RECKONINGS SUMMER 2013

NEWSLETTER OF THE DEPARTMENT OF MATHEMATICAL SCIENCES AT THE UNIVERSITY OF DELAWARE

Chair's Message

John A. Pelesko

Dear Students, Alumni, Colleagues, and Friends,

This past year has been both an exciting year and a sad year for the Department of Mathematical Sciences. In January, we very unexpectedly lost Professor Wenbo V. Li to a heart attack. Professor Li was an integral part of our department, a tremendous friend and mentor to our students, and a world-renowned researcher in probability. His passing leaves a void in our department that will not soon be filled. In the article in memoriam of Professor Li you will find more information about his career as well as place to share remembrances and condolences. I urge all of you who knew Professor Li to visit this

Inside *Reckonings*

In Memoriam

Professor Wenbo V. Li, of the Department of Mathematical Sciences, died of a heart attack on Saturday, January 26, near his home in Newark, Delaware, at the age of 49. Professor Li joined the University of Delaware directly upon completing his Ph.D. at the University of Wisconsin-Madison in 1992. He was promoted to Associate Professor in 1996 and the rank of Professor in 2002. He held an adjunct position with the Department of Electrical and Computer Engineering at UD, an adjunct position with the Department of Applied Mathematics and Theoretical Physics at Delaware State University, and an adjunct position in the Department of Mathematics at the Harbin Institute of Technology in Harbin, China.

During his distinguished career, Professor Li also held visiting positions at the University of Pennsylvania, Peking University, the Hong Kong University of Science and Technology, and was a Distinguished Visiting Professor at the Institute of Applied Mathematics of the Chinese Academy of Sciences. In 2006, his numerous and deep contributions to the fields of probability and statistics were recognized with his election as a fellow of Insti-

tute of Mathematical Statistics. The citation stated he was honored "for his distinguished research in the theory of Gaussian processes and in using this theory to solve many important problems in diverse areas of probability."

Professor Li advised numerous graduate students during his career and was an active mentor for many undergraduate research students. Since joining the university, Professor Li spearheaded the development of probability as a research focus of the Department of Mathematical Sciences and was a central figure in the growing research prominence of the department. He was very active in organizing conferences both in the United States and China; he supervised graduate students in both countries as well. The Proceedings of High Dimensional Probability VI, Banff, 2011, will

Students Earn Awards
in 2012–13

Louis F. Rossi, Director of Undergraduate Studies

The Department of Mathematical Sciences is pleased to announce the winners of its undergraduate and graduate student awards for the 2012–2013 year. Awardees are nominated by their peers and faculty, and final decisions are made by faculty committees based on student achievement.

The recipient of the 2013 S J Wolfe Scholarship this year is Michelle Markiewietz (right, with Undergraduate Director Rossi and Department Chair Pelesko). The

online guest book and share your memories.

Last year at this time, we were planning for a re-imagining of one of the department's three computer classrooms. I'm happy to report that renovations of Ewing 205 were completed last summer and our new active learning classroom was brought online for the fall semester. I want to thank our alumni and the College of Arts and Sciences for their support of this redesign. The new room contains interactive work stations designed to facilitate teamwork, smart board technology, and plenty of whiteboard space for sharing mathematics. In the fall, we used this room for courses for our mathematics education majors, our mathematics majors, and even our graduate students. This spring, two of our faculty, Ms. Patty Schwarzkopf and Ms. Tammy Rossi, have been piloting an innovative "flipped classroom" approach to our introductory mathematics courses in this space. In the coming year, we'll be working to redesign our other two computer classrooms, our approach to teaching many of our introductory courses and we will be bringing online our new degree program in Actuarial Sciences. The article by Professor Lou Rossi gives more detail on this exciting new major. I want to thank all of our generous donors who help support activities such as these and I hope that many of you will continue to do so in the future.

Our graduate program continues to be a hotbed of activity and a source of great pride for the department. This year, thanks to the leadership of our Director of Graduate Studies, Professor Tobin A. Driscoll, we received a grant from the U.S. Department of Education as part of the Graduate Assistance in Areas of National Need (GAANN) program. This award will allow us to extend additional fel-lowship support to students seeking graduate study in mathematics. We look forward to these new students joining our program and participating in the many targeted graduate activities that take place each year. I would also like to congratulate all of our students who have completed their Ph.D. degree this year. This is a tremendous accomplishment and you'll get to meet several of these students in the pages that follow.

This year, the department will be hosting three conferences. In May, we'll host the second annual "DelMar Day" workshop on computational mathematics. This joint effort with the University of Maryland launched last year and has already grown into an exciting event. In July, the department will host an international conference on "Novel Directions in Inverse Scattering." This meeting, co-organized by Professor Fiora Cakoni, Professor Peter Monk, and collaborators from Rice University and the Ecole Polytechnique, has the dual purpose of providing a forum for mathematicians around the world to present their latest results in this important area and of celebrating the long history of accomplishments in this area by Unidel Professor of Mathematics, Professor David Colton. Professor Colton's impact on this important field cannot be overstated, with his work having become the underpinnings of research in medical imaging, oil exploration, and cloaking technology. I'd like to extend a personal congratulations to Professor Colton and a thank you on behalf of the University of Delaware and the department for letting us share in his amazing career. Finally, in fall of 2013, the Finite Element Circus will return to the University of Delaware for the fifth time. This "traveling circus" of mathematicians working on finite element theory has been on the road since 1970 and we're looking forward to its next stop at UD.

Activities such as these and the many others you'll read about in this newsletter, along with our faculty's deep commitment to mathematical research and education is what leads to our continued high ranking among mathematics departments, year after year. For the third straight year, the Department of Mathematical Sciences was ranked in the top 100 mathematics departments worldwide by the Academic Ranking of World Universities. Of course, this high ranking is largely due to the faculty who have been among us the longest. This year, sadly, we'll see two of these long-time faculty members retire. I would like to personally congratulate Professor David Olagunju and Geraldine Prange on their outstanding careers. You will be missed but we look forward to seeing you on campus and at future department events. At the same time, I wish to extend a warm welcome to three new faculty members, Professor Nayantara Bhatnagar, Professor Jungeun Park, and Professor Christopher Raymond. In this newsletter you'll get to meet each of these outstanding additions to our faculty. I also wish to extend a warm welcome to the newest addition of our staff, Mr. David Caldwell, who joins us as our new computer support specialist.

I hope you will all take the time to enjoy this newsletter and read more about the many achievements of our students, alumni, and faculty. I highly recommend the article by Professor Pak-Wing Fok on the mathematics of vulnerable plaques and hope you'll find that article and all the others as enjoyable as I did. Please see the article about our students' impressive accomplishments as well. Thanks once again to all of our generous donors. If you are interested in supporting activities in the department, please see the last page of the newsletter, or feel free to call me at (302) 831-7180. I look forward to talking with many more of you in the future.

A **Mathematical Perspective** on Vulnerable **Plaques**

Pak-Wing Fok

One of the most challenging things about working in the life sciences as a Mathematician is that the systems of interest are seldom simple to describe. As Applied Mathematicians, we are trained to simplify, simplify, simply. We must neglect unimportant physical effects by non-dimensionalizing before solving anything. We are scolded by our grad school Professors for thinking about inertial effects when the Reynolds number is small. But it seems that in many biological systems, everything is important and whether we can neglect 90% of the effects and strip the problem down to a few nice equations is more questionable.

One thing that distinguishes us as Mathematicians is that we strive to work on beautiful problems. We are both artists AND scientists! Not only should the equations be applicable to real situations, but the problem should also be "cute" and contain some innovative mathematics. Finding problems that (i) engage biologists and (ii) satisfy the aesthetic constraint is hard. I would say that many people are content to do one of these, but the rewards are tremendous for someone who can achieve both.

My mathematical background is typical for someone who was initially interested in classical applied mathematics and PDEs. I took a lot of courses in fluids and waves. Most of the examples that were presented to illustrate PDEs came from thermal conduction and solid mechanics. However I think one has to work pretty hard to find contemporary biological problems where the physical variables can be reasonably described by smooth vector fields. Many biologists think in terms of the genome. It is ingrained in their DNA (pun

intended!). They ask themselves "what will happen to this pathway if I knock out that gene"? "How does this gene sequence affect the transcription of that protein"? The code on DNA is represented by four base pairs. This endless string of As, Cs, Gs and Ts is intrinsically discrete and it is not surprising that Bioinformatics is flourishing at the moment. Also, data from experiments is always noisy. Nowadays, I find myself turning to more statistical and/or probabilistic approaches to try to more easily connect with experimentalists.

My interest in "vulnerable plaque" (VP) was stimulated by one of the sessions at the Delaware 2009 MPI. Plaque is a build-up of fatty deposits within the walls of your blood vessel, but not all of it is harmful. In fact, we almost all certainly have some benign plaque somewhere in our bodies. However, some of these plaques can transition into unstable or "vulnerable" plaques (medically termed Thin-Cap Fibroatheromas). Such plaques typically have a necrotic core, few smooth muscle cells and are highly inflamed. Most strikingly, the cores are separated from the lumen (blood flow inside the vessel) by a "thin" cap (typi-

cally < 65 um) that can easily rupture due to stresses from the flowing blood or internal stresses in the plaque itself. To predict the vulnerability of plaque from the various imaging methods used by doctors is a very important problem in contemporary medicine.

The development of VP is extremely complicated and, naturally, as a well-brought up applied mathematician, I find the simplest model that can describe some of its characteristics. For example, one can describe the build-up of the necrotic cores in VP by reaction-diffusion (partial differential) equations. The sequence of events leading to necrosis is something like this: (i) Macrophages attach to the endothelium (ii) Macrophages enter the plaque because of the presence of chemoattractants (iii) Macrophages inside the plaque are deprived of oxygen and die. While relatively simple, these types of models are valuable because today's "enhanced" ultrasound imaging enables doctors to see necrotic/non-necrotic regions of the plaque and therefore make a diagnosis on vulnerability. They are the first of many steps in the path to connecting with imaging specialists and clinicians. Like many mathematical problems in medicine, progress on treatment will inevitably come from a union between theorists and practitioners.

From the **Editor**

Dear Department Alumni, Students, Colleagues and Friends,

I hope you enjoy seeing the fruits of the effort of our students, faculty and staff. We hope to add the accomplishments of alumni in future editions. Please keep us posted!

Richard Braun,
Development Committee Chair

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be dedicated to Professor Li's memory. His passing leaves a huge void in the mathematical community, in the life of the department, and in the lives of his students, friends, and family.

The Department of Mathematical Sciences held a "A Celebration of Life" to honor Professor Li on February 5th, 2013. Department Chair John Pelesko presided, and Associate Dean Doug Doren spoke to a sizable group in attendance which included former UD President David Roselle and current Dean George Watson. James Li gave a moving speech about his father's life and influence. Several of Professor Li's colleagues spoke as well: Professors Qing Xiang, YJ Leung, Felix Lazebnik, Rakesh and David Edwards from Mathematical Sciences spoke, as did Professor Lian-Ping Wang of Mechanical Engineering and Professor Cheng-Shun (Richard) Fang of Behavior Health and Nutrition, both of UD, and Professor Fengshan Liu of Delaware State University. The reminiscences ranged from the very personal to the strictly professional. Beyond mathematics, Professor Li's love of the outdoors and for travel was fondly remembered. At several times, a favorite saying was recalled: "Do it Once."

Professor Li is survived by his wife, Sunny Xiang, and his son, James. Any of Professor Li's many international friends and colleagues who wish to share remembrances or condolences can visit this link: http://www.math. udel.edu/php/deptapps/guestbook/index. php or http://wenbo.li.muchloved.com/

Contributions to UD in Professor Li's memory may be made by following instructions at the end of this newsletter.

(Profs YJ Leung, Q Xiang, F Lazebnik, J Pelesko and RJ Braun contributed to this article.)

New **Teaching** Seminar

Bryan Crissinger and Georgia Pyrros

In the spring of 2012, the Department of Mathematical Sciences added a new seminar series, the Teaching Seminar. The seminar is held once a month and is designed to be a forum for the exchange of a wide variety of issues relevant to teaching mathematics, pedagogical and otherwise. The seminar is open to anyone interested in these issues, from tenured faculty to graduate students.

Seminar topics have included moderated discussions on large class size and course coordination issues, the Socratic Method, using technology in the classroom, learning styles, academic honesty, mathematics discourse, and an introduction to Canvas by Mathieu Plourde from Academic Technology Services. Canvas is an open-source, online course management system being piloted by UD. Our first guest speaker from outside the university was Jennifer Whitfield, senior lecturer at Texas A&M, who spoke about using the WebAssign online homework system in their efforts to coordinate large sections of calculus.

As of this writing, our remaining speakers for the spring semester 2013 are Jinfa Cai (What does it mean to develop students' deep and rich understanding in Mathematics Classroom?), John Jungck (mathematical manipulatives and kinesthetic learning in mathematics), and Georgia Pyrros (reporting on the effectiveness of using WebAssign in MATH241 here at UD). Tentative plans for Fall 2013 seminars include reports from faculty who are currently piloting innovative teaching techniques such as the "flipped classroom."

Wolfe Scholarship recognizes a junior mathematics major with extraordinary ability. Several faculty recognize her outstanding performance in a number of advanced courses. The selection committee cited her work over the summer of 2012 and last winter with Prof. Cioabă on a problem originally posed by Graham and Pollak of finding the binary addresses of nodes in a graph such that the distance between nodes in a graph is equal to the number of different entries in their addresses. She will continue this project as a Summer Scholar this year.

The recipient of the 2013 Undergraduate Research Award goes to Jen Bruhns, research advisor for Prof. Braun (below, with Prof. Rossi and Prof. Pelesko), for her outstanding

work on tear film modeling over the last two summers as a Summer scholar. The Mathematical Sciences Undergraduate Research Award is given to a mathematics major who completes an outstanding original work of research during the 'research season' covering spring, summer and fall of the previous year. Jen will begin pursuing her Doctor of Optometry next year at New England College of Optometry, one of the top optometry schools in the country.

The recipient of the 2013 William Clark Award is Elizabeth Cangialosi (above, with
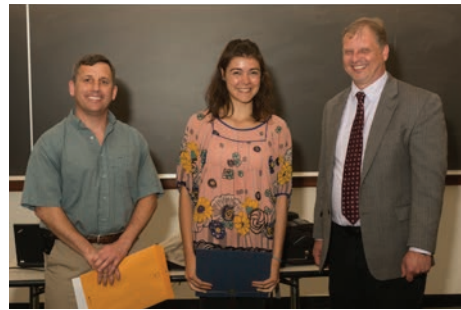
Prof. Rossi and Prof. Pelesko) which goes to a graduating senior with unusual abililty. During her time as an undergradaute, Liz has engaged in a number selective summer programs including an NSF REU. Liz is well known to her peers as Vice President of the Math Club and to faculty a top-notch student. In the summer of 2011, Liz was selected into the NSF sponsored Summer Mathematics Program for Undergraduate Women (SMP). In 2012, Liz was a part of our Mathematical Contest in Modeling team. Last summer, Liz was accepted into Research in Industrial Projects for Students in Hong Kong, and spent 8 weeks working with an international team working on problem in genomics. This
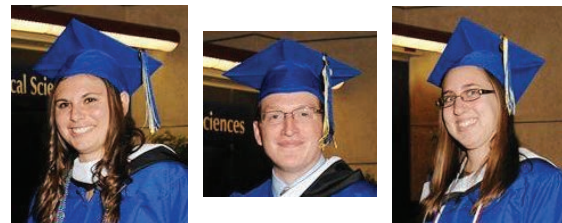
Outstanding Student Teacher award winners Jenna Enos, Karl Shively and Carly Toth

In addition to individual awards and prizes, the Department of Mathematical Sciences confers a number of merit-based Carl J. and Eleanor K. Rees Scholarships to mathematics majors with strong academic records. This year's Rees Scholarship recipients are Kevin Archibald, Griffin Casey, Jacek Cencek, Kelli Faust, Qiyu Han, Rebecca Guarino, Olivia Hessling, Nan Huang, Hannah Kretz, Xiao Li, Laura Molitoris, Rebecca Mongeau, Matthew Moye, Colleen O'Shea, Nicole Pinola, Kristin Ryan, Alexandra Sampugnaro, Kelly Saunders, Laura Snyder and Weiran Zhu.

summer, she will be at the NSA's Director's Summer Program.

The Outstanding Student Teacher award went to Jenna Enos, Karl Shively and Carly Toth, who demonstrated exceptional skill and creativity in developing rapport with students, planning and executing lessons, and incorporating suggestions and new ideas into teaching practice.

The SIAM Student Award went to graduate student Matt Hassell for his service to our SIAM Student Chapter.

The Baxter-Sloyer Award for outstanding performance by a graduate teaching assistant when to Siobahn Young.

Support for **Graduate Students:**
Graduate Assistance in Areas of National Need **(GAANN)**

Toby Driscoll, Director of Graduate Studies

The department has received a grant from the U.S. Department of Education as part of the GAANN program. This program provides fellowships to assist graduate students who want to pursue postgraduate degrees in a field designated as an area of national need, mainly in science, engineering, math, and education. The award will last for three years and brings about $400,000 to the university,

all of which goes directly to pay the fellows' tuition and stipends. Half of the funds are intended for females and members of underrepresented groups.

The GAANN Fellows will start by coming to campus in late July for our Graduate Review of Important Problems and Solutions (GRIPS) preparatory program. During GRIPS they are reminded of material and

habits of thinking that they will need to succeed in their first year of classes. The students also get to know one another and become comfortable in Newark before the fall semester starts.

After GRIPS the students take the university's and department's training for new

New **Hires**

Nayantara Bhatnagar joins the department as an Assistant Professor. She received her PhD from the Georgia Institute of Technology in the interdisciplinary Algorithms, Combinatorics and Optimization program in 2007, specializing in the analysis of convergence times of finite Markov chains. Her doctoral work was on convergence times of simulated and parallel tempering Gibbs samplers and Markov chains for random generation of graphs with given degrees. She spent time as a postdoctoral researcher at the University of California, Berkeley and at the Hebrew University of Jerusalem.

Nayantara's current research interests are in probability and combinatorics and specifically in random walks, Markov chains, statistical mechanical models and constraint satisfaction problems on random graphs. Her research in these areas involves designing and proving bounds on the convergence time of Markov chain samplers, often for Gibbs measures arising from statistical physics models such as the Ising, Potts and hardcore models. A second direction is studying the properties of these Gibbs measures on random graphs,

such as their uniqueness and extremality and understanding the connections with the mixing time of related Markov chains. Recently she has started a line of work in the area of non-uniform models of random permutations, their longest monotone subsequences and random Young tableaux.

Jungeun Park has joined the department as an assistant professor of Mathematics Education. She received her Ph.D. in May 2011 in Mathematics Education from the Michigan State University, under the direction of Sharon Senk. Jungeun's main research interests are mathematics education for undergraduate students in STEM fields and international comparison studies. Much of her dissertation was devoted to studying undergraduate calculus instructors and students' discourses about the derivative. She is currently expanding some of her dissertation work while analyzing calculus textbooks used in the United States and South Korea. She also plans on conducting a similar study in South Korea to explore whether and how the language differences are related to Calculus teaching and learning.

In her spare time, Jungeun enjoys exercising, hanging out with friends, meeting new people, traveling, listening to music and watching movies.

Christopher Raymond joined the department in Fall 2012, in a CNTT position at the rank of assistant professor. He was educated at CalTech (B.S.) and Northwestern (M.S., Ph.D.), with all of his degrees in applied mathematics. After a postdoc at the University of Wisconsin-Madison, he spent several years at NJIT before first joining Delaware in a visiting position in 2008.

He is interested in applied mathematics and mathematical modeling and appreciates the department's long time commitment to the Mathematical Problems from Industry Workshops, in which he has frequently participated. His research has focused on asymptotic and singular perturbation methods, often applied to reaction diffusion systems.

He has taught a variety of classes since first coming to Delaware, with a heavy emphasis on differential equations and classes in the calculus sequence. He especially enjoys bringing a mathematical modeling perspective to these classes and helping students to appreciate the connections between the mathematics they are learning and applied problems that they might see in other classes.

In his spare time, he enjoys reading, watching movies, hiking, and sampling food from different cultures.

teaching assistants. The Fellows don't have any teaching duties during the first year, but the initial training will help them know what to expect. We will be using some of the extra time afforded during the year to give them more than just the basic training.

During the year the Fellows are regular attendees at the Hallenbeck Graduate Student Seminar. The department feeds the students lunch while they meet to talk about math, research, teaching, or getting jobs. Faculty may not attend unless invited to speak, so that the students may really relax and discuss issues openly.

In January, the Fellows and other first- and second-year students participate in our pre-

paratory sessions for the written Preliminary Exams they must pass in analysis and linear algebra before they can go on to pursue the Ph.D. More experienced student mentors lead discussions and critically examine written solutions to sample problems.

To round out the first year, the Fellows will participate in our Groups Exploring the Mathematical Sciences (GEMS) summer research program. Each GEMS research project is a collaboration involving faculty, graduate, and undergraduate students. The graduate students work as both discoverers and teachers. At the end of the summer, each student presents the results of the research at our Summer Research Symposium.

Once Fellows complete their initial fellowship year, they will have a calculus teaching

assistantship and then be eligible for the university's Higher Education Teaching Certificate program. This program introduces advanced pedagogy and teaches career skills of assembling a teaching portfolio and looking for academic jobs.

The primary aim of our GAANN project is to increase the number of well-prepared U. S. citizens with doctoral degrees in mathematics and applied mathematics. In addition, the department and the College of Arts and Sciences are providing support to fund externally conducted research into our graduate recruiting, retention, and assessment practices, so that we may make permanent structural improvements to our program.

Matt **Zumbrum**

Matt Zumbrum, originally from Hanover, Pennsylvania, completed his undergraduate studies at Millersville University in May 2006 with a Bachelor of Science in Mathematics. Before coming to the University of Delaware, he worked as a statistical analyst for the Pennsylvania Health Care Cost Containment Council (PHC4), an independent state-agency that reports on the quality and cost of health care in the state. In his time at PHC4, he helped produce annual cardiac surgery and hospital-acquired infections reports, as well as quarterly patient safety reports.

Matt began his studies at UD in 2008 and has been working with Professor David Edwards on problems related to surface-volume reactions since 2010. Specifically, he uses perturbation methods and asymptotics, as well as numerical simulations, to study the binding effects of nonuniform receptor concentrations and arrays of reacting zones, with particular focus for application to optical biosensors. With support from the department, he has presented his work at several conferences, including the 2013 Joint Mathematics Meetings in San Diego, CA.

In 2012, Matt participated in both the Graduate Student Mathematical Modeling Camp held at Rensselaer Polytechnic Institute and the Mathematical Problems in Industry workshop held at UD. In these weeklong workshops, he worked in a group of graduate students mentored by a faculty member to model a rheology indexer and with a team of faculty, graduate students, and an industry mentor to develop algorithms to increase the productivity of a fuel cell assembly process. These were valuable experiences for working on new and interesting problems with industrial applications.
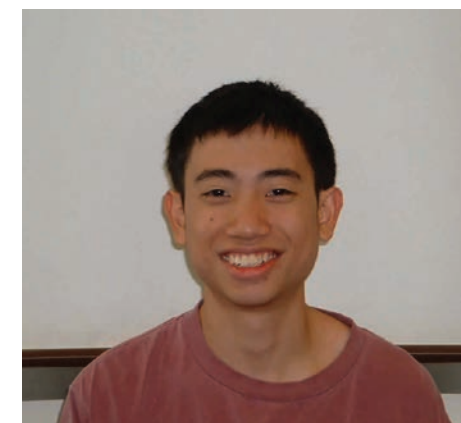
Aside from research, Matt has enjoyed his time at UD serving as a teaching assistant and instructor for several courses, being active with the student chapter of SIAM, and playing a variety of sports, especially ultimate frisbee. He would like to continue teaching and researching applied problems after graduation. Matt would like to thank the department faculty and staff for their support, especially Dr. Edwards for his guidance and dedication, and the graduate students for their friendship through the years.

Wisely **Wong**

Wiseley Wong grew up in Washington, Pennsylvania, a small town an hour away from Pittsburgh. He did his undergraduate studies at Carnegie Mellon University in Pittsburgh, Pennsylvania. In May 2008, he graduated with his Bachelor of Science in Mathematics. Because of Carnegie Mellon's focus in computer science, many of the mathematics classes he took were in the area of combinatorics and graph theory. Moreover, his father is a math professor, and together this motivated Wiseley to continue his studies at the University of Delaware to pursue a Ph.D. in mathematics.

In the Spring of 2010, Wiseley took a reading course with Professor Sebastian Cioabă to study algebraic and spectral graph theory, and Wiseley has been doing research with him since then. Spectral graph theory finds relationships between the eigenvalues of matrices corresponding to graphs with structural properties of graphs. Some of the work he has accomplished include finding sufficient eigenvalue conditions for edge-disjoint spanning trees in certain graphs. The parameter of graph toughness, informally speaking, involves how connected a graph is. Computing this parameter for graphs has been shown to be NP-hard, and Wiseley has determined this value for many families of graphs. Furthermore, he has found sufficient eigenvalue conditions that provide a lower bound for the toughness value of certain graphs. He has presented his work at many conferences, including ones in Urbana, IL, Tampa FL, and San Diego, CA.

When he decides to take a break from mathematics, he enjoys playing table tennis and video games. One of his favorite games is Super Smash Brothers Melee. Furthermore, he plays a wide range of music on the piano, including classical, ragtime, world music, Final Fantasy songs, and jazz forms of Super Mario Brothers themes. One of his future goals is to buy a Steinway, which will be incomparable both in quality and price to his current full-size keyboard.

After graduate school Wiseley plans to pursue a career in academia because he really enjoys teaching and working with students. He has volunteered to run sessions for the UD Math Circle and Mathcounts Day at the University of Delaware. Currently Wiseley is looking for academic jobs, and he would be very interested to settle down in California one day.

Wiseley greatly appreciates the support and guidance from Professor Cioabă throughout his graduate studies, and is thankful for the motivation and influence from his father when he was young. Lastly, he is especially grateful for his health, which has allowed him to make it this far. His transplanted kidney has been running strong for the last 18 years.

Yun **Zeng**

Yun Zeng grew up in Fuzhou, a small town in the southeast part of China. In June 2009, she received her Bachelor of Science degree in Mathematics from Dalian University of Technology.

She decided to broaden her knowledge in the field of applied math, as a graduate student at the University of Delaware. Her summer research experience in 2010, where she worked on the mathematical modeling of reverse draining of cylindrical magnetic soap films under the supervision of Dr. Pelesko, was a defining experience in her academic career. She chose to pursue a research path in the field of Fluid Mechanics. In the subsequent fall, she started to work on the modeling of the complex fluid dynamics, especially the power-law/stretched exponential responses of soft materials as observed in experiments. This anomalous behavior of soft materials can be related to a fractional derivative process. However, existing macroscale fractional constitutive models fail to describe the underlying microstructural physics of the fluid and are difficult to extend to nonlinear models.

Therefore, she took a more fundamental approach and performed mesoscale simulation to capture the temporal evolution and behavior of the fluid under different flows. Under simple shear flow, her model can capture the 'Newtonian plateau' for low shear rates and a shear-thickening as well as shear-thinning region with increasing shear rates. She has made substantial progress on investigating alternative scenarios for association/dissociation processes to model power law relaxation stress decay.

Yun presented a poster at the annual SIAM meeting in Minneapolis in July 2012. She presented her most recent work at the Society of Rheology meeting in Pasadena in Feb. 2013. In June 2012, she participated in a ten-day Industrial Mathematical Modeling Workshop for Graduate students in Calgary, Canada. From Sep. 2012 onwards, she has been serving as the President of the Association for Women in Mathematics student chapter at the University of Delaware. Through these experiences, she was able to grow both as a researcher and personally.
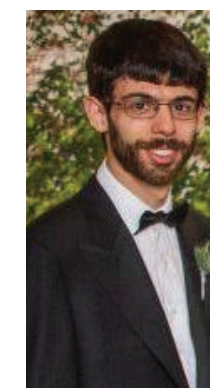
Outside the university, she enjoys photography and traveling, and hopes to travel around the world and experience many different cultures. She plans to continue her work on the modeling and the simulation of complex fluids in the future, in either academia or industry. She is grateful to her advisor for her support and guidance, as well as to the department for providing a great research environment.

Brian **Kronenthal**

Brian Kronenthal is originally from Yardley, Pennsylvania. He graduated Summa Cum Laude with a Bachelor of Science in Mathematics, and a minor in French, from Lafayette College in Easton, Pennsylvania. While at Lafayette, in addition to taking a myriad of mathematics courses, Brian worked with Dr. Lorenzo Traldi to study sets of n-sided dice with "paradoxical properties." In particular, they studied the interaction between pairs of tied dice, as well as other dice with certain attributes. Their paper appeared in the Journal of Combinatorial Mathematics and Combinatorial Computing. He also wrote an honors thesis with advisor Dr. Derek Smith on surreal numbers and combinatorial games.

During his first summer at UD, Brian worked with Dr. Felix Lazebnik to investigate cycles in algebraically defined graphs. Having enjoyed both the problems and the time spent with Dr. Lazebnik, Brian decided to continue working with him for his doctoral research. In particular, Brian used algebraically defined graphs to investigate a strategy for constructing new generalized quadrangles of odd order. Generalized quadrangles are incidence structures with applications to extremal combinatorics, geometry, group theory, and coding theory. He used methods from mathematical areas such as finite fields, number theory, and algebraic geometry. Brian's work has appeared in Finite Fields and Their Applications.

In addition to speaking at many seminars at UD, Brian has shared his work at many conferences. For example, Brian spoke in 2011 in Ghent, Belgium, and at Penn State University; in 2012 in Fort Collins, Colorado; and in 2013, in San Diego, California.

Brian's immediate career goal is to earn a tenure track position at a college or university that values outstanding teaching. From a young age, Brian has always enjoyed explaining concepts, and knew that he wanted to eventually become a teacher at some level. Teaching opportunities are one of the many factors that attracted Brian to UD. In addition to numerous semesters as a teaching assistant, he is grateful for having had the opportunity to teach Pre-Calculus, Calculus A, Calculus B, and Discrete Mathematics at UD as the primary instructor. In Spring 2012, Brian was awarded the Baxter-Sloyer Graduate Teaching Award for superior teaching effectiveness.

Beyond mathematics, Brian has several hobbies, including playing tennis (he played on his high school team), playing the piano (which he has done since the age of six), and rooting for the Philadelphia Phillies.

New **Programs**

Department introduces new Actuarial Science Major
by Lou Rossi, Director of Undergraduate Studies

A strong and vital undergraduate mathematics program is the foundation of any successful university. Over the last five years, our Department has seen a substantial growth in the number of math majors from 190 to over 270 this spring with almost the same number of mathematics minors. What many do not realize is that there is no such thing as a typical math major. With six undergraduate programs, Mathematical Sciences (BA and BS), Secondary Mathematics Education (BA and BS), Quantitative Biology, and Mathematics and Economics our offerings are as diverse as our students' interests. As the Director of Undergraduate Studies, I spend a lot of time focusing on three questions: Where do our math majors come from? What do they do while they are at UD? Where do they go when they graduate? The answers to these questions help drive the evolution of our programs. Most recently, student and faculty interest across the University led us to create a new program in Actuarial Sciences.

The new program is the latest interdisciplinary collaboration between Mathematics faculty and colleagues in other departments. For this degree program, mathematics is taking the lead role with active participation from the Departments of Economics, Management Information Sciences, Applied Economics and Statistics, and Finance. For the uninitiated, the creation of a new program requires a lot of conversations, bridge-building and of course paperwork. Approval by the Department, the College and University educational activity committees and eventually the Provost requires a full academic year of

meetings and deliberations. Having run this gauntlet during the fall and spring, we expect students will be allowed to major in Actuarial Sciences beginning in the Fall of 2013.

Actuaries are the professionals that study risk quantitatively and help companies manage it. While this program will be our newest offering, in the past many of our alumni have chosen the actuarial career track using our other degree programs as a springboard. Many work for insurance companies which rely heavily upon them, but actuaries also work for banks, private corporations and even the government. As alumni Matt Surles wrote to me recently, "One thing I find pretty interesting is how relevant my work is to what is taking place in the current day to day world. It is quite often that I read about something in the newspaper related to health care reform and then go to the office and have a project on the same topic." Not only are they are essential to the economic stability of nations, but they are highly sought and compensated in the private sector. Even in the midst of the Great Recession, a 2010 Georgetown University study found the unemployment rate of actuaries to be 0%, and that's one statistic every math major should know well. Certified actuaries advance along their career ladder through a battery of exams administered by the Society of Actuaries (SOA) and the Casualty Actuarial Society.

Math majors interested in this career path have typically chosen our Mathematics and Economics program and done well moving into the actuarial profession. Designed for students interested in graduate study in economics or the actuarial sciences, this particular degree program has grown from 40 students to just under 100 in the last five years. Based on student interest, the faculty

felt it was time to create an identifiable program for those interested in actuarial work. The new program is very similar to Mathematical and Economics, but includes more coursework finance, statistics and information systems, and slightly fewer required coursework in economics. The first two actuarial exams are Exam P (probability) and Exam FM (financial mathematics), and we expect our students to pass them during their sophomore or junior years. In the springtime, students already create informal study groups to prepare for these exams, and many students in our program have already passed them. The new program should provide more focused mentoring advising on exams and coursework. Also, several required courses have been accepted by the SOA to meet their Validation by Educational Experience (VEE) requirements.

As soon as the program 'goes live' in 2013, we expect to have 10–15 students per year declare this major. While we anticipate some students may shift from Mathematics and Economics into the new program, the two serve different purposes and both will continue to attract large numbers of majors. During many of the internal discussions leading to the creation of this program, some have wondered whether seven different undergraduate degree programs is too many. I take the opposite view. With over 100 employers seeking mathematics majors through the UD Blue Hen Jobs portal, I wonder if we are providing enough options for undergraduates who are interested in mathematics. Where there is student and faculty interest, we will continue to look for ways to improve our undergraduate offerings and expand into exciting new areas of opportunity.

QBio Qorner
Richard Braun and Gilberto Schleiniger, Associate Chair

The Quantitative Biology (QBio) major was established in the Fall of 2007, and is becoming a fully established major this year. The undergraduate Bachelor of Science in QBio is an interdisciplinary program offered in collaboration between the Departments of Biological Sciences and Mathematical Sciences. It was designed for students who like math and biology and who want to pursue and integrate both interests in their careers. This program is for students who want a challenge: we believe that there is no harder major on campus. The

roughly equal mix of mathematics, biology and chemistry is remarkably good background for solving fascinating and important biological problems. The QBio curriculum, supported by a major grant from the Howard Hughes Medical Institute, addresses the needs of 21st-century biology in ways not met by traditional biology or mathematics curricula: the mixing of mathematics and quantitative thinking with biological methods is in high demand.

The students we have had in the program have been remarkably successful so far. Here

is a sample of their next steps after the BS in QBio. The first graduate was Peter Ucciferro, in fall 2009; he is currently studying at the Philadelphia College of Osteopathic Medicine for a DO. The rest of that class of 2010 included the following students. Laura Sloofman is studying at the University of Illinois at Urbana-Champaign for a PhD in Biophysics and Computational Biology; Kelly Pippins is a Wilderness Fellow with the US National

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Conference Corner

DelMar Day 2013
by Francisco Sayas

The second edition of the DelMar Numerics Day, an annual workshop on Computational Mathematics organized by the Department of Mathematical Sciences at Delaware and the Department of Mathematics of the University of Maryland at College Park, took place on Saturday May 4 in College Park, MD. The keynote speaker this year was Jan Hesthaven from Brown University. The meeting also included twelve contributed talks. The website of the conference is http://delmar.math.umd.edu.

International Conference Celebrating Prof. David Colton at UD in August 2013
by Fioralba Cakoni and Peter Monk

An international conference on "Novel Directions in Inverse Scattering" took place at the University of Delaware, July 29 – August 2, 2013. This conference will celebrate

the scientific accomplishments of Unidel Professor of Mathematics David Colton and is organized by F. Cakoni (U of Delaware), L. Borcea (Rice University), H. Haddar (Ecole Polytechnique) and P. Monk (U of Delaware). The Institute for Mathematics and its Applications, the Department of Mathematical Sciences at the University of Delaware, and the French INRIA research laboratory at Saclay near Paris are among the sponsors of this international meeting.

Professor Colton is an internationally recognized leader in inverse scattering theory. He has contributed to the mathematical foundations of inverse scattering problems including uniqueness and reconstruction techniques. He is the pioneer of non-iterative techniques for solving inverse problem which are currently quite popular among mathematicians and engineers. David Colton has co-authored several books in this area and of more than 250 papers; in particular his book with R. Kress, Inverse Acoustic and Electromagnetic Scattering Theory has become a true classic and has been cited thousands times.

This conference was a scientific gathering of internationally recognized experts, as well as junior researchers, in the area of inverse scattering theory and focussed on novel techniques for solving inverse scattering problems. The goal of the meeting is to foster the exchange of new theoretical results, the latest trends, open problems and future

directions in the area of inverse scattering. The topics of the conference included rapidly developing mathematics at the frontiers of today's research in the area of inverse problems. Mathematics of this type underlies many real world applications including medical imaging, non-destructive testing, underground imaging and oil exploration, cloaking and enhanced visibility.

For more information please visit the conference website http://www.cmap. polytechnique.fr/~colton/

Finite Element Circus, Fall 2013
by Francisco Sayas

The Fall 2013 Finite Element Circus (FEC) will take place at the University of Delaware this coming fall semester. This is the fifth time, in its already long history, that this semiannual meeting of numerical analysts will be hosted by the Department of Mathematical Sciences in Delaware. The FEC runs during the weekend with short talks where researchers present their newest results on Finite Element theory and practice. Its very particular format (the order of the talks is set up with a lottery at the beginning of the meeting and duration of the expositions is decided after counting the number of speakers) makes this a very lively meeting that has been traveling along the East Coast universities since 1970. More information will appear on the department web pages in the near future.

QBio Qorner, continued from page 8

Park Service; Meghan McCabe is studying at the University of New Mexico for a PhD in Chemical Engineering.

From the Class of 2011: Zariel Johnson is studying at Thomas Jefferson University for a PhD in the biosciences with a focus on systems biology; Robert Sheehan is studying at the joint Carnegie Mellon University/University of Pittsburgh program in computational biology for the PhD; Danielle Toupo is studying at Cornell University for a PhD in applied mathematics; Matthew Gigantino went on to be a chemist in the Mid-Atlantic Regional Materials Test Laboratory at Norfolk Naval Shipyard.

For the Class of 2012: Alicia Liu is studying at the University of Connecticut for a PhD in genetics, genomics and bioinformatics; Ann Rackley is currently working as a programmer/analyst at Stinger Ghaffarian

Technologies; Frank Shen is studying at Penn State for an MS in statistics.

The class of 2013 is doing just as well. An example is senior Jennifer Bruhns; she won the first annual Undergraduate Research Award from the department. She is completed her undergraduate thesis on the interaction of the evaporating tear film and the cells underneath it on the front of the eye, under the supervision of Dr. Braun. She has accepted an offer with the School of Optometry at Indiana University, where she will study for both an MS and an OD.

The program has been profoundly helped by expertise of the advisory board. It is chaired by Dr. Anastasia Christianson, PhD, Sr. Director and Global Skill Leader, Biomedical Informatics, AstraZeneca Pharmaceuticals. The other members are: Dr. Robert E. Akins (PhD, Head, Tissue Engineering and Regenerative Medicine Research, A.I. Du-

Pont Hospital for Children and Adjunct Professor of Biological Sciences and of Materials Science and Engineering, UD); Dr. Bruce Boman (M.D., Ph.D., M.S.P.H., FACP, Associate Scientist, Center for Translational Cancer Research and Director, Cancer Genetics and Stem Cell Biology, Helen F. Graham Cancer Center; Professor of Medical Oncology, Thomas Jefferson University); Dr. James Bosley, Jr. (Ph.D., General Manager and Principal, Clermont Bosley LLC); Dr. Kelvin H. Lee (PhD, Gore Professor of Chemical Engineering, UD and Director, Delaware Biotechnology Institute); Dr. Robert Leipold (Ph.D., Research Scientist in Health Economics, United Biosource Corporation). We are most grateful for their continuing help.

We look forward to the growth and continued success of the program. If you are looking for a challenge, join in! More information can be found at http://www.udel.edu/qbio.

Brief News Items
from the **Math Department**

Mathematical Sciences Ranked in Top 100 for the Third Time

For the third year in a row, the Department of Mathematical Sciences at the University of Delaware was listed among the top 100 mathematics departments around the world, according to Shanghai Jiao Tong University's Center for World-Class Universities. The Center began releasing rankings of Universities and some areas of specialty in 2003.

The index evaluates departments worldwide in five subject fields, including mathematics. For the third straight year, the mathematics department was the only evaluated department at the University to be judged among the top 100 worldwide.

The 2012 Academic Ranking of World Universities (ARWU) subject ranking published by the center ranked Mathematical Sciences in the 76–100 range of departments. The same study put UD in the 54–67 range among U.S. institutions and in the range from 100–150 around the globe. (UDaily's article on the subject appeared on August 15th as well; it was used as a source for this article.)

The top 10 mathematics departments were, in descending order, Princeton, Harvard, UC Berkeley, Cambridge Stanford, Oxford, Universite Paris Sud (Paris 11), Pierre et Marie Curie Universite Paris 6, UCLA and MIT. UD Mathematical Sciences has active collaboration with several of these departments, including the Mathematical Sciences Research Institute at Berkeley, the Oxford Centre for Collaborative Applied Mathematics and the Oxford Computing Laboratory. The University of Minnesota Twin Cities was ranked 11th; that department is home to the Institute for Mathematics and Its Applications, in which UD Mathematical Sciences plays an active part.

For mathematics, the rankings are based on five indicators: the number of alumni and staff winning Fields Medals; the number of highly cited researchers selected by Thomson Scientific; the number of articles indexed in Science Citation Index—Expanded in the Mathematics field; and the percentage of papers published in the top 20% of math journals as cataloged by Science Citation Index. UD Mathematical Sciences does very well in the last three categories.

Prof. Sayas Awarded NSF Grant

Francisco-Javier Sayas has been awarded a grant of $300K from the NSF Division of Mathematical Sciences for a project on numerical simulation and analysis of transient waves in unbounded domains. The project is concerned with numerical methods for the acoustic wave propagation and scattering, including the analysis and testing of new schemes for coupling volume based methods with boundary integral equations. The grant includes funds to support two graduate students. More information may be found at the NSF website.

Grant for Student Support Awarded to Mathematical Sciences

The Department of Mathematical Sciences will receive a federal grant totaling about $400,000 to provide fellowships for students in the department's doctoral program. The grant was awarded by the U.S. Department of Education under its Graduate Assistance in Areas of National Need (GAANN) program. It will support four fellowships a year for three years. In conjunction with the grant, the mathematics department designed a recruitment and retention plan to enroll and retain more women and members of traditionally underrepresented groups in the graduate program. **Professor Tobin Driscoll** is the principal investigator; he will spearhead our recruiting and mentoring efforts. The key personnel from Mathematical Sciences includes **Professors Driscoll, Pelesko, Braun, Cakoni, Li** and **Schleiniger**. The oversight committee consists of the key personnel as well as Prof. Doug Doren, Associate Dean of the College of Arts & Sciences; Prof. Michael Vaughn, Associate Dean of the College of Engineering; Dr. Gabriele Bauer, Center of Teaching and Learning; and Dr. Joan Buttram, Director of the Delaware Education Research and Development Center. The grant is expected to have a lasting impact on our graduate program. A UDaily article on the subject has some additional information on the grant, and was a source for this news item.

Professor Cook Elected Fellow of the AAAS

L. Pamela Cook-Ioannidis, professor of mathematical sciences and associate dean of engineering at the University of Delaware, has been elected a fellow of the American Association for the Advancement of Science (AAAS). The award will be officially made at the AAAS annual meeting in February.

Prof. Cook was specifically recognized for her "significant contributions to the mathematics of fluids (compressible and viscoelastic) and to the profession, particularly in proactive service and leadership within SIAM," the Society for Industrial and Applied Mathematics. She is currently SIAM's vice president for publications, formerly was editor-in-chief of SIAM's *Journal on Applied Mathematics* (SIAP) and is an inaugural fellow of the society. She also served on the SIAM council, and is currently an associate editor on SIAP. Prof. Cook's research focuses on mathematical modeling of fluid mechanics, with a current emphasis on complex fluids — such as those used in shampoos and others that don't behave like water. She is conducting research on surfactants, or fluids that can act as detergents or dispersants.

At UD, she served as chairperson of the Department of Mathematical Sciences for nine years and chaired the University's Commission on the Status of Women for six years. She is currently a faculty scholar with the College of Arts and Sciences' Center for the Study of Diversity. She is very interested in improving the recruitment and retention of women in the fields of science, technology, engineering and mathematics (STEM), especially at the faculty and graduate student level.

She has also received the 2012 University Change Agent Award from the Women Engineers ProActive Network. Congratulations to Prof. Cook!

(This article is based on the UDaily announcement of the award by Ann Manser, 10 December 2012.) .

Professor Sebastian Cioaba Joins the Editorial Board of *Linear and Multilinear Algebra*

Professor Cioaba has been named to the editorial board of the journal *Linear and Multilinear Algebra*. This journal publishes original research papers that advance the study of linear and multilinear algebra, or that apply the techniques of linear and multilinear algebra in other branches of mathematics and science. *Linear and Multilinear Algebra* also publishes research problems, survey articles and book reviews of interest to researchers in linear and multilinear algebra. Appropriate areas include, but are not limited to: spaces over fields or rings, tensor

algebras, nonnegative matrices,inequalities in linear algebra, combinatorial matrix theory, numerical linear algebra, representation theory, Lie theory, invariant theory and operator theory. The audience for *Linear and Multilinear Algebra* includes both industrial and academic mathematicians.

Nick Brubaker Wins Prestigious NSF Postdoctoral Fellowship

Congratulations to Department of Mathematical Sciences graduate student **Nicholas Brubaker** for being awarded a prestigious NSF Mathematical Sciences Postdoctoral Research Fellowship (MSPRF). This three-year fellowship is awarded annually to 25–35 new or recent mathematics Ph.D.s from around the country. Upon graduating, Nicholas will go to the University of Arizona to study the equilibrium behavior of electro-capillary systems with Professor Joceline Lega. Specifically, he will work on surface tension driven folding (a.k.a., capillary origami), which has applications to micro-fabrication and self-assembly. He will begin his MSPRF in the fall of 2013.

Profs. Cakoni and Monk Receive IMA Funding for the International Conference "Novel Directions in Inverse Scattering"

The Institute for Mathematics and its Applications (IMA) has awarded funding to sponsor the international conference "Novel Directions in Inverse Scattering: Honoring David Colton" which takes place at the University of Delaware, July 29 – August 2, 2013. The conference will celebrate the scientific accomplishments of Unidel Professor of Mathematics David Colton. The conference is organized by F. Cakoni (Univ. of Delaware), L. Borcea (Rice University), H. Haddar (Ecole Polytechnique) and P. Monk (Univ. of Delaware). The University of Delaware is an IMA Participating Institution.

This conference will be a scientific gathering of international experts as well as junior researchers in the area of inverse scattering theory with focus in novel techniques for solving inverse scattering problems. The goal of this conference is to be a forum for the exchange of hot theoretical results, new trends, open problems and future directions in the area of inverse scattering. Applicability of the mathematics extends to many real life needs including medical imaging, non-destructive testing, underground imaging and oil exploration, cloaking and enhanced visibility.

For more information on the conference see http://www.cmap.polytechnique.fr/~colton/

Instructors Rossi and Schwarzkopf Awarded Instructional Improvement Grant

Instructors **Tammy Rossi** and **Patricia Schwarzkopf** of the Department of Mathematical Sciences have been awarded an Instructional Improvement Grant. The competitive award from the Center for Teaching and Learning is to support the development and implementation of the project "Flipping the Intro Math Classroom" for two courses: Math 010 Intermediate Algebra and Math 117 Pre-Calculus for Scientists and Engineers. Generally, flipping the classroom inverts the traditional teaching model. Students prepare for class by watching videos and/or reading course material and answering a few preliminary questions. With instructor guidance, class time is used to further investigate topics through the use of group activities. The potential impact from the program is significant: in the Spring 2013 semester alone, the combined enrollments for these classes is more than 180 students. The results may be of use in other introductory math courses as well.

Prof. Braun is College of Arts & Sciences Outstanding Scholarship Award winner

Professor Richard Braun is the winner of the College of Arts & Sciences Outstanding Scholarship Award for the year 2012–2013. The Arts & Sciences Outstanding Scholarship Award is based on publications, professional honors, receipt of competitive grants, scholarly contributions to one's field, and acknowledged reputation in scholarship. The recipient receives a check for $1,000 and a plaque.

Congratulations to Professor Braun on this well-deserved honor!

Many Thanks for Your **Support!**

Thank you to all the alumni, parents, and friends who have made generous contributions to the Department of Mathematical Sciences.

Mathematical Sciences drives break-through research and technological advances firmly rooted in mathematical knowledge. From the Internet and DNA testing to the creation of the skyscraper and space travel, mathematics plays a crucial role. Your gift to our department will support over 40 full-time faculty, over 60 graduate students, and more than 200 undergraduate majors that are changing the world. By supporting the Department of Mathematical Sciences, you will be providing valuable resources to our students such as research opportunities, scholarships, and much more.

The easiest way to make a gift is to visit **www.udel.edu/makeagift**. Our online form allows you to give via check or credit card. Please be sure to note "Department of Mathematical Sciences" in the "other" designation box. To mail in a check, please indicate "Department of Mathematical Sciences" in the check's memo section and mail it to:

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For additional information on how to make a gift, please visit **www.math.udel.edu/resources/alumni/giving.html**, or call the Development Office toll free at 866-535-4504 during normal business hours or email **annualgiving@udel.edu**.

Thank you again for supporting the Department of Mathematical Sciences!

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Donations honoring the memory of Professor Wenbo V. Li may be made by following the instructions at www.math.udel.edu or at the memorial site http://wenbo.li.muchloved.com/.

A memorial fund has been set up to support the Department of Mathematical Sciences.

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