Department of Applied Mathematics

013-2014 Newsletter

University of Colorado Boulder

History continued

Department of Applied Mathematics Newsletter

2013-2014

Department Chair: Mark Ablowitz, *Professor* Associate Department Chair: Anne Dougherty, *Senior Instructor* Chair of Graduate Studies: Per-Gunnar Martinsson, *Associate Professor*

Faculty

		Mark Ablowitz, Professor	Anne Dougherty, Senior Instructor
		Gregory Beylkin, Professor	Adam Norris, Senior Instructor
Inside this iss	sue:	James H. Curry, Professor	Sujeet Bhat, Instructor
		Bengt Fornberg, Professor	Murray Cox, Instructor
Affiliated and Adjunct Faculty		Keith Julian, Professor	Ryan Croke, Instructor
	3	Congming Li, Professor	Christian Ketelsen, Instructor
		Tom Mantueffel, Professor	Douglas Baldwin, Instructor, Research Associate,
PhD and Master's Student Graduates	4	James Meiss, Professor	Computer Tech
		Harvey Segur, Professor	Yolanda Hagar-Slichter, Instructor, Research Associate
		David Bortz, Associate Professor	Yiping Ma, Instructor, Research Associate
Department	5	Jem Corcoran Associate Professor	Ann DeFranco, <i>Lecturer</i>
History		Vania Dubia Accessione Profession	Silvia Chang, Lecturer
		Vanja Dukic, Associate Projessor	Jonathan Kish, <i>Lecturer</i>
New Faces	6	Manuel Lladser, Associate Professor	Sandy Williams, <i>Lecturer</i>
		Per-Gunnar Martinsson, Associate Pro- fessor	Michael A. Calkins, Lecturer, Research Associate
Student Awards	7	William Kleiber, Assistant Professor	Philippe Marti, Lecturer, Research Associate
		Juan G. Restrepo, Assistant Professor	Igor Rumanov, Lecturer, Research Associate
Faculty Awards	8	Jerrold Bebernes, Professor Emeritus	Sergey Voronin, Lecturer, Research Associate
		Bob Easton, Professor Emeritus	Marian Brezina, Research Associate
		Steve McCormick, Professor Emeritus	Lucas Monzon, Research Associate
Jim Meiss	9	John Williamson, Professor Emeritus	John Ruge, Research Associate
Conference			
		Staff	
Donations and 'Department'	10	Mary Fentress, Program Manager	Meg Kwiat, Student Assistant

Matthew Clifford, Graduate Program Assistant Ian Cunningham, Office Coordinator, Undergraduate Program Assistant Anna Gonzales, Accounting Tech Meg Kwiat, Student Assistant Eva Lambek, Newsletter Writer Jay LeCavalier, Computer Tech William Marquis, Computer Tech

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Affiliated and Adjunct Faculty

Affiliated Faculty

Steve Arendt, Colorado Research Associates

Meredith Betterton, Department of Physics

Elizabeth Bradley, *Department of Computer Science*

Richard Byrd, Department of Computer Science

Xiao-Chuan Cai, Department of Computer Science

John Cary, Department of Physics

Aaron Clauset, Department of Computer Science

John Crimaldi, Department of Civil, Environmental, and Architectural Engineering

Thomas DeGrand, Department of Physics

Alizera Doostan, Department of Aerospace Engineering

Scot Elkington, Laboratory for Atmospheric and Space Physics

Samuel Flaxman, Department of Ecology and Evolutionary Biology

Natasha Flyer, *Institute for Math Applied to Geosciences*

Baylor Fox-Kemper, Cooperative Institute for Research in Environmental Sciences

Debra Goldberg, Department of Computer Science

Thomas Hauser, OIT Administration

Ute Herzfeld, Cooperative Institute for Research in Environmental Sciences

Minhaly Horanyi, Laboratory for Atmospheric and Space Physics

Christine Hryena, *Department of Chemical and Biological Engineering*

Shannon Hughes, Department of Electrical, Computer, and Energy Engineering

Elizabeth Jessup, *Department of Computer* Science

Dhinaker Kompala, Department of Chemical and Biological Engineering

Manuel Laguna, LEEDS School of Business

Francios Meyer, Department of Electrical, Computer, and Energy Engineering

Nathalie Moyen, LEEDS School of Business

David Noone, Cooperative Institute for Research in Environmental Sciences

Lev Ostrovsky, Zel Technologies

Scott Parker, Department of Physics

Harihar Rajaram, Department of Civil, Environmental, and Architectural Engineering

Steve Sain, Institute for Math Applied to Geosciences

Siram Sankaranarayanan, Department of Computer Science

Daniel Scheeres, Department of Aerospace Engineering and Space Physics

Michael Shull, Department of Astrophysical and Planetary Sciences

James Syvitski, INSTAAR

Juri Toomre, Department of Astrophysical and Planetary Sciences

Henry Tufo, Department of Computer Science

Mahesh Varanasi, Department of Electrical, Computer, and Energy Engineering

Franck Vernerey, Department of Civil, Environmental, and Architectural Engineering

Patrick Weidman, Department of Mechanical Engineering

Jeffrey Weiss, Department of Astrophysical and Planetary Sciences

Joseph Werne, Colorado Research Associates

Adjunct Faculty

Fred Glover, College of Engineering and Applied Science

Hector Lomeli, Instituto Technologico Autonomo de Mexico

Annick Pouquet, Geophysical Turbulence Program, NCAR

PhD and Masters Student Graduates December 2013 Through Summer 2014

Yuanting Chen, PhD Bayesian Semi-Parametric Modeling of Time-to-Event Data Advisor: Vanja Dukic

Jose Humberto Garcia, PhD Beta-Plane Approximation of Wind Driven Ocean Circulation Using a First Order System Least-Squares Formulation Advisor: Thomas Manteuffel

Amrik Sen, PhD A Tale of Waves and Eddies in a Sea of Rotating Turbulence Advisors: Keith Julien and Annick Pouquet

Tobias Matthew Jones, PhD Algebraic Multigrid Methods for Parallel Computing, Systems, and Graphs Advisor: Thomas Manteuffel

Anthony Peter Rasca, PhD Modeling Solar Wind Mass-Loading Due to Dust in the Solar Corona Advisors: Keith Julien and Minhaly Horanyi

Meng Cao, M.S. *Non-thesis*

Yan Chen, M.S. Asymptotic Series Solutions to One-Dimensional Helmholtz Equation Advisor: Harvey Segur

Amanda Lynn Crawford, M.S. *Non-thesis*

Kerry Lynn Garcia, M.S. *Non-thesis*

Warren Lord, M.S. Non-thesis

Brita Bunnell Schneiders, M.S. The Impact of Calculus Workgroup and Oral Assessments on Student Learning: A Mixed Methods Approach Advisor: Mary Nelson—George Mason University

Richard Shafer, M.S. *Non-thesis*

Thomas Trantow, M.S. Numerical Experiments of Dynamical Processes During the 2011-2013 Surge of the Bering-Bagley Glacier System, Using a Full-Stokes Finite Element Model Advisor: Ute Herzfeld—CIRES

Dan Wu, M.S. *Non-thesis*

Christopher Vinyu Aicher, B.S./M.S. The Weighted Stochastic Block Model Advisor: Anne Dougherty and Aaron Clauset—Computer Science

Stephen Michael Kissler, B.S./M.S. Personalized Control of Diabetes Using a Two-Delay Model Advisor: David Bortz

Dylan Lowell Klein, B.S./M.S. Non-Thesis

2013-2014

Applied Mathematics: 1906-1966; 1989-2014: 25 years

Applied Mathematics is central to science and engineering education. As early as 1901 Engineering Mathematics was taught by faculty in the College of Engineering. Engineering Mathematics was organized as a separate Department of Engineering Mathematics in 1901. In 1948 the name of the unit was changed to the Department of Applied Mathematics and the Department granted its first Masters Degrees in that year as well. In 1958 it graduated its first BS degrees in Applied Mathematics. Soon afterwards, in 1962, the PhD degree in Applied Mathematics was approved by the Regents. In 1966 with hiring of S. Ulam by the Mathematics Department, the Applied Mathematics Department in the College of Engineering and Mathematics Department in the College of Arts and Sciences merged. The two departments were joined from 1966 until 1989.

In 1989, following a meeting of a number of faculty and administrators in the Sciences and Engineering, a recommendation was made to establish an independent Program in Applied Mathematics (APPM). The program was organized within the College of Arts and Sciences and was given authority to grant BS, MS and Ph.D degrees in Applied Mathematics. After 1989 APPM began a remarkable period of development; in 1996 the Regents approved changing its title to Department of Applied Mathematics. Thus with the re-emergence of this independent Program in 1989, APPM has now reached its 25 anniversary.

Instrumental faculty in the mid-1980s were Professors James Curry and Robert Easton who helped form an important committee with a vision to develop a new programmatic effort in Applied Mathematics. Early views were that the program would be housed in the Graduate School with faculty rostered in various departments; this would have been similar to how institutes were organized. In 1988 the committee recommended that Mark Ablowitz be hired as the first Director of the Program in Applied Mathematics. By the time Ablowitz arrived on campus in July 1989 to assume the position of Director, faculty committees had recommended that the Program be housed in the College of Arts and Sciences (A&S) where it is today. This supports the view that via A&S the Department can support engineering, science, and mathematics, as well as many other fields of application. In the early 1990s APPM began an affiliated faculty effort, where an affiliated faculty member from another department can direct a PhD student in conjunction with a co-advisor from APPM.

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Professor Curry, **Department Chair** 2003-2011



Professor Emeritus Easton



Professor Ablowitz, **Program Director and** first Department Chair 1989-2000; **Department Chair** 2012-Present

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Clockwise from top: Instructors Cox, Croke, and Ketelsen





Clockwise from top: Post-doc researchers Ma, Rumanov, and Voronin.



Staff-members Gonzales (left) and Fentress (right)



Professor Emeritus Steve McCormick

Warm Welcomes

The department hired three new instructors who began in Fall 2013. They are:

Murray Cox comes to APPM from Southwestern Adventist University in Keene, Texas. Born in Denver, Murray got his PhD from Texas A&M and has taught at University of California, Riverside. He is a Golden Gloves light-heavy weight (boxing) champion for Colorado and Texas and a direct descendent (Grandson) of Quanah, the last chief of the Comanche. He says that he loves Colorado and it is so good to be back home!

Ryan Croke received his doctorate from Colorado State University. His research focuses on Nonlinear Phenomena. Along with Dr. Ketelsen, Dr. Cox, and Dr. Bhat, he taught several sections of Calculus I for Engineers.

Longtime friends of the department will recognize Dr. **Christian Ketelsen.** He received his PhD from us in 2009, before joining Lawrence Livermore National Laboratory as a post-doctoral research associate. In Fall 2013 he returned to CU as our third new instructor.

The department has also taken on new post-doctoral researchers. They are:

Yiping Ma, working for Dr. Ablowitz. He is studying nonlinear wave dynamics in optical lattices. Yiping got his Bachelor's degree from the Hong Kong University of Science and Technology and his PhD from UC Berkeley.

Igor Rumanov is working for Dr. Ablowitz, focusing on random matrix methods, the study of matrices with random coefficients. He received his Bachelor's degree from the Moscow Institute of Physics and Technology and his PhD from UC Davis.

Sergey Voronin, working for Dr. Martinsson, focusing on Computational Mathematics and Physical Applied Mathematics from 2014 through 2016.

The office staff has also added two new faces:

Anna Gonzales is the new Accounting Technician. She was born in San Diego and began in July last year. She has twins that she says fills all her time out of the office.

Mary Fentress is the new Office Manager. Mary was born in Denver and worked for INSTAAR for thirteen years as the lead accounting tech. She has two daughters and one granddaughter.

Fond Farewells

Professor Steve McCormick retired from the Department of Applied Mathematics in December 2013. McCormick is a leader in computational applied mathematics, and has been with the department for over 20 years.

McCormick is a world renowned mathematician. He has over 200 publications and 20 Ph.D. students to his credit. His research interests vary widely, including multilevel methods, human organ simulation, vector and parallel supercomputing, and plasma physics among many other topics of study. He has three books: *Multigrid Methods, Multilevel Adaptive Methods for Partial Differential Equations*, and *A Multigrid Tutorial, Second Edition*. McCormick was also honored as a SIAM fellow in 2010 for "contributions to numerical partial differential equations, especially multigrid and first-order system least-squares methods". He plans to continue collaborating on a few funded research projects, but most of his leisure time will be devoted to traveling and a lot of hiking in the high country. Page 7



Top to bottom: award winners Ali, Coffey, Kightley, Kissler, and Stotsky

Student Awards

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PhD candidate **Ashar Ali** was awarded the NASA Earth and Space Science Fellowship. His proposal, "Investigating the effects of azimuthal structure on ULF-driven particle transport and energization in the radiation belts" is fully funded for this academic year, with the possibility of two more renewals. Ali's project will, in part, utilize data from NASA's Van Allen Probes to help us understand how Earth's radiation belts change in response to solar activity. Ali works in the Laboratory of Atmospheric and Space Physics under Dr. Scot Elkington.

Brennan Coffey, a double major in applied math and chemical engineering, was awarded the prestigious Barry M. Goldwater scholarship. Coffey is one of three CU students awarded the scholarship this year. The national scholarship is awarded to students of high academic merit who intend to pursue careers in science, mathematics, and engineering. Coffey has worked in CalTech's Jet Propulsion Lab during the summer. During the academic year he works in the interfacial science lab of Chemical and Biological Engineering's Daniel Schwartz. Coffey's work at CU involves the computational study of diffusion and how substances are absorbed by cell walls from blood.

PhD candidate **Eric Kightley** won an NSF Graduate Fellowship. NSF Fellows receive three years of research support, international research and professional development opportunities, and access to a supercomputer. Kightley is a first-year student in the Interdisciplinary Quantitative Biology program. His research with Professor David Bortz deals with microbial aggregate ecology. Microbial aggregation is a ubiquitous phenomenon with many important industrial applications, such as wastewater treatment and biofuel production. The efficiency with which these aggregates perform their desired task depends upon their distribution in space and in size. Kightley will seek to integrate population dynamics with spatial distribution models to improve the processing efficiency.

Concurrent Bachelor's/Master's student **Stephen Kissler** was awarded the Gates Cambridge Scholarship to research the spread of influenza. The Gates Cambridge Scholarship is a program that provides full funding for doctoral studies at Cambridge University in the United Kingdom. The goal of the Gates Cambridge Program is to "build a global network of future leaders committed to improving the lives of others" (Gates Cambridge.org). Kissler has worked with Associate Professor David Bortz on mathematical models of diabetes. At Cambridge, Kissler plans to study the spread of influenza through mathematical modeling.

PhD candidate **Jay Stotsky** won a four-year Department of Energy Computational Science Graduate Fellowship. DOE Fellowships are awarded to a diverse array of science and engineering disciplines but all have a common focus on using computing in their research. Stotsky is currently working with Associate Professor David Bortz on a project to model and simulate the structural properties of bacterial biofilms. Biofilms are surface-adherent communities of bacteria that excrete certain compounds that provide structural support and protection from external environmental conditions. This is problematic since biofilms can cause extremely rapid, microbiologically influenced corrosion (MIC) in many materials, costing billions of dollars per year. The goal of Stotsky's research is to develop models and algorithms for simulating biofilm biomechanics in order to develop better strategies for MIC mitigation.

Faculty Awards

Associate Chair Dr. **Anne Dougherty** received the Burton W. Jones Distinguished Teaching Award and the Marinus Award from the CU Parents Association. The Burton W Jones Award is a yearly award made by the Rocky Mountain Section of the Mathematical Association of America to recognize "extraordinarily successful teachers of mathematics at the post-secondary level." The Marinus Smith Award recognizes faculty and staff who have had a "particularly positive impact on our undergraduates" and is especially unique because recipients are nominated solely and voluntarily by their undergraduate students.

Associate Professor **Vanja Dukic**, and **Yanwei Zhang** of the University of Southern California, have won the 2014 Casualty Actuarial Society ARIA Award for the paper "Predicting Multivariate Insurance Loss Payments Under the Bayesian Copula Framework." From the CAS website: "This prize, established in 1997, is made to the author of a paper published by the American Risk and Insurance Association (ARIA) that provides the most valuable contribution to casualty actuarial science." Vanja wrote, "Bayesian statistics is essential to our understanding and management of risk, and a valuable framework for the actuarial profession." Prof. Dukic holds a dual undergraduate degree in Finance and Actuarial Mathematics, from Bryant University, and a PhD degree in Applied Mathematics from Brown University.

Professor **Bengt Fornberg** has won a Boulder Faculty Assembly (BFA) Award for Excellence in Research, Scholarly, and Creative Work and has also been selected as a 2014 SIAM Fellow. Candidates for the BFA award are nominated by their peers and must demonstrate ongoing excellence in their field. He has made major contributions in the field of numerical computation and his book, *A Practical Guide to Pseudospectral Methods*, has been cited over a thousand times.

Fornberg's induction as a 2014 Fellow of the Society for Industrial and Applied Mathematics is for "advances in spectral methods, radial basis functions, and other methods for computational fluid dynamics and partial differential equations". His recent work on applying gridless interpolating methods using radial basis functions to numerical solutions of partial differential equations has attracted considerable interest in the STEM fields.

Associate Professor **Per-Gunnar Martinsson** was the principal lecturer at a conference held in honor of his body of work. The conference was held in June 2014 at Dartmouth College. The lectures were the main feature of a meeting sponsored by the Conference Board of Mathematical Sciences (CBMS) and the National Science Foundation, and surveyed a body of work developed by Dr. Martinsson over the last 10 years, concerning so called "fast direct solvers" for elliptic partial differential equations. Selection as a CBMS speaker is highly competitive, with fewer than 10 people selected from across all the mathematical sciences each year. This is the third time an APPM faculty member has received this distinction, with Professor Harvey Segur chosen in 2008, and Professor Bengt Fornberg in 2011.

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Top to bottom: award winners Dougherty, Dukic, Fornberg, and Martinsson

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Boulder Dynamics Conference in Honor of Jim Meiss' 60th Birthday

When prominent mathematicians turn 60, they often have more than a birthday party: they have a conference in their honor. In this tradition, the Boulder Dynamics Conference was set for 21 July to 25 July 2014, was organized by Holger Dullin (Sydney), Bob Easton (CU), Hector Lomeli (UT Austin), and David Sterling (Somalogic), with support from the Applied Mathematics Department. The conference in honor of Meiss' achievements largely focused on current research in

Hamiltonian and more general dynamical systems theory. Participants came from as far away as Israel, Australia, the Netherlands, and Russia, while about half of the participants were from varying places around the US. The conference featured about 30 lectures over a five-day period; lecturers discussed new findings as well as gave historical overviews. The conference was fairly low-key and informal, with ample time for coffee, tea, and conversation.

Jim Meiss received his PhD from the University of California at Berkeley in physics in 1980. From 1980 until his time at CU, Meiss worked at the Institute for Fusion Studies at the University of Texas at Austin. He has been a professor at the University of Colorado Boulder in the Department of Applied Mathematics since 1989. Meiss is the author of three books and over 100 articles. Meiss's research interests include area preserving maps, symplectic maps, computational topology, antiintegrability, polynomial maps, twistless bifurcations, invariant tori, volume preserving maps, piecewise smooth bifurcations, and transitory dynamics.

One example of the range of topics discussed and lectured on is Meiss's moon-landing trajectory project, diagramed on the right. Completed in 1999, Meiss's research showed that the most economical landingpattern is a chaotic pattern. His trajectory is still used today in moon landings. Another example comes from one of the conference organizers, Holger Dullin of Australia, who has used dynamics to improve the Australian diving team by creating models to understand the spin of dives, providing insight on the divers' motions, ultimately creating better dives. Overall, Hamil-

tonian dynamics is a field with many applications and many of these were the subject of the lectures at Meiss's 60th Birthday Conference.







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From 1989 to 2000 Ablowitz was the first Director and subsequently became Chair of the Department. From 2000-2003, Professor Harvey Segur was Chair and from 2003-2012 Professor James Curry was Chair. Ablowitz is serving as Chair 2012-present.

In 1989 the task of building the newly created program was given to Ablowitz and his colleagues. The program originally had one staff member, Janet Horn. In addition to Ablowitz and Curry, two key faculty members, Jim Meiss and Harvey Segur, were appointed beginning Fall 1989. Soon after the program was formed a number of faculty moved from the Mathematics Department to APPM; this included Professors Jerold Beberness, Robert Easton, John Maybee and John Williamson. Thus the original four faculty along with the four that moved from the Math Department plus key new faculty who were hired the early-mid 1990s: Professors Beylkin, Li, Manteuffel, McCormick and Fornberg, formed the core of the unit and collaborated on shaping its future. Over time the current structure of the undergraduate and graduate curricula were developed.

In addition to hiring tenure track faculty the Program also hired two instructor/postdoctoral researchers, who typically spend three years with the unit before moving on to permanent, typically tenure track faculty positions. In the mid-1990s one of the people hired was Dr. Anne Dougherty. Anne, a remarkable teacher and advisor, decided she preferred to remain with APPM as a senior instructor. Over time, she made improvement of APPMs undergraduate program a priority. She became our Associate Chair during Professor Curry's term as Chair. She has been extremely influential in our teaching and service missions ever since.

During the past few years, APPM's teaching obligations have increased significantly. This is largely due to the decision by the College of Engineering to substantially increase its overall undergraduate enrollment. APPM is in a growth phase once again. Last year the Department hired two new faculty members: Stephen Becker and Mark Hoefer, and is again gearing up to recruit a new faculty member beginning fall semester 2015. We are looking forward to the future with high expectations and excitement.

We invite you to contribute to our Annual Fund Drive. Tax-deductible donations can be made here: <u>http://amath.colorado.edu/content/donate</u>

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