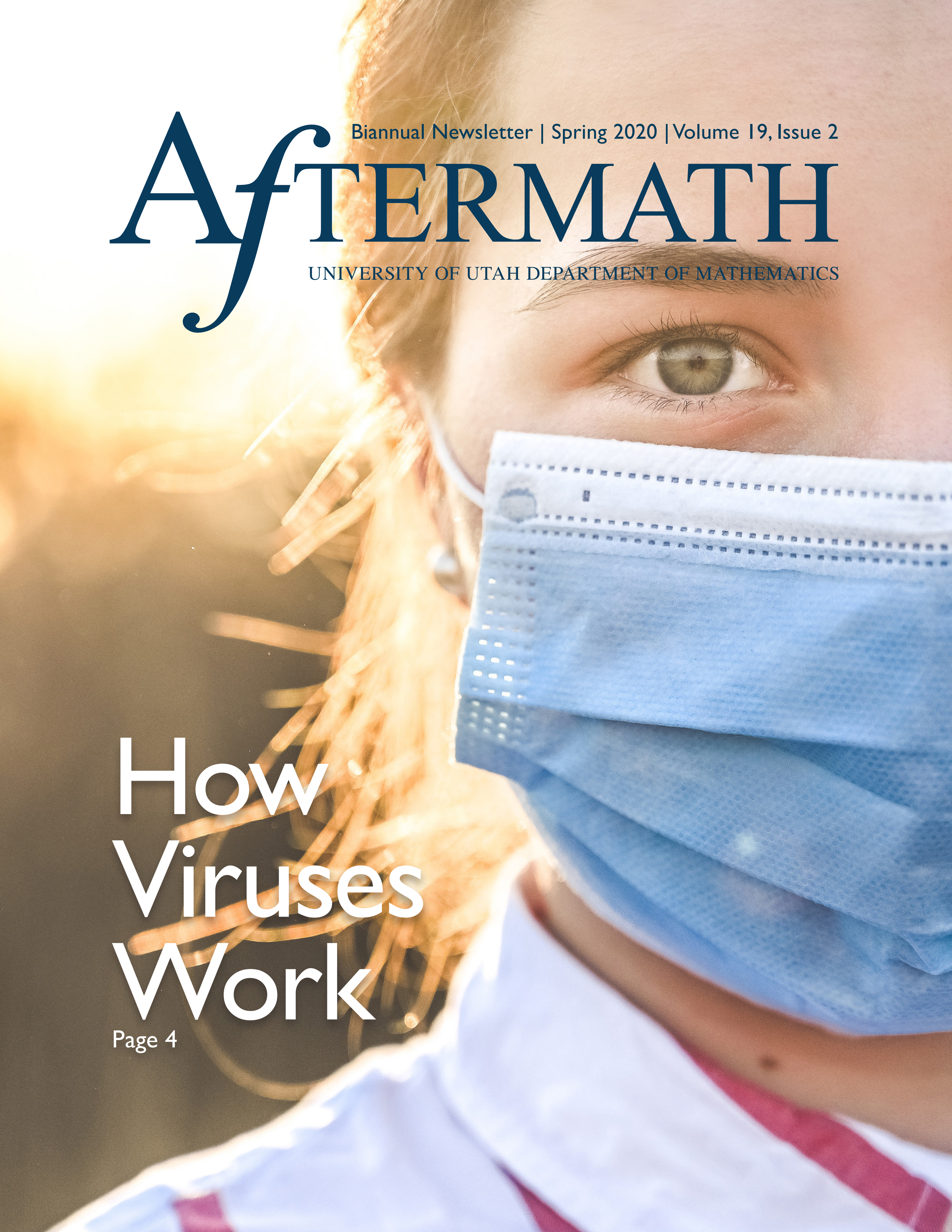

Biannual Newsletter | Spring 2020 | Volume 19, Issue 2

AFTERMATH

UNIVERSITY OF UTAH DEPARTMENT OF MATHEMATICS

How Viruses Work

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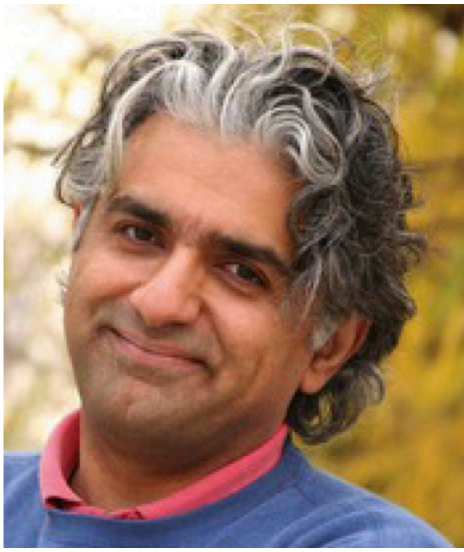
In This Issue

Message from the Chair

In these times of unprecedented events, Mathematics Department faculty and instructional staff made a swift transition in mid-March to online instruction for the remainder of the spring semester. In this way, our students were able to access recorded lectures and homework assignments and engage in video consultations with their instructors and peers, while observing new norms of safety including social distancing. The department and the university remain operational during this period, and our faculty, staff, and postdocs have transitioned to working from home. Online instruction for students will continue throughout the summer semester.



Davar Khoshnevisan

I have been impressed with the willingness and ability of the members of the Mathematics Department to make a smooth transition to online teaching and working from home. Not surprisingly, many of the onsite activities we normally plan for spring were canceled, including our graduate student recruiting, Student Awards Ceremony, College of Science Convocation, and Commencement. While we were sorry we could not celebrate these milestones with our students in person, the department created an online awards program to congratulate the Class of 2020 and to recognize students who received awards and scholarships. You can see the celebration at http://www.math.utah.edu. We are proud of our students!

Our cover story focuses on the work of our own Professor Fred Adler, a mathematical biologist, who has been working for many years on mathematical epidemiology—the study of the spread of diseases through populations. Professor Adler recently was awarded a seed grant from the University of Utah to study the COVID-19 virus. His research will involve mathematical modeling of the impact of viral interactions and evolution on the COVID-19 pandemic. You can read more about his research on viruses and the coronavirus in the newsletter.

In 2019, Assistant Professors Sean Howe and Priyam Patel joined our faculty. Before coming to the University of Utah, Howe was a National Science Foundation Postdoctoral Fellow at Stanford University. Professor Howe studies the Langlands program, an area of mathematics that develops analogies to explain the behavior of prime numbers using ideas grounded in geometry and physics. Professor Patel was previously at the University of California, Santa Barbara. She uses ideas from geometry and topology to understand curves on surfaces, symmetries, and hyperbolic manifolds and their finite covering spaces.

Our faculty have continued to be recognized nationally for their work. Assistant Professor Sean Lawley received a National Science Foundation (NSF) CAREER Award, considered one of the most prestigious NSF awards given to early-career researchers and educators; Professor Karl Schwede and Associate Professor Jon Chaika both received the coveted Simons Fellows Awards. These fellowships extend sabbatical research to a full year and are awarded based on a recipient's previous accomplishments and the impact of the work. Our University of Utah awardees

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include Instructor (Lecturer) Kelly MacArthur, who won the 2020 University of Utah Distinguished Teaching Award, one of the highest teaching honors bestowed by the University.

The university campus is now in the Orange Phase of our response to the coronavirus. For those who will be able to return to campus in the Orange Phase, this move will be gradual and will begin primarily with essential on-campus research activities. Telecommuting will continue for most employees, and undergraduate students will not be on campus.

As always, our department-wide accomplishments would not be possible without the generous support of our donors and friends. Their support drives the department forward, allowing our terrific faculty and students to make novel discoveries and have exceptional educational opportunities and experiences. From all of us in the Department of Mathematics, thank you for all you do.

Sincerely,

Davar Khoshnevisan
Professor and Chair
Department of Mathematics

Support Mathematics

CRIMSON
Laureate Society

The *Crimson Laureate Society* was established in May 2017. The charter of the society is to build a community of alumni and friends who are passionate about the advancement of scientific research and education at the University of Utah. The physical sciences, life sciences, and mathematics have been the fundamental building blocks for the technological and social leaps of the past century. Now, science is needed more than ever to improve lives and to provide innovative solutions for the global challenges we face.

From the microscopic to the cosmic, research in the College of Science supports transformative discoveries in drug development, clean energy, data science, climate change, and astronomy. At the same time, we teach fundamental science to the next generation of scientists, engineers, doctors, and others.

As a *Crimson Laureate Society* member, you can be an advocate for science in your community, making your voice heard as we work with legislators to create new science programs in Utah. You'll gain VIP access to events that present cutting-edge research from the U and around the world, while your philanthropic contributions will support science outreach, scholarships, faculty support, and research at the U.

We ask you to support the promotion and further advancement of science at the University of Utah by joining the *Crimson Laureate Society*. We hope you will join us in ensuring that science continues to drive creativity, critical thinking, and positive change for everyone in our community.

To recognize the importance of your participation, *Crimson Laureate Society* members are entitled to many exclusive benefits, including:

- VIP invitations and seating at featured College of Science events
- Recognition on our Hall of Fame donor wall and the College of Science website
- Opportunities to engage with our talented and accomplished faculty
- Recognition in the *Notebook* magazine (Collegiate Club and up)
- Venues for networking with College of Science alumni and friends
- Special tokens of appreciation based on your membership level

For more information, contact the College of Science at 801-581-6958, or visit www.science.utah.edu/giving.

How Viruses Work

Professor Fred Adler, a mathematical biologist in the Department of Mathematics and the School for Biological Sciences, had been working on mathematical epidemiology—the study of the spread of diseases through populations—for some time but began to feel he was cheating by not investigating the main way that viruses interact with their hosts: through the immune system. He had also looked into the evolution of virulence, studying how sick viruses and other diseases make us, but hadn't studied the mechanisms by which that works, which involve the specific proteins in the virus and how they function. "Finally, and this is true of much of my research," said Adler, "my grad students made me do it. I have had several outstanding students who developed projects on viral dynamics within hosts and cancer-causing viruses. They taught me most of what I know."

Adler recently was awarded a seed grant from the University of Utah to study the COVID-19 virus. Through the Office of the Vice President for Research, in partnership with the Immunology, Inflammation and Infectious Disease Initiative, the U has awarded $1.3 million in seed grants to 56 cross-campus projects that are examining a host of issues arising out of the COVID-19 pandemic. Adler's research involves mathematically modeling the impact of viral interactions and evolution on the COVID-19 pandemic.

How Viruses Work

Viruses are around us all the time. They can't replicate themselves without their hosts. They hijack cell machinery to their own ends, making more copies of themselves to make more viruses, to infect more cells, and ultimately more hosts. How do they do this? When a virus travels, it always includes its genome and a surrounding protein shell, or capsid, which keeps the viral genome safe and helps it latch onto cells. They latch on by linking to a receptor on the cell surface (called ACE2 in the case of the new coronavirus SARS-CoV-2), and then they sneak in. The next thing they do is to take over the cell's protein production machinery, suppress or evade the body's immune responses, create new viruses, get out of the cell, and somehow survive

Fred Adler

enough to infect more people. "It's pretty amazing what viruses can do, given that many viruses have only 10 genes of their own and are taking over a system thousands of times more complex," said Adler.

Some viruses have a greasy overcoat, called envelopes, made from the filaments of the membranes of the last cell they infected. This is why using soap and water to clean your hands is so important in preventing a virus like COVID-19 from spreading—the soap disrupts these greasy membranes.

If handwashing doesn't work, our next line of defense is the immune system. But on the face of it, our immune system makes no sense because it has the potential to kill the host it is supposed to protect. Yet, somehow, the immune system threads the needle and fights off most infections before turning itself off and without causing too much damage to the host. Mathematical models capture the complex chains of positive and negative feedbacks that govern this system.

One of Adler's favorite research quotes states that "viruses had to learn immunology the hard way." When a virus gets it wrong, it means instant death, so viruses learn to manipulate the immune system in a whole range of ways so they, too, can thread the needle and survive long enough to spread within a host and infect more hosts. Adler's favorite virus is the rhinovirus, the one that causes the common cold. It manages to make everyone just a little bit sick, transmit itself, but not generate lifelong immunity. Adler and others have used models to try to understand how it does this and are now thinking about the very different ways that coronaviruses may manipulate our immune systems.

Who Gives What to Whom

Epidemiology boils down to one question: who gives what to whom? The simplest models, and the ones used now to make decisions, say that everyone is equally likely to be infected and that all people are infectious for some time. Generally, these models work quite well, but it gets more complicated when we add people, demographics, and behavior to the mix. Geography, spatial location, and age can have a major effect on the spread of diseases and on their impact because different people are more likely to become severely ill or transmit the infection. When researchers have enough data to specify these differences, they can build a range of simple models and detailed ones to predict where an infection may spread. These predictions are useful for planning but also useful when we get it wrong because they help identify what we don't know or what might be changing. Models are a lot easier to experiment on than real populations, so we can test interventions—like vaccination—in the models and plan the most efficient ways to test them in the real world before we embark on widespread use.

Adler began his academic career as a pure math major at Harvard University, moved toward biology as a graduate student in applied mathematics at Cornell and as a postdoc at the Center for Population Biology at the University of California Davis. Later, he joined the faculty at the University of Utah in a position split evenly between the Department of Mathematics and the School for Biological Sciences. His original interests in ecology and epidemiology have broadened to include immunology and many fields of molecular and biomedical biology. He serves as president of the Society for Mathematical Biology and Director of the Center for Quantitative Biology.

Looking ahead, Adler expects we may continue to see future pandemics. In many ways COVID-19 has been the perfect storm because the virus is severe enough to shut down the healthcare system and the global economy but not so severe as to be easy to track down and eradicate. He is confident our experience with COVID-19, like the experience with SARS in parts of Asia, will make us far better prepared to respond quickly and effectively to the next pandemic. The mathematical modelers will be ready.

Getting to Know: Priyam Patel

Priyam Patel

Imagine a surface that looks like a hollow doughnut. The "skin" of the doughnut has no thickness and is made of stretchy, flexible material. "Some of my favorite mathematical problems deal with objects like this—surfaces and curves or loops on such surfaces," said Priyam Patel, assistant professor of mathematics, who joined the Math Department in 2019. "I like how artistic and creative my work feels, and it's also very tangible since I can draw pictures representing different parts of a problem I'm working on."

Patel works in geometry and topology. The two areas differ in that geometry focuses on rigid objects where there is a notion of distance, while topological objects are much more fluid. Patel likes studying a geometrical or topological object extensively so that she's able to get to know the space, how it behaves, and what sort of phenomena it exhibits. In her research, Patel's goals are to study and understand curves on surfaces, symmetries of surfaces, and objects called hyperbolic manifolds and their finite covering spaces. Topology and geometry are used in a variety of fields, including data analysis, neuroscience, and facial recognition technology. Patel's research doesn't focus on these applications directly since she works in pure mathematics.

Challenges as a Minority

Patel became fascinated with mathematics in high school while learning to do proofs. She was fortunate to have excellent high school math teachers, who encouraged her to consider majoring in math in college. "When I was an undergraduate at New York University (NYU), I had a female professor for multivariable calculus who spent a lot of time with me in office hours and gave me challenging problems to work on," said Patel. "She was very encouraging and had a huge impact on me."

As a woman of color, Patel often felt out of place in many of her classes at NYU. Later, she was one of a handful of women accepted into a Ph.D. program at Rutgers University. Unfortunately, these experiences led to strong feelings of "impostor syndrome" for her as a graduate student. Eventually, she overcame them and learned to celebrate her successes, focusing on the joy that mathematics brings to her life. She has also worked to find a community of mathematicians to help support her through the tough times. "I've received a lot of encouragement from friends and mentors both in and outside of my math community," she said. "I feel especially fortunate to have connected with strong women mentors in recent years."

Mentors and Outside Interests

Feng Luo, professor of mathematics at Rutgers, was Patel's Ph.D. advisor, and he played an active role in the early years of her math career. "Talking about math with Dr. Luo is always a positive experience, and his encouragement has been pivotal to my success as a mathematician," said Patel. Another mentor is Alan Reid, chair and professor of the Department of Mathematics at Rice University. Patel notes that there are many aspects to being a mathematician outside of math itself, and these mentors have helped her navigate her career and offered support, encouragement, and advice.

Patel loves mathematics but makes time for other things in life. She enjoys rock climbing, yoga, dancing, and painting. Music is also a huge part of her life, and she sings and plays the guitar.

Future Research

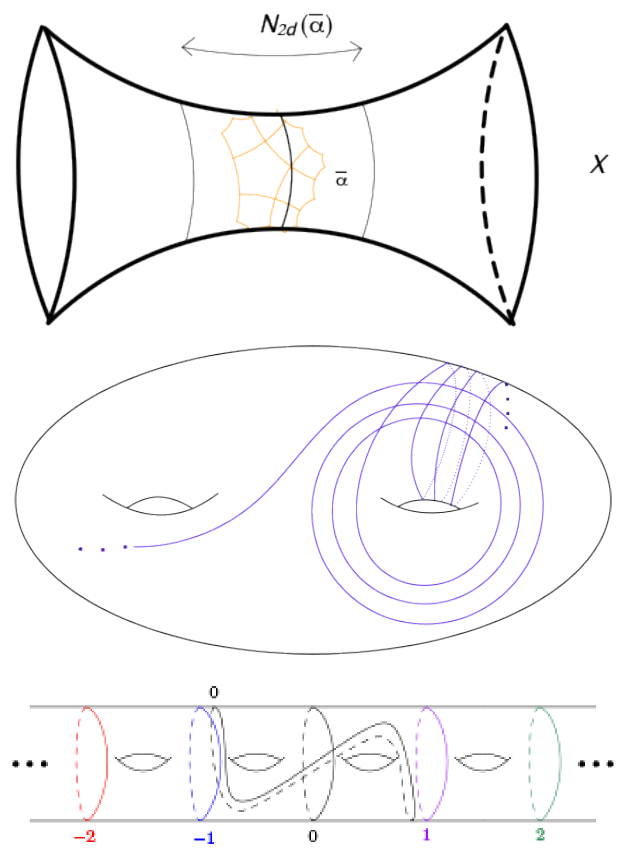
Patel is currently working on problems concerning groups of symmetries of certain surfaces. Specifically, she has been studying the mapping class groups of infinite-type surfaces, which is a new and quickly growing field of topology. "It's quite exciting to be at the forefront of it. I would like to tackle some of the biggest open problems in this area in the next few years, such as producing a Nielsen-Thurston type classification for infinite-type surfaces," she said. She is also interested in the work of Ian Agol, professor of mathematics at Berkeley, who won a Breakthrough Prize in 2012 for solving an open problem in low-dimensional topology. Patel would like to build on Agol's work in proving a quantitative version of his results. Other areas she'd like to explore are the combinatorics of 3-manifolds and the theory of translation surfaces.

Patel was featured in two separate articles in Quanta Magazine.

Here are the links to the two articles:

February: https://www.quantamagazine.org/mathematics-as-a-team-sport-20200331/

April: https://www.quantamagazine.org/how-has-coronavirus-affected-mathematics-20200428/



These are mathematical images created by Patel in doing her research.

Sean Howe

Getting to Know: Sean Howe

He almost missed out on mathematics as a career. When Sean Howe was a freshman at the University of Arizona, he originally planned to study creative writing. He was only planning on taking two semesters of calculus to meet basic degree requirements.

But something clicked when Howe's instructor took a day off from the regular curriculum to give a lecture on the different sizes of infinity or cardinality. "I was hooked," said Howe, assistant professor of mathematics, "and I was lucky to be in a department surrounded by a lot of great people who were willing to mentor me." He is particularly grateful to Rob Indik, associate professor of mathematics and associate head of undergraduate programs at the University of Arizona, who allowed Howe to participate in an undergraduate research project when Howe had almost no experience beyond calculus. The project opened doors for Howe academically and professionally.

Not surprisingly, there were bumps along the way as he worked on obtaining advanced degrees. He spent two years working on a master's degree in Europe before returning to the U.S. for a Ph.D. program at the University of Chicago. "Studying in Europe was an amazing opportunity mathematically and personally, but at times I also felt isolated, incompetent, or just plain stupid. Adjusting to a different educational system and having to do work in a foreign language was tremendously challenging," he said. The experience has given him empathy for the courage and strength it takes for a student from a different country, culture, or socioeconomic background to leave home to study at the U.

Research in the Langlands Program

Howe's research is in the Langlands program, an area of mathematics that develops analogies to explain the behavior of prime numbers using ideas grounded in geometry and physics. For example, the geometric idea of distance can be modified to give a new definition, depending on a prime number, of when two integers are "close." One can then count the number of approximate (for this new definition of close!) integer solutions to an equation using the same mathematical techniques that are used to break down music into fundamental tones.

"When someone asks about my research, I like to tell them I spend my days sipping lattes and thinking about prime numbers," joked Howe. "But the reality is I love the feeling of seeing something in a new light for the first time, and that's what I'm constantly chasing in my work." The goal of his research is to take a problem that feels intractable and find a new way to look at it that reveals a simple, elegant solution. Some of the topics Howe studies have applications to cryptography (the branch of mathematics that allows you to safely and securely buy products online without having your credit card information stolen), but that's isn't why he studies them.

Significant Mentors

Howe credits a number of professors who helped him in his career. "There are too many to name, and they've all played a role in shaping me into the mathematician I am today," said Howe. A few standouts are David Savitt, chair and professor of mathematics at Johns Hopkins University; Sergei Tabachnikov, professor of mathematics at Pennsylvania State University, and Frank Morgan, professor of mathematics at Williams College—both directed Howe's participation in undergraduate research projects; and thesis advisor Matt Emerton and mentor Benson Farb, professors of mathematics at the University of Chicago.

Howe is an active hiker and runner. After moving to Utah, he has added climbing and skiing to his outdoor activities. "One of the best things about being a mathematician is that you always have something interesting to think about," said Howe. "Of course, it can also be one of the worst things because it's sometimes hard to stop thinking about math!" His home life is busy with his wife and young daughter. He still enjoys writing short stories and essays, but for now, he pours his creativity into mathematics.

In the next year or so, Howe plans to explore some new conjectures in the Langlands program that have grown out of his recent work. "But the truth is I have no idea where my research will take me—and that's just the way I like it!"

Getting to Know: Graeme Milton

Distinguished Professor of Mathematics Graeme Milton

Graeme Milton has many research interests. His main area of study is on the properties of composite materials—their versatility makes it possible to apply them to a large number of fields. Interest in composites has exploded in the last 20 years with the ability to tailor make 3-D replicas of desired microstructures. "It has been very satisfying to see geometries that we once envisaged actually being built," said Milton. "An example of this is my 1995 work with Andrej Cherkaev, U professor of mathematics, on pentamode materials, which for many years got little attention." Pentamode materials are considered the grandfather of all (linearly elastic) materials because they can be used as the building blocks for any desired stable linear elastic response. In 2012, there was renewed interest in Milton and Cherkaev's earlier research when a team led by Professor Martin Wegener at the Karlsruhe Institute of Technology in Germany built a pentamode using laser 3-D lithography. More recently, the company Carbon3D Inc., based in Silicon Valley, has built bicycle seats for specialized bicycles, using a type of pentamode construction. An Italian civil engineer, Fernando Fraternali, has recently patented a design using pentamode materials sandwiched between plates as a seismic insulator.

"I like to think of the goal of my composite material research as trying to reveal how geometry affects material properties, and it does this in unexpected ways," said Milton. "Cloaking (making things invisible to certain applied fields) has been another of my research projects, and I've collaborated with many people on this, including our own associate professor of mathematics, Fernando Guevara Vasquez, and my former postdoc, Daniel Onofrei, who is now associate professor of mathematics at the University of Houston." Milton believes his 2006 paper on the subject with the late Romanian mathematician, Nicolae Nicorovici, was the first to introduce the word "cloaking" into the scientific literature outside computer science.

Roots in Australia

Born and raised in Australia, Milton was interested in mathematics in high school. "I discovered a way of bookkeeping to simplify the algorithm that gives the greatest common denominator of two numbers as a sum of these numbers each multiplied by a positive or negative integer," he said. "It enabled me to do some problems much faster than my classmates, and my math teacher wanted me to publish it—but I never did. Now I've forgotten what I did entirely!"

Milton's path to being a mathematician was not a straight trajectory. He originally wanted to become an officer in the Australian Air Force but was unable to meet the requirements due to childhood asthma. Growing up, few of his family had attended college, and the idea of a career in mathematics research was unthinkable. "My father wanted to do an engineering degree but couldn't afford the tuition, so that's probably why I started studying electrical engineering at Sydney University," said Milton. At that time, the Australian government had just made college free for all students, even providing stipends. "At university I almost flunked because I was studying advanced things like general relativity rather than the standard courses," he said. "The first year was okay because I could guess the right answer amongst the multiple choices. That didn't work in the second year, as there were no multiple choice exams, and I just scraped by."

He took a year off from college, working at a stereo factory in New Zealand. He hitchhiked around the country, went backpacking, and stayed in a few communes. When he returned to his studies, he was very motivated and changed to a physics degree. "I was fortunate to receive the University Medal, and I probably had the lowest grade-point average of anyone," he joked. He obtained a Ph.D. in Physics from Cornell University, did a postdoc at Caltech, and began his teaching career at the Courant Institute of Mathematical Sciences at New York University.

*Graeme Milton (left)
with husband, John Patton*

Coming to Utah

Milton was interested in coming to the U and the Mathematics Department because of its reputation and the caliber of the professors already working on the mathematics of materials. Another factor was the lure of great skiing and hiking, two of Milton's passions. He also discovered that Salt Lake is a great place for road and mountain biking. In 1999, he became a Distinguished Professor at the U and served as department chair from 2002-2005.

Value of Mentors

Milton appreciates the help mentors have given throughout his career, including Emeritus Professor Ross McPhedran, who introduced Milton to the subject of composites in 1979 during his final undergraduate (with honors) year at Sydney University. When some professors thought Milton may have plagiarized other works for his honors report, it was Ross who came to his defense. Milton was working on about 10 research papers and had no idea how to write well. "I remember

Continued on page 12

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my drafts were covered with red ink by Professors Ross McPhedran and Don Melrose," he said. "At the time I didn't appreciate it; however, in retrospect, I'm grateful for the red ink. I didn't really understand the need to provide proofs—I thought just stating the result would suffice if I thought it was not too difficult. I had to learn that without proofs, it makes it hard for others to follow. Ross and I continue to collaborate after more than 40 years."

Other mentors have included Milton's Ph.D. advisor, Michael Fisher, currently Emeritus Professor at the Institute for Physical Science and Technology at the University of Maryland, and George Papanicolaou, the Robert Grimmett Professor of Mathematics at Stanford University, who helped Milton land an assistant professorship position at the Courant Institute. Milton enjoys mentoring postdocs because they bring fresh perspectives and youthful energy to research.

Research Directions

In discussing his ongoing research, Milton confesses he likes to go in "orthogonal directions"—or 90 degrees from each other. He tackles problems ranging from very easy to very hard. "Some mathematicians make the mistake of only working on very hard problems," said Milton. "If you make progress, that's great. But, it can be very depressing not to make progress, and no progress can be a disaster if you're in a tenure-track position."

Milton is currently working on novel designs for earthquake isolators that will isolate a building from the moving ground and not have it move while an earthquake is in progress—welcome news for Salt Lake City residents who experienced an earthquake and aftershocks in March. His work is a collaboration with engineers in Italy, Portugal, and Sandia National Laboratories.

He is also working on some modified equations of general relativity that he discovered back in the 1970s. "What makes them interesting is that they could provide an answer to the missing energy and missing mass puzzle of the universe," said Milton. "If simplicity of the underlying equations is to be a guiding principle in physics, then my equations surely meet that principle. I just finished my paper, and it's posted on arXiv. So we will see." ArXiv is an open-access repository of electronic preprints (known as e-prints) approved for posting after moderation, but not full peer review.

Milton and his husband, John Patton, enjoy photography and have sold some photographs through a gallery. Milton had a photo of Mount Kenya published in a school textbook, and his photo of King Tutankhamen was photo of the week on the website of *Stock Solutions*. They both love film, and Patton is one of the founders of the LGBTQ+ festival. In fact, Patton named it "Damn These Heels." While Milton was chair, Patton founded a group, "Friends of the Math Department," who helped raise money and orchestrate many department events. They both love to travel.

John Warnock

John Warnock, Co-founder of Adobe Systems, Inc. Delivers U's Virtual Commencement Address

John Warnock, a computer scientist and visionary co-founder of Adobe Systems Inc., delivered the commencement address at the U's first-ever virtual graduation ceremony on April 30. In-person rites were not possible due to the COVID-19 pandemic.

Warnock, who received three degrees from the U, used his vision, passion, and intellect to launch a business that revolutionized graphics, desktop publishing, and web and electronic document technologies. Today, Adobe is one of the largest, most recognized software brands in the world.

A Salt Lake City native, Warnock received bachelor's degrees in mathematics and philosophy ('61), a master's in mathematics ('64), and a doctorate in electrical engineering/computer science ('69) from the University of Utah.

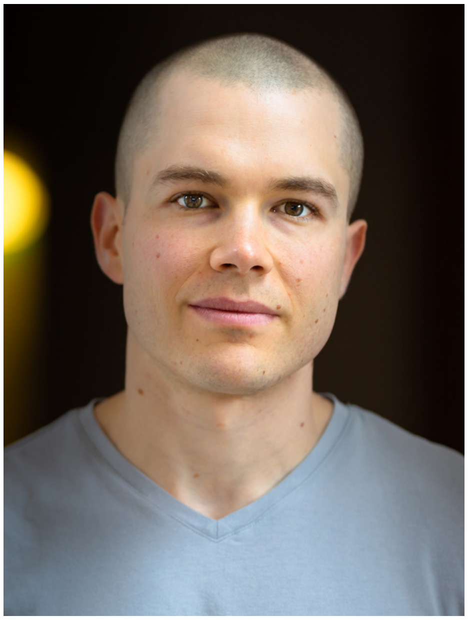
In 1982, Warnock and colleague Charles Geschke co-founded Adobe to explore a new approach to printing technology called PostScript; the duo's innovations included scalable type, computer graphics, and printing processes. In a short span of years, Adobe ignited a revolution with desktop publishing.

"The impact of Dr. Warnock's contributions to desktop publishing are as revolutionary as Gutenberg's printing press was in his day," said Richard B. Brown, dean of the College of Engineering. "His PDF standardized the representation of digital documents and is used daily by virtually everyone who has access to a computer. Adobe, the company he co-founded, has also given the world the premier software tools for creating digital graphics, so he has enabled others across the spectrum from engineering to art."

Warnock and his wife, Marva, provided a foundational gift of nearly $6 million for the John and Marva Warnock Engineering Building at the U and created three presidential endowed chairs in computer science, mathematics, and fine arts. They also are major supporters of the Moran Eye Center.

Sean Lawley Receives NSF CAREER Award

Sean Lawley, assistant professor of mathematics, has received a National Science Foundation CAREER Award. The award is considered the most prestigious NSF award for faculty members early in their careers as researchers and educators. It recognizes junior faculty members who successfully integrate education and research within their organizations. The award comes with a federal grant for research and education activities for five consecutive years.



Sean Lawley

"I'm very grateful to receive the award, and I'm excited to pursue the research projects and educational initiatives that it affords," said Lawley. "More broadly, this award recognizes the outstanding scientific environment and support of the Department of Mathematics, the College of Science, and the University of Utah as a whole."

In 2018, Lawley received a SIAM (Society for Industrial and Applied Mathematics) Life Sciences Early Career Prize.

Lawley obtained his undergraduate degree from Carnegie Mellon and his doctorate from Duke University. He joined the U as a postdoc in 2014 and became an assistant professor in 2016.

Kelly MacArthur Honored with U's Distinguished Teaching Award

Kelly MacArthur

Kelly MacArthur, instructor (lecturer) in the Mathematics Department, has received the 2020 University of Utah Distinguished Teaching Award. This is one of the highest teaching honors awarded by the university. The award was established more than 50 years ago, and MacArthur is the first woman from the Math Department to receive it.

"I'm delighted to be recognized by the university," said MacArthur. "Competition for the award is pretty intense, so it's an honor to receive it."

The Distinguished Teaching Award recognizes significant contributions to the teaching mission of the U. Only five faculty members are selected as outstanding teachers across the university each year.

MacArthur is currently working on a Ph.D. in undergraduate mathematics education.

Math Professors Named Simons Fellows

Two professors in the Department of Mathematics—Jonathan Chaika and Karl Schwede—have received Simons Fellows Awards in Mathematics from the Simons Foundation.

Jonathan Chaika

Karl Schwede

Jonathan Chaika. Associate Professor

“It’s such an honor to receive this,” said Chaika, “particularly because much of the work of mathematics is a relatively solo endeavor. We do this work for and as part of a community, so it’s invigorating to be recognized because it shows the support of our math community.”

Simons Fellows awards extend sabbatical research to a full year. Chaika received the award based on his previous accomplishments in mathematics and the impact of the work he plans to do.

Chaika’s research is in the field of dynamical systems, which seeks to understand a space and a map by following individual points. This map could represent the passage of time in a physical system. Ergodic theory is a sub-branch of dynamical systems that uses an idea called a measure to do this. A measure is an abstraction of the idea of length or area (or volume). One of the families of systems Chaika studies is billiards polygons. In these systems, a billiard travels in a straight line inside a polygon until it hits one of the sides. Once it hits a side, it obeys the law of elastic collision. It then continues to travel in a straight line until it hits the next side, where it again has elastic collision. Chaika and Giovanni Forni, a mathematician at the University of Maryland, have been able to show there are billiards in polygons, so the flow in different directions is usually uncorrelated.

Karl Schwede, Professor

“I’m thrilled to receive the award, and it’s humbling to be recognized in this way,” said Schwede. “At a more practical level, the award means I’ll be able to spend the time needed to finish some long-term projects, specifically a book. It will also allow me to visit co-authors and, hopefully, finish some other projects.” Schwede’s award is based on his scientific accomplishments in the five-year period preceding the application and on the potential scientific impact of the work to be done.

Schwede does basic research in mathematics, studying algebra, geometry, and particularly singularities. Much of his work is in the setting of modular arithmetic (also known as clock arithmetic), the same setting as much of our modern communication systems. For example, 5 hours after 10 is 3 or 5+10 = 3. “In this area, I have primarily studied singularities of geometric shapes by algebraic means,” said Schwede. Recently, he has begun working in mixed characteristic, which connects the positive characteristic of clock arithmetic with classical (5+10 = 15) geometric worlds.

He joined the U’s Math Department in 2014 as associate professor and became a professor in 2018.

PROFILES ON GRADUATE STUDENTS

The following are profiles of women graduate students in the Department of Mathematics. The profiles have been edited for space. To read each complete profile, go to "News Archive" on the Math website, or http://www.math.utah.edu/about/news/index.php.

Samantha Hill

Samantha Hill

Samantha Hill's research interests are in mathematical ecology. Specifically, she's interested in understanding how plants indirectly defend the plants around them against voracious insects.

"To study this, I work with my advisor, Professor Frederick Adler, to build mathematical models of how an insect forages for food," said Hill, a sixth-year graduate student and Ph.D. candidate. "These models help predict how to group plants together so that an individual plant is less likely to be eaten by different types of insects."

Hill enjoys the freedom and creativity in making up the rules in the imaginary world of plants and insects she studies, but she also likes that her research is inspired by an actual ecological phenomenon called "associational resistance" that has real-world implications. "Our inspiration also includes studies on how diversity can serve as a defense for plants in tropical forests. The implications are both ecological and agricultural. This type of modeling can contribute to agricultural research on plant defense that relies on plant community traits and insect behavior, rather than on pesticides," said Hill.

Hill completed her Ph.D. in May. She plans to go into industry, doing quantitative modeling at a biotech company to help in disease diagnosis, drug discovery, or treatment.

Anna Nelson

Anna Nelson

Anna Nelson became interested in math when she took a calculus class in high school. "David Gural made math fun, exciting, and applicable to our lives," she said. "He played Enya during tests and had a popcorn machine, where we made popcorn during our problem session time. He inspired me to pursue math education, which I eventually changed to applied math and computer science at Boise State University," she said.

Sabine Lang

Sabine Lang

Sabine Lang has always liked math. As a child, she saw math more as games and puzzles that she enjoyed. She always pushed herself to take more advanced math classes and participated in the International Mathematical Olympiad in her last year of high school. She studied at the renowned École Polytechnique Fédérale de Lausanne (EPFL), where she received a bachelor's and master's of science in mathematics. She has been working with Professor Gordan Savin and completed her Ph.D. in May.

Lang's research focuses on the "Theta correspondence," a conjectural correspondence between automorphic forms associated with the two groups of a dual reductive pair. "We start from a metaplectic group, together with its 'smallest' representation," said Lang. "Then we consider two subgroups contained in the metaplectic one. The Theta correspondence gives a list of the representations of the two smaller groups that can be found as restrictions of the initial representation. I don't have one big thesis question, but I'm working on different aspects of the Theta correspondence."

Lang is currently applying for teaching positions. Her focus has shifted to math education rather than research. "I'm convinced there's a lot to be done in math education to make the classrooms more inclusive and welcoming, and I want to contribute to this change," she said.

At the U, Nelson's research involves mathematically modeling a process in blood clotting called fibrin polymerization. During the blood clotting process, a blood protein (fibrinogen) becomes activated (converted to fibrin) and polymerizes to form a mesh that stabilizes the forming blood clot. Fibrinogen can bind to fibrin and affect the overall polymerization process, however, it's difficult experimentally to distinguish between fibrin and fibrinogen, making it an interesting challenge for mathematical modeling. The primary goal of Nelson's research is to use mathematical modeling to gain insight on this physiological process that has clinical and pathological implications. Understanding how blood clots can form can aid in the prevention of deep vein thrombosis and pulmonary embolism. She works under the supervision of Professor Aaron Fogelson.

She expects to complete her Ph.D. in the fall and plans to apply to several biotech companies as well as to postdoc positions.

Claire Plunkett

Claire Plunkett

Claire Plunkett, a second-year Ph.D. student, chose to study mathematics at the U because of the variety of mathematical tools and biological topics available in the mathematical biology program. She also likes the sense of community in the Math Department.

Plunkett's research is under the supervision of assistant professor of mathematics, Sean Lawley. She is studying how two molecules interact with each other when they can only react if they touch in particular orientations. To model this, she uses two spheres that are only reactive at patches on their surfaces. Her research includes modeling molecules that are bound to a surface but are partially reactive in a similar way. "The project excites me because the results from different types of protein interactions can be formulated in a way that makes it easier to compare the types' interactions. This has been difficult to do in the past," said Plunkett. "The project uses interesting math techniques and is an application of a math-to-biophysics problem, but the results will also be useful for materials science and other similar fields."

Plunkett hopes to become a math professor at a research university because she wants to continue doing research. She'll look for postdoc positions after she completes her Ph.D.

The image above illustrates Serrano López's research.

Allechar Serrano López

Allechar Serrano López enjoyed studying math when she was growing up in Costa Rica, but she also had periods where she focused on other things. After she took a course in groups and rings as well as another in field theory, she decided to complete an undergraduate degree in math.

Serrano López's research focuses on number theory—the area of math that studies integers (and their generalizations) and their properties—and her work involves counting elliptic curves over quadratic fields with prescribed torsion points. "These torsion points form a set with a very specific structure, and there are only a few possibilities for this structure," she said. She works under the direction of associate professor, Stefan Patrikis. "Stefan is very helpful and knowledgeable, and he also has built our research group from scratch," said Serrano López.

A few years ago, she became interested in teaching math education.

She is currently working on a fellowship project called "Building an Inclusive Math Learning Environment to Support Student Retention in STEM."

Serrano López hopes to remain in the U.S. and plans to apply for postdoc positions. Ultimately, she'd like to become a professor at a liberal arts college.

UNDERGRADUATE AWARD

Isaac Martin Awarded Prestigious Goldwater Scholarship

Isaac Martin, a junior studying mathematics and physics, has been awarded Utah's second Goldwater Scholarship for 2020-21.

During Martin's first four semesters at the U, he intended to pursue a physics Ph.D. and focused primarily on physics classes; however, after brief stints in two different labs, he realized mathematics is a better fit for his talents and interests.

When he's not doing math, Martin is most likely either playing piano, rock climbing, running in the foothills, or beating his roommates in Smash Bros Ultimate.

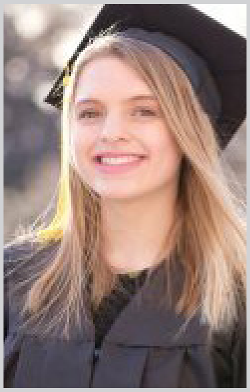
Martin hopes to have a career in academia as a pure mathematics researcher. "I'd especially like to study problems in commutative algebra and representation theory with relevance to mathematical physics," he said. Martin also remains interested in the world of condensed matter. "There is so much novel mathematics dictating theoretical condensed matter, and I expect many exciting breakthroughs will happen there in the near future."

Isaac Martin

The Goldwater Scholarship is a result of a partnership with the Department of Defense National Defense Education Programs (NDEP), Mrs. Peggy Goldwater Clay, Chair of the Board of Trustees of the Barry Goldwater Scholarship, and Excellence in Education Foundation.

Goldwater Scholars have impressive academic and research credentials that have garnered the attention of prestigious post-graduate fellowship programs. Goldwater Scholars have been awarded 93 Rhodes Scholarships, 146 Marshall Scholarships, 170 Churchill Scholarships, 109 Hertz Fellowships, and numerous other distinguished awards like the National Science Foundation Graduate Research Fellowships.

Delaney Mosier Receives Top College of Science Award



Delaney Mosier

Delaney Mosier, a graduating senior in mathematics, has been awarded the 2020 College of Science Research Scholar Award for her cutting-edge work in the area of sea ice concentration, using partial differential equation models.

In his letter of support for Mosier's nomination, Distinguished Professor Ken Golden, who has served as her supervisor and mentor, discussed her research abilities, natural leadership skills, and mathematical prowess, indicating that Mosier is one of the most talented and advanced students he has seen in his 30+ years of mentoring.

Mosier studies patterns in the behavior of sea ice in polar regions. She's interested in how physical processes affect these patterns on a short-term basis and how climate change can affect them in the long-term.

Mosier will begin her Ph.D. studies in applied mathematics this fall. She hasn't yet decided if she will work in industry, continue with climate research, or become a professor. "Whatever I decide to do, my goal is to use mathematics to have an impact on the world," she said.

The College of Science Research Scholar Award, established in 2004, honors the College's most outstanding senior undergraduate researcher. The Research Scholar must be a graduating undergraduate major of the College of Science, achieve excellence in science research, have definite plans to attend graduate school in a science/math field, and be dedicated to a career in science/math research.

In Memoriam: Professor Emeritus William J. Coles

William J. Coles

Professor Emeritus William J. Coles passed away Sunday, February 16, 2020, at the age of 90, surrounded by his wife, children, and granddaughters, after a long decline into vascular dementia. He was known for his radiant presence, integrity, compassion, and kindness.

He was born October 31, 1929, in Marquette, Mich. He received a Ph.D. in Mathematics from Duke University in 1954 and joined the University of Utah as assistant professor in 1956. He became a professor in 1964 and taught in the Math Department for 45 years until he retired in 2001.

He was a brilliant mathematician and exercised his pedagogical impulses for decades. His research significantly advanced the understanding of the oscillatory properties of solutions to ordinary differential equations. He played a strong role in helping transform the department from average standing to a Group I research department.

Overview of Mathematics Department Graduates

Students who will receive a Ph.D. in the spring or summer of 2020 are:

Matteo Altavilla
Hanna Astephan
Kevin Childers
Huy Dinh
Pinches Dirnfeld
Bridget Fan
Liz Fedak
Samantha Hill
Hyunjoong Kim
Sabine Lang
Janina Letz
Katie Link
Dapeng Mu
Patrick Murphy
Sergazy Nurbavliyev
Kiersten Utsey
Ziwen Zhu

Department of Mathematics Distinctions

UNIVERSITY FACULTY AWARDS

Kelly MacArthur—Distinguished Teaching Award

OTHER FACULTY AWARDS

Jonathan Chaika—Simons Fellowship

Sean Lawley—National Science Foundation CAREER Grant

Karl Schwede—Simons Fellowship

Mathematics Department Awards in 2020

UNDERGRADUATE AWARDS

Goldwater Scholarship
Isaac Martin

College of Science Research Award
Delaney Mosier

Calvin H. Wilcox Memorial Scholarship
Benjamin Huenemann

Junius John Hayes Diversity Scholarship
Sara Ahmed

Junius John Hayes Endowed Scholarship
Isaac Martin
Brian Udall

The Golden Scholarship
Anthony Do
Makayla Stewart

D. Keith Reed Memorial Scholarship
Boyana Martinova

Michael Zhao Memorial Scholarship
Miriam Galecki

Susan C. Christiansen Memorial Scholarship
Brooklyn Davis

Thomas Andrew Hurd Mathematics Scholarship
Irina Slaughter

Tom and Cathy Saxton Scholarship
Laura Snelling

C. Bryant and Clara C. Copely Scholarship
Bryce Fairbanks

Continuing Department Scholarship
Isaiah (Wolfgang) Allred
Emma Coates
Jonah Garner
Jason Hoag
Katherine Metcalf
Julia Walljasper

Mathematics Department Scholarship
Clayton Allard
Elijah Counterman
Calvin Lee

J. L. Gibson Senior Award
Amy Bradford
Mckay Jensen
Dylan Johnson
Delaney Mosier
Kira Parker
Chase Zagorec-Marks

Putnam Award
Emil Geisler

Pi Mu Epsilon
Clayton Allard
Eric Brown
Emil Geisler
Avery Hazelbaker
Alexandrea Jee
Ming Long Lee
Isaac Martin
Parker J. Oberg
Andrew Schlachter

GRADUATE AWARDS

T. Benny Rushing and Gail T. Rushing Fellowship
George Domat

Outstanding Graduate Student Award
Christian Klevdal
Yiming Xu

Don H. Tucker Postdoctoral Fellow Award
Ben Briggs

Outstanding Postdoc Award
Harold Blum
Jody Reimer

Faculty Undergraduate Teaching Award
Kelly MacArthur
Karl Schwede

Outstanding Staff Award
Vic Gabrenas
Paula Tooman

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