - (x - iy)$, where r is a quotient of two complex polynomials, of maximal degree $n > 1$. They found that in this case, there were at most $5n - 5$ zeroes.

This was just what the astrophysicists needed. The late Sun Hong Rhie had conjectured that if $N > 1$, then a cluster of N point masses acting as gravitational lenses will produce up to $5N - 5$ images of any star behind it. (See the 2011 **Quaternion** for details.) Rhie had boiled the problem down to the number of zeroes of a function ... that was of the form Khavinson and Neumann had investigated. The result went mainstream: **New Scientist** reported that *Astronomy study proves mathematics theorem*, **Science News** reported that *Accidental astrophysicists ... started with algebra and ended up learning about gravitational lensing*, and Khavinson and Neumann described their results in the **Notices of the American Mathematical Society**.

This story is unusual only in its timing. Applications of a mathematical discovery are often quite different from their motivation, and the applications frequently appear much later. In this case, the application was indeed quite different from the motivation, but the application was already waiting when the discovery was made.

Khavinson's paper in the **Notices** was not unusual for him: he has published several articles in mathematical journals of broad interest, including two papers in the **American Mathematical Monthly**, two in the **Mathematical Intelligencer**, and two in the **Notices of the American Mathematical Society**. These papers were "fun to write," and were intended for journals that are "fun to read."

Professor Khavinson will receive his title at the Fall Faculty Honors & Awards Ceremony. He is the second professor in the Department to receive this honor: Chris Tsokos is also a Distinguished University Professor – and the late Al Goodman was a Distinguished Research Professor before the DUP title was created.



Overcoming the Odds
Gangaram "Gan" Ladde

Many of USF's students are FTIC - First Time In College - *students, which means that they are the first members of their families to go to college. One of our department's senior faculty was the first in his family to go to school and the first in his town to go to college. Here is his story.*

"No one could have predicted that I would be here today, but that is not a miracle. It is the result of a thirst for knowledge." Today, Professor Gangaram Ladde is a leader in his field of stochastic differential equations, as a journal founder and joint editor, co-author of five monographs and textbooks and nearly two hundred publications, and as a consistently well-funded researcher. His success belies his humble origins and the challenges he faced.

"Gan" Ladde's hometown was Jalkot, a town of several thousand in south central India, about 340 miles east of Mumbai. Jalkot was poorly connected: the nearest town was six miles away and the nearest bus station was sixteen miles from his home. Although technically under British rule, Jalkot was within the realm of the *Nizam-ul-Mulk* of Hyderabad (of the Asaf Jah Dynasty). Whatever the theory, in reality, Jalkot was the base of a local warlord, about whom there are many stories. If he saw a townsperson with new shoes, he would call the lucky owner over and ask for his cut of the money used to buy the shoes.

Gan was the youngest in a family of one brother and four sisters, and they subsisted on a small farm of about ten acres and depended upon the seasonal monsoon for

water. He was the first member of his family to receive a formal education despite being the youngest. In 1948, at age eight, after seeing children of the well-to-do walking to a private school, Gan announced that he wanted to go to school, too. His family could not afford the tuition, but India was changing. In 1947, India won its independence from Great Britain, and then in 1948, Hyderabad State was liberated from the *Nizam* during the political integration of the hundreds of princely states into a single nation. India gradually initiated a rudimentary system of public education - and put local warlords out of business.

Gan's father acquiesced to his aspiration for an education. "I had to walk two miles each way to attend school, but I was happy for the chance to learn." Gan completed elementary school in three years. Further education was out of reach, for the nearest public middle school was some ten miles away. Moreover, his father was content that Gan could now read and write and had always expected that Gan would return to work on the family farm.

While running an errand in town a few months later, he met Gangaram V. Kale, a local businessman (and uncle of his future wife) who knew of Gan's excellent performance in school. Kale was very committed to the development of the town. "He asked me why I wasn't in school. I told him that my family couldn't afford it. He asked to meet with my father." As a member of the board of a newly established private school, Kale arranged for reduced tuition and a scholarship. Gan's father accepted the assistance, but still required Gan to help on the family farm, saying, "You can do your homework under a mango tree and work when you finish." So Gan began middle school, albeit three months late.

Gan did very well in middle and high school. Gan's family could not afford the school uniform or shoes - Gan wore sandals and had to make do with one new shirt every one or two years - but the school was understanding. "One of my teachers was very supportive and pushed me very hard. He would call upon me to work out problems that he was teaching the higher grade students. Fortunately, I was able to do them." Throughout, everyone held high hopes for him. The teachers did their best with their limited training and a lack of textbooks.

After high school, Gan missed a first class rating in the college entrance exam by just a couple of points. Still committed to attending college, he chose to work and earn money first. His father and friends pushed him to marry and use the dowry to pay for school. He resisted, having vowed not to take a dowry after learning of its darker side. "In the end, all I could say is, 'whose marriage is this?'"

He worked for two years as a teacher at Added middle school in Palsa, located sixty miles from Jalkot. On holidays, he returned home to help dig a well so that the family could have a more reliable source of water than the monsoon. "After two years, we had dug fifty feet. I had to say we failed." But his teaching was well-regarded. Although the principal wanted him to stay, Gan decided to undertake the task of his higher educational goal. Gan then contacted his high school teacher and one of the founders of his school, and he gladly offered to help Gan to get into the *Chatra Nivas*, a non-profit student housing at the college town Nanded. Taking his advice, he first applied to Chatra Nivas and then to People's College Nanded, an affiliate of Marathwada

University. After his admission to Chatra Nivas, he received a tuition-free education.

Never had Gan been so uncertain about continuing his education. "The admissions panel of Chatra Nivas grilled me for hours. Being a teacher was considered a strike against me." Some teachers abused their position of authority and spent their salary on vices. Gan answered their questions honestly: he smoked about once a month, he had been to a few movies, but he did not run around with girls. Finally, he said, "I am here for a chance. If I break any rule, kick me out and I won't say a word." This honesty and earnestness left a strong impression with a businessman on the panel, who pushed through his acceptance despite a two to three vote against admission.

The Chatra Nivas encouraged all admitted students to raise funds and/or goods for the organization. Gan volunteered, so one of the panel members went to Palsa with Gan. The School Board Chairman told everyone in the village that they should show their support. Within two hours, a truck full of donations were collected. Impressed by this show of support, the panel member told Gan that accepting him was the right decision.

College was a new experience in some ways. He had to buy his first pair of shoes, as sandals provided insufficient protection in the chemistry lab. By graduation, Gan and three other students accepted under similar circumstances sat at the top of their class. Gan earned his Bachelors of Science in Chemistry, Physics, and Mathematics in 1963.

Gan was accepted into the Master's program at Marathwada University, based in Aurangabad - population 95,000 in 1960 and 1.2 million now. In an unfamiliar city, with no income or place to stay, he initially planned to find a job, perhaps in a lab. However, Dr. A. A. Kayande, In-Charge of the Department of Mathematics, told Gan that he was their top rated applicant and that he would surely be awarded a scholarship; in the meantime, Dr. Kayande lent Gan money for a library card. This access to books solved one of Gan's problems. His housing concerns were resolved later that day. By coincidence, the supervisor of his Chatra Nivas boarding house in Nanded had also just moved to Aurangabad and opened a new boarding house. They ran into each other on the street, and he offered Gan a room.

After earning his Master's degree, Gan was invited to remain as a research scholar. He explained that he was to be married, and was told to get married, and he would have a scholarship when he returned. Two years later, in 1967, his department chair moved to North America and asked Gan to join him. "When I came to the US, I used four types of transportation: camel, bus, train, and airplane."

He earned his Ph.D. from the University of Rhode Island in 1972 and went into stochastic differential equations, a field dominated by engineers and having no journals. He was one of the first mathematicians to introduce mathematical rigor into the field, and launched one of the first journals, *Stochastic Analysis and Applications*, where he is the Editor-In-Chief. He worked at the State University of New York - Potsdam from 1973 to 1980, the period described in John Poland's American Mathematical Monthly article *A Modern Fairy Tale?* Gan then moved to the University of Texas at Arlington. He joined USF as a full professor in 2007, and is a living example of what is possible.

Nagle Lecturer Casts a Ray of Light on a Sea of Dark (Matter)

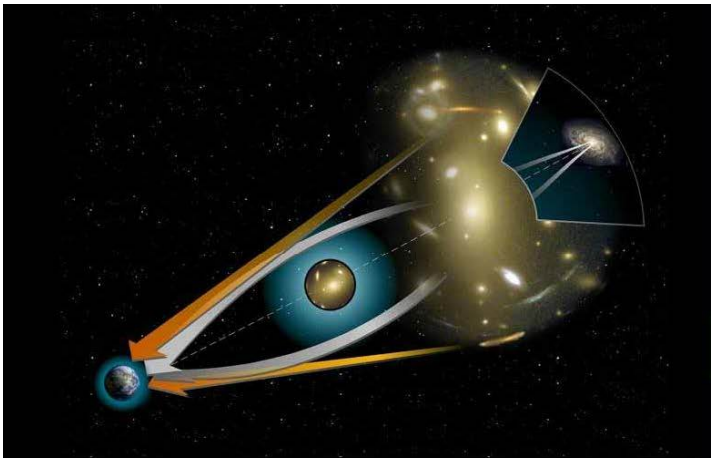
Only 5 % of the substance of the universe consists of "ordinary matter", Rutgers Professor Charles "Chuck" Keeton told a standing-room-only audience at the University of South Florida. The rest consists of an exotic "dark matter" and an even more exotic "dark energy." While we cannot see dark matter, we can observe its effects on ordinary matter and on light.

At his April 3 lecture, which was free and open to the public, Professor Keeton said that 27 % of the substance of the universe was a dark, electronically neutral, abundant, pervasive but clustered material that moves much slower than the speed of light and doesn't interact much with ordinary matter. But even if we can't see it and we can't collide with it, we can tell that it exists from the effects of its gravity.

Professor Keeton described two effects of dark matter's gravity.

Four decades ago, astronomers started measuring the velocities of stars in other galaxies. If most matter consisted of stars and dust clouds, then the gravitational force of the galaxy's mass should decline dramatically as the distance to the galactic center increased. As a result, stars far from the galactic center should be orbiting much more slowly than stars near the core. But astronomers found that stars far from the core still orbited so rapidly that the galaxies would fly apart unless something else held them together.

Meanwhile, an old phenomenon had a new application. *Gravitational lensing* occurs when a massive object, like a star or a galaxy, bends light from a source behind it so that an observer in front of it sees displaced, multiple or even smeared images of the light source around the massive object.



Light from a distant galaxy (upper right) cannot reach the Earth (lower left) because its direct line of sight is blocked by a massive object.

But that same object will bend light around it, so that light from the galaxy reaches the Earth from multiple paths.

An observer on Earth sees multiple images of the galaxy – all of them displaced, and some distorted.

Einstein's General Theory of Relativity gave a numerical prediction of gravitational lensing by the Sun. In 1919, Sir Arthur Eddington observed the star field behind and adjacent to the Sun during a solar eclipse, and confirmed that the images of stars were displaced by the amount that Einstein predicted. Eddington's observations helped convince the world of the validity of General Relativity.

In 1936, Einstein returned to gravitational lensing and predicted that images of stars behind a massive object could be distorted as well as displaced. And during the last few decades, astronomers have seen images of distant galaxies and quasars distorted, smeared, or multiplied by gravitational fields of dark objects in between the distant light sources and the Earth. Gravitational lensing became a tool for detecting dark matter, for while we cannot observe dark matter directly, we can observe it indirectly.

For a more detailed description, see the 2011 **Quaternion** article on **Gravitational Lensing and the Fundamental Theorem of Algebra**. Professor Keeton has also written a book on **A Ray of Light in a Sea of Dark Matter**.

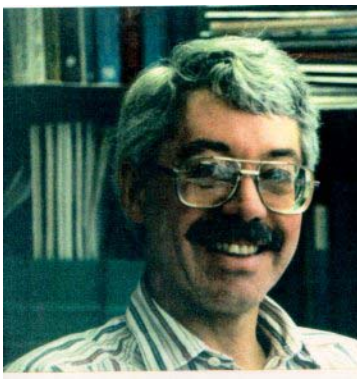
From observation and computer simulations, dark matter appears to cluster around galaxies in large haloes, and form immense strands through space. There is a theory that dark matter consists of "Weakly Interacting Massive Particles" (WIMPs). No one has observed WIMPs, so there are efforts to try to directly detect these particles. Since particles are detected by their interactions with normal matter, WIMPs are probably difficult to detect.

Dark matter is not all that we do not see: 68 % of the stuff of the observable universe seems to consist of an even more mysterious "dark energy". And we seem to live in a dark energy era. Keeton observed that the universe is about 13.77 billion years old, and that from age two billion to age ten billion, the universe was dominated by dark matter, which tended to pull the universe together. Since then, dark energy has come to dominate, and the universe's expansion is accelerating.

Asked about what kind of mathematics aspiring cosmologists should learn, Keeton said that the mathematics used are predominantly vector calculus, linear algebra, complex numbers, and potential theory. Relativity requires differential geometry and the study of manifolds.

The Voyager and Space Shuttle programs inspired Chuck Keeton to go into astronomy. After a B.A. from Cornell and a

Ph.D. from Harvard, he was a Bart J. Bok Fellow at the University of Arizona and later a NASA Hubble Fellow at the University of Chicago before settling down in the Rutgers University Department of Physics and Astronomy. In 2009, he won the Presidential Early Career Award for Scientists and Engineers.



The Nagle Lecture Series was established in honor of the late R. Kent Nagle, a mathematician deeply interested in mathematics in itself, in education and in society. In this spirit, the NLS invites world renowned scholars to speak on such matters in lectures designed for the general public.

Faculty News

We are happy to welcome a new professor, two new permanent instructors, and a new staff member to the Department.

Dan Shen comes to us from the University of North Carolina - Chapel Hill, where he was a postdoctoral fellow after receiving his doctorate in statistics from UNC in 2012 for his work on *Sparse PCA asymptotics and analysis of tree data*. His research interests are in neuroimaging data analysis, high-dimensional inference, statistical analysis of tree-structured data objects, and sample paths of stable processes. He came to UNC from the Chinese Academy of Sciences in Beijing, where he received his Masters' of Science in probability and statistics; he had previously received a Bachelors' of Science in mathematics education from Soochow University in Jiangsu, on China's eastern coast. He will be an assistant professor.

Amber Bieske was a visiting instructional specialist at USF; she was also an adjunct for Hillsborough Community College, the University of Tampa, and USF. She received her Master's degree from USF in 2010. She will be an instructor.

Ivan Rothstein comes to us from Florida Memorial University, where he was an assistant professor and coordinator of mathematics; he had previously been employed by the University of Puerto Rico and Science Applications International Corporation in Virginia. He received his doctorate in 2004 from Virginia Tech. He will be an instructor.

Flora Luna is a USF alumna (Class of 2004) who worked at Medicare Advantage Plans before coming to the Department last March. She is our new Fiscal and Business Assistant, replacing **Beverly Devine-Hoffmeyer**, who retired this January after nearly fourteen years in the Department.

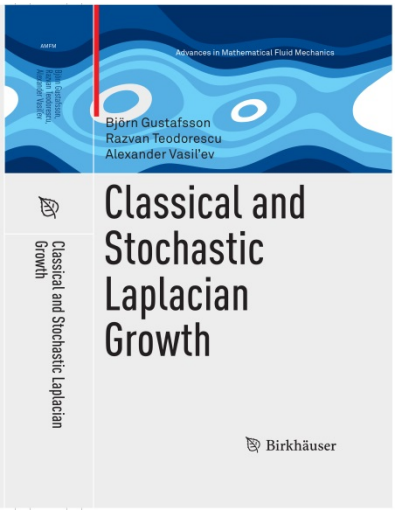
In other news...

Nataša Jonoska received a $ 399,999 as part of her $ 1.7 million grant from the National Institutes of Health for her proposal *RNA-guided Rearrangements: Experiments Coupled with Discrete Models*.

Nataša Jonoska, **Mile Krajcevski** and **Gregory McColm** were awarded the Best Paper Score Award at the Unconventional Computation & Natural Computation 2014 meeting for *Languages Associated with Crystallographic Symmetry*.

Wen-Xiu Ma was appointed Distinguished Overseas Professor for Exceptional Communication and Cooperation by the Shanghai University of Electrical Power.

Sueng-Yeop Lee and **Dmytro Savchuk** each were awarded Collaboration Grants for Mathematicians. Lee's grant was for work on *Two-Dimensional Coulomb Gas and Random Matrices*, while Savchuk's grant was for work on *Algorithmic Questions of Self-Similar and L-presented group*. Each professor will receive a five-year $ 35,000 grant from the Simons Foundation, a private foundation whose mission is to "... advance the frontiers of research in mathematics and the basic sciences."



Razvan Teodorescu and Bjorn Gustafssohn of KTH-Stockholm and Alexander Vasil'ev of the University of Bergen have a book coming out from Birkhauser next April, on *Classical and Stochastic Laplacian Growth*. From the back cover (already posted on Amazon): "This text covers a multitude of concepts, results, and research topics originating from a classical moving-boundary problem in two dimensions (idealized Hele-Shaw flows, or classical Laplacian growth), which has deep connections to many exciting modern

developments in mathematics and theoretical physics. ... The book aims to be self-contained through a systematic and consistent notation and background results. It is accessible to a wide readership, from beginner graduate students to researchers from a variety of domains in natural sciences and mathematics."

Chris Tsokos delivered a public address at the University of Tampa on *Mathematical Sciences and Global Warming: Myth and Reality*. Subtitled "Let the real data do the talking," Tsokos described work identifying major sources of CO_2 in the atmosphere.

STEM Education Center

Summer Activities

The Stem Education Center (SEC) conducted the 37th summer program for gifted high school students this year. The four-week Summer 2014 *STEM For Scholars* program started on July 7 and had its graduation Ceremonies on August 1, 2014. Forty students were selected and divided into two groups. Level I was for students entering grades 9 and 10, while Level II was for students entering grades 11 and 12. This year, in addition to Florida students, participants came from the U.K., Canada, Bolivia, California and New York.

The courses offered included:

Mathematics: In fully interactive mode, the topics covered included discrete mathematics, graph theory, basic braid operations, and knot theory. Research and discovery was the norm.
Computer Science: This was a project-based course with applications in bioinformatics, programming, cryptography, probability and genetics.
3D Visualization: The course focused on visually representing data and scientific concepts. Students explored applications related to STEM fields in various context, including digital imaging, 3D animation, game development, and 3D printing.
Interdisciplinary Research: Students received instruction in research methodology, including vetted resources, intellectual honesty and writing.

In addition to group research projects, individual research projects funded by the Academy of Applied Science/ Army Research Office, and mentored by the faculty, were conducted. Twelve students participated. A sample of research topics include:

1. Topological Properties of Large Erdös-Rényi Graphs and their Application
2. Optimal Approximations for Efficient Flight Predictions
3. Minimizing Loss of Momentum During the Separation of Multi-stage Rockets
4. Nano-probe Technology for Medical Imaging and the Development of Viable Design
5. Surface Generation Using Computational Modeling Procedure for 3D Printing Tissue Design

The staff of the program included: Dr. Manoug Manougian (Director), Dr. Razvan Teodorescu (Mathematics), Dr. Jing Wang (Computer Science/Engineering), Howard Kaplan (Director, AVC), Matthew Chrzanowski (Chemistry), and Richard Warner (Mathematics).

Grants and donations totaling $26,300 were received from such sources as the Academy of Applied Science/ Army Research Office, the Jacarlene Foundation, The Jagged Peak, and former students.

Student News

We were proud during commencements August, 2013, December 2013, and May 2014 to send 82 students on their way.

62 students received Bachelor of Arts degrees: Diana Abdikasheva; Angela Agostinone, *magna cum laude*; Sherae Ashwood; Steven Barta; Andrew Bassila, *cum laude*; Omar Brown; Enkai Cao; Jamie Carfagno; Yanella Carrion; Catlin Cartmell; Thomas Coleman; Robert Connelly, *cum laude*; Kamill Correa Santi; Brandon Dalrymple; Caitlin Darwin, *magna cum laude*; Ryan Dubas; Michael Francis; Daniel Friedrich; Clifton Garrison, *math honors*; Pamela Goly; Rakshit Gone; Karen Grant, *magna cum laude*, *with honors*; Ryan Grotheer; Raul Gutierrez; Courtney Halpin, *magna cum laude*; Cory Hartman, *magna cum laude*; Jacob Herrick; Corbin Hill; Hunter Hill; Toni Jung; Devin Karp; Kristopher Kindle; Carlos Kinsman; David Kotschessa A; Matthew Kubal; Daniel Levin; Shanna Lindemeyer, *summa cum laude*; Sterling Little; Wyatt Metzger; Amber Michelli; Maja Milosevic, *with honors*; Ekaterina Morozova; Joel Negron, *summa cum laude*; Keith Nieves; Michael O'Connell; Josiah Park, *magna cum laude*; Gabriella Pasquier; Madison Patten; Benjamin Perkins; Monica Pham; Sheeza Rashid; Jaryd Rosenfeld; Ronald Shamblen; Tracy Stefanovic, *summa cum laude*, *with honors* & *math honors*; Brandon Sweeting, *summa cum laude*; Ashley Thomas; Dereka Thompson; Emilia Turner; Michael Uanino; Xaxira Velasco; Tyler Withstandley; Balazs Zavaczki.

Fifteen students received Master of Arts degrees: Oliver Alber; Ryan Arredondo, *Properties of Graphs Used to Model DNA Recombination* under Nataša Jonoska; Louis Caponi, *On the Classification of Groups Generated by Automata with 4 States over a 2-Letter Alphabet* under Dmytro Savchuk; Grant Conine, *Topological Data Analysis of Properties of Four-Regular Rigid Vertex Graphs* under Nataša Jonoska; Mark Diba; Indu Rasika Hamudra; Brittany Hurst; James Klinedinst, *A Maximum Principle in the Engel Group* under Tom Bieske; Xin Luo; Suzana Milea; Maja Milosevic; Rafael Monteavaro; Savitha Namelikonda; Erika Oshiro; Cody Tessler.

Seven students received Doctor of Philosophy degrees: Nana Osei Bonsu, *Age Dependent Analysis and Modeling of Prostate Cancer Data* under Chris P. Tsokos; Jonathan Burns, *Recursive Methods in Number Theory, Combinatorial Graph Theory, and Probability* under Nataša Jonoska; Yiu Ming Chan, *Statistical Analysis and Modeling of Prostate Cancer* under Chris P. Tsokos; Bong Jin Choi, *Statistical Analysis, Modeling, and Algorithms for Pharmaceutical and Cancer System* under Chris P. Tsokos; Ram Kafle, *Trend Analysis and Modeling of Health and Environmental Data* under Chris P. Tsokos; Olusegun Otunuga, *Stochastic Modeling and Analysis of Energy Commodity Spot Price Processes* under Gangaram Ladde; Tadesse Zerihun, *Nonlinear Techniques for Stochastic Systems of Differential Equations* under Gangaram Ladde.

Twelve of the fourteen USF inductees into the Pi Mu Epsilon honors society.

Math Clubs

Pi Mu Epsilon

Pi Mu Epsilon is the national honor society for mathematics, and USF is the home of the Florida Epsilon Chapter of Pi Mu Epsilon.

The Pi Mu Epsilon Induction Banquet.

The Florida Epsilon Chapter held its annual Induction Banquet on April 25, 2014, at the Top of The Palms Restaurant in the USF Marshall Student Center. Fourteen USF students satisfied the stringent academic requirements for invitation to membership in the Society. They were *Andrew Bassila*, *Suzzanne Harmon*, *Donald Hood*, *Tyler Iorizzo*, *Corisa Kons*, *Melissa Kurtz*, *Jessica Leon*, *Alfredo Peguero-Tejada*, *Jessica Pickett*, *Andres Saez*, *Kierstin Simmons*, *Cheryl McCane*, *Stephanie Sanchez*, and *Micah Wine.*

USF Professor **Xiang-dong Hou** was the keynote speaker at the banquet with the presentation *Primes*, an overview of old and new exciting prime numbers results.

The Induction Banquet ended, as is

customary, with the presentation of the winner of the Pi Mu Epsilon Outstanding Scholar Award. This year, the prize went to graduating math major *Chi Phan*. She received a commemorative plaque and scholarship money, as well as congratulations from friends and professors for winning this annual award to the graduating student that best exemplifies scholarship and dedication to mathematics.

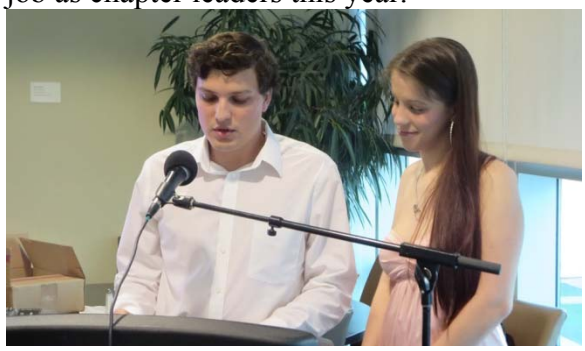
Hillsborough County Math Bowls.

The USF Department of Mathematics and Statistics and Pi Mu Epsilon hosted two Hillsborough County Math Bowls this year.

More that 400 of the best local high school math students participated in individual and team competitions in Algebra, Geometry, Pre-calculus, and Calculus. King High School was declared the sweepstakes (overall) winner in both competitions, based on the results obtained by its students.

Pi Mu Epsilon Leadership.

Maja Milosevic (President) and *Denys Kukushkin* (Vice-President) did an excellent job as chapter leaders this year.



Denys is the incoming chapter president for this academic year. The chapter's Faculty Advisor is Dr. **Fernando Burgos**, and Dr. **Mile Krajcevski** is the Permanent Correspondent.

Math Club

Math Club Meetings.

The USF Student Chapter of the Mathematical Association of America (MAA) is better known as the USF Math Club. It traditionally meets every other Friday of the academic year, and at each meeting there is free pizza, refreshments, and a featured student or faculty math presentation, or some fun math activity.

This year's presentations included "Quantum Computing" by USF Computer Science graduate student Matthew Morrison, "What is Game Theory" by USF Economics

Professor Dr. Andrei Barbosa, "Fun with Sign" by Polk State College Professor Li Zhou, "Logic for Mathematicians: The Basics" by USF Philosophy Professor Doug Jesseph, "Mathematicians, Mystics, Miracles" by Dr. Sasho Kalajdzievski from the University of Manitoba, and "Random Matrix Theory" by USF Mathematics Professor **Seung-Yeop Lee**.

Student Trips.

On December 6, eight math club members attended the 2013 MAA Suncoast Regional Conference at Hillsborough Community College SouthShore Campus in Ruskin, Florida. Five math club members traveled to Edison State College in Fort Myers to attend the 2014 MAA Florida Section meeting on February 21/22. Math Club members Jing Lin and David Kotschessa delivered the presentation *Isometry Group in the Maximum Metric*. Drs. Fernando Burgos and Fred Zerla accompanied the students on these trips.

Math Club Student Leadership.

David Kotschessa did an excellent job as the 2013-2014 Math Club President, while Brandon Sweeting served as the Vice-President. Andres Botello was the Treasurer in the fall semester of 2013, and Andres Saez did the job in the spring of 2014. The club website (http://mathclub.blog.usf.edu/) was efficiently maintained by Ayrton White.

Statistics Club

We have a Statistics Club at USF. The purpose of the Statistics Club at USF is to promote learning and career opportunities for students interested in the field of statistics and related areas. Specifically, the organization attempts to provide students with a forum to present and discuss related topics, to educate students of the requirements for professional designations in related areas, and to improve communication between the student body and the surrounding Tampa Bay area business and scientific communities.

Society of Aeronautics and Rocketry (S.O.A.R.)

S.O.A.R. is a USF student science club whose mission is to study space exploration. About twenty USF students are members of the club, with *Matthew Chrzanowski* as its President and Professor **Manoug Manougian** as its faculty advisor. It has successfully launched two rockets measuring 12 ft. and weighing 40 lbs. with a range of 8,000 feet. The feat was reported in The Tampa Bay Times, The Tampa Tribune, and the USF Oracle.