Prime Bits

Department of Mathematics

2016–2017

Chair's Communique

One afternoon this past July, I received a telephone call from Dean Steven Leigh of the College of Arts and Sciences asking if I would consider serving a one-year term as interim chair for the Department of Mathematics. He suggested that the department would benefit from my 13 years of experience as chair of the Department of Integrative Physiology. Flattered by the invitation and intrigued by the opportunity, I met with three former chairs (David Grant, Judy Packer, and Eric Stade) to learn about the Department of Mathematics. They described the strengths and weaknesses of the department and encouraged me to accept the invitation if the faculty concurred, which they subsequently did.

I began my one-year term on August 1 and have learned much about the department since then. My initial impressions are that the department has a number of strengths that bode well for its future, but there are some procedural issues that need to be resolved. The major strengths of the department include the commitment of the faculty to undergraduate teaching, the expertise of the administrative and technical staff, the many members of the faculty who have received research grants, the interactions with other academic units (especially Applied Mathematics) on campus, the support for diversity among the faculty and graduate students, the willingness of departmental members to assist each other in times of need, a culture of engaging in scholarly discourse through seminars and visiting scholars, and a cadre of retired faculty who retain an interest in the welfare of the department. Most encouragingly, I have been made to feel welcome in the department, which has strengthened my resolve to serve the department to the best of my ability.

Despite these many strengths, there are some issues that need to be addressed. The most pressing needs were identified at a four-hour retreat on September 22 that was facilitated by an external consultant and attended by most of the faculty. One element of the retreat involved small-group discussions in which participants were charged with providing suggestions on how to improve the climate within the department. The discussions were productive and, in general, resulted in suggestions that comprised changing some of the bylaws in the departmental constitution, reorganizing the structure and function of the executive committee, defining the mission and procedures for the graduate program, expanding the program for postdoctoral fellows, and engaging the junior faculty in shaping the future of the department. The retreat concluded with a one-hour exercise on how to have effective conversations and a final statement by each participant on a commitment to the future. Most of these statements underscored the willingness of the faculty to assist in moving the department in a positive direction.

We will address as many of these suggestions as possible during the current academic year and expect the department to emerge at the end of the spring semester with an even more promising future. To achieve our goals, however, the continued support of our alumni and friends is critical and greatly appreciated. 						**–Roger Enoka**

> The department of Mathematics decided last spring to select an interim chair from outside the department. We are very grateful that Professor Roger Enoka of the Integrative Physiology department selflessly agreed to serve our department in this role this academic year, applying his considerable administrative experience and expertise on our behalf.

Thank you! Richard Laver Graduate Fellowship almost fully funded

Last year we wrote in *Prime Bits* that the department's number one fundraising goal was to raise the remaining money needed to completely fund the endowment for the Richard Laver Graduate Fellowship, a living memorial to our former colleague Rich Laver, who succumbed to Parkinson's disease in 2012.

Rich was a superb set theorist and a wonderful man. He spent his career enriching the lives of his students and coworkers.

Due to the incredible generosity of the family and friends of Rich, we have almost met that goal: we have raised $93,000 of the $112,500 we need to award this graduate fellowship in perpetuity. If you would like to bring us closer to this goal, you can give at https://giving.cu.edu/fund/richard-laver-graduate-fellowship

In the meantime, the department this past year supplemented the annual proceeds of the endowment to award the second ever Richard Laver Graduate Fellowship to graduate student Mark Pullins.

New Faculty and Staff

Sandra Bailey

Sandra Bailey joined the Mathematics department staff in Fall 2016 as its "PPL" — the department's Payroll and Personnel Liaison — a crucial position responsible for handling all of the department's accounts.

Sandra grew up outside Philadelphia, came to Colorado on a mountain-biking trip, and decided to return permanently. She has spent 16 years in the West. She attended CU in 2001, studying Integrative Physiology (IPHY). She then joined the staff of IPHY, serving as their PPL.

Her initial impression of the Mathematics department is how active and numerous its seminars are, especially with attracting guest speakers from other institutions (something it can do because of generous contributions from its alumni).

Outside of CU, Sandra is a professional organizer, helping seniors, small businesses and people with disabilities. She is also an avid gardener and master composter. She can bring plants back from the brink of death.

Agnès Beaudry

Assistant professor Dr. Agnès Beaudry arrived in Boulder this Fall. She hails from New Brunswick, Canada (the one official bilingual province). She grew up as an Acadian, so as a Francophone. She started learning English at age 12, in the fifth grade.

Agnès attended McGill University in Montreal. She majored in mathematics, but came to the field via studying logic and philosophy. She recounts taking an "amazing" algebra course from the famous Henri Darman (sometimes called in Canada, "the Wayne Gretzsky of mathematics") that changed her life.

Agnès earned her PhD at Northwestern University, working under Paul Goerss in an area of algebraic topology colorfully dubbed, "chromatic homotopy theory." She then held a postdoctoral position at the University of Chicago under the supervision of Peter May. Her work has been celebrated by the National Science Foundation, which awarded her a research grant.

Agnès is excited about teaching at CU: "I'm really engaged in my teaching. I'm glad we have a big graduate program!"

Outside work, Agnès likes to hike and rock climb, and to read science fiction. About being in Boulder: "I love it. I've wanted to be here since graduate school and it's amazing that it happened. The stars aligned."

Magdalena Czubak

Dr. Magdalena (Magda) Czubak is an assistant professor at CU Boulder as of Fall 2016. She is originally from Poland, and came to the US at age 14 minus epsilon, moving to Queens, NY. Magda attended International High School at LaGuardia Community College in Queens, and then majored in Mathematics and Computer Science at Harpur College (SUNY Binghamton). She earned her PhD at the University of Texas Austin under the tutelage of Karen Uhlenbeck. She was a postdoctoral fellow at the University of Toronto, working under Jim Colliander. She then returned to Binghamton to become an assistant professor at her alma mater.

Magda's field of study is differential geometry as applied to partial differential equations, and has been nationally recognized for her work, having been awarded a prestigious Simons Collaboration Grant. Outside of math, she likes to swim, hike, and rock climb — because it's like math: "Problem solving, that's part of it. You really have to pay attention to what you're doing. You get stuck and have to try things. And then you have to push yourself to try these things. There are lots of parallels."

Magda also loves animals and volunteers at an animal shelter. She kept chickens before moving to Boulder, and would like to do so again. As for her thoughts on coming to Boulder: "The best thing that's happened to me. I'm very happy to be here. I'm very excited."

Lee Roberson

Dr. Lee Roberson is an instructor in the Mathematics department, an expert in the "active learning" method of teaching used in most of the department's introductory-level courses. Besides teaching, his job is to co-ordinate these courses, which are offered with many small sections taught by graduate students and lecturers. As such, he is involved in the professional development of these graduate students, training them to be better teachers.

Originally from Kentucky, Lee earned his bachelor's and masters degrees at the University of Kentucky, after which he took a year off to travel, backpacking through China and Nepal. He also coached soccer and worked construction.

He then earned his PhD in mathematics education at the University of Northern Colorado, his research studying the cultural relationships between mathematics students and mathematics faculty. He found that there's usually a disconnect (especially at the introductory and intermediate levels) between the culture of the way mathematics faculty view mathematics and how students perceive how faculty talk about mathematics.

Lee says he is "excited to be here" at CU Boulder, developing graduate students' pedagogy through the active-learning focus in our calculus courses. He is coordinating Calculus II right now, and will be coordinating Calculus I next semester. He's also working with graduate students on how to develop active learning materials for classes.

For fun Lee likes to run in the mountains, ski, play soccer, camp, and travel. As *Prime Bits* goes to press, he and his wife just had their first child.

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Mathematics Department Outreach Successes

It has been a busy year for the Mathematics Department Outreach Committee, which gives back to the community and helps young people develop.

Now in its eleventh year, the Colorado Math Circle brings together Colorado's top high school and middle school students for math talks and collaborative problem solving, challenging them to use creativity and ingenuity to tackle difficult problems. Co-sponsored by the Outreach Committee and the Applied Mathematics department, the math circle offers weekend meetings and afterschool meetings during the academic year, weeklong workshops during the summer, and a trip to a national math competition for the state's top high school students. Attendees are drawn from dozens of schools throughout the state.

Chaired by Presidential Teaching Scholar, Eric Stade, the Outreach Committee also helps fund the Advancing Algebra program for the Boulder Valley School District. Students in the district face a 25-30% failure rate in Algebra 1. They are working with local teachers to identify systemic factors for this dramatic failure rate. To date they have worked with teachers at both Boulder and Centaurus high schools, and have involved a number of CU undergraduates in facilitation, collaboration, and data collection. They have identified a data model that highlights some of the inequities and challenges they face, and are developing teacher workshops to plan next steps.

Over the past several years, Math graduate student Natalie Coston has undertaken various outreach activities, most of which have focused on cultivating mathematical curiosity and excitement in young students, with funding from the Outreach Committee and the CU Science Discovery program.

Coston designed and conducted a 3-week summer course for middle and high school students about various branches of mathematics through CU Science Discovery. She led a workshop about fractals for the CU Teen Science Cafe. When CU hosted an event which encouraged middle school girls to study STEM, she participated by leading a group through various workshops. She has found these outreach activities to be very rewarding.

Working with the College of Engineering's Integrated Teaching and Learning Laboratory and the Admissions Office, Mathematics graduate students Steven Weinell and Jeff Shriner helped promote mathematics during two high school recruiting trips, in which students from the Denver Schools of Science and Technology (DSST) visited the CU Boulder campus. During these outreach sessions, DSST students engaged in activities which attempted to answer the question, "What does a mathematician do?" The importance of understanding why something works, versus just knowing how something works, was emphasized while attempting an unsolvable maze, playing the counting game Nim, and learning a math-based card trick.

Student Achievements

Mathematics Learning Assistant and future elementary school teacher **Gabrielle Kristofich** was honored with a 2016-17 **McCray Scholarship**. The scholarship is awarded each year to a full-time, academically strong undergraduate student with demonstrated leadership ability.

Michael Mahoney is the recipient of the 2016-17 **Jack Hodges Award for Excellence in Mathematics** (funded by gifts from our readers), given annually to the advanced undergraduate Mathematics major who demonstrates the greatest promise in the mathematical sciences.

Kellin Pelrine won the 2016-17 **Jim and Laura Marshall Scholarship**.

Richard Dryer won the 2016-17 **George and Clara Moreno Scholarship**, which is awarded annually to an outstanding student in Mathematics.

Callie Kellackey received the 2016-17 **Marlene Massaro and David Pratto Scholarship in Mathematics**. This annual scholarship awards an exceptional upper level undergraduate Mathematics major.

Chayenne Theberge, Jeffrey Shriner, and **Erik Weinberger** received the 2016-17 **Adele V. Leonhardy Memorial Scholarships**. These scholarships are awarded annually to outstanding students who plan careers in teaching mathematics.

Caroline Matson won the **Frances C. Stribic Scholarship**.

Ian Long won the **W. J. Thron Summer Fellowship**, awarded annually to the most outstanding third or fourth year graduate student.

Natalie Coston, Nathan Davidoff, and **Mason Pelfrey**, received **University Summer Fellowships**.

Jonathan Belcher won a **Sieglinde Haller Scholarship**.

The Richard Laver GraduateFellowship was awarded to **Mark Pullins**.

Matthew Grimes had travel supported by a gift from **Jim and Laura Marshall**.

2015 W. E. Briggs Teaching Excellence Award

Cherry Ng and **Katharine Adamyk** with Professor Jeanne Clelland (middle)

2016 Burton W. Jones Teaching Excellence Award

Keli Parker, Professor Jeanne Clelland, **Matthew Grimes**, and **Jared Nishikawa**

2015 Putnam Exam Winners

Professors Keith Kearnes and Alexander Gorokhovsky, **Michael Moy, Kellin Pelrine**, Associate Professor Sergei Kuznetsov. Not pictured: **Derek Driggs**. Moy, Pelrine and Driggs tied for the top Putnam score from CU in 2015.

Math Club Update

The Math Club is being run by Dr. Divya Vernerey with the help of Assistant Professor Agnès Beaudry, and — with its many faculty talks aimed at undergraduates — is proving very popular with our students. Students will also be designing math department T-shirts this semester, and there will be an outing to an interactive puzzle game venue in Denver. Based on its success, we're starting an Actuarial Club this fall for students in our Actuarial Studies Program.

Undergraduate Research

In Summer 2016 the department again had a successful math research experience for our undergraduates and first year graduate students. This year we had six projects led by Professors Sean O'Rourke, Markus Pflaum, Kate Stange, Nat Thiem, Jonathan Wise, and Dr. Jordan Watts. Overall there were 17 undergraduates and 7 graduate students participating. They presented their work at a poster session on November 1.

Degrees Awarded

In May, the department awarded 8 Doctorates, 12 Masters, and 3 Bachelors degrees with Latin honors. Congratulations!

Matthew Timothy Grimes, PhD
Compactifications of the universal moduli space of sheaves and the log-minimal model program on the moduli of curves

Krisztián Havasi, PhD
Determinants in K-theory and operator algebras

Matthew G. Krupa, PhD
Differential Geometry of Projective Limits of Manifolds

Julie Linman, PhD
Minimal functions on the random permutation

Jared George Nishikawa, PhD
Applications of Cryptographic Hash Functions

Alexander Nita, PhD
The Essential Self-Adjointness of the Symplectic Dirac Operators

Charles Frederich Scherer, PhD
Maximal Comparable and Incomparable Sets in Boolean Algebras

Erica Hilary Shannon, PhD
Computing invariant forms for Lie algebras using heaps

Jonathan Adam Belcher, MA
Natalie A. Coston, MS
Nathan Kim Davidoff, MA
Taylor Klotz, MA
Jae Min Lee, MA
Xiaorong Liu, MA
Ian M. Long, MA
Caroline Liggett Matson, MA
Patrick Normile, BA/MA
Elizabeth Ellen Parsons, BA/MA
Mason Thomas Pelfrey, MA
Mark Pullins, MA

Evan Thomas Oliver, BA
summa cum laude
Oliver Atillo Orejola, BA
magna cum laude
Varodom Theplertboon, BA
summa cum laude

Faculty Achievements

Professor Sebastian (Yano) Casalaina-Martin received a research grant from the National Security Agency (NSA). He also won a National Science Foundation (NSF) conference grant to organize the Western Algebraic Geometry Symposium.

Professor Katherine Stange received an NSF "Eager" grant (Early-concept Grants for Exploratory Research).

Professor Sean O'Rourke won an NSF grant to work with Professor Behrouz Touri of the Department of Electrical, Computer, and Energy Engineering at CU Boulder.

Professors Keith Kearnes, **Peter Mayr** and **Agnes Szendrei** received an NSF grant for 2015-2018 for collaborative research on "Algebra and algorithms, structure and complexity theory."

Professor Jonathan Wise won an NSA Young Investigator grant.

Professor Nathaniel Thiem won a Simons Foundation Collaboration grant, joining **Professors Yano Casalaina-Martin, Suion Ih, Judith Packer,** and **Markus Pflaum** who are supported on these five-year grants.

The European Commission funded a "Research and Innovation Staff Exchange" grant. **Professors Markus Pflaum** and **Carla Farsi** will form a "node," allowing visitors from other nodes to come to CU Boulder for joint research and for our faculty to visit other nodes on the research network.

Professor Martin Walter was honored with a 2016 Boulder Faculty Assembly Award for Excellence in Leadership and Service. These awards are sponsored by the Office of the Chancellor.

Professor Judith Packer won the 2015 Ames Award from the Journal of Mathematical Analysis and Applications for her paper "Quantum Heisenberg manifolds as twisted groupoid C*-algebras."

Professor Jeanne Clelland's new book, "From Frenet to Cartan: The Method of Moving Frames" was accepted for publication by the American Mathematical Society. It will appear in 2017.

In Memoriam

We are sad to report that **Professor Homer Ellis** died this September after a long battle with cholangiocarcinoma. He was just shy of 83. Homer came to CU in 1965. He was dedicated to the "Moore Method" of teaching that he learned at Texas from Moore himself (a precursor to today's "active learning.")

Homer's research brought his background in differential geometry and his keen independent mind to bear on the world of physics. "The long-standing primary goal of my research is to explain as many as possible of the phenomena of physics as hidden properties of space brought to light by careful examination of its geometry."

His essay, "Einstein's real 'biggest blunder,'" on Einstein's failure to distinguish active and passive gravitational mass, won an "honorable mention" from the Gravity Research Foundation, the fourth time he received that honor.

We also regret to report that **Troy Seguin**, PhD, 2008 passed away in May 2016 after a courageous battle with colon cancer. He was 41. You can contribute to a campus memorial in his honor at gofundme.com/2n7a38s.

The Importance and Success of Active Learning

"Active learning" is a type of teaching that actively engages students in the classroom, something that traditional lecture courses have a hard time doing. It can involve anything as simple as giving students problems in the middle of lecture to think about and then share their thought processes with their neighbors, to having regularly scheduled group projects in class, to even "flipping" the classroom, where students are expected to read or view material outside class then spend all of class time working on projects.

While not new, the nation is waking up to the efficacy and import of active learning. The efficacy is so compelling the White House recently issued a "A Call to Action: Incorporating Active STEM Learning Strategies into K-12 and Higher Education."

The Mathematics department has for many years been a national leader in bringing active learning into the college mathematics classroom.

This effort began years ago when CU Math professors Robert Tubbs and Eric Stade re-designed our first-year calculus sequence to make use of active-learning by incorporating group work facilitated by undergraduate Learning Assistants. Three years ago our Calculus sequence was named by the Mathematics Teacher Education Partnership as one of four national models for how calculus should be taught, and the Helmsley Trust gave CU a grant to develop and disseminate materials for the calculus courses. At the same time, we hired Dr. Faan Tone Liu to coordinate our calculus courses,

and through her work with Tubbs and Stade those materials are now publicly available to teachers everywhere.

Based on this work, Tubbs was just named a principal investigator on a 5-year NSF grant to study how CU and similar schools have succeeded at active learning and what other institutions can do to make its adoption more widespread (see below).

Dr. Liu was also in charge of training our graduate TAs to be effective teachers using active learning. We recently hired Dr. John Martin to continue this work training our TAs. (We proudly note that both Liu and Martin got their PhDs in our department!) Liu organized a 3-day summer workshop on Inquiry-Based Learning (as active learning is also known), which was attended by graduate students and faculty.

But Calculus I and II are not the only courses in the Department which feature active learning. Our precalculus course was revamped this year as an active learning course (see the adjoining story). Our sophomore level statistics course is a flipped classroom, as is the recently developed Excel-based quantitative reasoning course in the Business school. The department is also planning on extending its successful model for Calculus I and II to Calculus III (multivariable calculus). We should also mention that we have three flavors of Calculus I: one for most STEM majors, one for life sciences majors, and one for Economics and Business majors, all which use active learning.

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Nationwide Active Learning Study Led By CU Math

The National Science Foundation just granted $3,000,000 to CU Boulder, the University of Nebraska-Lincoln, and San Diego State University to conduct a five-year study of how best to affect institutional change at colleges and universities to permanently adopt active learning in their mathematics classes.

The principle investigator for the CU portion of the grant is Professor Robert Tubbs, who helped bring

active learning to our department via our calculus sequence. He recently developed a new active learning modeling and reasoning course to replace College Algebra and to better prepare students for statistics courses. Assisting Tubbs will be co-principal investigators Professor David Webb of the CU School of Education and Professor David Grant of the CU Mathematics department.

Precalculus Reform Increases Student Success

The department is part of a national movement to develop better pathways through required math courses for all college students. Data show that students who take more than one semester to get to required calculus courses hardly ever do. So, the department no longer offers separate College Algebra and Trigonometry courses and redesigned its precalculus course as a one-semester prerequisite for CU students who need calculus for their majors.

This year we completely revamped how we teach precalculus, too, converting large lectures to small active learning sections with group work facilitated by undergraduate Learning Assistants. A survey mid-semester shows that students love the changes.

To better serve the needs of the third of students who are less well-prepared, they take an extra 2-hour a week supplemental section, whose success rate is outstanding. On the first day of class all students took a diagnostic. Those not in the supplemental section averaged 83% on the diagnostic, and 84% on the first midterm. The students in the supplemental section scored 61% on the diagnostic and jumped up to 72% on the first midterm, substantially narrowing the achievement gap. The gap was even smaller by the end of the semester!

Spearheading the changes in the precalculus course is instructor Dr. Divya Vernerey. Divya is from South India and came to the US at age 10. She earned her PhD in applied mathematics from Northwestern University and has been teaching for our department since. Outside of CU, Divya enjoys the South Indian dance, Bharatanatyam. She is the mother of two wonderful daughters.

Donors to the Mathematics Department

The Mathematics department is deeply grateful for the generous contributions by the donors listed below. Gifts to the department make possible scholarships, awards, and more. Our alumni and friends are the cornerstone of future success for today's and tomorrow's students.

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Thank you!

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We would love your support! Please contact our development coordinator Jazmin Brooks, jazmin.brooks@colorado.edu, or Professor David Grant, grant@colorado.edu, to discuss the many scholarships, funds, and endowments specific to the Department of Mathematics; or visit our website, math.colorado.edu, and click the "Give Now" button. Thanks!

Alumni News

Robert Snell (PhD, Mathematics, 1968) shared with Bill Jones his feelings about Prime Bits: "It has meant a lot to me to learn of the progress [that] CU has played in the world of mathematics. It has contributed so much to people like myself that have had the opportunity and the privilege of being involved with that department."

William A. Bernstein (BS, Applied Math, 1972) notes that he is not retired yet, "...but it looks better and better each and every day." William has been a loyal and devoted donor to the Mathematics department, donating each year on the anniversary of his father's birthday. Thank you, William!

Amanda (Geist) Sharrow (BA, Mathematics, 2008) reports that she was married in 2013. Her daughter was born in 2015. Amanda has been teaching math at Monarch High School in Louisville, CO since 2013.

Since its inception a quarter century ago, *Prime Bits* has been edited by Professor Emeritus William B. Jones. Our gratitude for what Bill has done for our department and its friends and alumni is unbounded.

This issue is edited by Professor David Grant and is intentionally more compact in order to meet the desire among a growing number of our alumni and friends to read *Prime Bits* in its electronic format (see the Prime Bits link on the department's home page, math.colorado.edu).

If you would prefer to receive only the online version in the future, please drop us an email at mathalumni@colorado.edu

In any format, we endeavor to keep our loyal alumni and friends abreast of what's going on at your alma mater and to express our gratitude for what your continuing support has meant for the department and its many generations of students past, present, and future.

Be Boulder.

University of Colorado **Boulder**