RECKONINGS SPRING 2012

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

Chair's Message

John A. Pelesko

Dear Students, Alumni, Colleagues, and Friends,

The past year has been an exciting one for the Department of Mathematical Sciences. Professor David Edwards concluded his term as Interim Chair, and I've had the great pleasure of beginning my term as chair. On behalf of the entire department, I thank Dr. Edwards for his excellent service and leadership during our transitional period. Personally, I look forward to Dr. Edwards return from sabbatical in September and to working closely with him over the next four years.

Before looking back to the past year, I want to tell you about a few of the exciting things to which we're looking forward over the next year. Those of you who were students here at UD undoubtedly spent time in one of the department's three computer classrooms. This summer, with support from our alumni and from the College of Arts and Sciences, we're beginning renovations on a re-imagining of Ewing 205. The new design will include interactive work stations designed to facilitate teamwork, smart board technology, and as much whiteboard space as the room can handle. Our goal is to provide our mathematics education majors with a space to try out the technology they'll be using in their future careers, to provide our mathematics majors with a space to experience more courses taught in an active learning format, and to provide out faculty with a test space to develop new courses as we anticipate the opening of UD's Integrated Science and Engineering Laboratory in fall of 2013. I want to thank all of the generous donors who help support activities such as these

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Spectral Graph Theory

Sebastian Cioaba

Graph theory has come a long way since its beginnings with the work of Euler in the 1736 solving puzzles involving bridges, islands and rivers in the city of Königsberg, Prussia (now Kaliningrad, Russia) to its modern days development as a robust discipline of mathematics and computer science having important interactions with other areas of mathematics and science and many real-life applications such as web-page ranking, clustering, error-correcting codes and network design.

A graph G consists of a set of vertices V and a set of edges E which are pairs of distinct vertices. Small graphs can be easily represented on a piece paper by drawing the vertices as dots and the edges as segments or curves joining adjacent vertices. Drawing graphs by hand is always fun and can be useful in some situations, but many interesting graphs are very large and one needs to use more sophisticated tools to study their properties. The web can be regarded as a large graph where the vertices are the web pages and the edges correspond to the hyperlinks. Social networks such as Facebook or Twitter are huge graphs whose structure is of interest for many people. The size of real-life networks is often large (ranging from hundreds of thousands to billions of nodes) and analyzing their structure by brute force is not feasible. The challenge is to use a small number of parameters who capture the shape of the network. Spectral graph theory (the study of eigenvalues of graphs) provides important algebraic tools for studying structural properties of graphs and has important connections to other areas such as expander graphs, computer science, ranking, network design and error-correcting codes.

Spectral graph has its origins in the work of Kirchhoff from 1850 in which the number of spanning trees of a graph was expressed in terms of the eigenvalues of the Laplacian of the graph. A spanning tree of a connected graph G is a subgraph of G that is connected and has no cycles. Spanning trees are of interest in mathematical chemistry and computer science and have been studied by other famous mathematicians such as Cayley and Kruskal. In a recent work with one of my Ph.D. students, Wiseley Wong, we have obtained best possible connections between the second

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Tear Film Research in Mathematical Sciences

Richard Braun

Every time you blink, a thin fluid film is left behind that covers the front of your eye. This tear film performs a number of functions: a smooth optical surface, defense against inflammation and foreign particles, and lubricating the eye's surface, to name a few. When the tear film is not healthy, a variety of maladies may occur. Dry eye is a collection of symptoms that clearly involves the tear film; dry eye may arise from a shortage of tear fluid for each blink, from too much evaporation of the tear film, or a combination of both. Once this shortage of tear fluid persists, pain and inflammation of the eye follow. Understanding the dynamics of healthy and unhealthy tear films may help lead to better understanding of the progression and treatment of dry eye and other conditions that afflict millions.

It seems that mathematical modeling can have a great deal to say about quantifying the dynamics of the tear film. The group involved in modeling the tear film has included Prof. Pam Cook, Prof. Toby Driscoll and me from

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Inside *Reckonings*

Chair's Message, continued from cover

and I hope that many of you will continue to do so in the future.

This summer, the department will be hosting two conferences. In mid-June, we'll see the return of the Mathematical Problems in Industry Workshop organized by Professor's Braun, Edwards, and Rossi. In early August, we'll be hosting a conference on Applied Analysis and Mathematical Biology in honor of Professor Robert P. Gilbert's 80th birthday. Organized by Professor Ou, this conference will feature distinguished speakers from around the world, attesting to Professor Gilbert's tremendous impact on mathematics during his long career. Next winter, we'll see the first study abroad program at UD to focus on mathematics. Taking place in Dominica and organized by Dr. Anthony Seraphin, this promises to be an exciting opportunity for all UD students.

This past April, the department hosted the first annual DelMar Numerics Day. Organized by Professor Plechac and Professor Sayas, this collaborative effort brings together faculty from the University of Delaware and the University of Maryland to discuss the latest trends in numerical analysis. Our faculty also remain active in organizing conferences elsewhere, with Professor Xiang serving as the chair of the organizing committee for "Wilsonfest," held at the California Institute of Technology this past March. As you'll see throughout this newsletter, these activities are just the tip of the iceberg of the many activities in which our faculty, staff, and students are involved. It is these activities as well as the commitment to research and teaching that leads to our continued high ranking among mathematics departments, year after year.

Of course, this high ranking is largely due to the faculty who have been among us the longest. This year, sadly, we'll see three of these long-time faculty members retire. I would like to personally congratulate Professor Robert P. Gilbert, Professor George Hsiao, and Margaret Donlan, on their outstanding careers. You will all be missed, but we look forward to seeing you on campus and at future department events.

I hope you will all take the time to enjoy this newsletter and read more about the many fine achievements of our students, alumni, and faculty. I highly recommend the article by Jeannie Moulton on "The Mathematics Behind Sherlock Holmes" and hope you'll find that article and all the others as enjoyable as I did. 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.

Spectral Graph Theory, continued from cover

largest eigenvalue of a regular graph and the maximum number of edge-disjoint spanning trees of the graph. The maximum number of edge-disjoint spanning trees of a graph is a measure of connectivity of the graph. We are currently working on extending our results to graphs with general degree distribution and other eigenvalues.

In the 1970s at Bell Labs, Graham and Pollak studied a network communication protocol suggested by J.R. Pierce which involved labeling the vertices of a network by sequences of 0, 1 and * such that each message can be routed from its source to its destination using these labels. This problem turned out to be equivalent to the problem of decomposing the edges of a graph into complete bipartite subgraphs. Graham and Pollak solved this problem for certain graphs using eigenvalue methods and this is the only method to check the optimality of a graph decomposition. In his M.Sc. thesis, my student Michael Tait studied a related conjecture from 1991 by Alon, Saks and Seymour. With Tait, we generalized and extended previous work of Razborov and Huang and Sudakov and constructed new counterexamples to this famous conjecture. Our work appeared in The Electronic Journal of Combinatorics and even though he is now a Ph.D. student at UC San Diego, Tait and I are still working on other related problems.

In more recent times, spectral graph theory has been fundamental in several areas such as web-page ranking and construction of expander graphs among others. The founders of Google computed the Perron-Frobenius eigenvector of the web graph and became billionaires. Eigenvalues of graphs played a crucial role in the construction of expander graphs. An expander is a constant-degree regular graph which cannot be disconnected into two large subsets of vertices without removing a large number of edges. Informally, an expander is a sparse, but highly connected graph. It turns out that d-regular graphs with small second largest eigenvalue are expanders. Expanders are fundamental in computer science and network design and can be also used to construct error-correcting codes to reliably transmit information over noisy channels. The best expanders are called Ramanujan graphs and have been constructed by Lubotzky, Phillips, Sarnak, and independently Margulis using tools from several areas of mathematics such as spectral graph theory, number theory and group theory. I am currently working on constructing expander graphs using certain families of equations over finite fields.

Connectivity is one of the most important properties of a network. The vertex-connectivity is the minimum number of vertices whose removal disconnects the graph.

The simplest way to disconnect a graph is by picking a vertex and removing its neighbors therefore, isolating that vertex from the rest of the graph. The set of neighbors can be seen as a local disconnecting set of vertices. In many situations, one is interested in finding non-local disconnecting sets which are sets of vertices whose removal disconnects the graph into large components. In recent research with Kim and Koolen, I have studied minimum non-local disconnecting sets for strongly regular graphs. These form an important class of graphs which lie somewhere between the highly structured and the apparently random. Our work disproved a conjecture of Brouwer regarding the size of the minimum disconnecting sets whose removal yields only non-singleton components. We showed that the graphs arising from certain partial linear spaces called copolar spaces and Δ spaces in finite geometry, are counterexamples to Brouwer's conjecture. We also showed Brouwer's conjecture is true for many infinite families of graphs including conference graphs and certain orthogonal array graphs. With my Ph.D. student Weiqiang Li, we are studying non-local disconnecting sets in strongly regular graphs arising from Steiner triple systems and from other orthogonal arrays.

Faculty **Honors**

Prof. Cristina Bacuta wins CAS Outstanding Teaching Award

Dr. Cristina Bacuta has been given this year's College of Arts & Sciences Outstanding Teaching Award. Each year, the college chooses just one faculty member from its over 600 faculty to receive this honor. This award is based on student and peer evaluations, alumni testimonials, number and range of courses offered, involvement in individual instruction, quality of advisement and mentoring, demonstrated commitment to student welfare and development, and acknowledged reputation in teaching. All of these qualities are exemplified by Dr. Bacuta. The College celebrated her achievement on May 16th at the CAS Awards Ceremony in the Roselle Center.

Dr. Bacuta joins several other award winners in the Department of Mathematical Sciences in recent years. Dr. John Pelesko was the CAS Outstanding Teaching Award recipient in 2006; Dr Alfinio Flores won the CAS Oustanding Advising award in 2011; Dr. Robert Coulter won the University Teaching Award in 2011.

Prof. Cook wins 2012 University Change Agent Award

Professor L. Pamela Cook (Professor of Mathematical Sciences and Chemical & Biomolecular Engineering, and Associate Dean of Engineering for Faculty Development) has been named the 2012 University Change Agent by the Women in Engineering ProActive Network (WEPAN).

WEPAN's mission is to catalyze change that will lead to the enhanced success of all women engineers in academic and professional settings. The University Change Agent Award honors an individual who has had a positive impact on their institution with regard to the climate for women in STEM (Science, Technology, Engineering and Mathematics) fields, with an emphasis on engineering.

Prof. Kristi Kiick, Deputy Dean of Engineering, stated that "Pam's tireless efforts have had a tremendously positive impact across UD. Please join me in congratulating Pam for this well-deserved, national recognition of her impact on the climate for women in our community."

Prof. Cakoni is elected scientific expert on the Advisory Board of the Academy of Finland

Professor Cakoni is elected as scientific expert on the Scientific Advisory Board for the "Center of Excellence in Inverse Problems Research" for a six-year term 2012–2017. The Scientific Advisory Board consists of two highly recognized scientific experts who are nominated by the Academy of Finland. The function of the Scientific Advisory Board is to support, strengthen and monitor the scientific work of the Centres of Excellence. Through Finnish Centres of Excellence Programmes, the Academy of Finland provides substantial and visible direction to Finnish science. The Finish Center of Excellence in Inverse Problems Research is at the cutting edge of research in inverse problems and is internationally recognized as a leading unit in the area.

Prof. Pam Cook takes reins as SIAM Vice President for Publications

Prof. Pam Cook, professor of mathematical sciences in the College or Arts and Sciences, affiliated faculty with chemical and biomolecular engineering, and associate dean for faculty development in the College of Engineering, has been appointed vice president for publications of the Society for Industrial and Applied Mathematics (SIAM). In addition to holding an annual meeting, specialized conferences, short courses and workshops, SIAM publishes 15 peer-reviewed research journals and approximately 25 books annually. This new role follows Prof. Cook's six years as SIAM Secretary, elected three times to the position, and as back-to-back terms as Editor-in-Chief of the SIAM *Journal on Applied Mathematics*. Both were the maximum allowable terms.

Prof. Li is a distinguished lecturer for NSF-CBMS Conferences

The National Science Foundation has announced support for NSF-CBMS Regional Research Conferences in the mathematical Sciences to be held during 2012. These bring to 341 the total number of such conferences since the NSF-CBMS Regional Research Conference Series began in 1969. These conferences are intended to stimulate interest and activity in mathematical research. Each five day conference features a distinguished lecturer who delivers ten lectures on a topic of important current research in one sharply focused area of the mathematical sciences. The lecturer subsequently prepares an expository monograph based upon these lectures, which is normally published as a part of a regional conference series. Support for about 30 participants is provided and the conference organizer invites both established researchers and interested newcomers, including postdoctoral fellows and graduate students, to attend.

The NSF-CBMS Conference, with ten lectures by Prof. Li, is titled "Small Deviation Probabilities: Theory and Applications" to be held on June 4–8, 2012, at the University of Alabama in Huntsville. Detailed information can be found at http://www.math.uah.edu/~cbms/

Professor Hsiao honored by journal dedication

A forthcoming special issue of the journal *Applied Numerical Mathematics* will be dedicated to Professor George C. Hsiao. This issue contains articles in addition to those published in *Mathematical Methods in the Applied Sciences 33* (18), 2010, which is also dedicated to Professor Hsiao in his honor. These articles

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From the **Editor**

Dear Department Alumni, Students, Colleagues and Friends,

It is a pleasure to give you a glimpse of our manifold activities, accomplishments and honors. Our award-winning faculty and staff is constantly striving to improve our teaching, research and advisement. We feature some pure and applied math research programs. Prof. Sebastian Cioaba discusses his work in algebraic graph theory. I discuss recent progress in mathematical modeling of tear film dynamics. The Faculty Honors section details recent awards and appointments for our faculty in diverse areas. Graduate students Claudio Torres and Bryan Petrak, soon to graduate and take jobs, discuss their experiences. Our new hires are profiled as well. Our faculty is often very active in organizing meetings, and the last year is no exception three meetings are discussed in Conference Corner. Accomplishment and activities are also listed in Brief News Items.

Please enjoy!

Richard Braun,
Development Committee Chair

Tear Film Research, continued from page 1

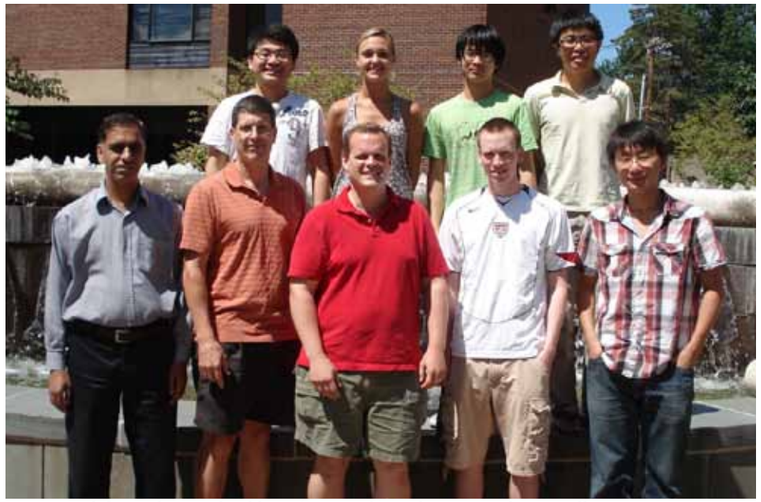
the faculty. The project has been funded by the NSF through two consecutive grants. We have had the good fortune to work with many talented graduate and undergraduate students.

What can mathematical modeling say about this situation? The tear film is a multilayer fluid; the main component of the film is the middle aqueous layer that is primarily water with some mucins and other chemicals inside it. The other layers are an outermost oily layer that suppresses evaporation and a mucus layer that helps ensure that the tear film wets the surface of the eye. Under some conditions, we can replace the two layers with boundary conditions and focus our study on the dynamics of the aqueous layer; this step alone is major progress in the modeling of the problem because significant decisions were made about the relative importance of what happens in the tear film.

An important observation is that the tear film is very thin (a few millonths of a meter) compared to its length (about one centimeter); for such a thin fluid, many terms in the full governing partial differential equations become negligible, and to a good approximation we can reduce the problem in its simplest form to one or a few nonlinear partial differential equations with appropriate boundary conditions. We have once again made a modeling decision in this process, and that is to use the geometry of the film (its thinness) to simplify the fluid dynamics to a few equations and one that are much easier to solve than the original problem. What can be done with these models?

Many blinks are not complete blinks; that is, many times our eyelids don't fully close. A valley forms in the tear film from a half blink which was caught on film by Dr. Ewen King-Smith in the College of Optometry at the Ohio State University. A thin film model with moving ends that model blinks was used to capture the film dynamics under these conditions. These blink models are introducing new mathematical challenges for the numerical methods that solve the partial differential equation. Dr. Alfa Heryudono completed a part of his thesis on comparing numerical results from using spectral methods to *in vivo* blink data; the agreement was good in many respects. He is now a faculty member at the University of Massachusetts at Dartmouth; he was supervised by Prof. Driscoll.

To study tear film dynamics in more realistic eye-shaped domains, we need to describe the eye shape in the computer; this is readily accomplished using a digital photo and Matlab image processing software. This has made for good undergraduate projects in our courses. Using that idea as a starting point, Dr. Kara Maki developed equations with sufficient continuity to allow accurate computation of tear film dynamics with a thin film equation. She used two different types of boundary conditions to compute dynamics of tear film motion on eye-shaped domains, in collaboration with Dr. Bill Henshaw at Lawrence Livermore



Front row, left to right: Javed Siddiqui (PSU York), Rich Braun, Toby Driscoll, Doug Freeman and Kaijing Wang. Back row: Longfei Li, Jen Bruhns, Ricky Shum and Quan Deng. Not pictured: Christian Paul.

National Laboratory. She could recover some observed dynamics in vivo. For example, small lamp black particles (fine soot, really), will flow around the top and bottom lid margins, with a split above the outer corner of the eye; similar results were seen in silico. She finished her thesis with me in 2009, went on to an IMA postdoc at the University of Minnesota, and is now on the faculty at the Rochester Institute of Technology. To my knowledge, these are still the only 2D computations of tear film dynamics in the literature.

Currently, Mr. Longfei Li is supported by the NSF grant. He is extending Dr. Maki's work on the eye shaped domain. He will be adding an important physiological variable called the osmolarity of the tear film. Osmolarity is thought to be a main cause of irritation and damage in dry eye. We hope to influence eye doctors interpretation of devices used to measure osmolarity at the lid margins in the clinic. Mr. Li has already finished a different project about heat transfer from within the eye through the tear film. He found an appropriate amount of modeling needed to recover the measured cooling observed on the front of the eye. That paper should appear in 2012.

Mr. Quan Deng is extending the study of cooling of the eye to include blinking and the interblink period. Using spectral methods, he has computed striking images of the temperature patterns that develop inside the eye during successive blinks. He has also been able to recover experimentally observed cooling in vivo. His work, together with Dr. Heryudono's, are the only computations with complete blink cycles that have been performed to date. He is working with Dr. Driscoll and me.

These projects have spawned numerous NSF-funded Research Experiences for Undergraduates (REU) projects. Some notable ones are mentioned here. Mr. Peter Ucciferro and Mr. Paul Parsons worked with then-Computer-and-Information-Sciences student Xiaolin Yang to capture a blink in formula in Matlab. Ms. Jennifer Bruhns and Mr. Douglas Freeman studied the effect of evaporation and osmolarity on the outermost layers of cells on the cornea. Ms. Bruhns has continued on this project with independent study and will do an undergraduate thesis on the topic. She will be applying to Optometry programs. Mr. Kaijing Wang and Mr. Christian Paul studied image processing methods to classify microscope images from the outermost surface of the tear film. The data came from Dr. King-Smith's lab at OSU, and their results were reported to him. This project was also used by Prof. Lou Rossi in the Math 512 capstone course and was chosen by three teams to study; they provided useful input for the 2012 REU project that will involve new students on the project.

The tear film dynamics project is an exciting and growing study with potential relevance to many people. New directions are still being added. The group recently received an NIH grant via Indiana Univeristy's College of Optometry to compare theory closely with new imaging methods for the tear film. More questions arise as old ones are answered; we hope to discover many new answers in the near future.

Faculty Honors, continued from page 3

have been authored by some of the participants of the Advances in Boundary Integral Equations and Related Topics, a conference in Professor Hsiao's honor held at Delaware in the summer of 2009. The journal featured an editorial about him which is available online (www.sciencedirect.com/science/journal/aip/01689274).

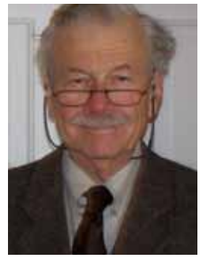
According to the editorial, "George brings unique perspective to his work, with his considerable strengths as an analyst combined with his computational expertise and his experience as an engineer. ... George may well be the only mathematician who has written codes in languages ranging from Fortran through Maple to Java, whilst also writing the definitive 612-page treatise on boundary integral equations (this latter with Prof. W. Wendland)."

The editorial continued, "We are very proud of having shared many fruitful and enriching academic and personal moments with George, and fell very pleased of having had the chance of editing this special issue of *Applied Numerical Mathematics* in his honor. There is no doubt that important periods of our own careers have been strongly influenced by the generosity and wisdom from George, for which we are extremely grateful to him."

George Hsiao has been a member of the Department since 1969 and currently holds the Carl J. Rees Chair Professor of Mathematics. At UD, he received the College of Arts and Sciences Outstanding Teacher Award in 1996 and its Outstanding Scholar Award in 2000. He also received the Francis Alison Professor Medal, the University's top faculty award, in 2000.

Professor Gilbert honored in special journal issue

Issues 2–4 of volume 57 of the journal *Complex Variables-Elliptic Equation* (CV-EE) was dedicated to Unidel Professor Robert Pertsch Gilbert on the occasion of his 80th Jubilee. Friends, colleagues and ex-students contributed to this issue. The list of contributors are V. Maz'ya, D-C Chen, S. Carl, H. Begehr, Y. Xu, F. Wassouli, A. O. Celebi, R. Ronkese, F. Cakoni, M. V. Klibanov, R. Kress, J-P. Groby, E. Ogam, A. Wirgin, G. N'Guerekata, X. Xie, M. Fang, P. Puci, M-Y. Ou, E. Wegert, S. Klinge, K. Hackl, B. Vernescu and P. Broadbridge among others. Currently the joint Editors-in Chief for CV-EE are Alexaner Pankov and Yonzhi Xu. Robert Gilbert was the Editor for this journal until he resigned several years ago. The journal is published by Taylor and Francis. The special issue, including Professor Gilbert's biography, can be found online at



http://www.tandfonline.com/toc/gcov20/57/2-4.

The biography in this issue states that "It is amazing to realize how many mathematicians have been, and still are collaborating with Bob." It goes on to note that he has worked on many different subjects including ". . . elastic plate problems, linear and nonlinear elasticity,elastic-plastic problems, contact problems for thermo-elastic and elastoplastic shells, Hele Shaw flows, flows in porous media, under water acoustics, . . . medical mathematics." Also: "Bob's first monograph, *Function Theoretic Methods in Partial Differential Equations,* sold 10,000 copies world wide, 7,500 in China alone." Professor Gilbert is a three-time winner of the prestigious Alexander von Humboldt Award.

The journal *Mathematical Methods in the Applied Sciences* will also dedicate an issue to Professor Gilbert and will appear later this year. That issue will contain papers by the authors Michael Klibanov, Alexander Pankov, Masahiro Yammamoto, Grigori Panasenko, Armand Wirgin, Rolando Magnani, Roger Temam, Umberto Mosco, Roberto Triggianni and Irena Lasiecka.

Alumni in the **Newsroom**

The Mathematics Behind Sherlock Holmes

by Jeannie Testa Moulton

Moriarty, the arch-enemy in the latest Sherlock Holmes film, gets his math skills from the University of Delaware. Well . . . not exactly, but the one of the brains behind the math in the film did. Dr. Derek Moulton received his Ph.D. from UD in Applied Mathematics in 2008. Moulton, who is now at Oxford University Oxford Centre for Collaborative Applied Mathematics (OCCAM), and his colleague, Prof. Alain Goriely, helped out with the math in *Sherlock Holmes: A Game of Shadows.* The Oxford pair used their math skills and their imaginations to create a board, a secret code and some history behind Moriarty.

The board

In 2010, Moulton and Goriely began working with Warner Bros to develop a blackboard for Moriarty's office. The board had to be mathematically accurate, highly visually interesting and historically correct. "When we did the equations on the blackboard, they got excited," says Goriely. So, from there, the pair began producing ideas for the mathematically bereft script. In particular, they devised a secret code for Moriarty, created a lecture that Moriarty gives on European tour, and offered advice on the mathematical aspects of the script.

If you've read the Sherlock Holmes stories, you know that Sir Arthur Conan Doyle gave precious little information on Moriarty. Mathematically, all that is given away in the story is that Moriarty wrote two books: one on the binomial theorem and another one on the dynamics of asteroids. Taking these cues, Moulton and Goriely creatively delved into the mathematical mind of Moriarty.

The code

One of the primary elements on the board, and a key aspect in Moriarty's evil plans, is his secret code that he uses to communicate with his henchmen as well as encrypt his own information about his global empire.

To code information, Moriarty codes each character in his message as three two-digit numbers. The numbers correspond to the page, line and character number of the same character in different locations from a horticultural book.

This sequence is further encoded using a public key based on Pascal's triangle. The public key is an integer p, which corresponds to a sequence of numbers, the Fibonacci p numbers. The Fibonacci p number sequence is defined as $F_p(n) = F_p(n-1) + F_p(n-p-1)$ with $F_p(0) = 1$ and $F_p(n) = 0$; $n < 0$. Having chosen p, any two digit number may be represented by giving the positions of the Fibonacci p numbers that add to the given number in the *minimal representation;* that is, for any integer N, there is a unique representation $N = F_p(n) + \phi$, with $\phi < F_p(n-p)$. By giving the positions of the minimal representation, Moriarty converts

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Featured Graduate Students:

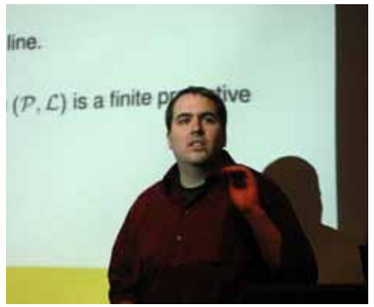
Bryan **Petrak**

Bryan Petrak grew up in Hollidaysburg, Pennsylvania and did his undergraduate work at the University of Mary Washington in Fredericksburg Virginia. In May 2003, he graduated with his Bachelor of Science in Mathematics and Psychology. While at Mary Washington, Bryan participated in various research opportunities in both mathematics and psychology. Specically, he worked with Professor Je Edmunds on a theoretical competing species model for our beetles; Professor Debra Steckler to study the acquisition of superstitions; and Professor Bruce MacEwen to study whether rats can count. After graduation Bryan spent two years as a mathematics teacher at Washington and Lee high school in Montross, Virginia. During this time Bryan realized that he missed studying mathematics and he decided to return to school. He attended Miami University in Oxford, Ohio and recieved a Master of Science in Mathematics. His advisor at Miami, Professor Tao Jiang, suggested that he continue his studies at the University of Delaware because of the strong research group in discrete mathematics.

During his rst summer at the University of Delaware, Bryan worked with Professor Felix Lazebnik on nding embeddings of partial planes into projective planes. Since then he has worked with Professor Lazebnik and Professor Gary Ebert to study the substructures of Figueroa planes, a family of nite projective planes. In particular, he has been been able to show that Figueroa planes have a fano subplane which is not contained in a larger classical subplane. He has also been able to show that the Figueroa planes of odd order have subplanes of order 3.

Bryan has presented work at various conferences including FQ10:The 10th International Conference on Finite Fields in Ghent, Belgium. In addition to his research, Bryan is active in the department. He was an organizer of the Hallenbeck Graduate Student Seminar from 2009–2011. He also served as the student representative on the Graduate Committee.

Outside of research, Bryan enjoys hiking—an interest that started from his time in Boy Scouts. He also enjoys traveling, camping and playing sports.



After graduate school, Bryan plans to pursue a career in industry where he can continue to work on problems in applied mathematics. While many people have influenced him inside and outside mathematics, Bryan appreciates Prof. Lazebnik and Prof. Ebert for their inspiration, guidance, and for their lessons in how truely beautiful mathematics is. He also appreciates other graduate students including Brian Kronenthal and Wiseley Wong, for always daring him to be better.

Claudio E. **Torres**

Claudio E. Torres grew up in Molina, Chile. He did his undergraduate studies at Universidad Técnica Federico Santa María, Valparaíso, Chile. He obtained his Bachelor in Computer Sciences in 2004 and a Professional Engineering degree together with a Master in Computer Sciences degree in March 2007 with a focus in Scientific Computing. His Master in Computer Sciences thesis work was directed by Prof. Luis Salinas and the main focus was to build a highly parallel and stable solver for a singular integro-differential equation. He adds that this was the beginning of his interest in pursuing a research career.

Right after he finished his studies in Chile, he was awarded a mobility grant called *Scientific Computing Advanced Training* (SCAT) funded by the European Union to go to the University of Bristol, Bristol, United Kingdom, for 10 months. His work there was in fluid dynamics, more specifically in vortex methods, directed by Dr. Lorena Barba. His work with Dr. Barba led to publishing his first paper in 2009 titled "Fast radial basis function interpolation with Gaussian by localization and iteration," which, he mentions, was a very challenging and a great learning experience.

Claudio joined the Ph.D. program in Applied Mathematics at UD in February 2008 and started working—from his first day—with Dr. Louis Rossi. The first research topic he worked on was an Ant-based routing in a computer network in collaboration with Dr. Chien-Chung Shen's group from Computer Science, UD. This topic brought Torres' attention due to his Computer Science background. However, the main focus here was modeling and analysis. The first challenge that Claudio had to handle was to translate the

algorithm to a dynamical system, which was finally obtained and validated after several headaches!, Claudio mentions. As a result of this work Claudio published the paper titled "Modeling, analysis and simulation of ant-based network routing protocols" in 2010. In the same context, Claudio worked in the analysis of a Slime Mold-based routing problem, which was also done in collaboration with Dr. Shen's group. From this work a conference paper and a journal paper were published, "Slime mold inspired path formation protocol for wireless sensor networks" in 2010 and "Slime mold inspired routing protocols for wireless sensor networks" in 2011, respectively. Claudio has presented this work in the SIAM annual meetings in 2009 and 2010.

The second research topic for Claudio is the hydrodynamic interaction of droplets in a turbulent tropical cloud. This work has been done in collaboration with Dr. Lian-Ping Wang's group from Mechanical Engineering at UD through the NSF funded PetaApps Cloud Physics project. Claudio mentions that it has been a very fruitful research experience

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Sherlock Holmes, continued from page 5

the 'book sequence' into a new, fully coded sequence of numbers.

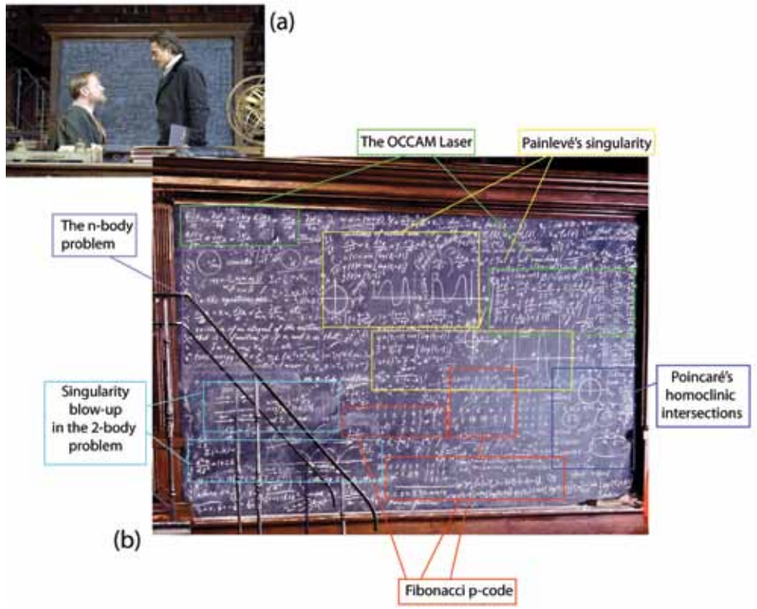
Using the code, Moriarty encodes both the messages he passes to his associates during book signings and the information of his empire in his little red notebook. The public key is passed to his associates during a key moment in his lecture, by changing the value of a particular variable.

Cracking the code (plot spoiler)

So how does Holmes unravel Moriarty's empire? Holmes first observes work related to the Pascal's triangle and Fibonacci p numbers written on Moriarty's board in his office. Later, he notices the slight difference in Moriarty's lectures, guiding him to the idea that an integer key is being passed to an associate, which he eventually realizes corresponds to the particular p in the Fibonacci p numbers. Holmes deduces that the horticultural book is serving as a cipher based on the fact that the flower in Moriarty's office is dying, and no proper horticulturalist would let a flower die. His powerful intellect does the rest.

The lecture

Other elements on the board surround a lecture for Moriarty that Moulton and Goriely devised. Building off Moriarty's work on asteroids, Moulton and Goriely based his character and motivation on the so-called n-body problem and the gravitational interaction of n masses. In particular, they turned to three key works around the end of the 19th century:



- George William Hill on the restricted three-body problem (1878), which gives the solution of the motion of an asteroid (or an object of negligible mass) moving around Earth, which is also moving around the Sun.
- Henri Poincaré's immensely important work on celestial mechanics
- Paul Painlevé on collisions between masses, which proved some very important results complementing the work of Poincaré

A taste of fame

Moulton and Goriely went on-set in London in December 2010 to direct the making of the board. According to Moulton, "When we went on set, we spent hours waiting in a cold trailer before we could even see the board we had designed. The equations were transcribed, with numerous errors, by a calligrapher with zero mathematical knowledge, and we weren't allowed to touch it. Everyone was very friendly, but it was a painstaking process."

A year later, they were invited to a screening for their efforts. Overall, the pair said they had a lot of fun with the project, but they also learned that Hollywood isn't all glamour. It turns out that trying to convince film producers how cool mathematics can be is a rather hopeless task, so most of their ideas never made it into the film. Still, if Hollywood calls again, Moulton says they will gladly take the opportunity to try to communicate some mathematics on the silver screen.

Popular press on the math in the movie

- Metro.co.uk: http://www.metro.co.uk/film/887898-sherlock-holmes-find-our-hidden-clues-to-outwit-the-detective-himself
- New Scientist: http://www.newscientist.com/blogs/culturelab/2012/01/the-mathematics-behind-sherlock-holmes.html

Torres, continued from page 6

because it has involved very interesting mathematical problems, from solving a linear system of equation in a super-computer to analyze the hydrodynamic interaction of droplets induced by the Navier-Stokes equation. From this research, Claudio and his collaborators have a paper ready to be submitted. Claudio has presented this work in the APS annual meeting 2011, among others.

The last, but not least, project that Claudio has worked on is in vortex methods. This method captured Claudio's interest because it is a meshfree method that provides a very good approximation for vorticity dominated fluid flow in unbounded domains. Claudio and his advisor Dr. Rossi have been able to extend it from 2D to 3D.

Outside the University, Claudio enjoys playing ping-pong, tennis and softball, although he may not be the best player, he mentions he really enjoys playing them. In the past two years Claudio has helped in the organization of the classic and *very* competitive Bocce tournament. The Bocce tournament is the once a year opportunity where the faculty members and graduate students compete for a year long recognition.

Claudio is considering a career in academia with interaction with the industry. Claudio is currently working in finishing his Ph.D. in Applied Mathematics and he recently accepted a postdoc offer at George Mason University. Claudio would like to thank to all the faculty and peers at UD that have helped him along the way, he especially thanks his advisor Dr. Louis Rossi for his great support along these years. Claudio thanks tremendously his wife Daniela for all her support and encouragement during these years. Claudio also thanks very much his two-year-old son Julian for challenging him in solving very applied problems, such as finding the optimal amount of ketchup for a finite number of fries or how to compute a line integral with spaghetti on the table.

Brief News Items from the Math Department

Funding Awarded to UD for MPI Workshop

Professors Edwards, Rossi and **Braun** have received funding from both the Institute for Mathematics and Its Applications (IMA) and the National Science Foundation (NSF) to support the 28th Annual Mathematical Problems in Industry (MPI) workshop (for a description of the workshop, see the Conference Corner). The IMA awarded the trio $5,000 towards this year's workshop at UD as one of its Participating Institution meetings; their reviewers noted that MPI was "very much in the spirit of the IMA's mission," which includes fostering collaborations between academia and industry, and training the next generation of researchers and educators. The NSF awarded $64,850 to Profs. Edwards and Rossi to support this year's workshop; Prof. Braun is senior personnel on the project. The program officer noted that "the reviewers found value in having a venue where faculty, students, and postdocs could work together with industry counterparts on mathematical problems arising from industry. . . . The reviewers found strength in the broader impact of the proposal, as the proposed activities would expose a new generation of junior researchers and students to industrial problems which require mathematical research." The Department thanks these organizations for their support and looks forward to a successful workshop.

Ph.D. student Isaac Harris addresses alma mater

Isaac Harris, class of 2010 from Kean University, visited his alma mater and spoke to students and faculty in the McNair program there. He spoke about his experiences working with **Dr. John Pelesko** and his research group here at UD, and his interest in applied math research. He also acknowledged the important role of Kean's McNair program and his summer research advisers there, **Dr. Beaugris** and **Dr. Avirappattu**. More information about Kean's (www.kean.edu/~mcnair/index.html) and UD's (www.udel.edu/mcnair/) very successful McNair programs is available via the given link.

Prof Cook delivers plenary address at ANZIAM

Pam Cook, professor of mathematics and associate dean of engineering for faculty development, was a plenary speaker at the ANZIAM 2012 conference in Australia this February. ANZIAM is the annual conference of the Australia/New Zealand Industrial and Applied Mathematics Society, a division of the Australian Mathematics Society. This annual conference attracts researchers in applied mathematics and related disciplines from all over Australasia.

Prof. Plechac continues and extends service to SIAM journals

On Jan. 1, 2012, **Dr. Petr Plechac** joined the Editorial Board of *SIAM Journal on Numerical Analysis (SINUM)*. The *SINUM* belongs to the leading journals in the field of numerical analysis and computations. The journal publishes research articles on the development and analysis of numerical methods. Topics include the rigorous study of convergence of algorithms, their accuracy, their stability, and their computational complexity. Also included are results in mathematical analysis that contribute to algorithm analysis, and computational results that demonstrate algorithm behavior and applicability. On Dec. 1, 2011 Dr. Petr Plechac was reappointed as Associate Editor of *SIAM Multiscale Modeling and Simulation*. Centered around multiscale phenomena, Multiscale Modeling and Simulation (MMS) is an interdisciplinary journal focusing on the fundamental modeling and computational principles underlying various multiscale methods.

Prof Plechac receives DOE grant

Dr. Petr Plechac has been awarded $154,000 for the academic year 2011–2012 from DOE Office of Advanced Scientific Computing and Research for the research on development of multiscale computational methods in stochastic simulations. The project is part of the joint collaborative research with Prof. D.G. Vlachos in UD Chemical Engineering on modeling and simulations tools for biomass conversion to renewable hydrogen.

Professor Cai receives NSF Grant

Professor Cai has received a grant of $1.5 million from the National Science Foundation for a three-year project titled "Longitudinal Investigation of the Effect of Curriculum on Algebra Learning from the Middle Grades through High School (LieCal-High School)." This project will investigate how different types of middle school mathematics curricula affect the learning of high school mathematics for a large sample of students (over 4,000) from ten high schools in an urban school district. This LieCal-High School Project is an extension of the previous NSF-funded LieCal-Middle School Project (see the following link for a UDaily article: www.udel.edu/PR/UDaily/2006/jan/NSF011706.html). Therefore, this project not only allows for investigating the impact of curricula on students' learning across their middle and high school years, but also allows for examining the development of students' algebraic thinking across seven years (grades 6–12). This is the only research project funded by NSF to investigate the curriculum effect across grade bands. Funds are available to support two full-time graduate students, and two undergraduate students.

Dr. Montes de Oca to invited to give keynote address at IJCCI 2011 in Paris

Dr. Marco Montes de Oca, Post-Doctoral Researcher in the Department of Mathematical Sciences, has been invited to give a keynote address at the Third International Joint Conference on Computational Intelligence (IJCCCI 2011) in Paris, France. The title of his talk is "Incremental Social Learning in Swarm Intelligence Algorithms for Optimization." The conference's website can be found at www.ijcci.org/.

Prof. Braun awarded NIH grant

Professor Richard Braun has been awarded about $100,000 from the NIH's National Eye Institute. The grant is a subaward that is part of a five year, roughly $1.15 million grant to the Indiana University College of Optometry, entitled "Tear film instability as a unifying mechanism for dry eye symptoms." Prof Braun will collaborate with researchers at Indiana and the University of Waterloo (Canada) to develop mathematical models of the tear film that compare directly with experimental measures of tear film dynamics.

Professor Li receives NSF Grant

Professor Wenbo Li has received a grant of $300,000 from the National Science Foundation for a three-year project titled "Topics in Small Value Theory of Probability." The project is concerned with developing methods and theory for the study of both typical behaviors and rare events of the type that positive random quantities take smaller values. The major objective is to extend the understanding of related areas and build a general small value theory based on systematic study of various techniques and applications. Funds are available to support graduate students over Winter and/or Summer.

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New Hires

Natalie Germann has joined us as a Post-Doctoral Researcher. She received her Ph.D. from the Swiss Federal Institute of Technology Zurich in 2011. Natalie's research focuses on the modeling, analysis, and simulation of viscoelastic fluids. Together with Prof. Cook and two collaborators from the Chemical Engineering Department, she is developing a new constitutive model that can predict the instabilities exhibited by highly concentrated solutions of certain types of surfactant molecules in inhomogeneous flow fields. As this model will be consistent with the first two laws of thermodynamics, she can develop a microstructural interpretation of the simulation results and thus gain insights into the mechanisms that drive the flow instabilities. During her first year of appointment, Natalie is teaching calculus. In her spare time, Natalie enjoys spending time with family and friends, singing and listening to music, experimenting with new recipes, etc.

Nicholas Gewecke received his Ph.D. in Mathematics in May 2011 from the University of Tennessee after working with Tim Schulze. He joined this department as a Post-Doctoral Researcher in August.

His research interests cover several areas of applied mathematics. His doctoral research involved the study of mushy zones, which occur during the solidification of alloys. His current research addresses the tear film, as he is working on a two-layer model that expands on previous models by explicitly including a lipid layer.

His nonacademic interests are varied. In particular, Nick enjoys playing a variety of sports, especially volleyball, and participating in choral groups.

Marco A. Montes de Oca joined us last year as a Post-Doctoral Researcher. He received his Ph.D. in Engineering Sciences in July 2011 from the Université libre de Bruxelles, Brussels, Belgium. Previously, he studied at the Instituto Tecnológico y de Estudios Superiores de Monterrey, Monterrey, N.L., Mexico and at the Instituto Politécnico Nacional, Mexico City, Mexico.

Marco is interested in what is known as "swarm intelligence." Swarm intelligence is both a phenomenon and a discipline. As a phenomenon, swarm intelligence is the collective problem-solving behavior exhibited by groups of animals that collect information individually, but process it socially through multiple direct or indirect interactions. As a discipline, swarm intelligence has a twofold goal: (i) to discover and improve our understanding of the principles that underpin the emergence of swarm intelligence in animals, and (ii) to adapt those principles to design artificial systems composed of many, yet simple entities that together solve complex problems. So far, swarm intelligence has found applications in data mining, optimization, and robotics.

Marco has been teaching Calculus I and III at UD. Previously, he taught European master's students the basics of "particle swarm optimization", a swarm intelligence technique for tackling continuous optimization problems.

Steven Senger joins us as a Post-Doctoral Researcher. He finished his Ph.D. last year at the University of Missouri, under the direction of Alex Iosevich.

Steven's main research interests are geometric and arithmetic combinatorics and frame theory. Much of his dissertation was devoted to studying the occurrences of geometric objects in subsets of various vector spaces. He also used frame theory to develop protocols for signal transmission through noisy media. He is currently extending some of his old work, while studying finite fields in the discrete group. He is also applying ideas from frame theory and geometric combinatorics to study swarming algorithms.

He is happily teaching both Finite Mathematics and Discrete Mathematics, which are two of his favorite courses. His other interests include playing live music, rock climbing, and the ancient board game Go.

Brief News Items, continued from page 8

Prof. Cai has been invited to be a distinguished speaker at CUHK

Jinfa Cai, Professor of Mathematics and Education, has been invited to be a distinguished speaker for the "Dr. Tien Chang Lin Technology Innovation Foundation Lecture Series in Education" by the Chinese University of Hong Kong in the Fall of 2011. The Dr. Tien Chang Lin Technology Innovation Foundation Lecture Series in Education was established by the Faculty of Education of The Chinese University of Hong Kong in January 2005. Dr. Tien Chang Lin was the 7th UC Berkeley chancellor from 1990–97 and an internationally known engineering scholar. "The main objectives of the lecture series are to invite prominent scholars from major universities around the world to share their expertise in specific fields of Education; to meet with educational practitioners and leaders to discuss issues that are important to the local educational community; and to explore possible ways to transfer their innovative ideas into local practice." Professor Cai will deliver a public lecture, open to all educators in Hong Kong. During his visit, Prof. Cai will also meet with faculty members and students at CUHK, and to exchange ideas on research and instructional initiatives.

Prof. Hsiao Gives Plenary Lecture at Georgian Conference

George Hsiao, Carl Rees Professor of Mathematics, recently delivered a plenary lecture at a conference in Tbilisi, Georgia. The Georgian National Academy of Sciences (GNAS) held the international conference "Continuum Mechanics and Related Problems of Analysis" from September 9–14, and it celebrated the anniversary of the GNAS as well as the 120th birthday of its first president, Nikoloz Muskhelishvili. Prof Hsiao's talk was entitled "Applications of Integral Equation Methods to a Class of Fundamental Problems in Mechanics and Mathematical Physics."

New Undergraduate Research **Award**

For many years, undergraduate research has been an exciting part of the Delaware experience for our math majors. This year, we started two new traditions to celebrate the beginning and end of our "research season." First, we had our first Mathematical Sciences Undergraduate Research Mixer this year, which was a lively affair where faculty and grad students announced summer research projects and topics to the undergraduates. Students could learn about our funding possibilities and our innovative Groups Exploring Mathematical Sciences (GEMS) program. Second, the Department of Mathematical Sciences is excited to announce the creation of the Mathematical Sciences Undergraduate Research Award. This award will encourage and foster research experiences for our undergraduates within and beyond the University of Delaware. Nominees will be accepted until November 30, and the award winner will be announced in early December each year. Those wishing to contribute to this effort may indicate "Mathematical Sciences Undergraduate Research Award" when they donate to UD.

Departmental **Recognition**

Mathematical Sciences Ranked in Top 100 for the Second Year

For the second 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 second straight year, the mathematics department was the only evaluated department at the University to be judged among the top 100 worldwide.

The 2011 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 54–68 range among U.S. institutions and in the range from 102–150 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 Princeton, Harvard, UC Berkeley, Stanford, Cambridge, Oxford, Pierre et Marie Curie Universite Paris 6, Universite Paris Sud (Paris 11), MIT, and UCLA. 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; 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.

The Academic Ranking of World Universities is published and copyrighted by Shanghai-Ranking Consultancy, an independent organization on higher education information.

This high ranking comes on the heels of a high ranking in the National Research Council's ranking in 2010. These achievements reflect the department's continuing emphasis on scholarly activity. Congratulations to everyone!

Conference Corner

Prof. Xiang organizes "the Wilsonfest" at Caltech

Professor Qing Xiang was chair of the organizing committee for the "the Wilsonfest" at Caltech. He is joined on the organizing committee by Jeff Dinitz (University of Vermont), Peter Dukes (University of Victoria, Canada) and Esther Lamken (San Francisco). The conference was in honor of Prof. Rick Wilson of Caltech; Prof. Xiang was mentored by Prof. Wilson as a postdoctoral fellow. For more information, please visit the conference web page at http://www.math.udel.edu/conferences/WilsonFest. The conference was supported by a grant from NSA (National Security Agency) and the Division of Physics, Mathematics, and Astronomy of Caltech.

Profs. Plechac and Sayas organize first DelMar Numerics Day

Professors Petr Plechac and Francisco Sayas of the Department of Mathematical Sciences are organizers of the first DelMar Numerics Day. It will be held on UD's campus in Newark on April 28, 2012. The numerical analysis conference is a collaboration between the UD and the Department of Mathematics at the University of Maryland in College Park. The other half of the organizing committee is Professors Ricardo Nochetto and Tobias van Petersdorff of UM. The meeting will feature a variety of topics from regional speakers, and the plenary talk will be given by Claudio Canuto of the Dipartimento di Matematica at the Politecnico di Torino (Turin, Italy). Complete information about the meeting can be found at http://www.math.umd.edu/delmar.

Mathematical Problems in Industry Workshop at UD in June

Professors Louis Rossi, David Edwards, and Richard Braun are organizing the 28th annual Mathematical Problems in Industry (MPI) Workshop to be held at UD's Newark campus, June 11–15, 2012. The organizing committee, chaired by Prof. Rossi, is rounded out by Profs. Joseph Fehribach and Burt Tilley (Worcester Polytechnic Institute), Prof. Donald Schwendeman (Rensselaer Polytechnic Institute) and Profs. Linda Cummings and Richard Moore (New Jersey Institute of Technology). The MPI Workshop is a lively, five-day interaction on the problems of interest to science and industry. On the first day, the industry representatives present their problems to the whole group. These problems vary widely in nature from those requiring basic physical modeling to those requiring significant computation (a partial list of problems brought to previous workshops is included in this site). For the rest of the week, the workshop participants break up into small working groups consisting of senior faculty and attending scientists, graduate students, and the industrial representatives, to discuss and tackle the problems in an informal setting. On the last day of the workshop, an academic representative from each group presents the results obtained and discusses possible future directions. A written report detailing the progress made during the workshop is prepared subsequently and sent to the industry representatives. Complete information about the meeting can be found at http://www.math.udel.edu/MPI. The MPI workshop is supported by grants from the National Science Foundation and the Institute for Mathematics and Its Applications at the University of Minnesota.

Going **Global!**

Study abroad in Dominica led by Prof. Seraphin

In January 2012, 13 UD students traveled with two faculty members to Dominica — The Nature Island for the "trip of a lifetime" as part of the University's Study Abroad Program. The students were from a variety of majors across the campus; the faculty were Dr. Anthony Seraphin (Associate Professor in Mathematics) and Dr. Steven E. Hastings (Professor in Food and Resource Economics).

The program was a collaborative effort between the College of Earth, Ocean, and Environment and the College of Agriculture and Natural Resources. Program Courses included FREC 150: Economics of Agriculture and Natural Resources and GEOG 235: Conservation of Natural Resources. The program also included UNIV 370-034: Study Abroad — Dominica FREC/GEOG which satisfied the Discovery Learning requirement.

Dr Seraphin promoting mathematics. (Photo: Dr. Hastings)

Taking a break in the Emerald Pool in the Carib Territory

Students learned about the physical, social and economic problems involved in integrating resource management and maintaining environmental quality, and the economic and management principles and their applications to agriculture, including agribusiness, natural resources and the environment of the Commonwealth of Dominica.

The courses were designed with the Caribbean in mind, but particularly focusing on the island of the Commonwealth of Dominica (15° 25' N, 61° 20' W). Dominica is part of the West Indies and is located in the eastern Caribbean Sea between Guadeloupe and Martinique. Students enjoyed the uniqueness of the island that is determined by its geology. Dominica is a rugged mountainous island of volcanic origin (highest point is Morne Diablotin 1,447 m). Dominica has a total land area of 754 sq km. Roughly 75% of the island is covered by thickly wooded mountains, with more than one quarter of it protected as national parks or forest reserves. It is the most mountainous of the Lesser Antilles, and its volcanic peaks are cones of lava craters and include Boiling Lake, the second-largest, thermally active lake in the world (World Factbook, 2007). The interior of the island is dominated by a series of high peaks and deeply incised valleys, which are carpeted by deep forest.

Outside of class, excursions included: Fort Shirley, a historic British fortress on the northwestern tip of the island; an ocean experience; a hike up Morne Diablotin; the Morne Trois Pitton National Park (tropical rain forest) and experienced the contrast in geography as they travelled from lowland (grass land) to highland (mountain vegetation and fauna) over a span of less than eight miles. Further excursions included the Carib Territory (home of the indigenous Kalinago people); another hike to the Valley of Desolation and Boiling Lake; the Soufriere sulphur-spring; Scott's Head (the demarcation point that separates the Atlantic Ocean and the Caribbean Sea); Sari Sari Falls; Tragalgar Falls; the Macoucherie Rum Distillery, the Dominica State College and others.

Students enjoyed their learning experience tremendously there. Dr. Hastings kept a blog of the course, commentary and many beautiful pictures from the 2012 Winter term experience can be found at http://dominica2012.wordpress.com.

Sinsay Dancers (Photo: Dr. Hasitings)

Webber Award 2012

The Department of Mathematical Sciences hosted the 2012 Webber Award ceremony on May 10, 2012. The recipients of the Webber Award were Valerie Maxwell, Mathematics and Science Education Resource Center, University of Delaware, and Jack Baldino, St. Mark's High School. They were chosen for outstanding contributions to mathematics education in Delaware. Valerie Maxwell has a vast experience teaching mathematics at different levels and has had a major impact in professional development of teachers of mathematics in the state. Jack Baldino has taught high school mathematics for over 50 years. He also did work with Dr. Webber early in his career.

The Webber Award is given in memory of Dr. G. Cuthbert Webber, Professor of Mathematics, University of Delaware (1937–1981), for work in advancing mathematics education. The ceremony was held at the Gore Recital Hall in the Center for the Arts and was attended by members of the Webber family, teachers, mathematicians, university administrators, and families and friends of the awardees.

The keynote address, "Challenges and Paradoxes in Mathematics Teaching and Learning," was presented by Dr. Diana V. Lambdin, Indiana University. She addressed issues related to determining the content of the school mathematics curriculum as well as additional challenges that need to be considered such as societal attitudes about mathematics, need for highly qualified teachers, and how student achievement is measured and compared.

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Thank you again for supporting the Department of Mathematical Sciences!

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