Math PUrview

Newsletter of the
Department of Mathematics ◆ Purdue University ◆ West Lafayette, Indiana Summer 2002

2002 Distinguished Mathematics Alumnus

Donald G. Saari and eight other School of Science alumni received Distinguished Alumni Awards from Dean Harry Morrison at an awards banquet held on April 19, 2002.

Donald G. Saari
M.S. 1964, Ph.D. 1967

Saari is a Distinguished Professor in the Departments of Mathematics and Economics at the University of California, Irvine. Prior to his appointment at UC-Irvine, he was on the math faculty at Northwestern University, where he began his career in 1968.

Saari's research interests are dynamical systems and applications to the physical and social sciences. He has written numerous books and journal articles on the general topics of voting and social choice, mathematical economics and game theory, and celestial mechanics.

His honors include a Guggenheim Fellowship; honorary doctorates from Purdue University, the Université de Caen, and Michigan Technological University; the Allendoerfer Award from the Mathematical Association of America; Fellow of the American Association for the Advancement of Science; and election to the National Academy of Sciences.

A past member of our department's Advisory Council, Prof. Saari is currently a member of the Council of the Social Choice and Welfare Society, the Joint Policy Board of Mathematics, the AMS Committee on Science Policy, the NRC Board on International Scientific Organizations, and the NRC Mathematical Sciences Education Board. §

Shahidi Named Distinguished Professor

Professor **Freydoon Shahidi** was appointed Distinguished Professor of Mathematics by the Purdue Board of Trustees on December 15, 2001.

Shahidi is regarded as a world leader in the field of automorphic forms. His work of the past few years is the culmination of two decades of work on developing the Langlands program that connects analytic information about L-functions with information in representation theory and number theory. This theory played a major role in the solution of Fermat's Last Theorem by Andrew Wiles.

Shahidi and his collaborators, including Henry Kim, a former Purdue postdoc, have proved many cases of Langlands functoriality. These results have already been used to dramatically improve work on the Ramanujan and Selberg conjectures which give information about number theoretic questions. The techniques that Shahidi pioneered are now known as the Langlands-Shahidi method.

Freydoon Shahidi

This work has been recognized throughout the international mathematics community. A Fellow of the Japan Society for Promotion of Science since 1993, Shahidi was appointed a Clay Mathematics Institute Prize Fellow in summer 2000 on the recommendation of Andrew Wiles. During the opening ceremonies of the 31st Iranian Mathematics Conference at the University of Teheran in August 2000, Shahidi was made one of the first three honorary members of the Iranian Mathematical Society. His work was mentioned by three plenary speakers at the American Mathematical Society's Mathematical Challenges of the 21st Century, intended to be a survey of the important work in all areas of pure and applied mathematics to be done in this century.

Shahidi's work has also been the subject of intensive seminars at the Institute for Advanced Study in Princeton. In June 2001, it was presented by Guy Henniart of Université de Paris-Sud (Orsay) in the Seminar Bourbaki in France, and a description of this work was part of the National Science Foundation's annual report to Congress.

Last year, Shahidi was named a Fellow of the John Simon Guggenehim Memorial Foundation. He is scheduled to deliver an invited talk at the August 2002 meeting of the International Congress of Mathematicians in Beijing. §

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Farewell and Welcome

As you peruse this newsletter, I'm sure you'll sense that we have had an exciting year here in the Mathematics Department. We're especially pleased and proud about the honors our faculty and students have received for their contributions to mathematics, to education, and to Purdue. Of course, *we* feel that we're doing well, but it is helpful to have these efforts recognized in a public way.

Carl Cowen

We are ending the second year of Purdue President Martin Jischke's leadership and ending the first year of Provost Sally Frost Mason's leadership. Both have gotten off to auspicious starts and have set in motion important changes on campus. Purdue has completed its first campus-wide strategic plan. Some of the important points of the plan are that we will attain or maintain pre-eminence in engineering and science and excellence in all areas of our work, increase the size of the faculty by hiring 300 new faculty members, increase the diversity of the faculty and the student body, and increase the interdisciplinary research efforts across the University. The policies of the next Dean of the School of Science will be an important part of how these plans will affect the Math Department, but we all hope that the mathematics programs will flourish in the changing environment.

This is a "Farewell" to you because my term as Head of Purdue's Mathematics Department has ended. It has been my pleasure to communicate with you in these pages and to meet with many of you while representing the Department over the past few years. I look forward to seeing some of you again when you visit campus or when our paths cross in other places — my door is always open to you! Next year, I'll be on sabbatical at Ohio State to learn something about the mathematics of neuroscience, but my email and postal addresses here will continue to work during my absence.

This is also a "Welcome" to Leonard Lipshitz, the new Head of our Department. He served a term as Head from 1992-1997 — thanks Leonard, for your willingness to take this responsibility again!

Please enjoy this issue of *Math PUrview* — we hope some of the items remind you of good times at Purdue and in our Department. Especially, we hope that our accomplishments make you proud to be a Purdue alum and friend and that you'll want to be a part of our efforts. I'm sure Leonard will appreciate your continuing support for the work of our Department. With your help, we will continue the traditions of excellence in the Mathematics Department as we face the challenges of the future.

— Carl

The Department and I thank Carl for his efforts and achievements on behalf of the Department during the last five years and wish him an interesting and productive sabbatical at Ohio State as he ventures into a new field.

Leonard Lipshitz

It is with mixed emotions that I reassume the position of Department Head. As Carl mentions above, President Jischke and Provost Mason are setting a new course for Purdue that will entail far-reaching changes. These changes will present us with both challenges and opportunities as we endeavor to keep both pure and applied mathematics strong and vibrant at Purdue.

We always enjoy hearing from alumni/alumnae and friends and hope that a growing number of you will keep in touch.

— Leonard

Math PUrview

is published for alumni and friends of the Purdue Department of Mathematics. We welcome your comments and suggestions for future newsletters.

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How to Zip a Region in the Plane . . . or "Look Dad, I did Applied Math!"

by Steve Bell

My father and I both finished our Ph.D. dissertations back in December of 1979, and over the winter break we sat down on the couch and passed each other lavishly bound copies of our dissertations to read. His thesis was a 300-page book on a fascinating issue about secondary school education. Mine was a 40-page ditty on boundary behavior of biholomorphic mappings in several complex variables that, even with the luxuriant binding, looked rather puny.

As I read my father's thesis, I immediately became absorbed in what was obviously a very erudite piece of work. I was proud of the old man! When I got to chapter two, I looked up to compliment him on his scholarship. I was surprised to see that he was looking at me with an expression on his face that I had not seen since the day I tried to explain to him that I had sprained my ankle jumping off the garage roof to test the parachute I had constructed out of bedsheets and clothesline. He was still holding my thesis open at the first page of the introduction. He asked, "What's a biholomorphic mapping?" I explained that a biholomorphic map was the same as a conformal mapping in the plane, and I drew some nice pictures to illustrate. My father looked pleased for a moment, but I had to add that in several complex variables, biholomorphic had nothing to do with conformal anymore. He shrugged and turned back to reading. A minute later he asked, "What the hell is a weakly pseudoconvex domain in complex euclidean space?" I explained what a convex domain was and could see that my father thought I was making sense, but his eyebrows started to rise again when I had to admit that *psendoconvex* domains could actually be concave in some directions. Soon after reading page two, my father put my thesis in a place of honor under the coffee table where it has remained until this day.

This was my first experience at trying to explain what I had chosen to do for my living to someone who really wanted to know—and I really wanted to tell him—but to no avail.

Back in 1979, there were only two questions that I could answer with authority. When my father asked what all this stuff was good for, I answered with pride, "Absolutely nothing!" (In 1979 that was cool. That's why I had a beard and he didn't.) When he asked me why on earth I did it, I answered, "Kicks." Now, in 2002, I would still answer "kicks," but I believe I have now shaved my beard long enough ago that I can give a much more compelling answer to the first question.

. . . "curiosity driven" pure math . . . can have dramatic moments of payoff.

Today, I want to explain to my father and anybody else who might have come to the conclusion that "curiosity driven" pure math is a silly, and perhaps even narcissistic passtime, that this activity can have dramatic moments of payoff. I want to explain how it came to pass that I discovered a potentially useful tool in the realm of computer technology—how to "zip" a region in the plane—without having the slightest motivation to do so.

What I can zip

Everybody knows what it means to zip their data today. You can compress a large file on your computer by "zipping" it so that it can be stored in less disc space. It can be transmitted across wires in shorter time when it is zipped, too. Later, you can rebuild the original file by "unzipping" it. I want to do something similar to some basic mathematical objects associated to a region in the plane.

Imagine a map of the continental United States printed on a sheet of rubber paper. Cut out the U.S. and throw away any islands so that the map is a single connected piece with no holes in it. A famous and very useful fact known as the Riemann Mapping Theorem asserts that it is possible to stretch this sheet of rubber in such a way that the map becomes a perfect circular disc. Furthermore, all the roads on the stretched map will cross at the same angles they made on the original map. Even if you were to add more roads to the original map, they would continue to cross at the proper angles on the stretched map. The stretching transformation that does this is called the Riemann Mapping, and the property that the angles get preserved under the transformation is expressed by saying this mapping is "conformal."

Here is just one example of the many uses of Riemann mappings. If you knew weather data on a grid of points in the United States, you might be able to figure out a way to predict tomorrow's weather. But what kind of grid would make sense on such a complicated shape as the U.S.? An optimal choice of a grid can be obtained by drawing the standard "radar scope" grid on the unit circle and unstretching it back to the full United States via that Riemann mapping. The pretty right angles made by the crossing of the concentric circles and the rays emanating from their common center on the radar scope will be preserved on their counterparts on the map of the U.S. Those right angles can be crucial for doing certain numerical simulations.

The mathematics of finding the Riemann map is intimately connected to another basic problem. Imagine a sheet of metal with temperature regulators positioned all around the edges. The shape of the sheet can be any odd shape. Let the sheet sit long enough so that the temperature inside stabilizes. If I know the temperature of the sheet at all the edge points, how can I figure out the temperature

(continued on page 10)

Conferences

Mathematics professors **Patricia Bauman, Daniel Phillips,** and **Aaron Yip** participated in a workshop "Advanced Electronic Materials and Anisotropic Materials," sponsored by the Purdue University Materials Consortium on November 2, 2001. Bauman spoke on "Anisotropic Mathematical Models in Superconductivity," Phillips on "Limiting Behavior for Liquid Crystal-Polymer Fiber Composites," and Yip on "Mathematical Methods for the Study of Material Interfacial Motions."

The Purdue Mathematics Department hosted the "Midwest Topology Conference" on November 10-11, 2001. Speakers included Matthew Ando (University of Illinois), Jesper Grodal (University of Chicago), John Klein (Wayne State University), Jean Lannes (Ecole Polytechnique), Bob Oliver (Paris 13), Dmitry Tamarkin (Harvard University), and Peter Webb (University of Minnesota). Conference organizers were professors **Brooke Shipley, Jim McClure, Clarence Wilkerson,** and Steward Priddy of Northwestern. Purdue, Northwestern, and NSF provided financial support.

The Department hosted the annual meeting of the Indiana Section of the Mathematical Association of America on October 20, 2001. Organized by **Carl Cowen**, the event brought about 90 college mathematics faculty from around Indiana to our campus.

Former Purdue students **Luca Capogna** (Ph.D. 1996) and **Loredana Lanzani** (Ph.D. 1997) hosted the "Harmonic Analysis, Multilinear Operators and Schrödinger Operators" conference at University of Arkansas April 11-13, 2002.

Professor **Freydoon Shahidi** was an organizer of the "Conference on L-Functions and Automorphic Forms" in honor of Joseph Shalika, held at Johns Hopkins University May 14-17, 2002.

Mathematics faculty and students participated in an Undergraduate Research Conference, held at Purdue on July 27, 2001 (below), where undergrads from Purdue and other institutions presented the results of their summer research investigations. A total of seven students, five of whom were supported by VIGRE funds, worked with faculty for eight weeks: ***Jose Carrion*** *of the U. of Puerto Rico, AF algebras;* ***Chris Manon*** *of Purdue, minimal surfaces;* ***Joshua Riddell*** *of Lake Forest, number theory and cubic reciprocity;* ***Keefe Roedersheimer*** *of Northern Kentucky, applied math and biology;* ***James Sherman*** *of Purdue, dynamical systems and Julia sets;* ***Jeremy Saddler*** *of Stone Child College, Montana, multidimensional medians; and* ***Yee Ching Yeow*** *of Purdue, linear fractional maps in several complex variables.*

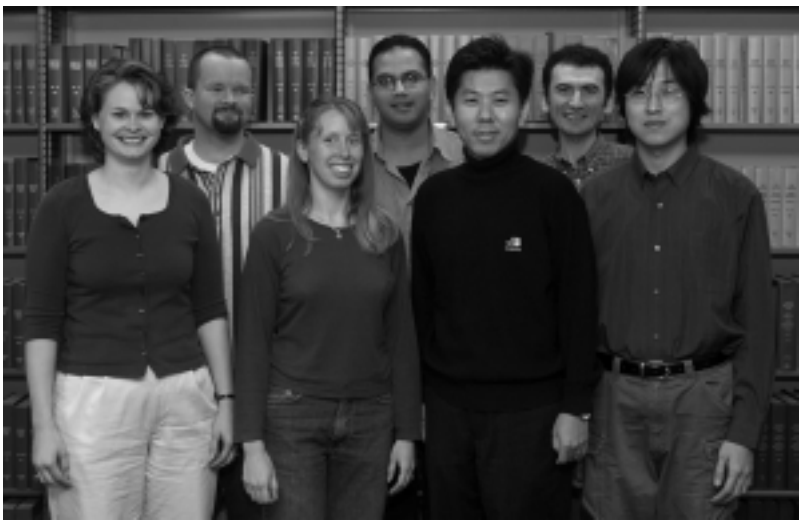
A conference in honor of the 75th Birthday of Professor **Jim Douglas, Jr.** was held at the University of Texas at Austin February 8-9, 2002. Douglas is Purdue's Compere and Marcella Loveless Distinguished Professor of Computational Mathematics.

The conference gathered different communities working in computational PDEs and exposed participants to some of the main current trends in the field. Speakers included Douglas N. Arnold, (Minnesota), Ivo Babuska (Texas at Austin), Jerry L. Bona (Illinois at Chicago), James H. Bramble (Texas A&M), Franco Brezzi (Pavia), Luis A. Caffarelli (Texas at Austin), Craig C. Douglas (Kentucky and Yale), Thomas Yizhao Hou (Cal Tech), Pierre-Louis Lions (Parix IX), Mitchell B. Luskin (Minnesota), Ricardo Nochetto (Maryland), J. Tinsley Oden (Texas at Austin), Chi-Sang Shu (Brown), Mary F. Wheeler (Texas at Austin), and Jinchao Xu (Penn State).

Jim Douglas (far left) and colleagues at the Great Wall near Beijing.

Before coming to Purdue in 1987, Douglas was on the faculties of Rice University (1957-67) and the University of Chicago (1967-87). He was affiliated with the Exxon Production Research Company for many years. Many of Douglas's more than 40 doctoral students and 60 postdocs joined in the conference's celebration of his distinguished career. Organized by Todd Arbogast and Irene M. Gamba of the University of Texas, the conference was sponsored by The Texas Institute for Computational and Applied Mathematics (TICAM).

TAs recognized for Outstanding Teaching



Front row left to right: Stephanie Gruver, Jennifer Hainge, Keeyoung Suh, Zhihong Li
Back row left to right: Chris Lomont, Rahul Desai, Yalcin Sarol

Seven Purdue graduate students received "2001-02 Excellence in Teaching Awards" from the Mathematics Department at an awards presentation on November 27. Teaching assistants Rahul Desai, Stephanie Gruver, Jennifer Hainge, Zhihong Li, Chris Lomont, Yalcin Sarol, and Keeyoung Suh received cash prizes of $250 each. Winners of the annual award are selected on the basis of student and faculty mentor evaluations.

Mathematics graduate students **Stephanie Gruver, Zhihong Li, Chris Lomont,** and **Yalcin Sarol** were also among Purdue TAs honored for their dedication to students and outstanding teaching contributions at the annual "Celebration of Graduate Student Teaching" banquet held on April 1 in the Memorial Union. This was the fourth year for this event, which is sponsored by the Committee for the Education of Teaching Assistants and the Office of the Provost.

Graduate Program in Review — 2001-02

This past year, 137 students were enrolled in the Mathematics graduate program. During this period, 27 students finished with M.S. degrees and 12 received Ph.D. degrees. The department has developed a number of interdisciplinary degree options. One of the newest, and also one that has generated a great deal of interest, is the Computational Finance Masters Program directed by Professors Ma and Viens.

Recruiting graduate students is very competitive, and the Mathematics Department is committed to attracting the best. This past spring, the Graduate Committee organized a recruiting weekend for applicants who had been accepted for admission in fall 2002. Most of the domestic applicants who in the end decided to come to Purdue visited during this weekend. The Mathematics Department has received both GAANN and VIGRE awards which helps us attract top domestic graduate students. To date we have 27 students supported by traineeships and fellowships through these programs.

In 2002, *U.S. News and World Report* announced rankings of the top mathematics and applied mathematics graduate programs. Purdue's mathematics program was ranked 26th overall while its applied mathematics program was ranked 27th.

Two More Graduates "Lift Off!"

Recent Purdue Ph.D. recipients **Liana Sega** and **Muthukrishnan Krishnamurthy** were named "Clay Mathematics Institute Liftoff Mathematicians" for summer 2002. They follow in the footsteps of two other Purdue grads to receive this award—Pedro Méndez (Ph.D. 2001, now at University of Utah) and Mahdi Asgari (Ph.D. 2000, now at University of Michigan).

While the Clay Mathematics Institute has been in the news in recent years because of its offers to pay millions of dollars to people who solve the big outstanding problems of mathematics, their practice of supporting young mathematicians who show exceptional promise is perhaps less well known.

Sega and Krishnamurthy are spending their summer fellowships at Purdue, before making spectacular, final liftoffs in fall 2002—Sega to UC Berkeley and Krishnamurthy to the Institute for Advanced Study in Princeton.

The Mathematics Department is as proud of these former students as any other of Purdue's more traditional astronauts!

2001-02 Graduate Fellowships

Andrews
Mark Ward

Ross
Yu-Lin Chang, An Fu

VIGRE
Charles Crosby, Thomas Garrison, John Hunter, Philip Mummert, James Price, Christina Selby, Scot Simon, Darren Tapp, Melissa Wilson

GAANN
Andrea Brian, Christine Cumming, Kayla Dwelle, Ruth Enoch, Miriosh Higgs, Natalie Kleinfelter, Luis Lomeli, Meike Niederhausen, Sandra Richardson, Sarah Ruppert

Fulbright
Anabel Beltran Cervantes

Carl C. Cowen, Jr.
John Hunter

T.T. Moh
An Fu

Student Re

Outstanding students were formally recognized in the Mathematics Department on April 26. Funding for awards and scholarships is provided by alumni and friends who target their contributions to Purdue award and scholarship funds. This year, mathematics scholarships ranged from $500 to $2500.

Jerison Award winner Celine Gallo and Professor Jim McClure, Chair of the Mathematics Undergraduate Majors Committe. Celine is the recipient of a Ruzicka-School of Science Undergraduate Research Award, which provides $3,000 for 10 weeks of full-time work on a research project. Celine worked this summer under the guidance of Prof. Marius Dadarlat on problems in operator theory.

Mathematics Awards

Eugene V. Schenkman Memorial Award ($250)	Brandon Zerbe
Glen E. Baxter Memorial Award ($400)	Keith Henderson Justin Mazur
Michael Golomb Mathematics Award ($400)	Glen Nixon Yee Ching Yeow
Meyer Jerison Memorial Award ($250)	Celine Gallo
Gerald R. MacLane Memorial Award ($300)	Ya Li
Merrill E. Shanks Memorial Award ($400)	Jeffrey Payne Christina Wettlaufer
Putnam Competition Award ($250)	Keith Henderson
Senior Achievement Award ($250)	Glen Nixon
School of Science Outstanding Achievement Award ($500)	Damir Dzhafarov Brandon Zerbe
School of Science Outstanding Senior ($100)	Yee Ching Yeow
Problem of the Week First Place Prizes	Damir Dzhafarov Haizhi Lin Yue Wei Lu Steven Schraudner Eric Tkaczyk Chit Hong Yam

Mathematics Scholarships

Alton D. and Juanita S. Andrews Memorial Scholarship	Lance Alexander Lee Ballard Susan Kowall Jeffrey Moser Susan Overstreet David Sapirstein Deborah Simon Bess Walker
Carl C. Cowen, Jr. Scholarship	Joseph Campbell
Mark Hoppy Memorial Scholarship	Jeanette Roell
Meyer Jerison Memorial Scholarship	Jennifer Bacon, Bess Walker
Virginia Mashin Scholarship	Christopher Drexelius Sheng-Kung Michael Yi
T.-T. Moh Scholarship	Yuhua Yu
Arthur Rosenthal Scholarship	Brenda Banning Patrick Jessee Christopher Scheper David Weissenborn
Helen Clark Wight Scholarship	Bess Walker
Robert E. Zink Scholarship	Lisa Bramer
Andris A. Zoltners Scholarship	Brent Monroe, Jeanette Roell
Mathematics Faculty Scholarship	Jason Dietz Michael Huffman Brandon Zerbe

Your Gifts are Important to Us!

As the Department of Mathematics continually works to improve the quality of its programs, one of our major goals is to increase the amount of money available for departmental student activities and support. Annual alumni contributions, no matter what the amount, are very important to our efforts in this area. We thank those who have helped support mathematics students in the past, and we hope that all of our alumni will consider designating the Mathematics Department as the recipient of future gifts so that we can continue to offer financial incentives to deserving students.

Actuarial Science at Purdue

by Richard Penney, Director

Members of the Actuary Club in Recitation Hall

It has been an active year for the Actuarial Program. This year we inaugurated a new scholarship program: the Towers Perrin Scholarships. Dale Woods from Towers Perrin was on hand at the award ceremony in April to give the first awards to Sebastian Kleber and Jeanette Roell. This program is in addition to the CIGNA, Lincoln, Trustmark, and Alumni Scholarships. Thanks to Towers Perrin and all of our industrial supporters!

Speaking of industrial support, this fall we will welcome several new members to the Actuarial Science Advisory Council: David A. Brentlinger (American United Life Insurance), Larry Jackson (Lincoln National), Aaron Lambright (CIGNA), and Dale Woods (Towers Perrin). The Advisory Council provides an essential link with the industry, making sure the program stays in touch with what's happening outside of the "ivory tower."

Academically, we have made several additions to the program, including a class on data bases (Microsoft Access) and requiring a class on Random Modeling (MA/STAT 474). We are working on getting a Visual Basic class into the program. We can now say that our program provides complete preparation for the first three exams! As proof of this, eight students passed Course 1, three Course 2, and one Course 3. We are hoping for even better results in coming years.

2002
Actuarial Science Awards

Junior Awards

Lincoln Scholarship
Lauren Coleman
Trustmark Scholarship
Michael Knowles

Sophomore Awards

Towers-Perrin Scholarships
Sebastine Kleber
Jeanette Roell
Lincoln Scholarships
Haizhi Lin
Wendy Thompson

Freshman Awards

CIGNA Scholarships
Patrick Jessee
Kensey Thurner
David Weissenborn
Alumni Scholarship
Devin Gardner

School of Science Outstanding Achievement Award winner Brandon Zerbe and Dean Harry Morrison. Brandon also received the Schenkman Award and a Mathematics Faculty Scholarship.

Glen Nixon (center) received the 2002 Golomb Award and the Senior Achievement Award. Following the awards program, Glen chatted informally with (left to right) Prof. Burgess Davis, his dad, and Eric Tkaczyk.

Professional Plaudits

Brooke Shipley is the recent recipient of two highly competitive and prestigious research awards for faculty in the early stages of their careers: a Sloan Research Fellowship ($40,000 for two years) and an NSF Faculty Early Career Development award ($300,000 for five years). Shipley will use her awards to investigate the interplay between the study of algebraic structures and topology. She hopes to use techniques developed in algebraic topology to attack questions that originate in algebra. These techniques include the use of a theory of obstructions, which determines whether certain constructions are possible. In another project, Shipley plans to extend existing algebraic models to include structures involving symmetries.

Brooke Shipley is an award-winning researcher and accomplished classroom teacher. She received the 2001 School of Science Outstanding Assistant Professor Award for undergraduate teaching and this spring was promoted from assistant to associate professor.

Laszlo Lempert

Laszlo Lempert was the winner of a 2001 Bergman Prize. Established in 1988, the prize recognizes mathematical accomplishments in the areas in which Stefan Bergman worked. Lempert's work has contributed to both the geometric and analytic aspects of several complex variables; his techniques include those from partial differential equations, complex analysis, real and complex geometry, and topology. One important contribution is his analysis of the complex Monge-Ampere equation. Previous Purdue recipients of the Bergman Prize are Professors David Catlin (1989) and Steve Bell (1991).

Irena Peeva

Irena Peeva has been named a Purdue University Faculty Scholar. Peeva was nominated by a School of Science faculty committee and appointed by Provost Sally Frost Mason. The honor recognizes outstanding accomplishments by faculty mid-way through their academic careers. The five-year appointment carries with it $10,000 per year of university funding for research. Peeva works in the areas of commutative algebra and algebraic geometry.

Book Notes

Former graduate student **Zhuan Ye** (Ph.D. 1992, thesis advisor David Drasin) of Northern Illinois University and his co-author William Cherry of the University of North Texas have published a research monograph, *Nevanlinna's Theory of Value Distribution* (Springer-Verlag, 2001). The authors provide a leisurely introduction to the field for those with no background in Nevanlinna theory, and the book is intended to be easily accessible to those with only a basic course in one complex variable.

Prof. **Leonard D. Berkovitz** has published *Convexity and Optimization in* $\mathbb{R}^n$ (Wiley-Interscience, 2001). The book presents the mathematics of finite-dimensional optimization, featuring those aspects of convexity that are useful in this context. It is intended for beginning graduate students in engineering, economics, operations research and mathematics, and strong undergraduates in mathematics.

Fabio Milner is the recipient of a School of Science Curriculum Development Award for summer 2002. The award will provide two months of summer salary while Milner works to enhance course placement and course redesign for MA 111, 153, and 154.

Fabio Milner

Johnny Brown

Johnny Brown, Professor of Mathematics, and **Eric Hall**, Research Assistant Professor of Mathematics, were among the "Top Ten Teachers of Undergraduate Science Majors" recognized by the Science Student Council at a School of Science recognition reception held in Stewart Center on April 12.

Eric Hall

Eremenko Receives University's Top Research Award

Professor **Alexander Eremenko** was one of two recipients of the 2002 Herbert Newby McCoy Award. The $3,000 award is given annually to a Purdue faculty member who has made the greatest contribution of the year to scientific knowledge. The recognition was established in 1964 through a bequest from Ethel Terry McCoy in memory of her late husband, an alumnus of the School of Science.

Eremenko has been on the Purdue mathematics faculty since 1992 and is considered by experts in his field to be a leader in complex geometric function theory. Recently, he and his collaborator, Mario Bonk of the University of Michigan, found a complete solution to a 70-year-old central problem in classical complex analysis. Eremenko has made fundamental advances in several areas, including entire functions, value distribution, and complex dynamics.

A recipient of a 2001 Humboldt Research Award, Eremenko is scheduled to present an invited address at the August 2002 International Congress of Mathematicians in Beijing.

(left to right) Carl Cowen, Alexandre Eremenko, Dean Harry Morrison, David Drasin, Roberto Colella, and Vice President for Research Gary Isom are pictured at an awards presentation and reception in Hovde Hall on April 23. Eremenko was nominated for the McCoy award by Professors Cowen and Drasin. Colella, Professor of Physics, also received a McCoy award, which is administered by the office of the Vice President for Research.

New Faculty Join Department

Several new faculty members will join the department in August 2002.

Professor of Mathematics

Jie Shen, Ph.D. 1987, Université de Paris-Sud; numerical analysis and scientific computing with applications in computational fluid dynamics and materials science

Associate Professor of Mathematics

Min Chen, Ph.D. 1991, Indiana University; numerical analysis, scientific computing, partial differential equations

Jaroslaw Wlodarczyk, Ph.D. 1993, Warsaw University; algebraic geometry

Research Assistant Professor

Michael T. Jury, Ph.D. 2002, Washington University; operator theory, functional analysis

Mark E. McKee, Ph.D. 2002, Princeton University; automorphic forms and L-functions, representation theory

Visiting Assistant Professor

Martin Deraux, Ph.D. 2001, University of Utah; several complex variables

David W. Kribs, Ph.D. 2000, University of Waterloo; operator theory, operator algebras

Oana Mocioalca, Ph.D. 2002, University of Florida; functional analysis

Dominic Naughton, Ph.D. 1999, Auburn University; representation theory of Lie algebras

Jae-Hong Pyo, Ph.D. 2002, University of Maryland; numerical analysis

Federico Tournier, Ph.D. 2002, Temple University; partial differential equations

Transitions

Prof. **James Thurber** retired in December 2001. A graduate of Brooklyn College, he received his Ph.D. from NYU's Courant Institute in 1961. After working for several years at the Brookhaven National Laboratory, Thurber came to Purdue as Professor of Mathematics in 1969. Throughout his career, he worked in several areas of applied mathematics, including transport theory, asymptotic analysis, and quantum field theory.

Lilian Reifel retired from the Mathematics Department staff in January 2002. A Purdue employee for over 18 years, Lil came to the Math Department from the Division of Financial Aid in January 1984 as our copy center operator. Lil also supervised and served the daily afternoon tea in the Math Library for several years. In May 1989 Lil moved from the copy center to the front desk of the Main Office. Always energetic, Lil continues to work part-time as a Hall of Music attendant for special events and concerts.

Jackie Oswalt recently resigned her position in the Math Department to move to Virginia with her husband, Dave. This was an exciting change for them, as their two sons now live on the east coast. Jackie had been with the department since 1984 and for several years her duties included serving as secretary for the actuarial science program. More recently, she was the department's office manager and administrative assistant.

(continued from page 3)

at a given interior point (without actually walking on the sheet and poking it with a thermometer at the point)? The answer for a circular metal plate is a lovely piece of classical analysis known as the Poisson formula. It is the Poisson formula that I want to "zip."

In a note like this where I try to justify my mathematical existence to my biological father, I cannot help but mention my mathematical father, my MIT Ph.D. thesis advisor, Norberto L. M. Kerzman. Every mathematician speaks of his or her mathematical parent with reverence. I inherited much of my mathematical taste from Norberto. I was recently delighted to discover at the Mathematics Genealogy Project web site

http://hcoonce.math.mankato.msus.edu

that Norberto and I are direct mathematical descendents of Siméon-Denis Poisson (1781-1840), who discovered the Poisson formula. My predilection to zip the Poisson kernel might be in my mathematical blood!

Now back to the Poisson kernel:

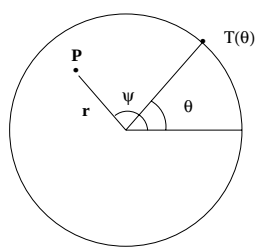


Figure 1

We can describe the temperature at the boundary of a circular disc of radius one by a function $T(\theta)$ where the number $T(\theta)$ is the temperature at the boundary point making an angle θ from the horizontal (see figure 1). Suppose we want to know the temperature at the point P at radius r such that the ray joining P to the center makes an angle ψ with the horizontal. The Poisson formula gives the answer: multiply $T(\theta)$ times the "Poisson kernel,"

$$P(\theta) = \frac{1}{2\pi}\frac{1-r^2}{1-2r\cos(\theta-\psi)+r^2}$$

and graph the result like this:

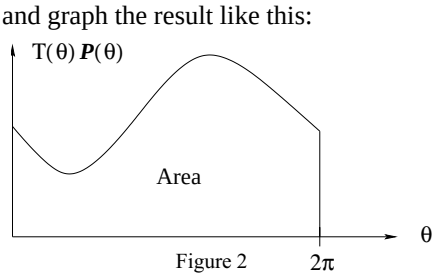


Figure 2

The value of the area enclosed by the graph (see figure 2) will be equal to the temperature at the point P. (Note: the angle of $\theta = 2\pi$ radians on the graph corresponds to 360°.)

What I have discovered in my pure curiosity driven research is that the Poisson kernel is always a "rational" combination of only *two* building block functions, even when the metal sheet is a very odd shape, and even when it is allowed to have holes punched out of it. The building block functions have the nice property that their values in the interior can be gotten from their values on the edge by an explicit formula known as the Cauchy integral formula.

An example of a "rational" combination of x and y is

$$\frac{2x^2y^3+4x^4y}{xy^2-5x^2y^2+7x^{10}y^3}.$$

It looks ugly, but all I need to know are finitely many values of the coefficients in front of each term and the powers of x and y in each term to calculate the function. Thus, I can zip the Poisson kernel by compressing its formula into knowing merely the values of my two building block functions on the edge of the domain and a few numbers that determine the rational combination.

What do you think about that, Dad? If somebody (somebody from Boeing, for example) needed to store Poisson kernels in a minimum of space, I could tell them how to do it . . . well, not really how to do it, actually. I could tell them that it could be done . . . This is a good moment to change the subject.

The path of curiosity driven research to applied math

My favorite example of a piece of pure curiosity driven mathematical research that became a powerful tool in the hands of the right people is the example of the Radon transform. Imagine an oddly shaped birthday cake sitting on your table. Imagine that I can slice the cake with a meat cleaver and measure the area of a slice without destroying the cake. Radon asked the question, "If I know the value of the area of each slice of the cake in every possible direction, can I reconstruct the shape of the cake from this information?" He answered the question in the affirmative, and he came up with a formula for the answer known as the Radon transform. This silly sounding exercise in pure math is the basis for CAT scan medical imaging.

Of course my discovery about zipping Poisson kernels is not as dramatic as the Radon transform. In fact, it might be a mere footnote in mathematical history if nobody ever really needs to zip Poisson kernels. I am telling this story to illustrate how it is possible for someone like me to stumble onto a potentially useful result as I stroll down the stairs of the ivory tower of pure mathematics. I came upon my discoveries from an even more ridiculous sounding direction than a cake slicing problem.

In 1977, my advisor, Norberto Kerzman, was working with Elias M. Stein studying something called the Szegö kernel in "strictly pseudoconvex domains in multidimensional complex euclidean space." Kerzman and Stein discovered a new property of this wild and exotic thing that surprised the experts, and they wrote a magnum opus on the subject [8]. I have worked on similar such things since then, and whenever I have received government grants for this purpose, I have been given the forboding warning that the NSF has decided to support my work; however, the project does not seem to have a "bearing on problems considered to be of strategic interest to the federal science enterprise." First my Dad, and then the NSF!

At some point after they had written their long paper on the subject, Kerzman and Stein realized they had also discovered something new about the Szegö kernel even in the case of a region in the plane like I described above in the heat problems. They wrote about their discovery in a beautiful little paper [9]. This short paper is an absolute gem. It shows how the Riemann mapping can be constructed using the new result about the Szegö kernel, complete with explicit formulas that were later shown to be very effective by numerical analysts [10, 11]. It also revealed something new and surprising about a 300-year-old formula, the Cauchy integral.

In 1979 I thought of mathematics as a huge blob of platonic goop in outer space, and I believed that before I could discover new mathematical truths I would need to grapple and claw my way far out into the blob before I would encounter unexplored territory. Now, after 20 years of doing mathematical research, I find that mathematics is more like a sponge than a blob. There are holes everywhere—big ones and little ones. If you think about mathematics for any length of time, you might just jam your head into one of them

and look upon a beautiful vista that no one has ever seen before. Good mathematicians are more like worms than mountain climbers. Kerzman and Stein showed me that there are new and beautiful truths to discover about something as old and well worn as the Cauchy integral formula.

Kerzman's and Stein's little paper also demonstrates that pure mathematicians cannot resist the temptation to do applied math when the opportunity presents itself, even though they might not actually strive for the opportunity. It seems highly unlikely to me that someone whose project it was to find a way to numerically compute the Riemann map would approach it from the point of the view of the Szegö kernel. And yet this approach yields an elegant and practical method indeed.

Steve Bell (right) with his thesis advisor, Norberto Kerzman, in 1980. Prof. Bell, who works in complex variables and partial differential equations, has been the recipient of several awards, including a Stefan Bergman Prize in 1990.

Kerzman always spoke fondly of his "little paper" with Stein, but he obviously considered it to be a mere trifle next to his big paper with Stein. Yet, I would be surprised if Kerzman's citation index does not make his little paper look like his greatest work. His name has already been immortalized in mathematical history in the phrase "the Kerzman-Stein integral equation for the Szegö kernel."

In my own work, I was motivated by things that I was curious about, not by what might be useful. After Kerzman and Stein showed that the Szegö kernel was a much more concrete and computable object than had been previously imagined, I took it upon myself, almost as a hobby, to see if I could express other mathematical objects in terms of the Szegö kernel. I was even able to bring into play some of the things I had discovered in multivariable complex mapping problems that my father had raised his eyebrows at. The result was that many things quickly fell into place in rather appealing ways, and I found that I might have done some applied math in spite of myself. I wrote a "little" book about it [1], just as a chip off the block of my thesis advisor should.

Not only could I zip the Poisson kernel, but I found I could zip the Bergman kernel, the Ahlfors maps, and the infinitesimal Carathéodory metric as well, and I could not resist pushing further in the subject as I wrote a series of papers [2]-[7]. (And as I look back on those papers, I think I could zip some of them considerably too now that I see the big picture more clearly.)

As I approach the age my father was back in 1979, I look forward to a climb back up the stairs of that ivory tower. I'm getting a strong urge to zip an abstract Riemann surface with finitely many handles and edges.

If you have not put this little note under the coffee table or into the recycling bin already, I thank you for your indulgence. I've needed to get this off my chest since 1979!

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2002 Research Experience for Undergraduates (REU)

Nine undergraduates from Purdue and other institutions spent eight weeks at Purdue's West Lafayette Campus this summer working on individual research projects with members of the mathematics faculty. Stipends of $3,700 were provided by the National Science Foundation's VIGRE program for seven students to conduct research in various areas, including operator theory, logic, applied math, and topology: **Carolyn Abbott**, Tufts University; **Damir Dzhafarov**, Purdue University; **Sarah Grove**, Youngstown State University; **Ben Kalafut**, Tulane University; **Chris Manon**, Purdue University; **Justin Mazur**, Purdue Unversity; **Seth Streitmatter**, Purdue University.

Two Purdue undergraduate math majors were supported by School of Science Undergraduate Research Awards of $3,000 each: **Celine Gallo**, Ruzicka Award; **Chris Scheper**, Spira Award.

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