Department of Applied Mathematics
- The University of Colorado at Boulder -

2015-2016 Newsletter
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Faculty and Staff

Department Chair: Keith Julien, Professor
Associate Department Chair: Anne Dougherty, Senior Instructor
Chair of Graduate Studies: Per-Gunnar Martinsson, Professor

-Faculty-
Mark Ablowitz, Professor
Gregory Beylkin, Professor
James H. Curry, Professor
Vanja Dukic, Professor
Bengt Fornberg, Professor
Keith Julien, Professor
Congming Li, Professor
Tom Mantuani, Professor
Per-Gunnar Martinsson, Professor
James Meiss, Professor
Harvey Segur, Professor
David Bortz, Associate Professor
Jem Corcoran, Associate Professor
Manuel Lladser, Associate Professor
Stephen Becker, Assistant Professor
Mark Hoefer, Assistant Professor
William Kleiber, Assistant Professor
Juan G. Restrepo, Assistant Professor
Jerold Bebernes, Professor Emeritus
Bob Easton, Professor Emeritus
Steve McCormick, Professor Emeritus
Anne Dougherty, Senior Instructor
Adam Norris, Senior Instructor
Sunet Bhat, Instructor
Murray Cox, Instructor
Brendan Fry, Instructor
Christian Ketelsen, Instructor
Brian Zaharatos, Instructor
Yolanda Hager-Slichter, Instructor, Research Associate
Yiping Ma, Instructor, Research Associate
Sergey Voronin, Instructor, Research Associate
Silva Chang, Lecturer, Math Placement Advisor
Ann DeFranco, Lecturer
Jonathan Kish, Lecturer
Cristian Mendoza, Lecturer, Help Room Coordinator
Eric Thaler, Lecturer
Sandy Williams, Lecturer
Nicholas Featherstone, Lecturer, Research Associate
Philippe Marti, Lecturer, Research Associate
Benjamin Miquel, Lecturer, Research Associate
Igor Rumanov, Lecturer, Research Associate
Chris Leibs, Research Associate
Lucas Monzon, Research Associate
Staffan Muenzemaier, Research Associate

-Staff-
Mary Fentress, Program Manager
Catriona Alcock, Graduate Program Assistant
Emily O’Connor, Graduate Program Assistant
Ian Cunningham, Office Coordinator, Undergraduate Program Assistant
Anna Gonzales, Accounting Tech
Desirée Holtz, Accounting Tech
Jacob Tafoya, IT Manager
Montek Thind, IT Student
Vidyadhar Deodhar, IT Student
Ksenia Lepikhina, IT Student
Jennifer Corpuz, Student Assistant
Meg Kwiat, Student Assistant
Michael Onischuk, Student Assistant
Sabrina Macneir, Student Assistant
Chelsea Yun, Student Assistant
Danielle Hawley, Writer

-Visiting Scholars-
Narcis Miguel Banos, University of Barcelona
Ali Demirci, Pennsylvania State University
Ezio Iacono, Chalmers University of Technology
Xudan Luo, Hong Kong University of Science and Technology
Affiliated Faculty and Adjunct Faculty

-Affiliated Faculty-
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
Scott Elkington, Laboratory for Atmospheric and Space Physics
John Evans, Department of Aerospace Engineering 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, Brown University
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 Hrycyna, Department of Chemical and Biological Engineering
Elizabeth Jessup, Department of Computer Science
Lakshmi Kantha, Department of Aerospace Engineering and Space Physics
Dhinaker Kompala, Department of Chemical and Biological Engineering
Rodger Kram, Department of Integrated Physiology
Manuel Laguna, LEEDS School of Business
Francios Mayer, Department of Electrical, Computer, and Energy Engineering
Nathalie Moyen, LEEDS School of Business
David Noone, Cooperative Institute for Research in Environmental Sciences, University of Oregon
Lev Ostrovsky, Zel Technologies
Scott Parker, Department of Physics
Harhar Rajaram, Department of Civil, Environmental, and Architectural Engineering
Steve Sain, Institute for Math Applied to Geosciences
Sriram Sankaranarayanan, Department of Computer Science
Daniel Scheeres, Department of Aerospace Engineering and Space Physics
Michael Shull, Department of Astrophysical and Planetary Sciences
James Svyitski, 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-
Aimé Fournier, Mesoscale and Microscale Laboratory, NCAR
Fred Glover, College of Engineering and Applied Science
Hector Lomeli Ortega, Instituto Tecnologico Autonomo de Mexico
Annick Pouquet, Geophysical Turbulence Program, NCAR
# Graduates
## Summer 2015 — Spring 2016

<table>
<thead>
<tr>
<th>Summer 2015</th>
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<tbody>
<tr>
<td>Ignas Satkauskas, M.S.</td>
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<tr>
<td>Kenneth Blair, B.S.</td>
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<td>Raymond Dao, B.S.</td>
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<th>Fall 2015</th>
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<tr>
<td>Ioana Illies, M.S.</td>
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<td>Delyan Kalchev, M.S.</td>
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<td>Zachary Mullen, M.S.</td>
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<td>Sean Braxton, B.S.</td>
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<td>Dara Chhim, B.S.</td>
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<td>Michelle Duggan, B.S.</td>
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<td>Daniel Helfrich, B.S.</td>
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<td>Daniel Kinzie, B.S.</td>
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<td>Kevin Macias, B.S.</td>
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<td>Daniel Matthias, B.S.</td>
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<td>Matthew Spacek, B.S.</td>
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<th>Spring 2016</th>
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<tr>
<td>Ashar Ali, Ph.D.</td>
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<td>Ze Chang, Ph.D.</td>
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<td>Bao Lei, Ph.D.</td>
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<td>David Nieves, Ph.D.</td>
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<td>Anthony Wong, Ph.D.</td>
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<td>Allison Betley, M.S.</td>
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<td>James Folberth, M.S.</td>
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<td>Hristina Kalcheva, M.S.</td>
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<td>Wayne Mitchell, M.S.</td>
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<td>Richard Schweizer, M.S.</td>
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<td>Rachel Tuthmaher, M.S.</td>
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<td>Benjamin Wiley, M.S.</td>
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<td>Ed Yasutake, M.S.</td>
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<td>Theodore Elberts, B.S./M.S.</td>
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<td>Scott Fielder, B.S./M.S.</td>
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<td>Pawel Janas, B.S./M.S.</td>
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<td>Branden Olson, B.S./M.S.</td>
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<td>Raymond AuYeung, B.S.</td>
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<td>Zachary Britt, B.S.</td>
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<td>Phu Dang, B.S.</td>
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<td>Dominic Dobis, B.S.</td>
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<td>Jordan Firstenberg, B.S.</td>
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<td>Mario Gjurekovec, B.S.</td>
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<td>Anna Hoffie, B.S.</td>
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<td>Zachary Lane, B.S.</td>
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<td>Shu Lee, B.S.</td>
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<td>Ryan Leonard, B.S.</td>
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<td>Christopher LeSueur, B.S.</td>
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<td>Louie Long, B.S.</td>
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<td>Nikola Maksimovic, B.S.</td>
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<td>Rami Meharzi, B.S.</td>
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<td>Branden Olson, B.S.</td>
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<td>Kyle Ostrom, B.S.</td>
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<td>Kaitlyn Parsons, B.S.</td>
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<td>Harrison Pielke-Lombardo, B.S.</td>
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<td>Jordan Prosky, B.S.</td>
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<td>Evan Ronchevic, B.S.</td>
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<td>Noah Seidenfeld, B.S.</td>
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<td>Joseph Stewart, B.S.</td>
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<td>Emily Stohl, B.S.</td>
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<td>Iracli Zhuzhunashvili, B.S.</td>
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Letter from the Chair

This newsletter marks the first time that I, as a new chair, have the honor of providing my comments to the Department of Applied Mathematics (APPM) newsletter. I joined APPM as a tenure-track faculty in 1998 and have had the privilege of both participating and observing the units evolution and growth in many important areas.

I would first like to offer my sincere gratitude to APPM's previous Chair, Professor Mark Ablowitz. Professor Ablowitz started his tenure at the University of Colorado at Boulder in 1988 as Director of the Program of Applied Mathematics. Under his leadership this program rapidly matured and gained Departmental status in 1995. Professor Ablowitz was APPM's first Chair, a position he returned to from 2012-2015. I can unequivocally state that his stewardship has been invaluable in strengthening the foundations of the department. Professor Ablowitz remains one of APPM’s most accomplished and distinguished researchers and is recognized internationally for his many seminal contributions in the area of physical applied mathematics.

APPM has seen several changes in its classified staff positions. Program Manager Mary Fentress, who joined the unit in 2013, continues to play a crucial leadership role. Jacob Tafoya was hired on in 2015 as the IT Manager focused on managing APPM’s educational and research IT mission. Career advancements have resulted in Anna Gonzales (Accounting Technician) and Catriona Allcock (Graduate Program Assistant) moving on to new positions. Gonzalez remains employed on the Boulder campus as the Budgets and Grants Coordinator for the School of Education and Allcock has taken a position with Lockheed Martin. APPM was fortunate enough to find replacements for these positions: Desiree Holtz, from the private sector, was hired into the accounting tech position, and Emily O’Connor was hired from the Department of Transportation to become APPM's Graduate Program Assistant.
APPM is currently in a period of substantial growth. A primary driver for this fact is the increase in the undergraduate enrollment and the associated demand for student credit hours for core mathematics courses within the College of Engineering and Applied Science. Student credit hours have grown from 17,000 in AY 2012-2013 to 23,000 in AY 2015-2016. This has introduced new challenges for APPM. The following summarizes APPM statistics for AY 2015-2016. APPM had nineteen tenured and tenure track faculty, seven instructors, seven lecturers, and eleven postdoctoral researchers. Beginning Fall 2016, APPM's tenure track faculty will grow to twenty-two with the hiring of two assistant professors (Zachary Kilpatrick and Yu-Jui Huang) and one associate professor (Eric Vance). APPM's affiliated faculty group remains strong and diverse with forty-two members representing faculty over twenty-three departments and local academic institutions. Affiliated faculty can direct Ph.D. students as associate advisors. Applied Mathematics had 146 undergraduate majors (including double majors), sixty-six undergraduate minors, and seventy-nine graduate students majors in 2015-2016 Academic Year.

We hope that increased enrollment will continue to result in additional tenure track faculty lines. The quest for a unified location on campus that houses APPM's entire educational and research mission still remains a high priority. High-level discussion with upper administration are on-going. A successful solution in this arena will undoubtedly provide that foundation to catapult APPM to higher levels of excellence.

APPM's scholarly output remains highly productive. In 2015, APPM faculty published fifty-four papers or chapters in peer-reviewed journals or books, and gave many invited lectures. Professor Gregory Beylkin was elected as a fellow of SIAM (Society of Industrial and Applied Mathematics), becoming the fourth member of the APPM faculty with this accolade. Professor Dukic was elected as a fellow of the American Statistical Association, becoming the first member of the faculty to hold this honor. Applied Mathematics also received a total of $2.049 million in grants. This comprised of $1.313
million as PI directed funds and additional $736 thousand as collaborative grants with other units.

AY 2015-2016 also bought notable accomplishments to our graduate and undergraduate students. This includes two NSF Graduate fellowships (Antony Pearson and Jacqueline Wentz), one NASA Graduate Fellowship (Meredith Plumley) and a Goldwater scholarship to undergraduate (Derek Driggs). APPM undergraduates continued to excel in the international math modeling competition. Each year, the Consortium for Mathematics and Its Applications (COMAP) holds the Mathematical Contest in Modeling (MCM) and the Interdisciplinary Contest in Modeling (ICM). Sixty CU Boulder undergraduate students divided into twenty teams participated in the 2016 MCM and ICM. Out of the 12,446 teams who participated, CU Boulder was recognized for one Outstanding Team and the MAA Winner, five Meritorious, seven Honorable Mentions, and seven Successful Participants. Since 2000, CU Boulder teams have received a remarkable sixteen Outstanding designations.

The Department of Applied Mathematics is one of the leading departments of applied mathematics in the world. We strive for excellence in teaching, research and service. It is an honor to be part of world renowned faculty in fundamental areas of research and amongst students who continue to garner accolades on behalf of the department and the university.

We look forward to many more successful academic years.

Keith Julien
On the Christmas Eve of 2011, Mark Hoefer received an email linking one of his theories to experiments taking place in Gothenburg, Sweden. It was a momentous occasion. During his time with the National Institute of Standards and Technology (NIST) as a postdoctoral fellow, Professor Hoefer and colleagues had proposed a hypothesis surrounding the existence of dissipative droplet solitons. He felt strongly he was correct, but lacked part of the puzzle, the physical observations. On the other side of the world, Ezio Iacocca’s former PhD advisor gave a lecture on his research. Afterward, an audience member brought Professor Hoefer’s hypothesis to the speaker’s attention, a discussion that ultimately led to the momentous Christmas Eve email. Theory and experiment had at last intersected. Now a Swedish International Postdoctoral Fellow in CU Boulder’s Applied Mathematics Department, Dr. Iacocca works closely with Professor Hoefer and, with their associates, continue their exciting findings.

In 2013, they published “Spin Torque-Generated Magnetic Droplet Solitons” in Science, one of the world’s top academic journals. The paper spurred excitement among the academic community, and the project maintained its momentum. A new paper, “Magnetic droplet nucleation boundary in orthogonal spin-torque nano-oscillators” has been published in Nature Communications, another widely recognized and prestigious academic journal.

This publication discusses dissipative droplets, which are magnetic solitons that Professor Hoefer and colleagues theoretically predicted to exist in materials where dispersion, anisotropy, dissipation, and forcing balance each other. This balance is possible to achieve experimentally using ferromagnetic materials with perpendicular magnetic anisotropy (PMA) and a current-induced forcing known as spin transfer torque. In addition to their novel physical features, these solitons may be useful for spintronic applications where the electron’s spin, in addition to its charge, is used for signal and information processing. In this paper, the dissipative droplet’s condition for existence, or nucleation boundary, is derived analytically and measured experimentally. This is achieved by weakly nonlinear stability analysis of the Landau-Lifshitz magnetic equations of motion including dissipation and forcing. From a uniform state, localized forcing excites plane waves when spatially uniform dissipation is balanced or exceeded. However, in materials with PMA, the uniform state exhibits a subcritical Hopf bifurcation. The corresponding plane waves that compose this bifurcation are modationally unstable, a nonlinear instability that results in the coalescence of waves and, ultimately the formation of a large amplitude dissipative droplet. In contrast, the corresponding equation without PMA exhibits a supercritical Hopf bifurcation and the formation of a stable, weakly nonlinear time-periodic solution. Looking for instability and taking into account asymmetries present in the experiment, an analytical expression for the nucleation boundary as a function of applied fields and current (forcing) is obtained. Experiments show a remarkable agreement and fits to the analytical expression enable the in-situ determination of relevant material parameters such as the spin torque efficiency and asymmetry, with good accuracy. These results reconcile different nucleation trends previously observed experimentally under a single, closed-form expression.
Student Awards

Derek Driggs
Barry Goldwater Scholarship

The Barry Goldwater Program aims to produce a continuing source of highly qualified scientists, mathematicians, and engineers by awarding scholarships to college students who intend to pursue research careers in these fields.

Michelle Maiden
National Science Foundation Fellowship

The NSF Graduate Research Fellowship Program recognizes and supports outstanding graduate students in science, technology, engineering, and mathematics disciplines.

Antony Pearson
National Science Foundation Fellowship

The NSF Graduate Research Fellowship Program recognizes and supports outstanding graduate students in science, technology, engineering, and mathematics disciplines.

Meredith Plumley
NASA Earth and Space Science Fellowship

NASA’s Earth and Space Science Fellowship program solicits graduate fellowship proposals to fulfill the NASA Science Mission Directorate to understand the Sun and its effects on Earth and the solar system.

Jacqueline Wentz
National Science Foundation Fellowship

The NSF Graduate Research Fellow Program recognizes and supports outstanding graduate students in science, technology, engineering, and mathematics disciplines.
Warm Welcomes

Ian Grooms joined APPM as an Assistant Professor in the fall of 2015. He earned his B.S. in Mathematics from the College of William & Mary in 2005 and his Ph.D. in Applied Mathematics from CU Boulder in 2011. At the Courant Institute he worked as a post-doc from 2011 to 2015. His research develops and applies novel mathematical methods to problems in climate-atmosphere-ocean science.

Brian Zaharatos is an APPM Instructor. He earned his Ph.D. in Applied Mathematics and Statistics from the Colorado School of Mines, his M.A. in Philosophy from the University of South Carolina, and his B.S. in Mathematics and Philosophy from the State University of New York, Stony Brook. His primary interests are in applied statistics, the philosophy of statistics, and teaching methods that promote interdisciplinarity. Brian has worked on research projects in solar cell performance modeling, and on a team that provides statistical support for litigation and residential building energy analysis. In his free time, Brian enjoys playing hockey, running, cycling, hiking, and playing the guitar.

Nicholas Featherstone is a Lecturer and a Research Associate with APPM. He is currently working with Professor Julien on his research. He is a lead participant in the NSF funded CIG group (Computational Infrastructures for Geodynamics) with the responsibility of producing a community code to investigate the magnetohydrodynamics of the Earth’s liquid iron outer core on massively parallel computing architectures. His research interests include Computational Mathematics, Nonlinear Phenomena, and Physical Applied Mathematics. Before joining APPM, he was affiliated with JILA.
Warm Welcomes

Jacob Tafoya joined APPM as the IT manager in July of 2015. Jacob is originally from Albuquerque, New Mexico, and he attended Southwestern College in Winfield, Kansas on a tennis scholarship. Jacob is a gifted cook and baker, as he won first place at the New Mexico State Fair for tortillas. While not baking or playing tennis, Jacob enjoys swimming, bicycling, hiking, disc golf, and spending time with his dog, Zora.

Desiree Holtz joined the APPM department as our Accounting Tech in January 2016. She has lived in Colorado for over twenty years. When she is not playing the guitar with her band, she enjoys gardening and hiking.

Emily O’Connor, the Graduate Program Assistant, is the latest addition to the APPM staff. She joined the department in the summer of 2016. She is originally from Chicago. In 2014, she graduated from CU Boulder. In her free time, she enjoys snowboarding, hiking, crafting, and spending time with her dog.

Fond Farewells

Catriona Alcock
Brendan Fry
Christian Ketelsen
Cristian Mendoza

and those not pictured: Anna Gonzales, Chris Leibs, and Sergey Voronin
2015-2016 Highlights

Antony Pearson, Michelle Maiden, and Jacqueline Wentz were awarded National Science Foundation Fellowships this past year. The fellowship is awarded to graduate students pursuing research-based Master’s and doctoral degrees in science, technology, engineering, and mathematics. The program received 17,000 applications and granted 2,000 awards. The fellowship provides $34,000 per year for three years.

The Society of Industrial and Applied Mathematics (SIAM) published a book by Professor Bengt Fornberg titled, A Primer on Radial Basis Functions with Applications to the Geosciences. The textbook was co-authored with Dr. Natasha Flyer, who is an affiliated faculty member of APPM, a NCAR scientist, and Professor Fornberg’s wife.

Each year, the Consortium for Mathematics and Its Applications (COMAP) holds the Mathematical Contest in Modeling (MCM) and the Interdisciplinary Contest in Modeling (ICM). Out of the 12,446 teams who participated, CU Boulder was recognized for one Outstanding Team and the MAA Winner, five Meritorious, seven Honorable Mentions, and seven Successful Participants.

We invite you to contribute to our Annual Fund Drive. Tax-deductible donations can be made here:

http://www.colorado.edu/amath/donate

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