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SIAM Marks 60th Anniversary at Minneapolis Meeting

With an AWM–SIAM Sonia Kovalevsky Lecture titled "The Role of Characteristics in Conservation Laws," Barbara Keyfitz emphasized her direct connection to the work of Sonia Kovalevsky (1850–1891), whose Cauchy–Kovalevsky theorem makes clear the importance of characteristics in PDEs. (At the Joint Math Meetings early this year, by contrast, Keyfitz titled her Noether Lecture "Conservation Laws—Not Exactly à la Noether," pointing to the more distant relation between current research in conservation laws and the celebrated theorem of that name by Emmy Noether (1882–1935). In fact, Keyfitz says, it is well known that weak solutions to conservation laws do not preserve the symmetries described by Noether's theorem; Noether herself moved away from her early work on invariant theory and went on to a career as a founder of modern algebra.)

The contributions in hyperbolic conservation laws for which the Kovalevsky committee cited Keyfitz include work with Herbert Kranzer on the "novel and important notion of singular (also called delta) shocks" and their properties. She and her collaborators also "spearheaded the revival of the rigourous treatment of transonic gas flow." Her work has applications in aerodynamics and in models of multiphase flow in porous media.

In the lecture, Keyfitz followed an overview of progress in the field with a gratifying recent update: After "languishing for 25 years," she said, one of her and Kranzer's results was resuscitated recently by Marco Mazzotti of ETH Zurich. Mazzotti explored a variation on the familiar equations of two-component chromatography, which he terms "Langmuir/anti-Langmuir adsorption isotherm," and discovered solutions that appeared in numerical simulations to exhibit singular shocks. In a real tour de force, Keyfitz said, Mazzotti and co-workers were able to design an experiment that demonstrated an example of these elusive objects.

"When I discovered numerically the singular solution in nonlinear binary chromatography," Mazzotti wrote to *SIAM News*, "I had never heard of the existence of that type of solution to hyperbolic equations. Keyfitz's papers allowed me to put my results into context. Particularly her 1995 paper with Kranzer (*Journal of Differential Equations*) was decisive in providing me with the conceptual and mathematical tools needed to find an explicit expression for the

See **Kovalevsky Lecture** on page 4

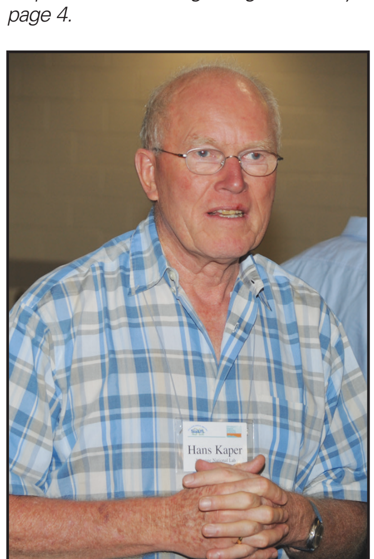
Chosen to give this year's AWM–SIAM Sonia Kovalevsky Lecture, Barbara Keyfitz (left) of Ohio State University accepted the prize from AWM president Jill Pipher at the 2012 SIAM Annual Meeting in Minneapolis. Citing Keyfitz for "pioneering and seminal contributions to the field of hyperbolic conservation laws" (see accompanying article), the prize committee also commended her for "an outstanding record of professional service." SIAM had the same idea in the latter case: Keyfitz also received the SIAM Prize for Distinguished Service to the Profession in Minneapolis. See page 3.

2012 John von Neumann lecturer Sir John Ball of the University of Oxford (right), pictured with SIAM president Nick Trefethen, was honored for "his deep contributions to our understanding of the mechanics of materials via the calculus of variations and other branches of mathematical analysis, especially his pioneering work on existence theorems and constitutive models for nonlinear elasticity, cavitation in solids, irregular minimizers and material microstructure, and, more recently, defects in liquid crystals."

Also celebrating a 60th birthday this year is Carlos Castillo-Chavez (second from left), whose contributions to mathematical epidemiology were recognized in Minneapolis at a session organized by admiring and grateful students and colleagues as part of the Workshop Celebrating Diversity. Speaking at the session were, from left: Castillo-Chavez's daughter Melissa Castillo-Garsow of Yale University, a journalist and writer; early mentor Simon Levin of Princeton University; first postdoc Zhilan Feng of Purdue University; longtime colleague Mac Hyman of Tulane University; and former graduate student Gerardo Chowell of Los Alamos National Laboratory.

Together, the speakers told the story of a remarkable career in which early twists and detours—a thwarted ambition to become an actor, an aversion to working on infectious diseases, announced to Levin by Castillo-Chavez on his arrival in Princeton—led with seeming inevitability to an emphasis on mentoring, over research (path-breaking research in infectious diseases, in fact) and just about everything else. The founding of the Mathematical and Theoretical Biology Institute, and its eventual relocation from Cornell to Arizona State University, gave Castillo-Chavez a platform from which he could influence hundreds of students to consider careers in mathematical modeling and analysis. The ASUs of the world, Castillo-Chavez said at the conclusion of the session, can reach far more students than an elite institution ever could. The many MTBI alumni in attendance provided strong confirmation of his vision and impact.

"Tony Chan is not your average university president." Sparked by Chan's remarkable invited talk on big themes in image processing, SIAM president Nick Trefethen devotes his column in this issue to advances and algorithms discussed in the talk, and to the equally remarkable career leading up to Chan's appointment in 2009 as president of Hong Kong University of Science and Technology. See page 4.



Hans Kaper of Georgetown University is co-director of the NSF-funded Mathematics and Climate Research Network and, as of very recently, editor-in-chief of SIAM News. In Minneapolis, as in Vancouver at ICIAM 11, he was on the lookout for interesting topics for SIAM News coverage; he is now in the process of forming an editorial board.

Annual meeting photos by John Markovich unless otherwise noted.

Michele Benzi (left) and Tasso Kaper, co-chairs of the organizing committee for the 2012 SIAM Annual Meeting. One innovation introduced at the meeting, in which both took active roles, was a minisymposium during which a group of invited speakers made themselves available to students at all levels, who were free to ask questions about anything to do with careers in the math sciences. See page 5. Photo by Susan Whitehouse.

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Uncertainty Quantification 2012

Statistical Approaches to Combining Models and Observations

By L. Mark Berliner

Continual improvements in both computational assets and observational data are revolutionizing science and engineering. However, models, computations, and observations are subject to a variety of sources of uncertainty, mandating the need for quantification and management of uncertainty. Bayesian hierarchical modeling is a framework for combining diverse datasets, mechanistic and statistical models, and computation in a fashion that manages uncertainty (see, for example, [1,5]).

Hierarchical probability models are sequences of conditional distributions that correspond to a joint distribution. Let X, Y, and Z be three random quantities (scalars, vectors, or space–time fields), and let $p(x,y,z)$ denote their joint probability density. This density admits the factorizations

$$p(x,y,z) = p(x \mid y,z)\, p(y,z) = p(x \mid y,z)\, p(y \mid z)\, p(z),$$

where $p(x \mid y,z)$ is the density of X given $Y = y$ and $Z = z$. This is elementary mathematics but suggests a powerful applied modeling strategy, in which we form models in three primary steps: (1) *Data Model*: a probability distribution of observations Y conditional on the processes or state variables X of interest and on model parameters θ_Y; (2) *Process Model*: a prior distribution for X conditional on parameters θ_X; and (3) *Parameter Model*: a prior distribution for θ_Y and θ_X. Bayes' theorem provides the posterior distribution of X and the parameters conditional on the observed data $Y = y$. The posterior distribution is the Bayesian answer. From it, we derive probabilities of hypotheses and events of interest, estimates, confidence intervals, predictions and associated intervals, etc.

The data model $p(y \mid x, \theta_Y)$ is typically a "measurement error model." For example, we might consider a model based on $Y = x + \varepsilon$, where ε is a random, unobservable error. The parameter θ_Y might include unknown measurement error variances, measurement biases, and so forth. The power of the strategy is the ability to treat diverse datasets. Suppose, for example, that $Y = (Y_w, Y_\psi)$, where Y_w are wind measurements and Y_ψ are pressure measurements over some region. $X = (W, \psi)$ are true winds and pressures. We expect that (Y_w, Y_ψ) would display a complicated, difficult-to-model dependence structure. If the lion's share of that structure arises from the underlying relationship between W and ψ, however, we may be able to defend the data model

$$p(y_w, y_\psi \mid w, \psi, \theta_Y) = p(y_w \mid w, \theta_Y)\, p(y_\psi) \mid \psi, \theta_Y);$$

that is, Y_w, Y_ψ are conditionally independent. Notice that $p(y_w \mid w, \theta_Y)$ does not include ψ in the conditioning; this does not mean that Y_w and ψ are independent, but rather that they are conditionally independent given $W = w$.

The process model offers the opportunity to incorporate scientific modeling of the quantities of interest. Often, we formulate models from underlying differential equations or discretized versions of them [4,10]. For our wind–pressure example, the geostrophic approximation suggests that winds are proportional to the gradient of the pressure field. We can incorporate this notion in a stochastic geostrophic approximation,

$$p(w, \psi \mid \theta_X) = p_g(w \mid \psi, \theta_X)\, p(\psi \mid \theta_X),$$

where p_g is based on the actual geostrophic relation [8]. This example indicates how we can incorporate mechanistic models among the quantities in X. In some examples we model the process of interest conditional on boundary and/or initial conditions and then model those conditions. Finally, with the parameter model we can incorporate further information (calibration studies, for instance, lead to priors for θ_Y) in a fashion that allows for uncertainty. For example, physical theory may suggest the values, or at least interpretations, of some quantities in θ_X. This information is used to construct the prior, but allows for uncertainty. Moreover, that uncertainty responds to the data through the posterior distribution.

Analysis of Bayesian hierarchical modeling is often compute-intensive. Such advances as Markov chain Monte Carlo, sequential Bayes, and particle filtering have made serious BHM applications possible (e.g., [7]). However, use of process models requiring runs of large-scale, supercomputer models for single iterations of a Monte Carlo Bayesian calculation are typically feasible. This suggests the need for approaches that can incorporate ensembles from large models. Let $\boldsymbol{O} = (O_1, \ldots, O_n)$ denote an ensemble of size n. (We can account for ensembles from different models and/or generated from various model parameterizations, but I do not do so here.) The following potential strategies are organized around the BHM skeleton presented earlier.

First, consider modeling $\boldsymbol{O}$ *as if* the data were observational [2]. That is, we form a data model $p(Y, O \mid x, \theta_Y, \theta_O)$. The parameter θ_O includes variation from the ensembling, model-to-model differences, and model biases (or offsets), thereby allowing us to learn about these features based on Y. This framework also lends itself to the design of hybrid experiments involving both observational data and computer models. (See [6].)

Next, we can use model output to formulate a process model prior in a variety of ways. Much of the literature in the design and analysis of computer experiments (e.g., [9]) begins with a Gaussian process model for model output: $p(o \mid \theta)$ for some collection of parameters θ. In many cases, θ are unknown parameters in a covariance function characterizing the dependence structure of output as a function of model inputs. This model is then updated to produce $p(o, \theta \mid O)$. Related ideas are known as "model emulators." In any case, transferring such results to form priors on true processes (X) remains a challenge. In yet another possibility, data analysis on model output can lead to parameter prior models (e.g., [3]). Finally, various combinations of these modeling strategies are feasible.

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Deadline Changes for DMS Math Biology Program

The National Science Foundation's Division of Mathematical Sciences has announced a new deadline for the submission of proposals to its Mathematical Biology program. The submission window for full proposals is now November 1 to November 15, annually.

The Mathematical Biology program is shifting its deadline in order to continue the program's longstanding practice of co-review and co-funding with the Directorate of Biological Sciences, which recently introduced deadline changes for three of its divisions.

Only research proposals submitted during this period will be considered for review; however, conference and workshop proposals should still be submitted about eight months before the requested starting date.

For more information on the Mathematical Biology program, readers should see www.nsf.gov/funding/pgm_summ.jsp?pims_id=5690&org=DMS&from=home].

SIAM Honors Excellence and Innovation at 2012 Prize Luncheon

The following recipients of SIAM awards and prizes were recognized in Minneapolis on July 10, during the 2012 SIAM Annual Meeting:

I.E. Block Community Lecture. Robert Bridson, University of British Columbia, Canada; the lecture was titled "Creating Reality: The Mathematics Behind Visual Effects."

AWM–SIAM Sonia Kovalevsky Lecture. Barbara Lee Keyfitz, Ohio State University, with a lecture titled "The Role of Characteristics in Conservation Laws."

Richard C. DiPrima Prize. Thomas A. Goldstein, Stanford University, for his dissertation "Algorithms and Applications for L1 Minimization."

George Pölya Prize. Vojtěch Rödl, Emory University, and Mathias Schacht, University of Hamburg, Germany.

W.T. and Idalia Reid Prize in Mathematics. Ruth F. Curtain, University of Groningen, The Netherlands, who gave a lecture titled "Large Algebraic Properties of Riccati Equations."

SIAG/FME Junior Scientist Prize. Sergey Nadtochiy, University of Oxford, UK, who gave a lecture titled "Market-Based Approach to Modeling Derivatives Prices."

SIAM Awards in the Mathematical Contest in Modeling

2011 Problem A, The Continuous Problem: "Snowboard Course"
Solution: "A Half-Blood/Half-Pipe: A Perfect Performance"
Students: Enhao Gong, Rongsha Li, and Xiaoyun Wang
Faculty Adviser: Jimin Zhang
Tsinghua University, PRC

2011 Problem B, The Discrete Problem: "Repeater Coordination"
Solution: "Clustering in a Network"
Students: Daniel Furlong, Dylan Marriner, and Louis Ryan
Faculty Adviser: Susan Martonosi
Harvey Mudd College

2012 Problem A, The Continuous Problem: "The Leaves of a Tree"
Solution: "The Secrets of Leaves"
Students: Cheng Fu, Hangqi Zhao, and Danting Zhu
Faculty Adviser: Zhiyi Tan
Zhejiang University, PRC

2012 Problem B, The Discrete Problem: "Camping Along the Big Long River"
Solution: "C.A.R.S: Cellular Automaton Rafting Simulation"
Students: James Jones, Suraj Kannan, and Joshua Mitchell
Faculty Adviser: Changbing Hu
University of Louisville

Student Paper Prizes

2011 Recipients:
Necdet Serhat Aybat, Pennsylvania State University; PhD in 2011, Columbia University; for "Unified Approach for Minimizing Composite Norms." (Co-Author: Garud N. Iyengar, Columbia University)

Sungwoo Park, Knight Capital Group; PhD in 2011, University of Maryland, College Park; for "Portfolio Selection Using Tikhonov Filtering to Estimate the Covariance Matrix." (Co-Author: Dianne P. O'Leary, University of Maryland, College Park)

Xiangxiong Zhang, Massachusetts Institute of Technology; PhD in 2011, Brown University; for "On Maximum-Principle-Satisfying High Order Schemes for Scalar Conservation Laws." (Co-Author: Chi-Wang Shu, Brown University)

2012 Recipients:
Brittany D. Froese, Simon Fraser University, Canada, for "Convergent Finite Difference Solvers for Viscosity Solutions of the Elliptic Monge–Ampère Equation in Dimensions Two and Higher." (Co-Author: Adam Oberman)

Stefanie Hollborn, Johannes Gutenberg University Mainz, Germany, for "Reconstructions from Backscatter Data in Electric Impedance Tomography."

Marina Moraiti, University of Pittsburgh, for "On the Quasistatic Approximation in the Stokes–Darcy Model of Groundwater–Surface Water Flows."

Outstanding Paper Prizes
Nir Ailon, Technion, Israel, and Bernard Chazelle, Princeton University, for "The Fast Johnson–Lindenstrauss Transform and Approximate Nearest Neighbors," *SIAM Journal on Computing*, Volume 39, Issue 1 (2009), 302–322.
Matthew D. Finn, University of Adelaide, Australia, and Jean-Luc Thiffeault, University of Wisconsin, for "Topological Optimization of Rod-Stirring Devices," *SIAM Review*, Volume 53, Issue 4 (2011), Expository Research Papers section, 723–743.
Bart Vandereycken, École Polytechnique Fédérale de Lausanne, Switzerland, and Stefan Vandewalle, Katholieke Universiteit Leuven, Belgium, for "A Riemannian Optimization Approach for Computing Low-Rank Solutions of Lyapunov Equations," *SIAM Journal on Matrix Analysis and Applications*, Volume 31, Issue 5 (2010), 2553–2579.

SIAM Prize for Distinguished Service to the Profession. Barbara Lee Keyfitz, Ohio State University.

The John von Neumann Lecture. Sir John Ball, University of Oxford, UK, gave the 2012 lecture, "Liquid Crystals for Mathematicians."

The 2012 W.T. and Idalia Reid Prize was awarded to Ruth F. Curtain (University of Groningen, The Netherlands) for her "fundamental contributions to the theory of infinite dimensional systems and the control of systems governed by partial and delay differential equations." Curtain titled her prize lecture "Large Algebraic Properties of Riccati Equations." The Reid Prize was established in 1993 to recognize outstanding work, or other contributions to, the broadly defined areas of differential equations and control theory; it has been given annually since 2000.

2011 SIGEST Authors
Each issue of SIAM Review*'s SIGEST section features the slightly modified version of a paper originally published in one of SIAM's research journals. SIGEST papers are judged to be of exceptional quality and of potential significance to the entire SIAM community.*

Margaret Beck and C. Eugene Wayne, Boston University, "Using Global Invariant Manifolds to Understand Metastability in the Burgers Equation with Small Viscosity," *SIAM Review*, Volume 53, Issue 1 (2011), 129–153; published originally in SIADS.

Stephen A. Gourley, University of Surrey, UK, and Xingfu Zou, University of Western Ontario, Canada, "A Mathematical Model for the Control and Eradication of a Wood Boring Beetle Infestation," *SIAM Review*, Volume 53, Issue 2 (2011), 321–345; published originally in SIAP.

Anna Pagh, Rasmus Pagh, and Milan Ružić, University of Copenhagen, Denmark, "Linear Probing with 5-wise Independence," *SIAM Review*, Volume 53, Issue 3 (2011), 547–558; published originally in SICOMP.

Alex Olshevsky, Princeton University, and John N. Tsitsiklis, Massachusetts Institute of Technology, "Convergence Speed in Distributed Consensus and Averaging," *SIAM Review*, Volume 53, Issue 4 (2011), 747–772; published originally in SICON.

SIAM Fellows, Class of 2012
Tamer Başar, University of Illinois at Urbana–Champaign
Michele Benzi, Emory University
Anthony M. Bloch, University of Michigan
Pavel B. Bochev, Sandia National Laboratories
Richard A. Brualdi, University of Wisconsin–Madison, Emeritus
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M. Gregory Forest, University of North Carolina at Chapel Hill
Susan Friedlander, University of Southern California
Irene M. Gamba, University of Texas at Austin
Walter Gautschi, Purdue University, Retired
Donald Goldfarb, Columbia University
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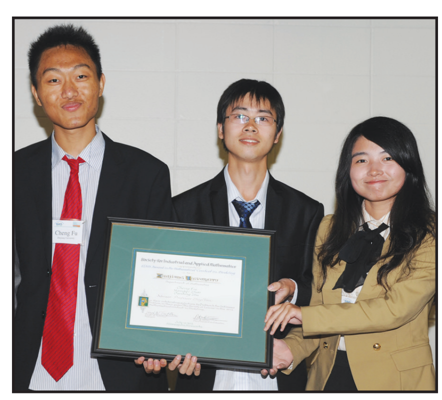
Tao Tang, Hong Kong Baptist University
Edriss S. Titi, Weizmann Institute of Science and University of California, Irvine
Robert J. Vanderbei, Princeton University
Richard S. Varga, Kent State University, Emeritus
Jan C. Willems, Katholieke Universiteit Leuven
Thaleia Zariphopoulou, University of Oxford and University of Texas at Austin.

Barbara Keyfitz, the Dr. Charles Saltzer Professor of Mathematics at Ohio State University, received the 2012 SIAM Prize for Distinguished Service to the Profession from SIAM president Nick Trefethen. Keyfitz was recognized "for her long-term and pervasive advocacy of applied mathematics in several leadership roles. As the Director of the Fields Institute in Toronto (2004–2008), Keyfitz revitalized applied mathematics programming at the Institute with initiatives such as the successful Fields–MITACS Industrial Problem-Solving workshops. The innovative Canada-wide graduate industrial research internship program for students in the mathematical sciences was created by MITACS–NCE while she served on its Board of Directors. The program has since expanded from applied mathematics to cover all disciplines. She was President of the Association for Women in Mathematics (2005–2006). In SIAM, Keyfitz served as Vice President for Programs (1998–2003), and was instrumental in forming closer links between SIAM's US-based and Mexican communities, in particular through the organization of numerous SIAM–SMM conferences. Currently, as President of ICIAM, she is leading applied mathematics globally."



SIAM awards in the 2012 Mathematical Contest in Modeling went to (top photo, from left) Cheng Fu, Hangqi Zhao, and Danting Zhu of Zhejiang University for their Problem A solution, and to (bottom photo, from left) Suraj Kannan and Joshua Mitchell (with James Jones, not shown) of the University of Louisville for Problem B.

Vojtěch Rödl of Emory University (left) and Mathias Schacht of the University of Hamburg, Germany, received the 2012 George Pólya Prize for "their seminal work on the regularity method for hypergraphs." Rödl and Schacht, according to the prize citation, "have produced a central body of results developing, extending, and consolidating Szemerédi's regularity method for hypergraphs. They have also shown how this method leads to remarkable results like the generalized hypergraph removal lemma and the theorem that every decidable, hereditary property of k-uniform hypergraphs is testable with one-sided error."

The 2012 SIAG/FME Junior Scientist Prize was awarded to Sergey Nadtochiy (University of Oxford, UK) for "his impressive contributions to Mathematical Finance and his original, sophisticated and rigorous mathematical analysis of challenging problems in volatility modeling and derivative pricing theory." Nadtochiy is the first recipient of the prize, which was established by the SIAM Activity Group on Financial Mathematics and Engineering in 2010 to recognize outstanding work in the field by a junior researcher.

A Talent for Making Things Happen

FROM THE SIAM PRESIDENT

By Nick Trefethen

Tony Chan is not your average university president. For a start, it's hard to imagine any other who could have given such a fascinating technical presentation at a SIAM Annual Meeting. The talk, "Image Processing and Computational Mathematics," was presented July 10 in Minneapolis.

Chan began by telling us that he and SIAM both turned 60 this year, but he didn't know whose birthday came first. I've looked into the matter, and it turns out SIAM, having been incorporated on April 30, 1952, is three months younger.

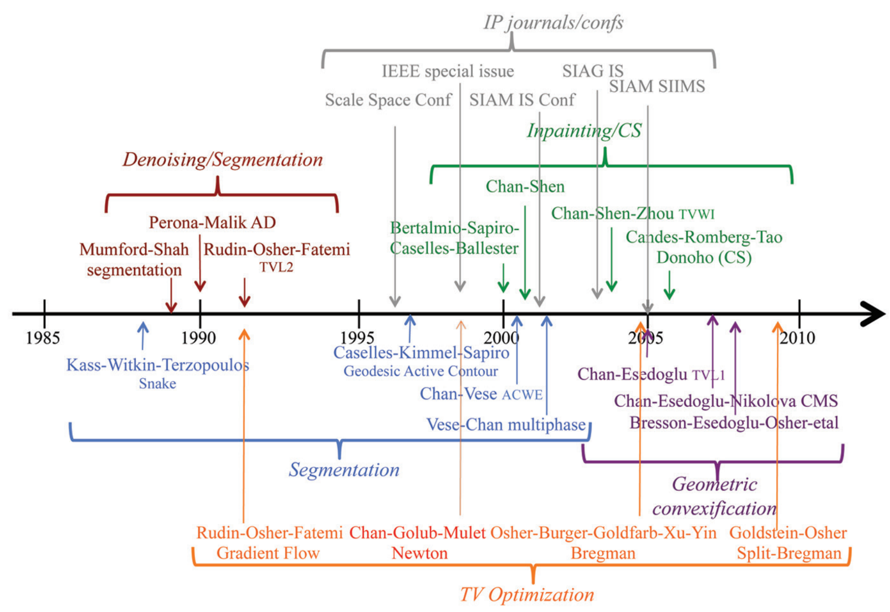
I first met Tony Chan on my arrival in graduate school at Stanford in 1977. I remember a cool Caltech graduate with long hair and exceptional enthusiasm. Pretty soon he was organizing the weekly Serra House volleyball game, to which my contribution was designing the t-shirts.

Even back then, in his thesis on finite difference methods for PDEs, Chan showed a special interest in how mathematics can really be used. He had a knack for spotting what was limiting the speed or accuracy of an algorithm and finding the right modification to fix it. Image processing hardly existed in those days, but Chan was growing expert in the tools that would draw him into the field.

In his talk in Minneapolis he showed striking figures illustrating the power of today's imaging algorithms, nicely contextualized by historical timelines. One long-established theme of the field is denoising of images, which is sometimes done by solving PDEs like the Perona–Malik equation and its relatives. Another is segmentation—identifying automatically the geometric components that make up an image. A third is inpainting, in which imperfections in an image (telephone wires, scratches, superimposed text, . . .) can often be eliminated with no visible trace. We've come a long way from the day when Stalin airbrushed Trotsky out of Communist Party photos.

As the field of image processing was developing, so was Chan's career. After a postdoc at Caltech and a junior faculty position at Yale, his hair now a little shorter, he took up a permanent position at UCLA, and his talent for making things happen began to show itself on a larger scale. He was a principal investigator on the NSF proposal for the creation of IPAM, the Institute for Pure and Applied Mathematics. The proposal was successful, and Chan became one of the early directors of IPAM, which has helped establish UCLA as one of the top universities for mathematics in the world. Chan was not to run IPAM for long, however, for in 2001, not yet 50, he became dean of physical sciences at UCLA.

Did I mention SIAM? The future university president was a mainstay of our society from the beginning. Chan has served as an editor of SIREV and SISC and a member of the SIAM Council and Board, and most importantly, he and Kirk Jordan were the authors of a proposal to found a new SIAM journal, *SIAM Journal on Imaging Sciences*. In his talk he proudly pointed out that SIIMS is the only SIAM journal whose title spotlights an area of science rather than mathematics. Under the editorship of Guillermo Sapiro, it ranks second only to *SIAM Review* in impact factor ratings in applied mathematics. Readers of this column know that I trust at most the first digit of an impact factor, but SIIMS's success is resounding enough to show up even on this measure!



In an invited talk in Minneapolis, with a historical timeline as backdrop, Tony Chan illustrated the power of many imaging algorithms now in use.

As his administrative scope kept widening, it is remarkable how active Chan remained in research with students, postdocs, and colleagues—including Luminita Vese (UCLA), Xavier Bresson (now at City University of Hong Kong), and Ernie Esser (now at UC Irvine), whom he credited as contributors to his talk. Chan is among the most highly cited of Highly Cited Researchers on the Thomson Reuters list, and you will see his algorithms anywhere you look in image processing, including in his 2005 SIAM textbook with Jackie Shen.

In 2006, Chan rose to national prominence in the USA when he was appointed head of the Mathematical and Physical Sciences Directorate at the National Science Foundation, with a budget of more than $1 billion per year.

And then in 2009, he moved to his current position as president of Hong Kong University of Science and Technology. For two years running, HKUST has been ranked in the Quacquarelli Symonds University Rankings as the No. 1 university in Asia.

But let's get back to image processing, because I haven't mentioned the most exciting theme of Chan's talk. This was the link, or I should say the many links, between imaging sciences and structured non-smooth optimization problems related to the total variation (TV) and the L^1 norm. Even Tony Chan is human, and by the end of his talk, he was running a little short of time. So he wasn't able to give proper attention to a remarkable table he had put together, "Algorithm connections, old and new," displaying a column of algorithms in mathematical optimization lined up against a column of related algorithms in image processing. Among the optimization ↔ imaging connections listed were these:

Method of multipliers ↔ Bregman iteration

Uzawa's method ↔ Linearized Bregman iteration

Alternating direction method of multipliers ↔ Split Bregman iteration

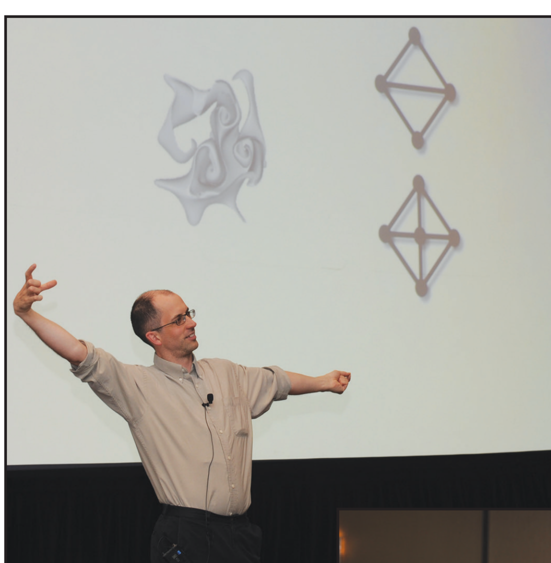
Forward–backward splitting ↔ Fixed point continuation

Arrow–Hurwicz algorithm ↔ Primal–dual hybrid gradient iteration

Newton-like methods ↔ Semismooth Newton for TV

There is much more going on here than I can possibly indicate in a few lines, and I am grateful to Jorge Nocedal and Steve Wright for teaching me a little about the many resonances in the field of optimization excited by Chan's table.

The L^1 norm is everywhere these days. The compressed sensing people perform miracles of sparsity with it; in machine learning it helps make better predictions; and when it comes to image processing, Stan Osher likes to say that L^1 "forgives and forgets errors." Our children may not know what's going on when they bend reality in Photoshop, but it's all about algorithms developed by optimization and image processing leaders like Tony Chan. Motion picture analogs were presented in another memorable hour in Minneapolis, in the Block Community Lecture by Robert Bridson. These are exciting times in non-smooth optimization and image processing. Happy Birthday, Tony! Happy Birthday, SIAM!



I.E. Block Community Lecturer Robert Bridson ("Creating Reality: The Mathematics Behind Visual Effects") is a computer scientist at the University of British Columbia and co-founder and chief scientist of the graphics company Exotic Matter. Like many exciting speakers, he concluded with a look at open challenges: more physics (for simulating foam), more scale (stormy oceans), more coupling (wet hair and clothing as an actor dives into water); more interaction with artists. In short: More Math!

Audience members lined up to ask questions; shown here, Benjamin Seibold of Temple University.

Kovalevsky Lecture

continued from page 1

rate of propagation of the singular solution that matches nicely the experimental measurement. After learning of my first results and efforts, and despite my being a clear outsider, Barbara Keyfitz took the time to look into what I was doing and then encouraged me enthusiastically, thus providing very valuable support and motivation."

One of Keyfitz's points in the lecture was that characteristic surfaces give information on analytical as well as geometric properties of solutions of hyperbolic equations, via, for example, the symbol of the operator and the mechanism of Fourier transformation. This analysis is the basis of Rauch's proof, following work of Brenner, that multidimensional conservation laws are unlikely to be well-posed in L_p unless $p = 2$. The power of analysis of this type, she suggested, has not yet been fully exploited.

Partly as an illustration of related open questions, Keyfitz concluded with a computational result of which she was clearly very proud: an extension to the full Euler equations of ideal gas dynamics that exhibits (again numerically) a cascade of rarefaction waves, called "Guderley Mach reflection" by Keyfitz and collaborators Allen Tesdall and Richard Sanders (who built on pioneering work by Tesdall and John Hunter). This phenomenon has also been verified experimentally, she says, by Beric Skews and colleagues.

Uncertainty Quantification 2012

Modeling Hurrricane Storm Surge

In a multipart minisymposium on model calibration and validation, Clint Dawson presented joint work of his group at UT Austin, Joannes Westerink of the University of Notre Dame, and Rick Luettich of the University of North Carolina at Chapel Hill on the development of numerical methods for modeling storm surge, and on their efforts to validate the models against historical data. Highlights of the talk and a brief discussion of ongoing work of Dawson's group with Ibrahim Hoteit of King Abdullah University of Science and Technology follow.

When a hurricane threatens the coastal United States, the first image to appear in the media is typically a swirling vortex of clouds observed from a satellite. The images that follow are often stock footage of winds blowing down trees and tearing through structures, and of waves crashing onto shore. There is usually much discussion of the "category" of the storm, which is a measure of the maximum sustained winds in the hurricane. What the general public does not realize is that the most destructive part of a hurricane is usually the storm surge—that is, the flooding caused by wind and waves pushing water inland. Furthermore, the hurricane category does not directly correlate to the magnitude of the surge. Storm surge can result in enormous loss of life and property, and can forever change coastal landscape and ecology. This has been evident in recent hurricane and tropical cyclone events in the United States and around the world. Therefore, the mathematical and computational modeling of hurricane storm surge is a topic of great interest.

High-fidelity simulation of storm surge requires several components: (1) an accurate description of the physical system, (2) inclusion of all physically relevant processes, (3) numerical resolution of the flow, and (4) accurate solution of the mathematical model. This leads to the development of highly resolved discretizations, which can capture local topography, bathymetry, bottom friction, and hydraulic conveyances that enhance flow and structures that impede flow. Furthermore, the numerical algorithms should be phase-accurate, should minimize numerical dissipation, and should be stable under highly advective flow regimes.

The applications of storm surge models generally fall into two categories: hindcasting and forecasting. Hindcast simulations are used to study the effects of historical hurricanes, to understand the physics of the events, and to guide decision makers in the development of new hurricane protection systems, such as levees and seawalls. Hindcast simulations are an integral part of determining which coastal communities qualify for federal flood insurance. They can also be used to calibrate and/or validate a storm surge model with data collected during the event. Hindcast simulations therefore rely on obtaining high-fidelity data for the hurricane wind field, bathymetry, coastal topography, and land-use characteristics for the flooded region. That is, hindcast simulations try to minimize uncertainty through extensive and accurate collection of data related to all aspects of the storm. These simulations are intensive both in the human capital required to collect and verify the inputs to the model, and in the computational resources required.

Forecast simulations are used to predict storm surge in real time as hurricanes approach land. They are used to guide emergency managers in ordering evacuations and deploying resources to the regions most likely to be affected. These simulations are fraught with uncertainties. The hurricane-force winds and storm track are uncertain, and in many cases the hurricane may threaten an area of the coast for which important data—on bathymetry, coastal topography, or bottom friction—either is not available or is unreliable. A forecast simulation must occur in real time; it must be completed and the results processed in time for emergency managers to make quick and ultimately life-saving decisions.

At the recent SIAM UQ meeting, Clint Dawson of the University of Texas at Austin described a collaborative effort of UT Austin, Joannes Westerink of the University of Notre Dame, and Rick Luettich of the University of North Carolina at Chapel Hill to develop efficient and accurate numerical methods for modeling storm surge, and to extensively validate these storm surge models against historical data. This effort has led to the development of the Advanced Circulation (ADCIRC) storm surge modeling system. The ADCIRC model has been used in the design of new levee protection systems in southern Louisiana, and in the development of new federal flood insurance maps for many states along the Gulf of Mexico and eastern coast of the U.S. A storm surge forecasting system, called the ADCIRC Surge Guidance System, or ASGS, is also being developed and implemented for real-time hurricane forecasting.

To overcome some of the uncertainties in the forecast models, Dawson's group at UT Austin is working with Ibrahim Hoteit of King Abdullah University of Science and Technology to develop novel data-assimilation methods that can incorporate data collected during the hurricane event into the ASGS forecast system. This research, which is very much in progress, will also rely on the development and deployment of new sensor and data collection apparati that can provide real-time surge, wind, and wave data.

What If You Could Spend an Hour with Anyone in your Field . . .

A SIAM tradition was born at AN12 in Minneapolis. A group of student members and plenary speakers spent two hours in an informal, conversational-style session, held as part of the meeting's Student Days. The session's main goal was to give students the opportunity to ask questions of plenary speakers in a relaxed and unintimidating setting, and this goal was amply met.

Among the 24 students were several undergraduates and representatives from SIAM student chapters. Split into two circles, each group of students engaged in conversation with four plenary speakers. Students asked about the topics of the speakers' talks, and also requested advice on course selection, adviser selection, and postgraduate career options, among other concerns.

Giving generously of their time, participating plenary speakers and prize lecturers John Ball, Gunnar Carlsson, Tony Chan, Barbara Keyfitz, Claude LeBris, George Papanicolaou, Emily Shuckburgh, and Valeria Simoncini also shared insights about their scientific interests, their decisions about types of research questions to pursue, and their career choices. The speakers, in turn, questioned the students: how they first got interested in mathematics and what aspects of mathematics and its applications interest them the most. At times, the plenary speakers even asked questions of each other, in exchanges that were enlightening for all.

The demand for an event of this type was high, as forecast by input from focus group sessions run at earlier meetings by SIAM membership manager Susan Whitehouse. The conversations in both circles flowed non-stop for the full two hours, with the plenary speakers switching circles at the end of the first hour, so that each student got to meet both groups of four speakers. Meeting co-organizers Michele Benzi and Tasso Kaper got the conversations going, but after that had little work to do as moderators. Participants of all ages appeared to enjoy this lively event, and many of the students commented afterward how useful and interesting it was.—*Tasso Kaper, Boston University.*

How do you keep up with the literature in your area? If your research is interdisciplinary, how do you learn about the other field? These and other questions came up in an informal session held for the first time at the SIAM Annual Meeting in Minneapolis. Small groups of students got together with some of the meeting's invited speakers, who answered questions about their talks, research, careers, and other professional concerns. Shown here in one of the two circles is moderator Tasso Kaper (back to the camera) and speakers George Papanicolaou, Tony Chan, Gunnar Carlsson, and John Ball. Photo by Susan Whitehouse.

SIAM Columbia Chapter Broadens Audience With 2012 "Math–Startup Collaborative Meet-up"

On February 29, the Columbia University Chapter of SIAM hosted this year's "Math–Startup Collaborative Meet-up." The event, held annually over the last few years at Columbia, exposes students majoring in mathematics and other quantitative disciplines to the exciting opportunities awaiting them in the burgeoning startup community in New York City. The goal is to raise awareness of mathematically oriented career paths that lie outside the finance sector, which has been a popular destination for many Columbia students. Startup companies based in Silicon Alley face plenty of quantitative problems, and they need smart students or graduates to crack them.

Traditionally, the Meet-up has been geared toward graduate students in mathematics and applied mathematics. But this year, the Columbia Chapter opened the event to the greater university population, including undergraduates and students in such fields as statistics, computer science, economics, and business. To help build this wider audience, the chapter—for the first time—formed collaborations with Columbia Business School and the Application Development Initiative (ADI), the software development group on campus, which co-sponsored the event.

The chapter was very excited to welcome a number of prominent mathematicians and data scientists hailing from New York City-based startups, including Bitly, Foursquare, Buzzfeed, Sailthru, and Codecademy. This year's event was particularly notable in that, for the first time, all the speakers had studied at Columbia. The presenters discussed the role that math plays at their companies and in their daily lives, and fielded questions about the projects they've tackled since entering the startup world. Audience members were able to get a unique look at the practices, tools, and data used on a daily basis at these companies.

(Readers can find two interactive examples of recent Bitly data team projects on the Internet—a map produced in conjunction with *Forbes* magazine that highlights what Americans are reading and what news outlets are popular in certain geographic areas, at http://www.forbes.com/special-report/2012/media-map.html; and a graph on the Bitly blog, at http://blog.bitly.com/post/13832700785/how-science-lovers-see-the-internet, created in collaboration with *Scientific American* that visualizes how people who read about science see the Internet. The graph, which is based on the tracking of "click" patterns of readers in different scientific fields, also appeared in the magazine's December 2011 issue.)

The presenters, who are almost all data scientists, implement machine learning algorithms, statistics, and other mathematical tools on a daily basis. Working for the most part with huge amounts of data generated by millions of users of Foursquare, Bitly, and others, they are the ones who try to make sense of the data, identifying important user trends, among other things. A reception following the event gave students the chance to become better acquainted with the presenters and with each other.

The event was a great success, with over a hundred undergraduate and graduate students, as well as alumni, in attendance. Students left with a better understanding of career options in the private sector that require the quantitative and problem-solving skills they have developed through their coursework, outside the escalating migration to finance. "Very rarely do you get to learn about so many interesting problems in the emerging field of startups, and for me, it was a great opportunity to discover the people working on them," says computer science student Justin Hines. "The event made the entire sphere that much more tangible, which is an incredible feeling."

Blake Shaw (left), Mike Dewar, and Ky Harlin—from New York City-based startups Foursquare, Bitly, and Buzzfeed, respectively, and all former students at Columbia—shared their expertise and experiences at this year's "Math–Startup Collaborative Meet-up," an annual event hosted by the Columbia University Chapter of SIAM.

Ultimately, the organizers hoped that the event would inspire a new generation of students in quantitative disciplines to put their skills to use in building new companies, helping not only to re-invigorate the technology startup scene in New York and beyond, but also to contribute to an economic revival in the country.—*Vighnesh Subramanyan, Willie Neiswanger, and Ilana Lefkovitz, applied math majors, Columbia 2012.*

Travel Grants for Math Congress of the Americas

The National Science Foundation will provide partial travel support for up to 60 U.S. mathematicians to attend the inaugural Mathematics Congress of the Americas, which will be held August 5–9, 2013, in Guanajuato, Mexico. The American Mathematical Society will administer the grant program.

Only mathematicians who are affiliated with a U.S. institution at the time of travel are eligible for funding. The program will support both U.S.-based invited speakers (senior mathematicians) and early-career mathematicians; women and members of U.S. groups underrepresented in mathematics are especially encouraged to apply.

Instructions for applying can be found on the AMS website at http://www.ams.org/programs/travel-grants/mca. Applications will be accepted from September 15 through October 31, 2012. For more information, readers can contact: Steven Ferrucci, (800) 321–4267, ext. 4113, or (401) 455–4113; sxf@ams.org.

Information about the program, organization, and registration procedures for MCA 2013 is available on the congress website (http://www.mca2013.org/).

James Murray receives the William Benter Prize in Applied Mathematics

James Murray

City University of Hong Kong (CityU) has awarded the second William Benter Prize in Applied Mathematics to James Murray, one of the hugely influential scientists in the field of mathematical biology.

James Murray, Senior Scholar, Princeton University; Professor Emeritus of Mathematical Biology, University of Oxford; and Professor Emeritus of Applied Mathematics, University of Washington, was chosen as the winner for his unprecedented contributions to using mathematical models to address a wide spectrum of biomedical problems by understanding the underlying biomechanics of the human body for more accurate predictions of the outcome of various human interactions.

The William Benter Prize in Applied Mathematics was set up by the Liu Bie Ju Centre for Mathematical Sciences at CityU in honour of Mr William Benter for his dedication and generous support for the enhancement of the University's strengths in mathematics research. The US$100,000 prize, given once every two years, is awarded to outstanding mathematicians whose contributions have had a direct and fundamental impact on scientific, business, finance and engineering applications.

The Prize was presented to James Murray at the opening ceremony of the International Conference on Applied Mathematics 2012: Modeling, Analysis & Computation organized by the Liu Bie Ju Centre for Mathematical Sciences at CityU on 28 May 2012.

Biographical Sketch

James Murray was born on 2 January 1931 at Moffat, Scotland. He received his bachelor's degree in mathematics and doctorate in applied mathematics from the University of St Andrews, Scotland in 1953 and 1956, respectively. He was awarded a master of arts degree in 1961 and a doctor of science degree in mathematics in 1968 from the University of Oxford, UK. He became Professor of Mathematical Biology at the University of Oxford in 1986, before which he had held positions in Harvard University, University of London, University of Michigan and New York University. He left Oxford for the University of Washington in the late 1980s. James Murray became Emeritus Professor of Mathematical Biology at Oxford in 1992 and became Emeritus Professor of Applied Mathematics at the University of Washington in 2000.

He was the founder and director of the Centre for Mathematical Biology at Oxford from 1983-1992 during which time it became the world centre in theoretical biology. He was also the founding President of the European Society for Mathematical and Theoretical Biology, the largest scientific society in the field from 1991-1994.

James Murray holds many prestigious honors and awards. He is Guggenheim Fellow, Fellow of the Royal Society of Edinburgh, Fellow of the Royal Society of London, Fellow of the Institute of Biology, UK, and Foreign Member of the French Academy of Sciences. He won the London Mathematical Society Naylor Prize for Applied Mathematics in 1988, the Akiro Okubo Prize in 2005 and the European Academy of Science Leonardo da Vinci medal in 2011.

Citation

James Murray began working on the application of mathematics to biology in the late 1960s, at which time there was no recognized field of mathematical biology, and he has played an influential role in the development of the field over the last fifty years. His book, *Mathematical Biology* published in 1989, has become a classic in the field which is still widely used in teaching and research. His contributions and achievements have earned him the title of "the father of modern mathematical biology".

James Murray adopts an interdisciplinary approach to research with an aim to increase scientists' understanding of the real world and to help improve the well-being of all living things. His research is characterized by diversity, originality and depth. Over the past decades, he has developed original and practical mathematical models to study various areas in biology, ecology, medicine and psychology. His many contributions include the study of animal coat pattern formation, the spread and control of rabies, brain tumour growth and control, marital interaction and divorce prediction, bovine tuberculosis, the mechanochemical theory of biological pattern formation, wound healing and scar formation. In recent years, he has worked on how individuals can affect group decisions in social animals, the benefit of cannibalism, and climate changes and species extinction.

James Murray is at the forefront in establishing a bridge between mathematics and biology, and his contributions have led to significant advances not only in biological knowledge but also in applied mathematics.

— News release from City University of Hong Kong

Professional Opportunities

Send copy for classified advertisements to: Advertising Coordinator, SIAM News, *3600 Market Street, 6th Floor, Philadelphia, PA 19104–2688; (215) 382–9800; fax: (215) 386–7999; marketing@siam.org. The rate is $2.55 per word (minimum $295.00). Display advertising rates are available on request.*

Advertising copy must be received at least four weeks before publication (e.g., the deadline for the November 2012 issue is September 28, 2012).

Advertisements with application deadlines falling within the month of publication will not be accepted (e.g., an advertisement published in the November issue must show an application deadline of December 1 or later).

Institute for Advanced Study

School of Mathematics

The School of Mathematics has a limited number of memberships with financial support for research in mathematics and computer science at the institute during the 2013–14 academic year. The school frequently sponsors special programs; however, these programs comprise no more than one-third of the membership so that a wide range of mathematics can be supported each year. “Non-equilibrium Dynamics and Random Matrices” will be the topic of the special program in 2013–14. Horng-Tzer Yau of Harvard and Thomas Spencer of the institute will lead the program. Juerg Froehlich of ETH and Herbert Spohn of Zentrum Mathematik will be among the senior participants. More information about the special program for the year can be found on the school’s homepage (http://www.math.ias.edu/).

Several years ago the School of Mathematics established the von Neumann Fellowships. Up to eight of these fellowships will be available for each academic year. To be eligible for a von Neumann Fellowship, applicants should be at least five, but no more than 15, years after receipt of a PhD.

Veblen Research Instructorships are three-year position that were established in partnership with the Department of Mathematics at Princeton University in 1998. Three-year instructorships will be offered each year to candidates in pure and applied mathematics who have received a PhD within the last three years. The first and third years of an instructorship are usually spent at Princeton University and will carry regular teaching responsibilities. The second year is spent at the institute and dedicated to independent research of the instructor’s choice.

Candidates must have given evidence of ability in research comparable with at least that expected for a PhD degree. Postdoctoral computer science and discrete mathematics applicants may be interested in applying for a joint (two-year) position with one of the following: Department of Computer Science at Princeton University, http://www.cs.princeton.edu; DIMACS at Rutgers, The State University of New Jersey, http://www.dimacs.rutgers.edu; or the Intractability Center, http://intractability.princeton.edu. For a joint appointment, applicants should apply to the School of Mathematics as well as to one of the above, noting their interest in a joint appointment.

Applicants can request application materials from: Applications, School of Mathematics, Institute for Advanced Study, Einstein Drive, Princeton, NJ 08540; applications@math.ias.edu. Applications can be made online at: https://applications.ias.edu. The deadline for all applications is December 1, 2012.

The Institute for Advanced Study is committed to diversity and strongly encourages applications from women and minorities.

Argonne National Laboratory

2013 Named Postdoctoral Fellowship Program

Argonne National Laboratory is accepting applications for 2013 Named Postdoctoral Fellowships. Argonne awards these special postdoctoral fellowships internationally on an annual basis to outstanding doctoral-level scientists and engineers who are at early points in promising careers. The fellowships are named for scientific and technical luminaries who have been associated with Argonne and its predecessors, and the University of Chicago, since the 1940s. Candidates for these fellowships must display superb ability in scientific or engineering research, and must show definite promise of becoming outstanding leaders in the research they pursue. Fellowships are awarded annually and can be renewed for up to three years. A 2013 fellowship carries a stipend of $80,000 per annum with an additional allocation of up to $20,000 per annum for research support and travel. The deadline for submission of application materials is October 9, 2012. Applicants should identify an Argonne staff member to sponsor the nomination. The sponsor could be someone who is already familiar with an applicant’s research work and accomplishments through previous collaborations or professional societies. If applicants have not yet identified an Argonne sponsor, they should visit the detailed websites of the various research programs and research divisions at http://www.anl.gov.

Detailed instructions on application requirements and procedures can be found at http://www.dep.anl.gov/Postdocs/Namedpostdoc.htm. Applications are to be submitted online, with supporting letters of recommendation submitted to Named-Postdoc@anl.gov. All correspondence should be addressed to Argonne Named Postdoctoral Fellowship Program. One application is sufficient to be considered for all named fellowships.

Argonne is an equal opportunity employer and values diversity in its workforce. Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

North Carolina State University

Department of Mathematics

The Department of Mathematics at North Carolina State University invites applications for one or more tenure-track positions, beginning in the fall of 2013, depending on the availability of funding. The department is seeking exceptionally well-qualified individuals who have research interests compatible with those in the department. Applicants in all areas of pure and applied mathematics will be considered. Among the several areas of special interest are computational geometry/topology, scientific computation, analysis, numerical analysis, and mathematical biology. Candidates must have a PhD in the mathematical sciences, an outstanding research program, a commitment to effective teaching at the undergraduate and graduate levels, and demonstrated potential for excellence in both research and teaching. She or he will likely have had successful postdoctoral experience. Final candidates are subject to criminal and sex offender background checks. If a final candidate’s highest degree is from an institution outside of the U.S., they will be required to have their degrees verified at http://www.wes.org. Degrees must be obtained prior to start date.

The Department of Mathematics has strong research programs in both pure and applied mathematics. Many members of the department participate in interdisciplinary programs and research groups on campus and in the broader Research Triangle community. More information about the department can be found at http://www.math.ncsu.edu.

Applicants should submit application materials at http://www.mathjobs.org/jobs/ncsu. Materials should include a vita, at least three letters of recommendation, and a description of current and planned research. To be considered for this position, applicants should also go to http://jobs.ncsu.edu/postings/9937 to apply for this job and complete a Faculty Profile; applicants should reference Position number 00102680. Applicants who have questions concerning this position can write to math-jobs@math.ncsu.edu. Applications received by November 15, 2012, will be given priority.

NC State is an affirmative action/equal opportunity employer; in addition, NC State welcomes all persons without regard to sexual orientation. The College of Physical and Mathematical Sciences welcomes the opportunity to work with candidates to identify opportunities for spouses or partners. For ADA accommodations, applicants can contact Human Resources via email to employment@ncsu.edu or by calling (919) 515–2135.

NC State participates in E-verify. Federal law requires all employers to verify the identity and employment eligibility of all persons hired to work in the U.S.

Cornell University

Department of Mathematics

The Department of Mathematics at Cornell University invites applications for three tenure-track assistant professor positions, or higher rank, pending administrative approval, starting July 1, 2013. The searches are open to all areas of mathematics, with an emphasis on the areas of probability; algebra, in particular, number theory; analysis, in particular, PDE; and topology.

Applicants must apply electronically at http://www.mathjobs.org. For more information about positions and application instructions, applicants should see: http://www.math.cornell.edu/Positions/positions.html. Applicants will be automatically considered for all eligible positions. The deadline for applications is November 1, 2012. Early applications will be regarded favorably.

Cornell University is an affirmative action/equal opportunity employer and educator. The Department of Mathematics actively encourages applications from women and minority candidates.

University of Michigan

Center for the Study of Complex Systems

The Center for the Study of Complex Systems at the University of Michigan invites applications for a tenure-track position as assistant professor of complex systems. The appointment will begin September 1, 2013.

Required Qualifications: Candidates must have a demonstrated interest in complex systems and a doctoral degree in a related field, such as computer science, information science, physics, computer engineering, bioinformatics, economics, sociology, or mathematics, among others.

Information about the center can be found at: http://www.cscs.umich.edu.

Application Procedures: All applications must be submitted via e-mail to: complex.systems.faculty.position@umich.edu. Applicants should submit one PDF file that includes: a current CV, statement of current and future research plans, a statement of teaching philosophy and experience, and one writing sample. At least three letters of recommendation are required and can be sent electronically in separate PDF files to the same e-mail address. The application deadline is September 30, 2012.

Georgia Institute of Technology

School of Mathematics

The School of Mathematics is accepting applications for faculty positions at all ranks and in all areas of pure and applied mathematics and statistics. Applications by highly qualified candidates, especially those from groups underrepresented in the mathematical sciences, are particularly encouraged.

Applicants should see http://www.math.gatech.edu/resources/employment for more details and application instructions.

ICES POSTDOCTORAL FELLOWSHIP

The Institute for Computational Engineering and Sciences at The University of Texas at Austin is now accepting applications for the 2013 – 2014 ICES Postdoctoral Fellowship

The ICES Postdoctoral Fellowship Program offers fellowship awards for exceptional computational scientists, mathematicians, and engineers who have recently completed doctoral studies in areas relevant to research conducted at the Institute.

Fellowship stipends are $60,000 per year. Fellows will receive UT employee benefits and relocation expenses. U.S. citizens are especially sought, however, foreign scholars may also be considered. Applications must be received by December 1, 2012

For further details and instructions for application submission, see:
https://www.ices.utexas.edu/programs/postdoc/

Announcements

Send copy for announcements to: Advertising Coordinator, SIAM News, 3600 Market Street, 6th Floor, Philadelphia, PA 19104–2688; (215) 382–9800; marketing@siam.org. The rate is $1.65 per word (minimum $225.00). Announcements must be received at least one month before publication (e.g., the deadline for the November 2012 issue is September 28, 2012).

Eighth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory

March 25–28, 2013
Athens, Georgia

The Eighth IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena: Computation and Theory will be held at the University of Georgia, in Athens, Georgia, March 25–28, 2013.

The conference will focus on computational and theoretical aspects of nonlinear wave phenomena. Interdisciplinary aspects of the subject will be emphasized, as well as interaction between computation, theory, and applications. The conference is sponsored by NSF, UGA, and IMACS.

Honorary Chair: R. Vichnevetsky (USA), (honorary president of IMACS).

General Chair and Conference Coordinator: T. Taha (USA).

Co-Chairs: R. Beauwens (president of IMACS, Belgium), G. Biondini (USA), and J. Bona (USA).

Keynote Speakers: Nicholas M. Ercolani (University of Arizona), Beatrice Pelloni (University of Reading, UK), and Harry Yeh (Oregon State University).

Two tutorials will be given.

Latest Information and AWARDS for Students: http://waves.uga.edu.

Contact: Thiab Taha, Computer Science Department, University of Georgia, Athens, GA 30602; (706) 542–3477; thiab@cs.uga.edu.

WPI

Worcester Polytechnic Institute

Department Head, Mathematical Sciences

Worcester Polytechnic Institute (WPI) invites applications for the position of Head of the Mathematical Sciences Department. The department currently comprises 28 full-time faculty and offers outstanding academic programs, including the B.S., M.S., and Ph. D. in Mathematical Sciences; maintains vibrant research programs in applied and computational mathematics and statistics; and is the home of the Center for Industrial Mathematics and Statistics, with strong industry-university alliances. The department boasts over 170 undergraduate majors and 80 graduate students and serves a vital support role for other degree programs.

WPI seeks a dynamic individual with demonstrated leadership ability who will build upon the department’s strengths, recruit outstanding faculty, promote scholarly initiatives, foster corporate relations, and steer the department to its next level of excellence and visibility. Applicants must have an earned doctorate and a strong international reputation, a distinguished record of scholarly achievement in application-oriented mathematical sciences supporting the department’s strengths, administrative experience or clear potential, and a record of excellence in teaching. The department head will be expected to represent the department within both the constituent and academic communities and to coordinate extramural funding activities. More information about the department and its mission, goals and objectives, undergraduate and graduate programs, and faculty research areas is available at http://www.wpi.edu/academics/math.html.

Founded in 1865, WPI is one of the nation’s oldest technological universities. Today, WPI is a highly selective private university with an undergraduate student body of over 3600, and 1400 full-time and part-time graduate students enrolled in more than 50 programs. U.S. News and World Report consistently ranks WPI among the top national universities. Its innovative project- based curriculum engages students and faculty in real-world problem solving, often at one of WPI’s 25 Project Centers located around the globe. The university is located in the heart of Massachusetts and an hour’s drive west of Boston.

Applications should include a curriculum vitae, a letter of intent that describes professional interests (research, teaching and administrative), and contact information for a minimum of three references. Applicants are encouraged to apply through MathJobs (www.mathjobs.org), but application materials may also be submitted (as a single PDF file) to masearch@wpi.edu. Nominations are welcome and should be sent to masearch@wpi.edu. Applications from women and minority candidates are especially encouraged. For full consideration, applications should be received by November 1, 2012. Questions can be addressed to kwobbe@wpi.edu.

To enrich education through diversity, WPI is an affirmative action, equal opportunity employer.

--A member of the Colleges of Worcester Consortium--

A Subversive Model of Particle Physics

By Barry A. Cipra

In a fitting homage to "an extraordinary man," Alan Newell of the University of Arizona gave the inaugural Martin D. Kruskal Prize Lecture at this year's SIAM Conference on Nonlinear Waves and Coherent Structures, held June 13–16 at the University of Washington, Seattle. Newell described some of his ideas for an alternative to the Standard Model in particle physics, based on phase transitions in pattern-forming systems, taking seriously the slogan on a T-shirt his longtime friend and colleague was known to wear: "Subvert the Dominant Paradigm."

"Martin Kruskal was one of kind," Newell says. "He would always encourage doing slightly unusual things." Dogged determination was another of his attributes, Newell recalls. "Once a problem gripped him, he never let go."

Both traits were key to Kruskal's signature achievement: the discovery of solitons (see sidebar). The particle-like behavior he and Norman Zabusky observed in numerical solutions to a classic wave equation inspired a paradigm shift in mathematical physics. Fifty years ago, integrable systems of differential equations were virtually synonymous with linearity; within a decade, integrable systems of nonlinear equations had taken center stage, a position the nonlinear theory has occupied ever since. "Linear theory," Newell quips, "is a rest home for applied mathematicians."

Newell makes no claim that his own observations will shift any paradigms. But if they do, it will be due in part to the example of a man who was a role model for subversive thinking.

Whence Symmetry

The Standard Model is the outrageously successful theory that accounts for three-fourths of physics. (It unifies the strong, weak, and electromagnetic forces; only gravity escapes its embrace.) In the broadest of outlines, it posits quantum fields based on certain unitary and special unitary groups, from which spring the bosons and fermions of the observed (and sometimes unobserved) universe. Its most recent tour de force is the apparent spotting of the long elusive Higgs boson, which purports to explain why some particles have inertia or mass—the ratio of momentum to speed, or energy to speed squared.

A key word in the Standard Model is *symmetry*. In accord with the principle discovered by Emmy Noether nearly a hundred years ago, conserved properties stem from symmetries (put very loosely: Things that don't change depend on changes that effect no change). The Standard Model sports a global spacetime playground based on translational and rotational symmetries, dotted with the swings, seesaws, and monkey bars of the symmetry groups SU(3), SU(2), and U(1). These symmetries (along with a batch of "accidental" ones that seemingly come for free) enforce a physics of conserved energy and momenta (both straight and angled), spin and charge (electric, color, and weak hyper). In particular, the unitary groups give rise to "fractional" spin and charge: quantities that require a full two or three turns to remain invariant.

Alan Newell's aim is to squeeze the local gauge symmetries out of the global symmetry of spacetime.

To Newell, those groups seem somewhat jerry-rigged: They're posited precisely to give the results the theory needs. Accordingly, he set out to see if it would be possible to start with nothing more than the symmetries of translation and rotation and "stress" them into producing objects with fractional invariants. The Standard Model already makes use of symmetry breaking, of course. (It's part of how the Higgs boson accomplishes its massive undertaking.) But Newell's aim is to squeeze the local gauge symmetries out of the global symmetry of spacetime.

It doesn't take a degree in theoretical physics to imagine that it might be possible. Evidence for spatial symmetry breaking is as plain as the ridges on your fingertips. "We have such systems all over the place," Newell says. "They're called pattern-forming systems."

The "grand-daddy" of pattern-forming systems, Newell notes, is Rayleigh–Bénard convection, with its roiling regularity. A thin layer of fluid, heated from below, becomes a rhythmic sea of stripes, with hot fluid forcing its way up along one edge of each stripe and denser, cool fluid diving down along the other edge. The width of the stripes (or honeycombs, also a frequently observed pattern) is determined by the physics, but the orientation is a more or less random choice. Indeed, different portions of the fluid may opt for different orientations. The upshot is that, in striped patterns, "phase grain boundaries" are widely seen, along with point defects known as concave and convex disclinations (see Figure 1). On your fingertips, these point defects are known as triradii and loops.

Figure 1. *What goes around comes around. Could point defects known as concave (left) and convex (right) disclinations, which arise in pattern-forming systems, account for fractional charges and spin in the Standard Model of particle physics?*

For these two-dimensional disclinations, an imaginary two-headed arrow perpendicular to a stripe, when transported continuously in a circle around the point defect, turns only halfway around, a natural analog to the fermion spin of 1/2. Newell and colleagues have worked out an extensive 2-D theory of "phase diffusion" to account for the stable patterns observed in phase grain boundaries. When the theory is taken into higher dimensions, the analog of concave disclinations leads to loops that twist by multiples of $2\pi/3$. In one case, the result is a defect with index $\pm 2/3$, which Newell calls a "pattern up quark"; in another case, the result has index $\pm 1/3$, for a "pattern down quark." In the convex case, the 3-D analog is a "pattern lepton" with index ± 1.

Despite the suggestive names and results, "this is *not* an attempt to replace the Standard Model," Newell says. It's "just a little game" that's "more than likely destined for the dustbins of history." Nonetheless, it's interesting to see what happens to the simplest symmetries when a system is stressed far from equilibrium, he adds. "There's a lot of interesting geometry. And there are so many open questions."

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New (and Old) Wave Math

Martin Kruskal (1925–2006) worked on a wide range of problems in pure and applied mathematics, but is best known for the discovery of solitons. Made over the course of a decade in collaboration with Norman Zabusky, Robert Miura, John Greene, and Clifford Gardner, the discovery began with an analysis of the now-famous Fermi–Pasta–Ulam problem. In a numerical experiment, the researchers sought to gauge the effect of weak nonlinearity in a system of coupled harmonic oscillators. They had expected the system to "thermalize," with energy in the lowest Fourier mode flowing irreversibly into higher modes—indeed, the original idea for the experiment was to study the *rate* of thermalization. Instead, they found that the energy never went beyond the first few modes, and reverted to the first mode in almost periodic fashion.

Kruskal and Zabusky found that the continuum limit of the FPU system led to the Korteweg–de Vries equation, already familiar from the theory of uni-directional shallow water waves. The KdV equation had originally been introduced to account for the existence of "solitary" waves, famously first observed in 1834 by the Scottish engineer John Scott Russell. It has a simple solitary wave solution in the form of a hyperbolic secant whose speed varies with its amplitude: The taller the wave, the faster it goes. But Kruskal and Zabusky found additional gold in the KdV equation.

In a four-page paper published in *Physical Review Letters* in 1965, they reported the results of their own numerical experiments, in which they found that a single-crested cosine wave (in a domain with periodic boundary conditions) quickly decomposed into a train of solitary waves of different heights and, hence, different speeds. (Technically speaking, the hyperbolic secant is not a solution of the KdV equation on a finite interval with periodic boundary conditions, but only the greatest of sticklers—like Kruskal—ever sweats the exponentially small stuff.) Because of their varying heights, the solitary waves—there were seven of them in the numerical experiment—traveled at different speeds, and thus had to interact as they traveled around and around the periodic domain. That's where the real surprise popped up and solitons earned their name: Instead of merging like raindrops or shattering like glass balls, the solitary waves emerged from the collisions intact.

It's easy to be blasé these days about nonlinear waves that interact like particles, but it was an eye-opener in the 1960s. In their write-up, Kruskal and Zabusky underlined the key observation: "Here we have a nonlinear physical process in which interacting localized pulses do not scatter irreversibly."

Kruskal realized that conserved quantities had to be lurking within the KdV equation. In fact, there are infinitely many. The KdV equation, moreover, turned out to be prototypical in this regard: Kruskal and colleagues started finding integrable systems under virtually every nonlinear rock they examined. The theory grew from a cottage industry to one of the main themes of modern mathematical physics.—*BAC*