Gracing a wall of the James Fletcher Building, the “Cosmic Triptych” installation is a joint effort between the Society of Physics Students and participants in the Center for Science and Mathematics Education REFUGES program. The work was made possible by the artistic talents of Emmelyn Redd in April 2018.
Message from the Chair

We have seen tremendous activity in the department during the past academic year, and we’re on track to achieve important goals through the remainder of 2019. In the pages that follow, you can read about the exciting work of professors Pearl Sandick and Anil Seth, as well as the accomplishments of undergraduate and graduate students.

I am pleased to report that the department has implemented a completely revised graduate program, including a new core curriculum structure; a clear set of benchmarks and milestones aimed at promoting student success; and integrated advising checkpoints to monitor student progress. Our program is already being viewed as a model on campus, and many other departments are adopting the innovative features we developed.

We have immediately seen the fruits of this effort. In fact, we had one of most successful graduate recruiting seasons in recent history: 14 outstanding new Ph.D. students will join us this fall, with interests spanning all of the department’s core research areas—from experimental astrophysics and observational cosmology—to high energy theory and condensed matter physics.

At commencement, over 40 students graduated with bachelor’s degrees in physics, nearly an all-time high for us, and two students received bachelor’s degrees in physics teaching. We’re now gearing up for our summer Research Experience for Undergraduates (REU) program attracting students both locally and from around the country.

This summer, we will welcome new physics education researcher, Ramón Barthelemy, as a tenure-track assistant professor. We have other faculty offers pending, and we hope to have more good news to report in the fall.

Finally, this will be my last message as chair of the Physics & Astronomy Department. I appreciate the trust you have given me in guiding the department over the past year. In July, I will begin my term as the new dean of the College of Science. I look forward to continuing to work closely with the Physics & Astronomy Department to advance its most important priorities!

Sincerely,

Peter E. Trapa
Chair
Department of Physics & Astronomy
Molecular motors are the engines that power the ability of cells to transport internal “cargo” or essential substances to the cell membrane via the cytoskeleton. The cytoskeleton acts like a super highway moving cargo to and from different parts of the cell. Two families of motor proteins, kinesin and dynein, help transport the cargo along microtubules.

For nearly four years, graduate student Flo Doval has been immersed in studying these transport systems in assistant professor Michael Vershinin’s lab in the Physics & Astronomy Department.

“My research focuses on the kinesin-microtubule system—in particular how cargos are routed through a complex network of filaments,” said Doval. The cytoskeleton of a cell is comprised of three individual filament networks, one of which is the microtubule network, and one of the motors associated with the microtubule network is called kinesin.

“I’ve investigated how the geometry of a single intersection of microtubules can affect how cargos driven by multiple kinesin motors navigate that intersection,” said Doval. “Lately, I’ve been scaling up the experiment to see how the geometry of multiple intersections can impact cargo routing outcomes.”

So far, her research supports the idea that a cell could use the architecture of the cytoskeleton network to regulate where cargos are routed. “Understanding this potential mechanism for regulating transport is important for biomedical research,” said Doval. “Often a breakdown in transport is associated with such things as kidney disease, chronic respiratory infections, some cancers, and neurodegenerative diseases, such as Parkinson’s or ALS.”
Creating a Supportive Environment for Women

Doval became interested in physics in high school by reading pop science books and books about astrophysics by Brian Greene, Janna Levin, and Neil deGrasse Tyson. She went to Barnard College and decided to become a physics major. “One of my professors was Janna Levin, so it was kind of a dream come true to study with her,” said Doval.

As a field, physics has a reputation for not being welcoming to women, but Doval found Barnard’s physics department very supportive. When she started graduate school at the U, however, she was discouraged by a faculty member who made it clear that he didn’t think she belonged in the program.

“It was such a profound and unwelcome change from the relationships I’d had as an undergrad,” said Doval. Since then, her experiences have gotten better—she’s had great professors, made friends, and made good progress in her work. “I’ve put a lot of time and energy into pushing for policies that I think are providing more support and protection for graduate students,” said Doval. “When I finish my Ph.D., hopefully in May 2020, I’d like to believe that I’ve had some lasting impact on the department and that future students will experience a friendlier and more welcoming environment.” Since she began at the U, Doval has been very involved in the local chapter of Women in Physics and Astronomy (WomPA) as well as the Graduate Student Advisory Committee (GSAC).

When she isn’t focusing on cells and routing outcomes, Doval loves to cook and do cycling. She runs a weekly food blog with a college friend, and they’re trying to cook every recipe in the America’s Test Kitchen cookbook called The Complete Cooking for Two Cookbook. You can follow their progress on Instagram@friday_night_dinners.

“I feel my research is just scratching the surface of all there is to know about cargo routing in cells and how the geometry of microtubule network architecture affects these outcomes,” said Doval. “I love working in this field because it’s wide open—there are so many questions still to be asked, so much room to add layers of complexity, and so much to be learned at each step.”
Cameron Owen of Boise, Idaho, a senior honors student who recently graduated with a major in chemistry and physics and a minor in mathematics, has received the prestigious Churchill Scholarship to study at the University of Cambridge in the United Kingdom. He is one of only 15 students nationally to receive the award this year and is the fourth consecutive Churchill Scholar from the U.

“Cameron’s achievement is a testament to his scientific curiosity and diligence in his undergraduate research,” said Dan Reed, senior vice president for Academic Affairs. “A fourth Churchill Scholarship award in as many years demonstrates the value of undergraduate research and mentorship experiences at the U, and that our students are among the best and brightest in the world.”

The Churchill Scholarship, established in 1963 at the request of Winston Churchill, provides undergraduates with outstanding academic achievement in the science, technology, engineering and math fields the opportunity to complete a one-year master’s program at the University of Cambridge. Students go through a rigorous endorsement process in order to apply, but only after their home institution has been vetted with the Churchill Foundation. The U was added to the foundation in 2014.
Owen, a recipient of a 2018 Barry Goldwater Scholarship, came out of high school with an interest in chemistry. He joined the lab of Peter Armentrout, Distinguished Professor of Chemistry, after hearing about Armentrout’s research in his honors science cohort. While at the U, Owen has published his research and traveled twice to the Netherlands as part of the National Science Foundation Research Experience for Undergraduates program.

Owen and Armentrout, in an ongoing collaborative effort with the Air Force Research Laboratory, are currently studying the activation of methane by metal atoms, particularly gold, in the gas phase. Methane activation, the process of breaking the carbon-hydrogen bond of methane, and subsequent functionalization could eventually be used to convert the enormous amounts of methane from natural and shale gas feedstocks into usable products like methanol or ethane. “I want the activation of methane into liquid fuels and other viable products to be environmentally beneficial and economically advantageous,” Owen said. “Current processes that activate methane are exorbitant in both time and energy.”

At Cambridge, Owen will explore how methane chemically attaches to the surfaces of certain metals. “My project will be purely theoretical,” he said. “But I’ll be able to apply what I’ve learned about certain metals that react with methane in the gas phase to potential catalysts of the future. You can extend those results to better understand the activation of other greenhouse gases in order to create more effective real-world catalysts.”

Owen is looking to continue his work in a doctoral program after his return from Cambridge.
Exploring New Physics

A decision to take a physics class for “fun”
during her senior year at New York University changed the
course of Pearl Sandick’s life. At the time, Sandick was majoring
in math and had planned to continue her studies in a Ph.D.
program. “The professor noticed that I was enjoying the physics
class and suggested that I think about a physics graduate program
instead of math,” said Sandick, associate professor of physics and
astronomy and associate chair of the U’s Department of Physics
& Astronomy. “I was floored—no professor had ever directly
couraged me like that before—and she had a good point: I did
enjoy physics. After some serious conversations with my mom and
my professors, I decided to make the switch. The encouragement
of one professor literally made all the difference.”

She earned a Ph.D. from the University of Minnesota in 2008 and
was a postdoctoral fellow in the Theory Group at the University of
Texas at Austin before moving to Utah and the U in 2011.

Beyond the Standard Model

As a theoretical particle physicist, Sandick is able to study some
of the largest and smallest things in the universe. Dark matter
is the mysterious stuff that gravitationally binds galaxies and
clusters of galaxies together, but despite large-scale evidence for
the existence of dark matter, there are compelling arguments that
dark matter might actually be a new type of elementary particle.
Some particles are composite, like protons and neutrons. Electrons
are an example of an elementary particle—they are the most
fundamental building blocks of their type and are not composed
of other particles. Other examples of elementary particles include
quarks, neutrinos, and photons.

The Standard Model of Particle Physics is the theory that explains
how all the elementary particles interact with each other and
combine to form composite objects like protons and neutrons.
The Standard Model can make amazingly accurate predictions, which are tested in collider experiments and with cosmological observations, but the theory has some shortcomings that make particle physicists think there must be something beyond the Standard Model. For example, the Standard Model does not include a satisfactory explanation for the dark matter in the universe. Sandick’s research, currently supported by the National Science Foundation, is in exploring theories of “new physics” that fix theoretical problems with the Standard Model and explain previously unexplained phenomena like dark matter. “For any interesting new theory, my research proposes ways to experimentally support or falsify it, with the hope of eventually identifying the true fundamental theory of nature,” said Sandick.

Challenges for Women in Physics

Women are still widely underrepresented in physics. In college, Sandick got used to being one of the very few women in the room, and in graduate school, she wanted to become a physics professor at a time when only 5% of full professors in physics were women. “Like many women in male-dominated professions, I’ve experienced my share of gender-related weirdness,” she said. “Every day I’m thankful that the bulk of my negative gender-related experiences are, and continue to be, primarily exhausting and disappointing rather than dangerous or devastating.” Sandick notes that there are still a lot of equity and cultural issues to address in the field. “Science should be for everyone, and there’s a lot of work to be done to address the complex issues that lead to severe underrepresentation of certain groups. If we want to see change, we need to listen, learn, and do the work to make science more inclusive,” she said.

Sandick is committed to organizations that support women in physics. She has served on the American Physical Society’s (APS) Committee on the Status of Women in Physics (CSWP) and was recently the Chair of the National Organizing Committee for the APS Conferences for Undergraduate Women in Physics (CUWiP) The APS CUWiP hosts approximately 2,000 undergraduate physics majors each January at various locations around the country to discuss science, career paths for physicists, and social issues that can affect the experiences of scientists from underrepresented groups. Locally, she is the founder and faculty sponsor of the University of Utah Women in Physics and Astronomy (WomPA).

When she isn’t teaching or doing research, she spends every minute with her family—a three-year-old daughter and a supportive husband.

“This is an incredibly exciting time for dark matter and particle physics,” said Sandick. “We’re still searching for physics beyond the Standard Model, including an explanation for dark matter, so there’s still a lot of work to be done. Right now, one of the most exciting challenges is using experimental data in novel ways in order to get every bit of information out of it that we possibly can. It’s a great time to be creative in terms of how new physics might look from the theoretical point of view and how it might appear in current or upcoming experiments.”
On his office wall is a photograph that shows in detail an area of the Andromeda Galaxy, a spiral galaxy located approximately 2.5 million light-years from Earth, and the nearest major galaxy to our own Milky Way. Anil Seth, associate professor of Physics & Astronomy, fell in love with astronomy in high school in Lincoln, Nebraska. Now, when he isn’t teaching classes at the U, or mentoring graduate students, he spends his time searching for black holes at the centers of low-mass galaxies.

“I still get excited by the fact that we can look through a telescope and find things in the universe that can tell us how and why we got here,” says Seth. “As I’m doing my research I often feel like an archaeologist, too, because I’m looking for clues to tell me what happened.”

For every large galaxy like the Milky Way there are many smaller galaxies. Some of these smaller galaxies are satellites that orbit around the larger galaxies, and they can be torn apart by the bigger galaxy’s gravity. This process takes millions of years.

Dwarf Galaxies Hold Secrets

“These are the galaxies that I study,” says Seth. “For example, orbiting around our Milky Way galaxy are companion dwarf galaxies called the Magellanic Clouds. If you go to the Southern Hemisphere, you can see them with the naked eye. What I’m trying to find out through my work is whether these low-mass dwarf galaxies have black holes.”
Finding a black hole requires observations with cutting-edge telescopes to monitor the effect of gravity on the motions of the stars that surround it. Seth had been studying black holes for nearly a decade when his research paid off with a big discovery. In 2014, he and his collaborators found the first black hole at the center of an “ultra-compact dwarf” galaxy.

“It was pretty exciting for my team and me,” says Seth. “Once we were able to track the speed of the stars orbiting in the galaxy, we were able to prove the presence of a black hole. This particular one is 21 million times the mass of our sun, or 15 percent of the total mass of the galaxy itself.”

Since then, Seth’s research has progressed. Last year, one of his students, Dieu Nguyen, published a paper showing that in a sample of five nearby low-mass galaxies (with 5-50 times fewer stars than the Milky Way), at least four of them have clear black holes. Nguyen followed up this work by showing there may be a 10,000 solar mass black hole in the fifth galaxy. Taken together, this work is the first really strong evidence that massive black holes are common at the centers of low mass galaxies, and it gives scientists an important clue that the seeds of the black holes we see at the centers of galaxies today must have been abundant in the early universe.

Seth received his undergraduate degree from Wesleyan University in Middleton, Connecticut. At Wesleyan, he played cello, in addition to his work in astronomy. “I began playing cello as a young child,” he said. “My mother is a pianist, and she encouraged my musical abilities, so I continued to play through college. I considered pursuing a career in music, but I’m happy that I chose astronomy.” He completed his Ph.D. at the University of Washington.

Community Outreach

In addition to his research, Seth wants to make sure the Physics & Astronomy Department is able to continue its community outreach efforts. The department travels to schools across Utah, providing demonstrations and teaching kids about the universe.

The department also sponsors star parties, which are open to the public Wednesday evenings (weather and nighttime skies permitting) at the Physics & Astronomy Department’s observatory on campus. For details, see http://web.utah.edu/astro/.

“The star parties and our public lectures are such a great way for us to connect with the community,” said Seth. “We’re always looking for ways to get people interested in astronomy.”

Seth is also founder and director of an astronomy internship program at Bryce Canyon National Park in Utah. To learn more, see http://www.physics.utah.edu/~aseth/Bryce_Internship.html.
Peter Trapa Selected as New Dean of the College of Science

University of Utah senior vice president for Academic Affairs Dan Reed announced that Peter Trapa has accepted an offer to serve as the next dean of the College of Science.

Trapa is currently chair of the university’s Department of Physics & Astronomy and previously served as the chair of the Department of Mathematics and special assistant to the dean of the College of Science. Trapa also was the inaugural presidential fellow in 2016-17 under former U President David Pershing. He was named a fellow of the American Mathematical Society in 2019.

“Trapa is regarded as an excellent and innovative administrator, a strong advocate for students, staff and faculty, and an outstanding scholar,” Reed said. “He is a great communicator who is able to develop consensus and cultivate a positive culture. His deep understanding of the university and the state will serve the College of Science well as it continues to rise among its peers.”

The College of Science consists of three departments—chemistry, mathematics and physics and astronomy—and the School of Biological Sciences. It also includes several interdisciplinary centers. It has annual research expenditures of approximately $40 million.

Following completion of the appointment approval process, Trapa will assume his position on July 1, 2019.

“I’m honored to be named the next dean of the College of Science,” Trapa said. “It’s an exciting time for the college, and I look forward to working to advance its world-class research reputation and further propel its central educational mission both within the university and the state of Utah.”

Trapa joined the U’s Department of Mathematics in 2001; he was named chair of the department in 2011, serving in that position until 2017. He served as special assistant to Henry White, current dean of the College of Science, in 2017-2018.

He has served as chair of the Department of Physics & Astronomy since 2018, where he has overseen development of a model graduate program, reorganized departmental leadership and staff, and implemented a strategy to recruit exceptional and diverse faculty.
Trapa also has played a key role in state-level discussions about math courses, requirements, assessments and the need for strong high school curriculums that prepare students for college course work. He served on the state’s Math Task Force, the Standards Review Steering Committee, and as a director and member of the National Association of Math Circles, among others service work.

Trapa’s main research interest is representation theory, a kind of mathematical quantification of the symmetries that arise in physical theories. He has published extensively, and has contributed to solutions of the most outstanding problems in his discipline. Trapa is currently managing editor of the American Mathematical Society’s journal *Representation Theory*.

Trapa received undergraduate degrees in mathematics and integrated science from Northwestern University and a doctoral degree in mathematics from the Massachusetts Institute of Technology. He did postdoctoral work at Harvard University and the Institute for Advanced Study at Princeton before joining the U.

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**Gernot Laicher Receives Distinguished Teaching Award**

*Each year,* the University of Utah recognizes the achievements of members of its faculty with Distinguished Teaching Awards. This year’s honorees include Gernot Laicher, professor/lecturer in the Department of Physics & Astronomy.

Honorees are nominated by students. Here is what students said about Laicher:

“[Laicher] is one of the most effective lecturers I have had the pleasure of taking a course from. His ability to not only understand the questions that we had in each activity but to anticipate difficulties we may encounter based on his experience and to expertly explain how to circumvent them was amazing. Prof. Laicher also shines in his mentoring of students outside of the classroom proper,” said one nominator.

Laicher has been teaching continuously for 20 years at the U, with his primary teaching responsibilities being in connection with undergraduate and graduate laboratory courses, several of which he designed himself.

“Because of his past research involvement, he has a keen sense of what is required for students to learn in these lab courses in order to successfully make the transition to productive research,” said other nominators.

Laicher received a master’s degree in physics from the State University of New York at Buffalo and obtained a Ph.D. in physics from the U.
Graduate student Jason May was recently awarded a National Science Foundation Graduate Research Fellowship (NSF-GRF) for his work in STEM Education and Learning Research. The NSF-GRF Fellowship recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based master’s and doctoral degrees at accredited U.S. institutions.

Under the direction of Professors Jordan Gerton, Lauren Barth-Cohen, and Claudia De Grandi, May’s work has focused on researching the changes of student attitudes and competency in newly reformed introductory laboratory courses designed as Introductory Physics for Life Science (IPLS) labs. He studies how students respond, both academically and socially, to introductory computational methods, collaborative group work, and scientific modeling while working within high-stakes research-oriented laboratory courses. His research is conducted using both quantitative research methods (survey analytics, coding of student assessments, etc.) and qualitative research methods (interviews, video and audio observations, etc.).

“After I obtain my Ph.D., I plan to work as a postdoctoral researcher at a research-based university to continue my work in Physics Education Research (PER),” said May. “Ultimately, I hope to become a professor teaching physics and/or education courses and conducting PER.”

Tino Nyawelo, assistant professor (lecturer) in Physics & Astronomy, along with Nitin Phadnis, assistant professor in the School of Biological Sciences, have received the U’s College of Science Award for Fostering Undergraduate Research Excellence. The award recognizes excellence in fostering undergraduate research and promoting experiential learning during the academic year.
Overview of Physics & Astronomy Graduates

In 2018-19, 47 undergraduates were awarded bachelor’s degrees in physics; two received a bachelor’s in physics teaching.

Students who obtained a Ph.D. in 2018-19 are:
- Hassan Allami
- Doug Baird
- Elwin Bassett
- Paul Bergeron
- Jessica Galbraith-Frew
- Matthew Groesbeck
- Nathan Gundlach
- Vikrant Kamble
- Jihee Kim
- Zhuxi Luo
- Rajesh Malla
- Jason Martineau
- Lauren Simonsen
- Mandefro Teferi
- Xiaoju Xu
- Shuhei Yamamoto

Physics & Astronomy Student Awards in 2019

UNDERGRADUATE AWARDS
- Paul Gilbert Outstanding Research in Astronomy & Astrophysics
- Isaac Martin
- Outstanding Undergraduate Research
- Seo Y. Ahn
- Logan Draper
- Thomas J. Parmley Scholarship for outstanding students in physics and astronomy
- Galen Bergsten
- Walter W. Wada Endowed Scholarship for physics majors
- Katerina Excell
- Preston J. and Phyllis R. Taylor Undergraduate Award for Overcoming Obstacles
- Patrick Robinson
- Tyler Soelberg Memorial Award for exceptional performance in science coursework and creative ventures
- Tomey Alement
- Diversity Scholarship for women and underrepresented groups
- Mario Homer

Outstanding Undergraduate Teaching Assistants
- Maile Marriott
- Quintin Medina
- David and Karen Imig Undergraduate Scholarship for Women
- Hattie Butts
- Outstanding Senior
- Robert Stahulak
- Outstanding Junior
- Chase Zagorec-Marks
- Outstanding Sophomore
- Kaden Richards

GRADUATE AWARDS
- J. Irvin and Norma K. Swigart Endowed Graduate Scholarship
- Su Kong
- Xiaojie Liu
- Neda Lotfizadeh
- Outstanding Graduate Students in coursework and research
- Renuka Pechetti
- Abhimanyu Sharma
- Outstanding Teaching Assistants
- Sebastian Atwood
- Doug Baird
- Diversity Scholarship for women and underrepresented groups
- Flo Doval
- Henna Popli
- National Science Foundation Graduate Research Fellowship
- Jason May
- Willard L. and Ruth P. Eccles Fellowship for Senior Graduate Students in Astronomy
- Renuka Pechetti
- Xiaoju Xu
Crimson Laureate Society
Join the Crimson Laureate Society at the College of Science! Society members advocate for science, gain exclusive benefits, and drive the future of research and education at the University of Utah. Your annual membership will start today with any gift of $100 or more to any department or program in the College. For more information, contact the College of Science at 801-581-6958, or visit https://science.utah.edu/giving/index.php.