

AMATH

UNIVERSITY OF
WASHINGTON
SPRING 2009



Note from the Chair

During the first weekend of April, Applied Mathematics celebrated its 25th anniversary as a department. The department has a long and distinguished history (see Page 6) that dates back to its initial inception as a Program of Applied Mathematics in the late 1960s. The anniversary brought together 150-200 alumni from different periods in the history of the department as well as almost all of its current and past faculty members (see Pages 4-5). The historic weekend celebrated the achievements and efforts of our forerunners in the department and highlighted the continuing excellence of the department as manifested in its current and new faculty members and exceptional graduate students. Indeed, the palpable enthusiasm and pride exhibited at the anniversary weekend demonstrated the formative role that UW Applied Mathematics has played, and is currently playing, in the professional development and career paths of numerous people in academia, industry, and education. Your support for the past 25 years has been invaluable and we hope to continue to count on you in the next 25 years. Despite the recent economic downturn and looming state budget cuts, the department is committed to continuing to offer the highest level of graduate research training and support possible. If you find yourself in a position to contribute to the educational mission and vision of the department please visit the departmental webpage (www.amath.washington.edu/giving/). We look forward to another 25 years of being at the forefront of Applied Mathematics research and education!

Best regards,

J. Nathan Kutz, Professor and Chair

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The Chairs of Applied Mathematics at Seattle's Lake Union, April 5, 2009
(left to right) J. N. Kutz, W. Criminale, F. Wan, R. O'Malley, K. K. Tung, J. Kevorkian, C. Pearson

Contents

new faculty
Professor Ulrich Hetmaniuk

2

research highlight
Professor Randy LeVeque

3

alumni highlight
25th Anniversary of AMATH

4-5

The history of AMATH

6

News and notes

7

AMATH calendar of events

8



Professor Ulrich Hetmaniuk

New Faculty Ulrich Hetmaniuk

Ph.D. 2002 Colorado

Advisor: C. Farhat

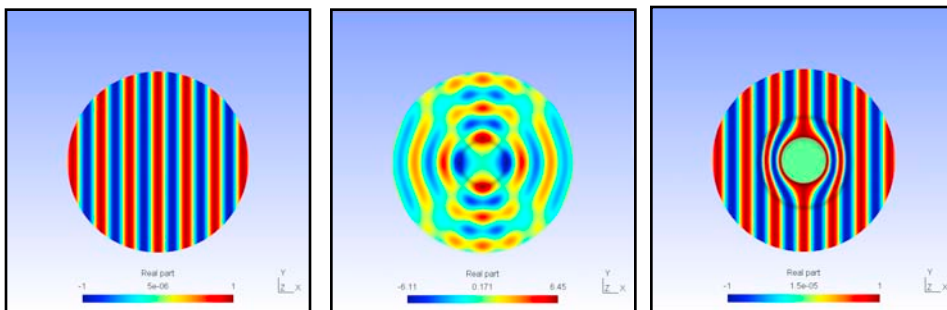
Thesis
Fictitious Domain Decomposition Methods for a Class of Partially Axisymmetric Problems: Application to the Scattering of Acoustic Waves

Scientific Computing, Finite Elements and Wave Propagation

Ulrich Hetmaniuk was originally educated in France, being awarded a degree from the Ecole Polytechnique in 1996 and the Ecole des Ponts et Chaussées in 1999. He then moved to Boulder, Colorado and graduated from the Department of Aerospace Engineering Sciences at University of Colorado, Boulder, in 2002. He was awarded the Robert J. Melosh Medal for the Best Student Paper in Finite Element Analysis in 2002. He went on to a postdoctoral position at Sandia National Laboratories (2003 – 2008). In Fall 2008, Ulrich joined the department of Applied Mathematics.

His research combines large-scale simulations and the study of efficient discretization techniques. His thesis work studied the scattering of acoustic waves by partially axisymmetric obstacles. It combined a domain embedding approach with Fourier series and the finite element method. At Sandia Labs, Ulrich has solved large-scale eigenproblems for structural dynamics where hundreds or thousands eigenpairs are requested. He designed a multigrid-based eigensolver and participated in the development of Anasazi, a block eigensolver package within the Trilinos framework. Another important topic of his research is the study of discretization methods. He is interested in special finite elements, multiscale enrichment methods, and a posteriori error estimation.

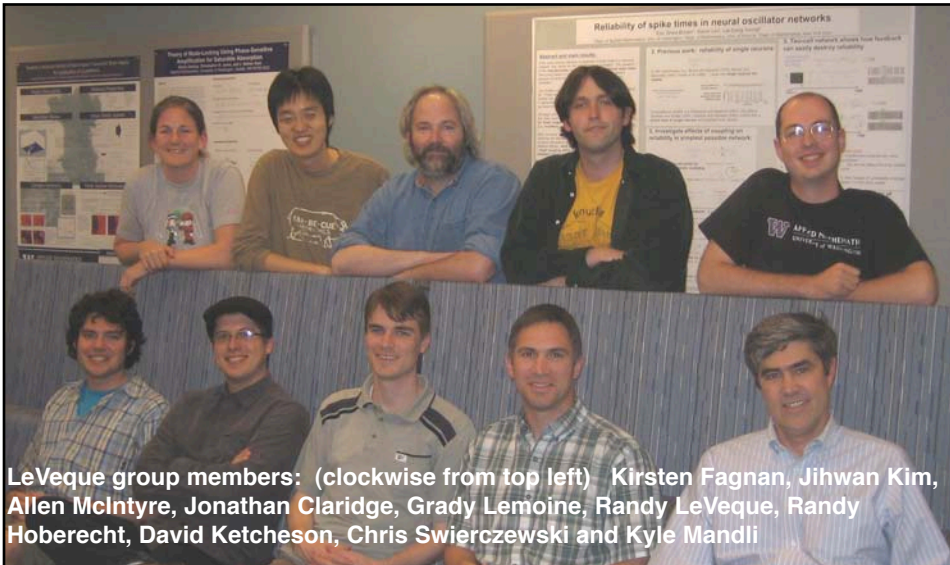
The figure below illustrates a finite element simulation of acoustic cloaking. The left picture depicts the isolines for the acoustic pressure in a homogeneous material. The middle picture plots the isolines for the acoustic pressure in a heterogeneous material. The right picture illustrates the isolines for the acoustic pressure when cloaking material surrounds the heterogeneity. This work is in collaboration with Prof. G. Uhlmann and Dr. H. Liu from the Department of Mathematics.



Cloaking at the UW

You may have heard some of the exciting mathematical developments around the topic of cloaking. The University of Washington is one of the leaders in this field, having on faculty one of the original proponents of the theory, Prof. Gunther Uhlmann, Adjunct Professor of Applied Mathematics. To learn more about Ulrich's work in cloaking and his broad assortment of computing applications, see his website at

amath.washington.edu/~hetmaniu



LeVeque group members: (clockwise from top left) Kirsten Fagnan, Jihwan Kim, Allen McIntyre, Jonathan Claridge, Grady Lemoine, Randy LeVeque, Randy Hoberecht, David Ketcheson, Chris Swierczewski and Kyle Mandli

Research Highlight
Randall LeVeque
 U.C. San Diego 1977
 Ph.D. Stanford 1982

 Advisor: J. Olinger

 Thesis
**Time-Split Methods for
 Partial Differential
 Equations**

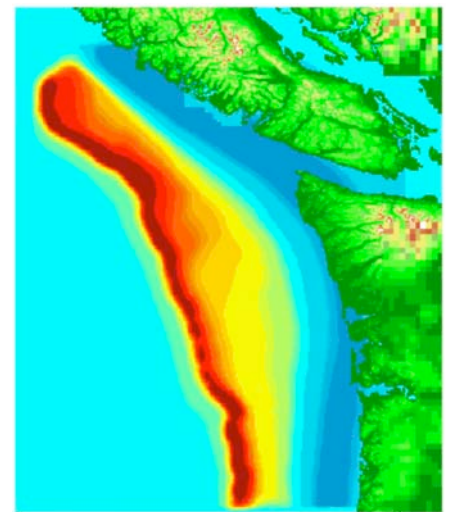
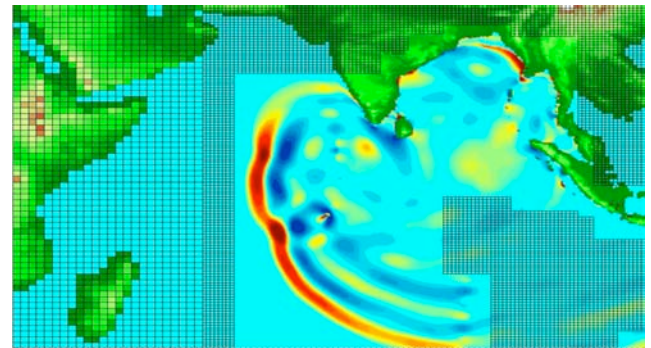
Hyperbolic Problems and Applications

Hyperbolic problems arise naturally in almost every mathematical model of flow or wave propagation: in aerodynamics, astrophysics, seismology, traffic flow, and optics, to name just a few application areas. Often these equations are nonlinear, leading to discontinuous shock wave solutions, but even for linear equations it can be challenging to compute accurate numerical solutions, particularly if the wave propagates through complex heterogeneous media with discontinuous material properties. For the past 15 years much of my group's work has centered around the development and use of the Clawpack software, designed for solving general systems of conservation laws. The package incorporates adaptive mesh refinement to allow a concentration of grid points in regions of interest, a crucial ingredient for most real world problems. This aspect of the software is still under active development with Marsha Berger at the Courant Institute, with whom I've been collaborating since our graduate school days in Computer Science at Stanford. A major revision of Clawpack is also currently under way: the user interface and visualization portions are being modernized using powerful open source Python packages, and a new web-based interface allows students to explore hyperbolic problems using only a web browser (you can too, at www.clawpack.org).

In recent years, several of my students have adapted this software to study hazardous geophysical flows. As one example, the figure to the right shows the tsunami that might be created by a megathrust earthquake on the Cascadia Subduction Zone, a region off our coast that is remarkably similar to the subduction zone near Sumatra where the catastrophic Indian Ocean Tsunami of 2004 originated. A magnitude 9 event occurred on the CSZ in 1700, as is known from historical records in Japan, and probably generated 12 meter waves on the coast of Washington. David George developed the Tsunami modeling capability in Clawpack as part of GeoClaw. He is now a USGS Mendenhall Postdoctoral Fellow at the Cascades Volcano Observatory in Vancouver, WA, and continues to collaborate with my group in extending this code to model massive debris flows (as might occur if Mt. Rainier erupts and its glaciers suddenly melt and flow towards Tacoma).

Another current interest in my group is the study of shock wave propagation in the body. Beneficial uses include lithotripsy, in which kidney stones are pulverized noninvasively, and recent developments in Extracorporeal Shock Wave Therapy (ESWT), where smaller amplitude shock waves are used to stimulate healing of bones or wounds. A negative aspect of shock waves is the potential for damaging healthy tissue. Numerical models can be used to guide therapy and explore biomechanical effects. We are doing this in collaboration with researchers at the Center for Industrial and Medical Ultrasound at APL. We are also working with researchers at the UW Medical School and the Veterans Administration to study the mechanics of mild traumatic brain injury (mTBI), which affects hundreds of thousands of veterans who have been exposed to blast waves in Iraq or Afghanistan.

Working in computational science these days is very exciting with ample opportunities to collaborate with scientists and engineers on physics-based simulations on a scale never before possible. Mathematical challenges still abound in the development of mathematical and numerical models that can make efficient use of modern computer architectures to address problems of interest to society. The Applied Mathematics Department, with its strong connections to many other units on campus, is an ideal environment for developing these cross-cutting tools.



Figures: Numerical simulations of the 2004 Tsunami wave in the Indian Ocean (top). This Tsunami was one of the deadliest natural disasters in human history. The bottom figure is a simulation of the Cascadia Subduction Zone of the Washington State coast, a region remarkably like the subduction zone off the Sumatra Coast.

Applied Mathematics Anniversary



Peter Schmid, Professor ('94-'07)



James Rossmann ('02) & Prof. Nathan Kutz



Prof. Randy LeVeque & Zhilin Li ('94)



Jihyouon Jeon ('07) & Tim Reluga ('04)



Zhilin Li ('94) and Prof. Hong Qian



Jane White ('95), Prof. Mark Kot, Michael Neubert ('94), Margaret Brown ('94)



Chris Curtis ('09), Dean Gull ('09), Katie Oliveras ('09), Kirsten Fagnan ('10), Christine Lind ('09), Dustin Lennon (MS '07), Eleftherios Kirkinis ('10)

Applied Mathematics is now on Facebook! Keep up with your classmates and the other alumni of the department by joining the "UW Applied Mathematics" group on facebook. Although just started, the group already has 63 alumni members from around the country and world.

Celebrating 25 Years!



Kristin Swanson ('99), Prof. Jerry Kevorkian ('64-'02) & Arnold Kim ('00)



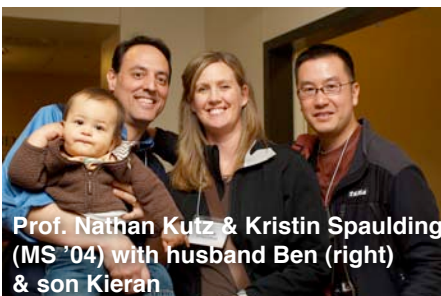
Beth Ong ('89) & Prof. Loyce Adams



Tom Trogden ('12), Mikala Johnson ('13), Joy Zhao ('15) & Prof. Bernard Deconinck



Prof. Peter Schmid, Kraig Winters ('89) & Prof. Bill Criminale



Prof. Nathan Kutz & Kristin Spaulding (MS '04) with husband Ben (right) & son Kieran



Prof. Frederic Wan ('82-'94), Robert O'Malley, and K. K. Tung



The Faculty: J. N. Kutz, F. Wan, M. Kot, I. Dumitriu (adjunct), R. O'Malley, B. Deconinck, L. Adams, T. Rockafellar, P. Schmid, R. LeVeque, J. Kevorkian, U. Hetmaniuk, K. K. Tung, C. Pearson, H. Qian, W. Criminale, E. Shea-Brown. (Not pictured: C. Bretherton, J. Murray, E. Todorov)

About 200 people participated in the 25th anniversary weekend activities. The weekend culminated with a Sunday brunch on Lake Union celebrating the retirement of Profs. Robert O'Malley and William Criminale. You can find more photos of the event online by following the "Alumni & Friends" link on the department's webpage: www.amath.washington.edu

A Brief History of the Department of Applied Mathematics

From Program to Department: The Birth of Applied Mathematics from the Engineering Sciences



Carl Pearson

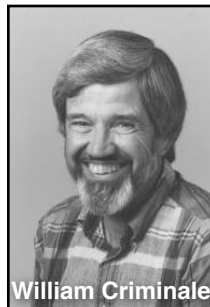
The Department of Applied Mathematics at University of Washington formally became an independent department within the College of Arts and Sciences on July 1, 1985, with Prof. Frederic Wan as its first Chair.

The history of the unit goes back much further. In 1969, under the direction of Professor Carl Pearson, the instruction of applied mathematics courses on campus was consolidated under the Applied Mathematics Committee. In 1972 the Applied Mathematics Committee became the Applied Mathematics Group and in 1976 obtained authorization from Washington State's Higher Education Council

to offer Master of Sciences and Doctor of Philosophy degrees in Applied Mathematics. As a result several, of our graduates predate the start of the Department. The vision of Prof. Pearson in forming Applied Mathematics has had a profound impact on all of us as faculty and students who have had a part in the department. Professor Pearson attended graduate school at Brown University and received his Ph.D. in 1949. He had a wide variety of experience in both the academic and professional worlds, having taught at Harvard and at the Technical University of Denmark, as well as at U.W. He also spent some years in industry, including working at Arthur D. Little Inc., Sperry Rand Co., and at Boeing Aerospace Co. Professor Pearson authored a number of books, some of them classics in the field of applied mathematics still used today.

In June 1982, the Applied Mathematics Program was formed as "an organization that will function and operate within the Graduate School in a manner parallel to an academic department" (as phrased by Provost George M. Beckman). Professor William Criminale was appointed the Chair of the Applied Mathematics Program. Several faculty from Aeronautical and Astronautical Engineering, Chemistry, Chemical Engineering, Oceanography, Mathematics and Statistics joined this new interdisciplinary program. Many of the courses were initially joint listed with the engineering, statistics and oceanography departments on campus, and gave our program the strong interdisciplinary character that it maintains to this day. With the arrival of Professor Frederic Wan in 1982, the administrative structure for formally establishing the program as a department was carried through. Since that time, the department has maintained research excellence in a wide variety of application areas and maintained a prominent standing in the applied mathematics community.

NOTE: It does not take advanced mathematics to realize that for various reasons (including some ambiguity in the start date of the department) our anniversary celebration this past Spring marks 24 years, not 25. Perhaps this is a fitting tribute to the fact that we have always been comfortable with approximate solutions and perturbation methods ($\epsilon=1/25=0.04$).



William Criminale



Frederic Wan

Where are we now?

Applied Mathematics ranked 4th in the country!

Recently, the Department of Applied Mathematics was ranked 4th nationally among applied mathematics programs and departments in the Chronicles of Higher Education 2008 ranking of faculty productivity and citations. This quantitative ranking showed the UW Applied Mathematics department to have the highest number of citations per faculty member. In fact, our citation count was almost *twice* any of the other top ten applied mathematics programs in the country. This aspect of the ranking is one of the most telling as it pertains to the relevance and impact of our faculty research.

For details, please see:

chronicle.com/stats/productivity



Prof. James Murray, faculty '91-'07

The **2009 Bakerian Prize Lecture** was given by Professor James Murray FRS on 26 March, 2009. The title of Prof. Murray's talk was "Mathematics in the real world: From brain tumours to saving marriages". The Bakerian Lecture is the Royal Society's premier lecture in the physical sciences. It originated in 1775 through a bequest by Mr Henry Baker FRS, of £100 for an oration or discourse which was to be spoken or read yearly by one of the Fellows of

the Society "on such part of natural history or experimental philosophy, at such time and in such manner as the President and Council of the Society for the time being shall please to order and appoint." Previous award winners include P. A. M. Dirac, Rutherford, Lord Rayleigh, Maxwell, Faraday. Those interested in watching the lecture, visit royalsociety.org/live. Congratulations Jim!



David Ketcheson & Family, PhD '09

David Ketcheson will finish his Ph.D. studies under the direction of Prof. Randy LeVeque. His work has encompassed a broad range of topics including: strong stability preserving Runge-Kutta methods, high-order finite volume methods for hyperbolic PDEs and applications of elastic/acoustic wave propagation methods for heterogeneous media. David has had an outstanding career at UW Applied Mathematics, submitting or publishing 9 journal articles and winning the SIAM Student Paper Prize 2008. Not only

did David win a prestigious DOE Computational Science Graduate Fellowship to support his graduate studies, this past Autumn he was also awarded an NSF Mathematical Sciences Post-doctoral Fellowship to study in the Division of Applied Mathematics at Brown University. David, however, has decided instead to join the inaugural faculty of King Adullah University of Science and Technology (KAUST) as an Assistant Professor. Congratulations David!

More Awards



Guillaume Lajoie



Josh Goldwyn



Bob O'Malley

Guillaume Lajoie was awarded two top graduate research fellowships from the Canadian government. Guillaume will choose between an NSERC (Natural Sciences and Engineering Research Council of Canada) post graduate scholarship or a FQRNT (Fonds québécois de recherche sur la nature et les technologies). Guillaume is working with Prof. Eric Shea-Brown on "Nonlinear dynamics of state transitions and information encoding in stimulus-driven neural networks."

Josh Goldwyn was awarded the NIH Ruth L. Kirschstein National Research Service Award for Individual Predoctoral Fellows. Josh is studying "A Model-Based Approach for Optimizing Cochlear Implant Stimulation" with Prof. Eric Shea-Brown. In this research he is developing mathematical and computational methods that characterize the neural response to cochlear implant stimulation and how auditory information is processed by cochlear implant listeners. The long-term goal of this research is to develop novel stimulation strategies that improve speech and music perception for cochlear implant (CI) users.

Bob O'Malley was elected one of the inaugural SIAM (Society for Industrial and Applied Mathematics) Fellows of the class of 2009. The SIAM Fellows program recognizes outstanding achievements and service in fields served by SIAM. In addition to his body of research work in asymptotics and perturbation methods, Bob has played a key role in SIAM, serving as president of SIAM during 1991-1992. He continues to play a role in SIAM as one of its book editors, editing and coordinating the book reviews in SIAM Review.

Calendar of Events

Watch for the Boeing Distinguished Colloquium during the academic year 2009-2010. The colloquia, featuring leaders in the applied mathematics community, are every other Thursday at 4 p.m. in Guggenheim 220. A reception follows and all are welcome.

Thank You!

As many of you are aware, private support is playing a larger and more critical role in the educational mission of public institutions of higher learning, especially as state support is lagging far behind that of private institutions. We are very grateful for the generous support of our alumni and friends and would like to express our gratitude to those who have supported the educational and research mission of the department over the past several years. Our current students are indebted to you! We especially thank the following recent donors.

Loyce Adams, Celeste Berg, Hilda Brown, Gregory Cain, Jean Crocker, Venus de la Cruz, Bernard Deconinck, Anil Dissayanake,

Gerald Fagnan, Petri Fast, Charles Grant, Madeline Helmke, Diane Henderson, John Haverfield, Madeline Helmke, Willy Hereman, Christine Janus, Vishesh Kapur, Steve Kjosness, Mark Kot, Nathan Kutz, Crystal Lee, Sheena Lee, Jeffrey Lovit, The Henry Luce Foundation, B. MacKinnon-Patterson, John MacKinnon, Rosemary Mandli, Tracie Mandli, Kimberly Nash, Robert O'Malley, Carrie Ortiz, Matthew Patterson, Carol Rovegno, Howard Rovegno, Jennifer Rovegno, Colleen Shea-Brown, Duane Storti, K.K. and Pat Tung, Frederic and Julia Wan, Mark Wheir.

If you would like to contribute to mission and vision of the department, visit: www.amath.washington.edu/giving/



Get your AMATH T-shirt! You can purchase an AMATH T-shirt for \$10 by contacting Keshanie Dissanayake: keshanie@amath.washington.edu.

W APPLIED MATHEMATICS
UNIVERSITY of WASHINGTON

414 Guggenheim Hall
Box 352420
Seattle, WA 98195-2420

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