UC Irvine
School of Physical Sciences

2024 Dean's Report

Building a Better **Future** Through Science

A student enjoys the view of the April 8th partial solar eclipse from the Physical Sciences Plaza on the UC Irvine campus.

Photo: Steve Zylius / UC Irvine

A Message from **Dean Bullock**

The School of Physical Sciences has the broadest of jurisdictions: the entire Earth as a system is our purview; all the planets and suns in the cosmos are ours to understand; the deepest mysteries of the quantum world and the technologies waiting to be unlocked by them are ours, too. We strive to understand the makeup of all matter, the nature of all energy and the deepest mathematical truths that underpin the universe.

With such great breadth comes great opportunity, and we in the UC Irvine School of Physical Sciences are making the most of this wonderful position. Award-winning faculty from our top-ranked departments of Chemistry, Earth System Science, Mathematics and Physics and Astronomy are making advances that expand our basic understanding of reality and provide solutions to the most significant problems of our age.

Contained in this report are several stories that exemplify what we do. One lab has developed technology poised to revolutionize the detection and treatment of cancer (page 6) and another has made a transformative breakthrough in the production of quantum-scale devices for next-generation electronics (page 12). Using satellite data, a UC Irvine-led team has uncovered vigorous glacial melting in Antarctica (page 9), while another faculty member is working with private industry to capture planet-warming carbon dioxide (page 11).

Though real-world problems drive much of what we do, we equally strive to advance fundamental questions of the kind that transcend the human experience. For example, UC Irvine is the birthplace of FASER, the newest experiment at the Large Hadron Collider at CERN, which has led to the detection of neutrinos for the first time at a particle collider (page 15). Neutrinos are a type of subatomic particle that the late UC Irvine physicist and Nobel laureate Frederick Reines co-discovered.

Our dedication to advancing knowledge also shines through in our educational programs. The Department of Mathematics has just launched a new Bachelor of Science degree in Applied and Computational Mathematics (page 17). Rooted in theoretical foundations, the new degree offers deep practical applications of the kind that will make the degree highly valuable in the job market.

We also remain deeply committed to serving our surrounding communities (page 18). Our outreach programs have inspired young minds and fostered a love for science and discovery. Partnerships with local middle and high schools have strengthened our impact, enabling us to reach students in Orange County – many of whom would be the first in their families to attend college.

As we reflect upon a fantastic year and look to a bright future, I want to acknowledge the effort and dedication of our entire school community – faculty, students, staff, alumni and supporters – in making our aspirations a reality.

Together, we are making the world better through math and science and building a future enhanced by wonder and discovery.

James S. Bullock, Ph.D.
Dean and Professor of Physics and Astronomy
School of Physical Sciences
University of California, Irvine

Highlights

UC Irvine
School of Physical Sciences

University of California, Irvine
2023-2024 Dean's Report

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Photo: Steve Zylius / UC Irvine

AirUCI Hosts Live Stream Chat With NASA Astronaut **Tracy Caldwell Dyson**

On July 8, NASA Astronaut and former UC Irvine postdoctoral researcher, Tracy Caldwell Dyson, called in from the International Space Station and greeted a crowded room in the Natural Sciences II building that included undergraduate students enrolled in Professor Don Blake's Student Airborne Research Program. Professor Barbara Finlayson-Pitts prepared questions to ask Dyson, like what it's like watching Earth from space.

"It's almost like seeing an infant swaddled in its blanket," said Caldwell Dyson, who explained how Earth and the life it cradles feel especially vulnerable against the infinite backdrop of space. "It just affirms how important it is that we protect and take care of our environment."

Caldwell Dyson described her journey to becoming an astronaut. She said astronauts come from all different walks of life, but that one thing unites them: they all enjoyed what they were doing before joining the astronaut corps, and that you need that energy and enthusiasm to help carry you through the rigors of astronaut training. "When you really enjoy what you do, it brings out the best in you," Caldwell Dyson said.

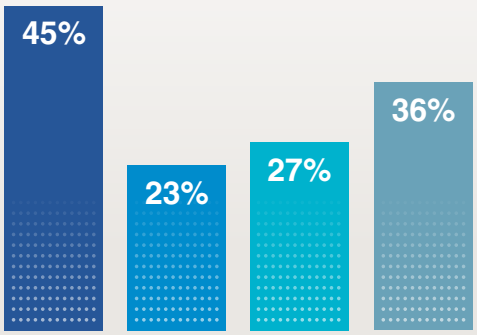
Before Tracy Caldwell Dyson came to campus in 1998, she let her soon-to-be faculty mentors, Professors Barbara Finlayson-Pitts and John Hemminger of the UC Irvine Department of Chemistry, know something important: she was in the middle of applying to become a NASA astronaut, and if she got the job it meant she would have to cut her postdoc short.

Hemminger and Finlayson-Pitts knew the astronaut dream was a long shot – after all, less than one percent of applicants make it into the Astronaut Corps – so they hired Caldwell Dyson, who'd just finished her Ph.D. in chemistry at UC Davis. While at UC Irvine, she studied how to measure exotic air pollutants as part of the Atmospheric Integrated Research (AIR) group.

A year into her postdoc, Caldwell Dyson got the call that NASA wanted her. UC Irvine lost a postdoc, but it gained a scientist-astronaut colleague who over a decades-long career in space regularly returns to campus to talk about her experiences.

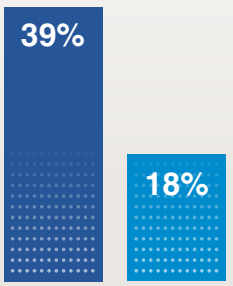
Facts & Figures

1,937
Undergraduate Students
as of Fall 2023



- Women
- Underrepresented minorities
- Low-income students
- First generation college students

566
Graduate Students
as of Fall 2023



- Women
- Underrepresented minorities

OUR **BUILDINGS**

1968
Rowland Hall
145,215 sq ft.

Frederick Reines Hall
99,024 sq ft

2000
Multipurpose Science and Technology Building
13,995 sq ft

Degrees Awarded in 2023-24

476
Undergraduate Degrees

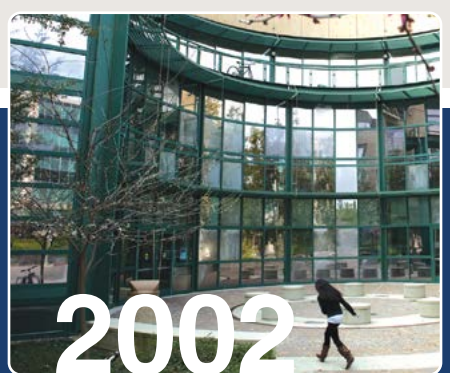
75
Graduate Degrees

Facilities

415,072
square feet

Classroom Labs
24,719 square feet

Research Labs
210,657 square feet

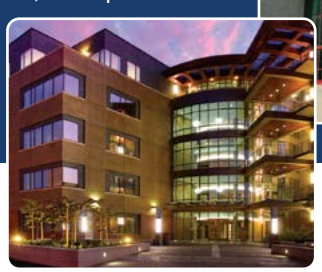


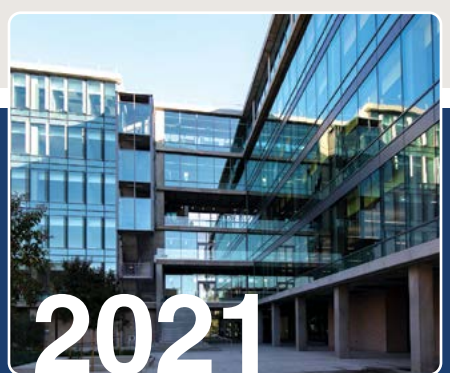
Natural Sciences 1
30,727 sq ft

2003

Croul Hall
41,814 sq ft

Natural Sciences 2
34,755 sq ft





Interdisciplinary Science and Engineering Building
40,449 sq ft

Health

Pushing Cancer Treatment into the Future

Lumitron Technologies, a company housed in the UC Irvine Research Park and co-founded by Professor Christopher Barty of the UC Irvine Department of Physics & Astronomy, is developing a novel X-ray and electron beam machine called HyperVIEW™ that aims to selectively image cancer in the body and eliminate it while minimizing damage to surrounding tissue.

"The machine has now generated electron beams that can be used to treat cancer anywhere in the human body and x-ray beams that follow the same path as the electrons that can image cancer at 100 times beyond the resolution of conventional clinical systems," said Barty. "The holy grail is that ultimately you will have the ability to guide your cancer treatment in ways that nobody's ever been able to do before." HyperVIEW™ is a fourth-generation, laser-Compton X-ray technology Barty started developing when he was a scientist at Lawrence Livermore National Laboratory. HyperVIEW™ X-rays will "allow you to image soft tissues at potentially cellular levels, something that has only ever been done at billion-dollar synchrotron facilities," Barty said, which means Lumitron's technology could one day both track and treat cancer at the cellular level in the human body. The company plans to have FDA approval for initial, precision cancer imaging applications by late 2025 and moved HyperVIEW™ to pre-clinical cancer treatment studies late this summer. "With this technology, we may eliminate the need to ever remove a breast or prostate again," said Barty. ●

Photo: Steve Zylius/UC Irvine

Vehicle Brakes Produce Charged Particles That May Harm Public Health

Scientists know relatively little about particles released into the air when a vehicle driver brakes, though evidence suggests those particles may be more harmful to health than particles exiting the tailpipe. In a new study, University of California, Irvine researchers show how most of these particles emitted during light braking carry an electric charge – something that could potentially be exploited to help reduce air pollution from vehicles.

"We found that up to 80% of aerosol particles emitted from braking are electrically charged and that many of them are highly charged," said Adam Thomas, a doctoral candidate in the lab of Jim Smith, professor of chemistry, who led the study alongside UC Irvine postdoctoral researcher Paulus Bauer.

The research is part of a broader team effort at UC Irvine to understand the public health impacts of non-tailpipe emissions in areas beset by car traffic, including many areas in Southern California.

"The toxicity and health effects of brake wear particles are largely unknown," said Manabu Shiraiwa, professor of chemistry at UC Irvine and one of the researchers behind the university-wide project.

"If they are charged, they can be removed easily from the air before they have a chance to have an impact at all on health," said Smith. "All you would need to do is to collect them with an electrostatic precipitator – a device that exposes the charged particles to an electric field and efficiently sweeps them away."

> "We found that up to 80% of aerosol particles emitted from braking are electrically charged and that many of them are highly charged."

The public health risk posed by brake emissions is not borne equally by a population – lower-income parts of cities tend to be more traffic-heavy than others, which creates an environmental justice issue wherein certain socioeconomic classes are more exposed to brake emissions than others.

Photo: Lucas Van Wyk Joel/UC Irvine

Lead study authors Adam Thomas (right) and Paulus Bauer (left) hold a brake rotor and caliper next to the lathe they and their UC Irvine team used to measure car brake emissions.

According to Professor Barbara Finlayson- Pitts, Distinguished Emeritus Professor of Chemistry and the principal investigator of the project at UC Irvine, emissions from braking are not well-characterized but are potentially significant in high-traffic areas. "These areas are often in poorer communities and highlight an important aspect of environmental justice that has been largely overlooked," Finlayson-Pitts said.

Scientists Help Link Climate Change to Madagascar's Megadrought

A UC Irvine-led team revealed a clear link between human-driven climate change and the years-long drought gripping southern Madagascar. Their study appears in the journal *Nature Climate and Atmospheric Science*.

"Using remotely sensed observations and climate models, we saw evidence that climate change is affecting the hydrological cycle in southern Madagascar, and it's likely going to have big implications for the people that live there and how they grow their food," said Angela Rigden, assistant professor at UC Irvine and lead author. "The rainy season is getting shorter, with delayed onset of those seasons."

The Rigden team used a multi-year satellite record of vegetation greenness to show shifts in southern Madagascar's water availability. "We've taken satellite-based remote sensing data of plants and related it to how much water is available in the soils," Rigden explained.

The team compared this shift to what climate models predict without human-driven climate change, noting a narrower rainy season window. "That's the fingerprint of climate change," Rigden said.

The long satellite record from the 1980s enabled them to see climate change effects, corroborated by climate models.

Christopher Golden, an associate professor of nutrition and planetary health at the Harvard University T.H. Chan School of Public Health and study co-author, has done fieldwork in Madagascar for 25 years. Rigden joined the study in 2021 after the UN declared a famine in southern Madagascar due to climate change.

"Our study shows that this phenomenon is entirely driven by climate change," said Golden. This information helps policymakers allocate relief aid and better prepare for future droughts. "We can develop strategies to adapt," Rigden concluded. ●

Photo: Francesco Ungaro

Photo: NASA

UC Irvine-led Team Uncovers ‘Vigorous Melting’ at Antarctica’s Thwaites Glacier

A UC Irvine-led team used high-resolution satellite radar data to find evidence of the intrusion of warm, high-pressure seawater beneath West Antarctica’s Thwaites Glacier, as reported in the *Proceedings of the National Academy of Sciences*. This intrusion causes “vigorous melting,” requiring a reassessment of sea level rise projections.

The team used data from Finland’s ICEYE satellites, which monitor Earth’s surface changes with InSAR radar, showing tidal effects on Thwaites Glacier. Lead author Eric Rignot, UC Irvine professor of Earth system science explained that continuous time series compared with tidal cycles revealed seawater coming in at high tide and sometimes getting trapped under the glacier.

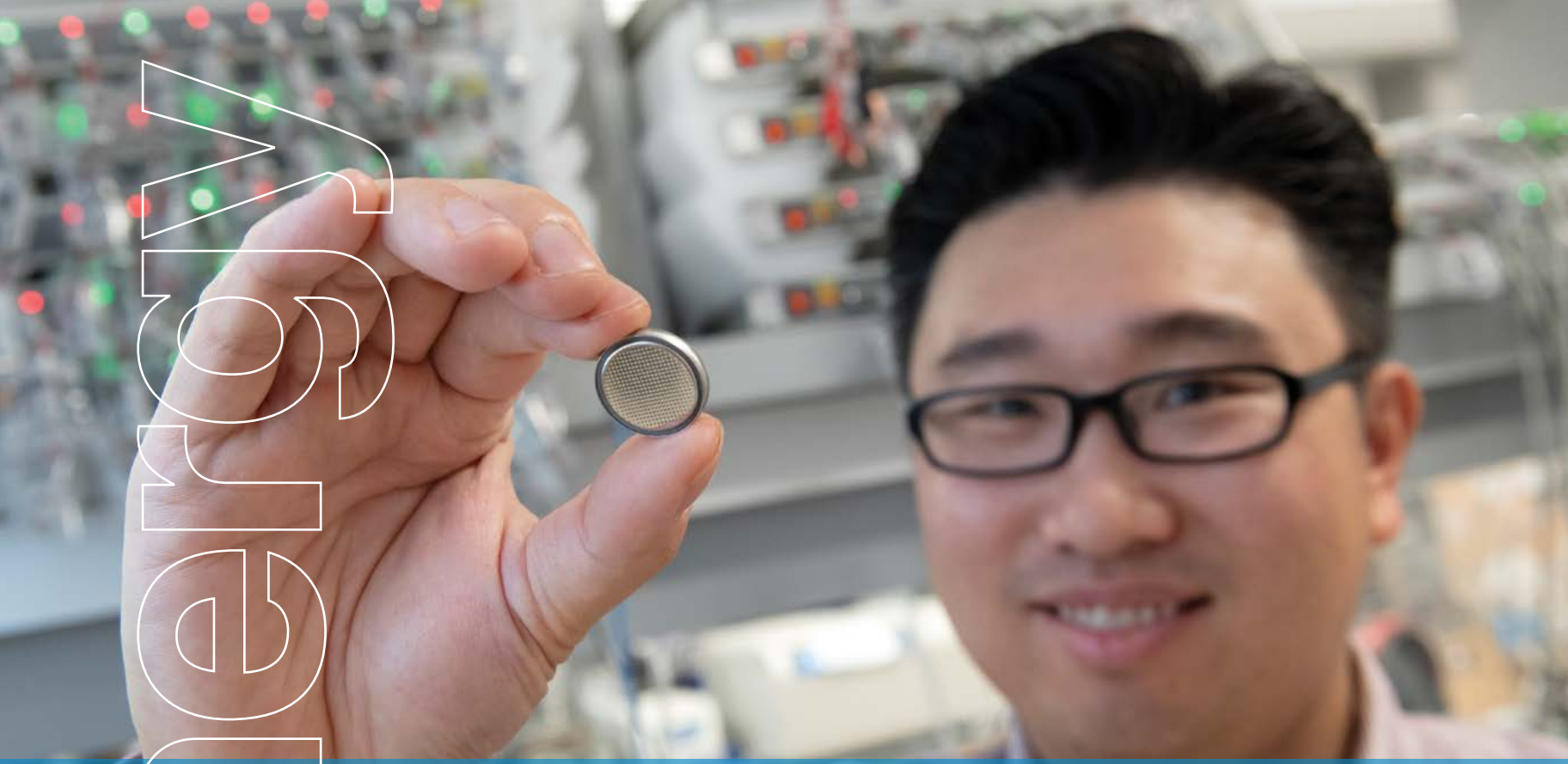
Co-author Michael Wollersheim, ICEYE Director of Analytics, noted, “Observing these processes from space and using radar satellite images, which provide centimeter-level precision InSAR measurements at daily frequency, marks a significant leap forward.”

Co-author Christine Dow, professor in the Faculty of Environment at the University of Waterloo in Ontario, Canada, said, “Thwaites is the most unstable place in the Antarctic and contains the equivalent of 60 centimeters of sea level rise. The worry is that we are underestimating the speed that the glacier is changing, which would be devastating for coastal communities around the world.”

Rignot said that he hopes and expects the results of this project to spur further research on the conditions beneath Antarctic glaciers, exhibitions involving autonomous robots and more satellite observations.

The team, including Enrico Ciraci, Bernd Scheuchl, and Valentyn Tolpekin, received financial support from NASA and the National Science Foundation.

> “Thwaites is the most unstable place in the Antarctic and contains the equivalent of 60 centimeters of sea level rise.”



UC Irvine Scientists Create Long-Lasting, Cobalt-Free, Lithium-Ion Batteries

In a discovery that could reduce or even eliminate the use of cobalt – which is often mined using child labor – in the batteries that power electric cars and other products, scientists at the University of California, Irvine have developed a long-lasting alternative made with nickel.

"Nickel doesn't have child labor issues," said Huolin Xin, the UC Irvine professor of physics & astronomy whose team devised the method, which could usher in a new, less controversial generation of lithium-ion batteries. Until now, nickel wasn't a practical substitute because large amounts of it were required to create lithium batteries, he said. And the metal's cost keeps climbing.

To become an economically viable alternative to cobalt, nickel-based batteries needed to use as little nickel as possible.

"We're the first group to start going in a low-nickel direction," said Xin, whose team published its findings in the journal Nature Energy. "In a previous study by my group, we came up with a novel solution to fully eliminate cobalt. But that formulation still relied on a lot of nickel."

To solve that problem, Xin's team spent three years devising a process called "complex concentrated doping" that enabled the scientists to alter the key chemical formula in lithium-ion batteries as easily as one might adjust seasonings in a recipe.

The doping process, Xin explained, eliminates the need for cobalt in commercial components critical for lithium-ion battery functioning and replaces it with nickel.

Photo: Steve Zylius/UC Irvine

The UC Irvine Story Behind a Top Carbon Capture Company

Professor Shane Ardo of the UC Irvine Department of Chemistry is on the advisory board for a company called Captura, a startup that aims to sequester planet-warming carbon dioxide (CO_2) from ocean water at a scale of around 10 gigatons of CO_2 each year. UC Irvine ChAMP Physics alumnus Chengxiang "CX" Xiang founded Captura in 2021 with fellow Caltech professor Harry Atwater.

The vision: machinery takes in ocean water, processes it, captures pure CO_2 out from the water and then puts the ocean water back with no polluting byproducts. The plan is to then store the captured CO_2 deep under the ocean floor in depleted oil reservoirs, or to create new uses for it.

A big part of Captura's mission involves fostering an emerging carbon economy wherein CO_2 removed from the climate system acquires new life by becoming an ingredient in consumer products like concrete.

It's a simple concept, but it's in the details that Ardo's lab is working on that could define the future of Captura. One hurdle facing the company is to grow its operations to a scale that can actually make a dent in atmospheric CO_2 concentrations.

"One of the challenges and opportunities is to really try to scale as quickly as you can," said Xiang. "You're not going to make a difference if you're doing tens or 100s or even 1,000s of tons of CO_2 per year. Billions of tons per year of CO_2 will be required in the next few decades based on a lot of scientific consensus." The average American emits about 15 or 16 tons of CO_2 per year.

Captura sequesters CO_2 out of the ocean using electricity – a resource that may not be much of an issue at the relatively small scale of Captura's current system, but which, at a scale of 10 gigatons of CO_2 per year, could significantly impact operating expenses. That's where the Ardo lab comes in.

Photo: Lucas Van Wyk Joel/UC Irvine

Professor Shane Ardo inspects Captura's prototype at Caltech's Kerkhoff Marine Laboratory.

"The efficiency of the reactions will ultimately dictate electricity needs and overall CO_2 cost," said Ardo, whose carbon capture research was supported by a Department of Energy (DOE) Advanced Research Projects Agency-Energy (ARPA-E) grant to Atwater, Xiang and Ardo in 2021.

Recently, Ardo and one of his graduate students, Munho Yang, submitted a patent application based on research describing materials that can safely remove CO_2 from ocean water.

The Ardo lab work could one day help Captura cut its energy costs – and, ideally, soon. According to the Intergovernmental Panel on Climate Change (IPCC), for the world to avoid the worst impacts of human-driven climate change, humanity needs to not only curb its emissions, but it also needs to develop technology like Captura's to help stave off climate change's worst impacts.

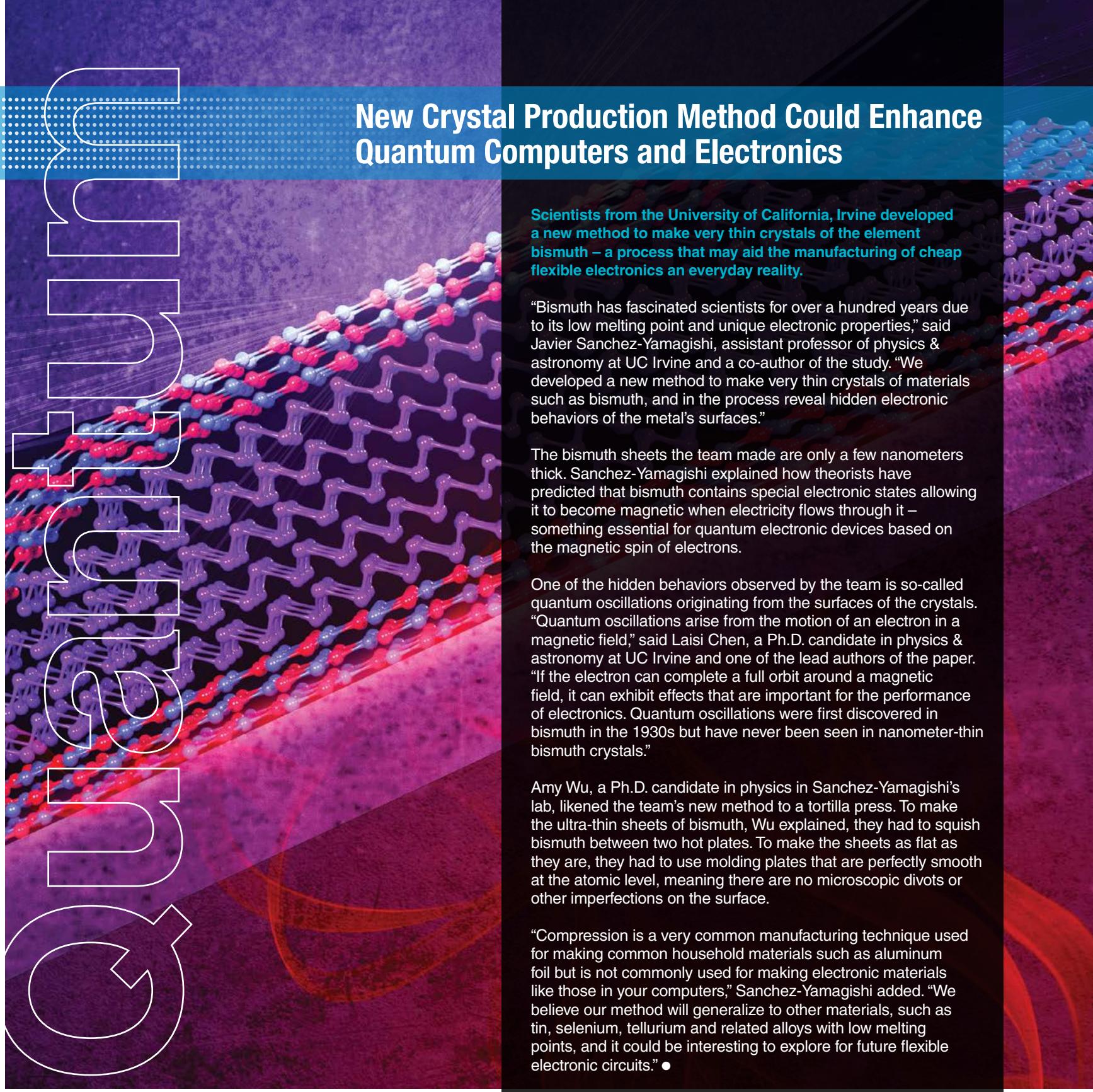
"We don't have a lot of time, right?" Ardo said. "That's what we're told, so we need to work fast and innovate quickly, and even fail quickly so we can identify successes." ●

"Doping also increases the efficiency of nickel," said Xin, which means EV batteries now require less nickel to work – something that will help make the metal a more attractive alternative to cobalt-based batteries.

Xin said he thinks the new nickel chemistry will quickly start transforming the lithium-ion battery industry. Already, he said, electric vehicle companies are planning to take his team's published results and replicate them.

"EV makers are very excited about low-nickel batteries, and a lot of EV companies want to validate this technique," Xin said. "They want to do safety tests." ●

New Crystal Production Method Could Enhance Quantum Computers and Electronics



Scientists from the University of California, Irvine developed a new method to make very thin crystals of the element bismuth – a process that may aid the manufacturing of cheap flexible electronics an everyday reality.

"Bismuth has fascinated scientists for over a hundred years due to its low melting point and unique electronic properties," said Javier Sanchez-Yamagishi, assistant professor of physics & astronomy at UC Irvine and a co-author of the study. "We developed a new method to make very thin crystals of materials such as bismuth, and in the process reveal hidden electronic behaviors of the metal's surfaces."

The bismuth sheets the team made are only a few nanometers thick. Sanchez-Yamagishi explained how theorists have predicted that bismuth contains special electronic states allowing it to become magnetic when electricity flows through it – something essential for quantum electronic devices based on the magnetic spin of electrons.

One of the hidden behaviors observed by the team is so-called quantum oscillations originating from the surfaces of the crystals. "Quantum oscillations arise from the motion of an electron in a magnetic field," said Laisi Chen, a Ph.D. candidate in physics & astronomy at UC Irvine and one of the lead authors of the paper. "If the electron can complete a full orbit around a magnetic field, it can exhibit effects that are important for the performance of electronics. Quantum oscillations were first discovered in bismuth in the 1930s but have never been seen in nanometer-thin bismuth crystals."

Amy Wu, a Ph.D. candidate in physics in Sanchez-Yamagishi's lab, likened the team's new method to a tortilla press. To make the ultra-thin sheets of bismuth, Wu explained, they had to squish bismuth between two hot plates. To make the sheets as flat as they are, they had to use molding plates that are perfectly smooth at the atomic level, meaning there are no microscopic divots or other imperfections on the surface.

"Compression is a very common manufacturing technique used for making common household materials such as aluminum foil but is not commonly used for making electronic materials like those in your computers," Sanchez-Yamagishi added. "We believe our method will generalize to other materials, such as tin, selenium, tellurium and related alloys with low melting points, and it could be interesting to explore for future flexible electronic circuits." ●

Photo: Eli Krantz / Krantz NanoArt

UC Irvine Scientists Create Material That Can Take the Temperature of Nanoscale Objects

University of California, Irvine scientists recently discovered a one-dimensional nanoscale material whose color changes as temperature changes. The team's results appeared in *Advanced Materials*.

"We found that we can make really small and sensitive thermometers," said Maxx Arguilla, UC Irvine professor of chemistry whose research group led the study. "It's one of the most applied and translatable works to come out of our lab."

Arguilla likened the thermometers to "nano-scale mood rings," referring to the jewelry that changes color depending on the wearer's body temperature. But instead of simply taking a qualitative temperature reading, the changes in the color of these materials "can be calibrated and used to optically take temperature readings at the nanoscale," Arguilla said.

"The need to measure temperature is important because a lot of biological and industrial processes depend on tracking minute changes in temperature," he added. "We may now have thermometers that we could try poking into the cells."

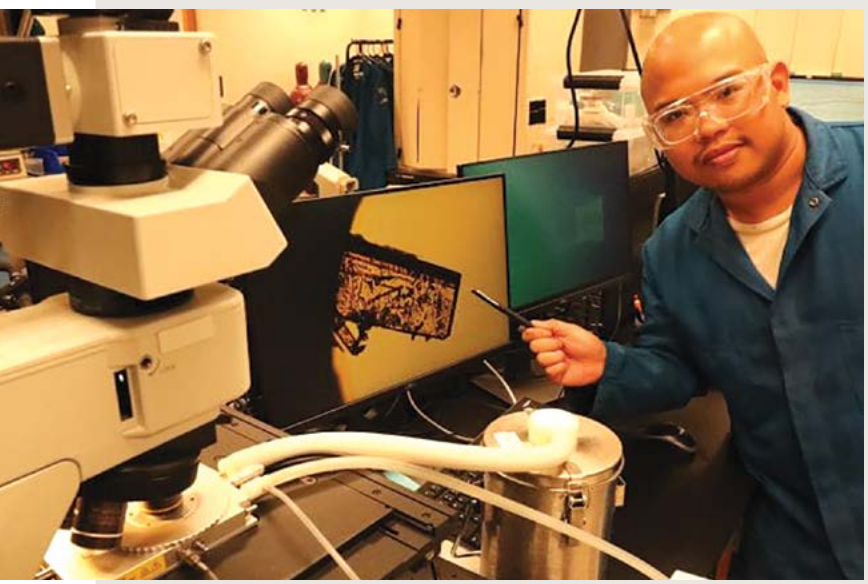


Photo: Lucas Van Wyk Joel/UC Irvine

UC Irvine postdoctoral scholar Dmitri Cordova inspects a sample of the crystal that Professor Maxx Arguilla's lab used to discover the new nano-scale thermometers.

According to Dmitri Cordova, a postdoctoral scholar in Arguilla's group, optical thermometers can also potentially measure temperatures and assess the efficiencies of micro- and nano-electronics, including circuits and data storage devices. Industries already use optical thermometers when fabricating computer components, but the team's new material is "at least an order of magnitude more sensitive," Cordova said.

The breakthrough happened when Cordova and colleagues grew crystals in their lab that, at nanometer length scales, resemble helical "slinkies." They grew the crystals at first so they could subject them to heat stress to see at what temperatures the crystals disintegrate. Cordova and undergraduate researcher Leo Cheng noticed that the colors of the crystals systematically shifted from yellow to orange, depending on the temperature.

> "The need to measure temperature is important because a lot of biological and industrial processes depend on tracking minute changes in temperature."

The team then took precise measurements of the temperature range the colors corresponded with, and they found that light yellow colors corresponded to temperatures around -190 degrees Celsius, while red-orange colors corresponded to temperatures around 200 degrees Celsius.

To retrieve nanoscale samples of the material, the lab stuck a piece of adhesive tape to bulk-scale crystals, peeled it back and transferred nanoscale samples stuck to the tape onto transparent substrates.

Arguilla explained that the discovery is the first step toward discovering new classes of materials to take temperature readings at nanometer scales.

Next, his lab plans to test other nano-scale materials to see if they can develop thermometers that can measure a wider range of temperatures.

Researchers Find Exoplanet That Appears to be Too Big for Its Sun

A research team including UC Irvine astronomers discovered an exoplanet far too massive for its sun, challenging previous ideas about planetary and solar system formation. Using the Habitable Zone Planet Finder at the Hobby-Eberly Telescope, researchers detected planet LHS 3154b, 13 times more massive than Earth, orbiting the "ultracool" star LHS 3154, nine times less massive than our sun. This finding is detailed in a paper published in *Science*.

"This is the first time such a high-mass planet has been found orbiting close to a lower-mass star, and it calls into question our previous assumptions about interactions between stars and planets," said co-author Paul Robertson, UC Irvine associate professor of physics and astronomy and HPF project scientist. Co-author Suvrath Mahadevan, the Verne M. Willaman Professor of Astronomy and Astrophysics at Penn State, explained that stars are believed to be created from large gas and dust clouds, which can also create planets. "The planet-forming disk around the low-mass star LHS 3154 is not expected to have enough solid mass to make this planet, but it's out there, so now we need to reexamine our understanding of how planets and stars form."

The heavy planetary core of LHS 3154b requires more solid material in the planet-forming disk than models predict, raising questions about star formation. The HPF's infrared detection sensitivity enabled the discovery of this relationship between a massive planet and its dwarf star. Robertson's UC Irvine graduate student Rae Holcomb also participated in the research, funded by NASA, the National Science Foundation, and the Heising-Simons Foundation. ●

(Above): Artistic rendering shows the possible view from LHS 3154b toward its low-mass star, LHS 3154. The relative sizes of the exoplanet and star are causing astronomers to reevaluate previous assumptions about planet and solar system formation.

Illustration: Penn State

Team is First to Detect Neutrinos Made by a Particle Collider

In a scientific first, a team led by physicists at the University of California, Irvine has detected neutrinos created by a particle collider. The discovery deepens scientists' understanding of the subatomic particles, which were first spotted in 1956 and play a key role in the process that makes stars burn.

The work could also shed light on cosmic neutrinos that travel large distances and collide with the Earth, providing a window into distant parts of the universe.

The results come from the Forward Search Experiment, or FASER, a particle detector designed and built by an international group of physicists and installed at CERN, the European Council for Nuclear Research in Geneva, Switzerland. There, FASER detects particles produced by CERN's Large Hadron Collider.

"We've discovered neutrinos from a brand-new source – particle colliders – where you have two beams of particles smash together at extremely high energy," said UC Irvine particle physicist and FASER Collaboration Co-Spokesperson Jonathan Feng, who initiated the project, which involves over 80 researchers at UC Irvine and 21 partner institutions.

Neutrinos, which were co-discovered nearly 70 years ago by the late UC Irvine physicist and Nobel laureate Frederick Reines, are the most abundant particle in the cosmos and "were very important for establishing the standard model of particle physics," said FASER Co-Spokesperson Jamie Boyd, a particle physicist at CERN. "But no neutrino produced at a collider had ever been detected by an experiment."

> "We've discovered neutrinos from a brand-new source – particle colliders – where you have two beams of particles smash together at extremely high energy."

Since the groundbreaking work of Reines and others like Hank Sobel, UC Irvine professor of physics & astronomy, most neutrinos studied by physicists have been low-energy neutrinos. However, the neutrinos detected by FASER are the highest energy ever produced in a lab. They are similar to the neutrinos found when deep-space particles trigger dramatic particle showers in our atmosphere.

FASER itself is new and unique among particle-detecting experiments. In contrast to other detectors at CERN, such as ATLAS, which stands several stories tall and weighs thousands of tons, FASER is about one ton and fits neatly inside a small side tunnel at CERN. And it took only a few years to design and construct using spare parts from other experiments.

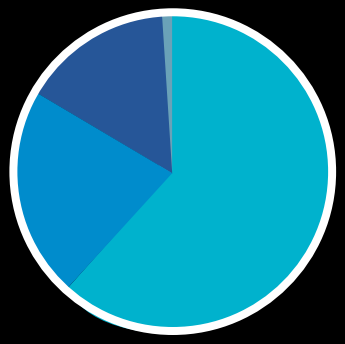
Beyond neutrinos, one of FASER's other chief objectives is to help identify the particles that make up dark matter, which physicists think comprises most of the matter in the universe, but which they've never directly observed.

Photo: CERN

Research Expenditures

Total Research Expenditures:

$67 million



- **Federal:** $40.8 million
- **State:** $.3 million
- **Private:** $14.8 million
- **Other:** $11.3 million

GRANT HIGHLIGHTS

Professors Jeffrey Streets and Jesse Wolfson were awarded a $2.5 million National Science Foundation (NSF) Research Training Groups in the Mathematical Sciences (RTG) grant spanning five years. The grant supports efforts to improve graduate student research training and professional development in mathematical sciences.

The National Science Foundation recently awarded an $18-million grant to a team of scientists to design the most powerful laser in the world. The team includes Franklin Dollar, a professor of physics & astronomy at the University of California, Irvine.

Jennifer Prescher, UCI professor of chemistry was part of a team that was awarded a $2.5-million Chan Zuckerberg Initiative grant, for a four-year project to create new bioluminescent probes and platforms for imaging hard-to-access tissues.

NASA awarded a $2.8 million grant to researchers at the University of California, Irvine for a five-year project to survey Antarctica's ice sheet. Led by Eric Rignot, UCI professor of Earth system science, the newly funded endeavor aims to provide the most detailed record yet of the condition of glaciers on the vast southern continent.

Department of Mathematics Launches New Bachelor of Science in Applied and Computational Mathematics

The Department of Mathematics launched a new Bachelor of Science degree in Applied and Computational Mathematics, with its inaugural cohort beginning in fall 2024. The new program is a significant addition to the academic offerings of the School of Physical Sciences and underscores the Department of Mathematics' commitment to adapting to evolving educational and professional landscapes.

Since UCI's founding, the Department of Mathematics has distinguished itself with its comprehensive curriculum and diverse specializations, encompassing seven distinct tracks, four of which tailor themselves to applied mathematics. These concentrations include Applied and Computational Mathematics, Data Science, Mathematical Finance and Mathematical Biology. The creation of the Bachelor of Science in Applied and Computational Mathematics coalesces these applied tracks into a single, structured program. The new degree program not only streamlines the path for students dedicated to applying mathematical principles to solve complex, real-world problems but also continues to support pure mathematical studies through the existing Bachelor of Science in Mathematics degree program.

The curriculum for the new degree program is rooted in theoretical foundations while offering extensive practical applications. Special emphasis is placed on computational skills, including valuable coding proficiencies in Matlab and Python, preparing students to meet current and future industry demands.

A. Park Williams Receives 2023 MacArthur "Genius Grant"

UC Irvine Physical Sciences alumnus A. Park Williams was named a 2023 MacArthur Fellow by the John D. and Catherine T. MacArthur Foundation. As a MacArthur Fellow, Williams will receive a grant for his research on climate change and its connection to terrestrial events like droughts and wildfires. It is considered among the most prestigious fellowship programs in the world. While there are no quotas or limits, typically 20 to 30 Fellows are selected each year. Since 1981, 1061 people have been named MacArthur Fellows.

Williams received his Bachelor of Science in Earth and Environmental Sciences from UC Irvine in 2003. He is an associate professor of geography at UCLA who, as a hydroclimatologist, uncovers new insights into how climate change influences drought, wildfires and tree mortality.

Photo: John D. and Catherine T. MacArthur Foundation

OUTREACH

Fostering the Next Generation of Scientists

The School of Physical Sciences is committed to developing and participating in outreach programs and initiatives for underrepresented students in surrounding communities that will impact their awareness of and interest in Physical Sciences pathways.

EmpowHER 2nd Annual Conference

On December 16th, the School of Physical Sciences welcomed 17 students from Godinez High School in Santa Ana to UC Irvine for the annual Empowering Women through High School Engagement and STEM Research (EmpowHER) Conference. The event, funded by an American Association for University Women grant, offers high schoolers insights into STEM majors, research, and career paths. The program helps students tackle imposter syndrome and build confidence in pursuing a STEM education. Dr. Brenda A. Rounds, a chemistry professor at Cal State Los Angeles, delivered an inspiring keynote on her journey as a Latina in STEM. Following her address, UC Irvine students led a panel on life as STEM students and building community on campus. The conference ended with students meeting Professors Jenny Yang and Herdeline Ardoña, who shared research stories and gave a look at their labs.

Photo: Ash Hormaza/UC Irvine

Photo: UC Irvine

LEAPS Brings Santa Ana Middle-Schoolers to UC Irvine

On March 5th, 48 students from Sierra Preparatory Academy in Santa Ana visited the UC Irvine School of Physical Sciences for the Laboratory Experiments and Activities in the Physical Sciences (LEAPS) Outreach Program, which brings underrepresented students from Santa Ana schools to UC Irvine to see science in action. The students enjoyed live science demonstrations from the departments of mathematics, physics & astronomy, Earth system science, and chemistry. Demonstrations included making toothpaste for elephants, lighting a gummy bear, and using ultraviolet light to reveal invisible ink on paper. After touring labs, students were given an exclusive campus tour and had lunch in Brandywine dining hall. “The program was a success,” said Ash Hormaza, the program coordinator for the Office of Access, Outreach and Inclusion in Physical Sciences. “I hope the students had fun, envisioned themselves as future university students, and left with a desire to learn more about science.”

Math CEO Outreach Program Reveals Best Mentoring Practices

Alessandra Pantano, professor of mathematics at UC Irvine, and director of Math CEO (Math Community Educational Outreach), founded the program with Professor Li-Sheng Tseng in 2014. The program hosts weekly tutoring sessions for students from underprivileged schools in Southern California at UC Irvine, tutored by undergraduate volunteers from the math department. In 2022, Pantano and Professor Sandra Simpkin of the School of Education received a $1.5 million National Science Foundation grant to research key factors in helping kids learn math. The findings highlight the importance of mentor-mentee relationships. Since its inception, Math CEO has evolved, guided by such findings, focusing on mentor-mentee relationships and being aware of the cultural backgrounds of its largely Latinx students. “Participating in Math CEO helps kids develop math proficiency, motivation, problem-solving skills, and an interest in math,” said Pantano. “They also learn teamwork, persistence, and gain familiarity with college and STEM careers.” Professor Tseng has been expanding the high school component, launched in 2019. The program aims to continue fostering math education in middle schoolers through high school and into college. “Our goal is to raise college awareness, motivate students to excel in math, and get interested in STEM fields,” said Tseng. “Math CEO engages students from 6th to 12th grade, providing a welcoming atmosphere to explore mathematics as a gateway to college.”

Photo: Alice Vo/UC Irvine

Photo: Colin Winchell

Physical Sciences Hosts Orange County Department of Education Science Olympiad

In February, over 900 middle and high school students from 49 schools across Orange County visited UC Irvine to compete in a regional Southern California heat of the nationwide Science Olympiad competition. Teams competed in events testing their knowledge in fields from astronomy to Earth science. UC Irvine undergraduates in the Chemistry Department worked with faculty and staff to turn class knowledge into events. “Many of our undergraduates are committed to making the event a success,” said Professor Kimberly Edwards. The UC Irvine Science Olympiad Club, founded by engineering student Antonio Velasco, encouraged STEM majors to participate. “We’ve created an impact beyond campus by mobilizing volunteers for SoCal tournaments,” Velasco said. “Engagement this year was great,” Edwards added. “We had nearly 150 undergraduates involved as event writers or volunteers.” The event was a collaboration between UC Irvine and the Orange County Department of Education (OCDE).

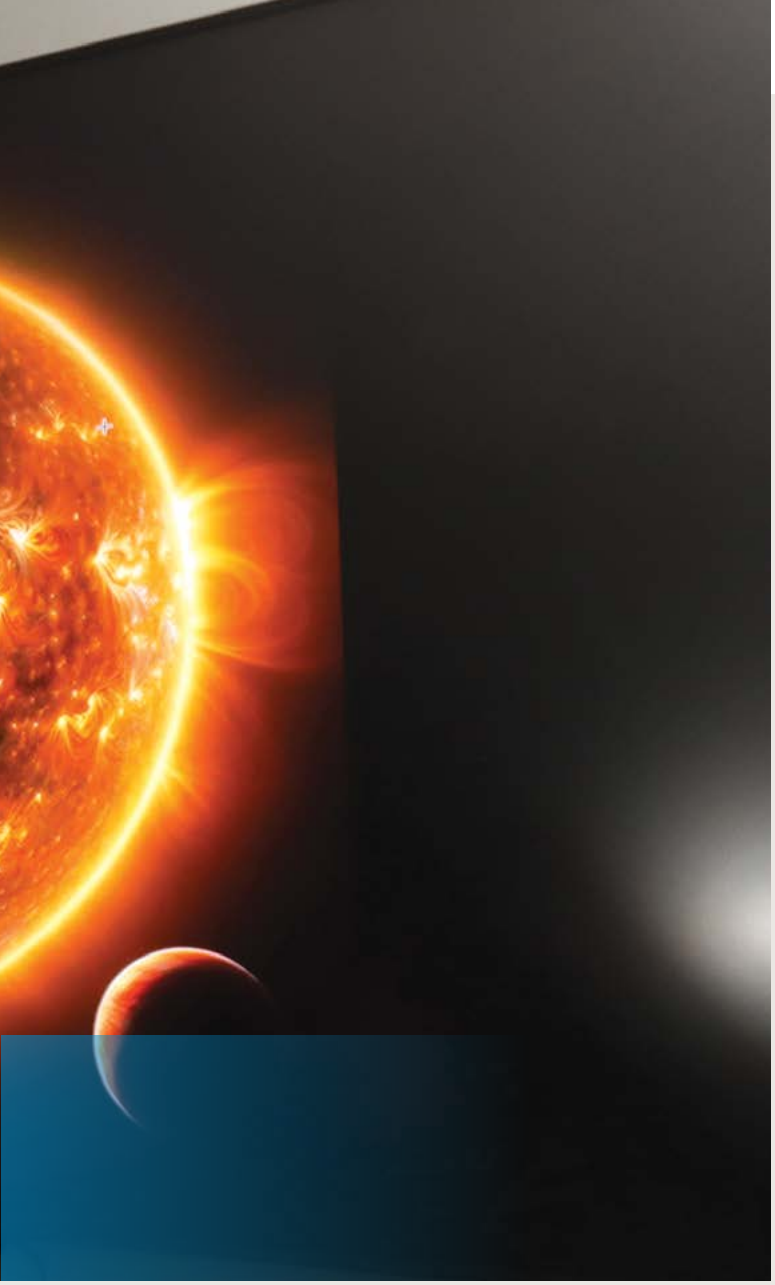
Amber Wong Finds Her Place Among the Stars

The Physical Sciences undergraduate is helping others find their path in the cosmos, too

That undergraduate and rising senior Amber Wong should land among the stars as an astrophysics major at UC Irvine almost seems preordained. When she was a child, Wong, who's majoring in astrophysics in the UC Irvine Department of Physics & Astronomy, visited Edwards Air Force Base near her hometown of Lancaster, California. There, she climbed a ladder and dropped into the cockpit of an F16 fighter jet. She sat in the jet and watched the sunrise and the last few stars in the night sky blink out of sight.

At another turn, Wong and her mom drove to the desert one night so they could see the night sky. "It was really dark," Wong said. "We saw the Perseids meteor shower." Wong saw the spine of our home Milky Way galaxy that we can see here on Earth arcing across the sky, and that's when she felt it: a tug toward the stars and an urge to know more about them. The night sky cast a spell on Wong, and today she works to uncover the mysteries it holds as a research assistant in the lab of UC Irvine professor Paul Robertson.

Photo: Lucas Van Wyk Joel/UC Irvine



When Wong first enrolled at UC Irvine, she began with a major in engineering, but after a year of classes, the pull of the stars became too strong, and in the summer after her freshman year Wong switched her major to physics. Wong felt a common hurdle: imposter syndrome. She doubted her ability to succeed in physics course-work. But then Wong started going to sessions at UC Irvine's Learning & Academic Resource Center (LARC), where she met many other physics students with similar struggles, but who were working together to overcome their challenges.

At LARC there was an undergraduate learning assistant who facilitated physics lessons and who explained topics to Wong in a way that resonated. "She was very cool," Wong said of the learning assistant. "Plus, I made a bunch of friends in LARC. It was comforting, it was mental support, I was more prepared for my classes, and it helped boost my confidence. It's been a very slow, years-long iterative process of me slowly proving to myself that I can do this."

Alongside Professor Robertson, Wong researches stars called M dwarfs, which are between 8 to 60 percent of the mass of our sun. The conventional thinking is that a star like that doesn't produce enough material in the early stages of its formation to make planets as big as Jupiter or Saturn. It's part of a project called the GEMS (Giant Exoplanets around M-dwarf Stars) survey, which seeks to understand the extreme limits under which planets can form in a galaxy.

"These are the biggest planets orbiting the smallest stars, and their existence poses some fascinating questions," said Robertson. "Small stars have less material available to form planets, so to find Jupiter-sized planets orbiting them is intrinsically rare." The typical view is that you need a star at least the size of our sun to form something Jupiter-sized.

For her part in the survey, Wong is analyzing data from observations coming from land- and space-based telescopes. "Her analysis will measure properties of exoplanets and their host stars, including fundamental characteristics like their masses and radii," said Robertson. "These measurements are crucial inputs to models of planet formation that are trying to understand how such large planets form around small stars."

So far, Robertson and his team have discovered that gas giants orbiting M dwarf stars appear to require a lot of metal, much more than exists on planets like Jupiter. "Because Wong is using so much data, from so many telescopes, it is a big computational effort to synthesize all of that into meaningful answers to the questions we're posing," said Robertson.

"These are the biggest planets orbiting the smallest stars, and their existence poses some fascinating questions."

Wong found her place among the stars, and she now helps others find their paths, too, in her work as a peer academic advisor in the Physical Sciences Student Affairs Office. When she's not traversing the cosmos or helping others do the same, Wong loves to cook. Her signature dish is vodka pasta, and soon she'll try making sourdough bread. Making sourdough is no cakewalk, but the way Wong talked about it you wouldn't think there was a novice in the room.

It was the confidence of someone who now believes they can aim for the stars and land among them.

Bryant Pahl Wants to Tell You a Story

Bryant Pahl was nervous. He stood by the steps leading up to a stage in a crowded room in the UC Irvine Newkirk Alumni Center, waiting for the emcee to call his name. He was at the final round of the UC Irvine heat of the UC Grad Slam science communication competition after spending countless hours prepping a three-minute pitch about his doctoral research on ancient climate change in the lab of Professor Kathleen Johnson in the UC Irvine Department of Earth System Science.

"And now, I'm honored to welcome to the stage, Bryant!" The emcee called. Pahl straightened his tie, climbed the stairs to the stage, and started his story. "Caves," Pahl told a hushed audience. "They're dark, mysterious, a little bit scary and, also, Earth's libraries…" That was how Pahl started his tale, but the story of Pahl's journey to that stage began a long time ago, in the high deserts of Southern California under a clear night sky.

Pahl was twelve years old, and he lived with his family in Joshua Tree, California. Pahl and his two brothers would often escape into the backyard of their home to talk and gaze at the stars.

What he saw stood in stark contrast to the night sky in Long Beach, where he and his family lived before moving to the desert. Now, far from major city lights, Pahl could see not only the stars but also the spine of the Milky Way galaxy that arcs across clear night skies. "I remember when I moved there, one of the first things I said was 'What is that?'" Pahl remembers upon catching a glimpse of the cosmos.

It was in the silent exchange Pahl had with the stars that he made a promise to himself: he would go to college to become a scientist, something no one in his family had ever done before. The stars spoke to Pahl, and many years later as an undergraduate at UC Santa Barbara, he started out majoring in astronomy. Pahl took an astronomy class with Professor Robert Antonucci, and after Antonucci lectured on the Earth and climate change, he felt inspired to switch his major to geoscience. "I was inspired by Professor Antonucci, who emphasized a chapter in our textbook about the Earth and the impact of future climate change as being the most important chapter we could take away from the class," said Pahl, who was galvanized to share the science behind climate change with the world.

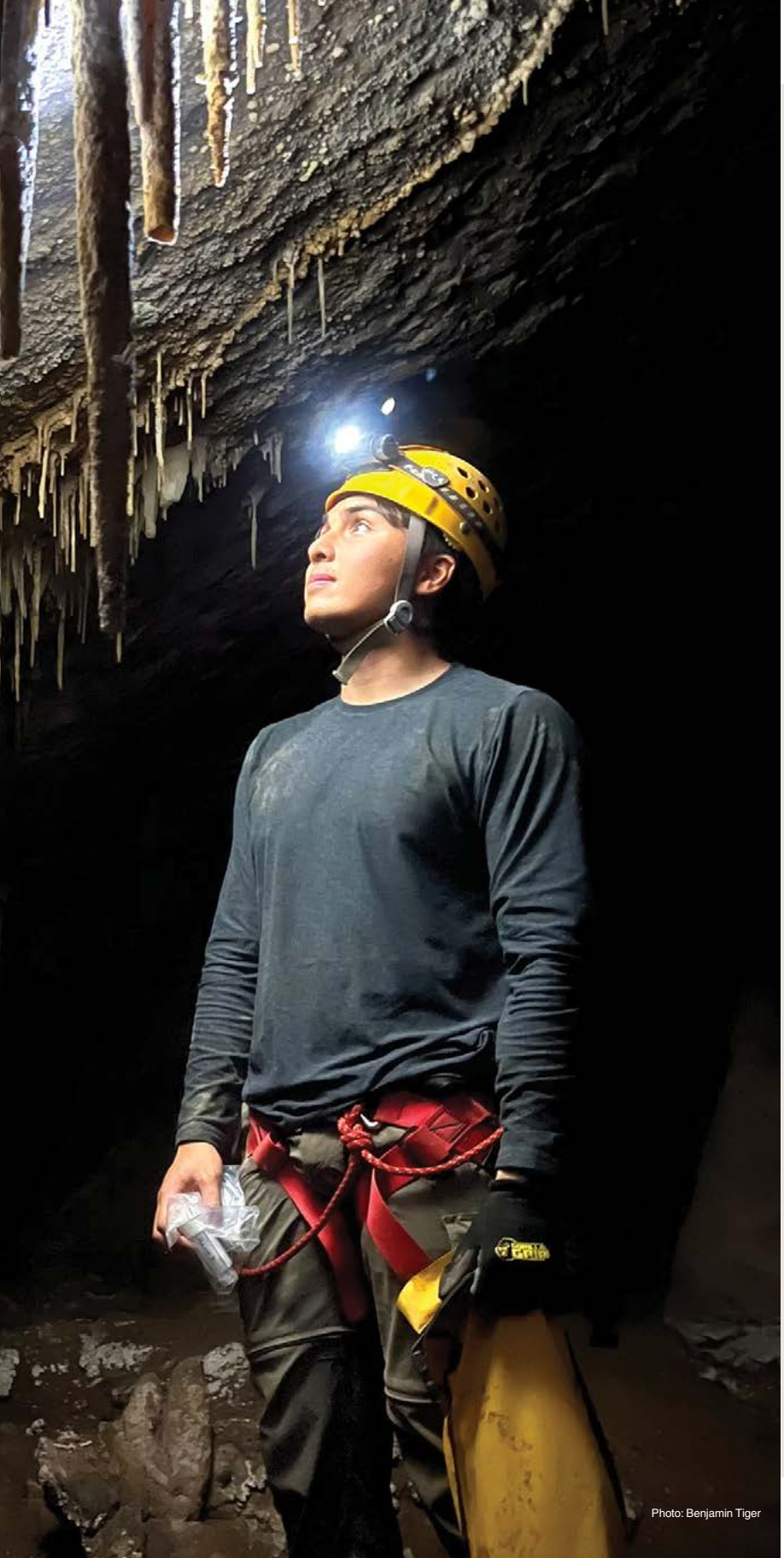


Photo: Benjamin Tiger

Pahl sees himself, first and foremost, as a storyteller. One of the reasons he took a path into science is the grand story he thinks the natural world must tell. For him, science is a way of translating the science of our planet into stories that resonate with others. In 2021, Pahl became the UC Irvine School of Physical Sciences' science communication fellow for his department, a role he used to chronicle the stories of the school's Earth system scientists. Long before that, Pahl discovered the power of storytelling when he was a student at UC Santa Barbara, and he found a campus-affiliated website called "Humans of UCSB." It was a page inspired by the popular "Humans of New York," which publishes stories about everyday New Yorkers.

In much the same way, Pahl, as a UC Irvine Earth system scientist, is working to tell our planet's hidden stories. "The story I'm trying to tell in my climate records is about a time when Earth was warmer than pre-industrial conditions before humans started changing the climate," Pahl said. To tell that tale, Pahl travels to caves in places like Mexico so he can enter what he called Earth libraries in his Grad Slam presentation. He calls them libraries because the samples he collects consist of layers of rock that accumulated very slowly over many thousands of years.

"They're dark, mysterious, a little bit scary and, also, Earth's libraries…"

The layers, like the pages of a book, contain chemical clues that may reveal how past periods of climate change unfolded – something that may provide clues to how modern, human-driven climate change will unfold. "If we can observe where there are tipping points in Earth's climate, that can inform us about what can happen to a specific region in the future," said Pahl. "It would be good to be able to train models on better observational data. It's about taking observations from the past to better predict how climate change will change in the future."

Pahl's still writing the ending of his UC Irvine story as he works to finish his doctoral research in the coming year. But we know how the story starts: Pahl is looking at the stars that inspired him to dream about what might be possible. And, in their quiet way, the stars look back at him, wondering what will come.

Undergraduate Mentoring Program Celebrates 20th Anniversary

Photo: The White House

When you're a mentor and you give a mentee advice, it can be hard to know exactly how the advice you just gave will go on to help your mentee. This was not the case with UC Irvine Department of Chemistry alumnus Aaron Katzenstein and his mentee, Stephen Chen, who Katzenstein met through the UC Irvine School of Physical Sciences' Undergraduate Mentoring (PSUM) program.

Chen wanted to apply for a competitive internship where Katzenstein works at South Coast Air Quality Management District (AQMD) in Diamond Bar, and hearing this, Katzenstein encouraged Chen to not only submit an application through an online portal but also to mail a paper cover letter and résumé to the AQMD board members involved in the intern selection process. Chen took the tip to heart, and he mailed a physical copy of his internship application and landed the gig. The impact of Katzenstein's mentoring did not end there.

Later, in 2014, President Barack Obama gave the commencement speech at UC Irvine's graduation ceremony at Angel Stadium in Anaheim, Ca. Chen was so moved by Obama's speech that he wanted to express his appreciation to the President. Recalling Katzenstein's advice, Chen pulled out his pen and hand-wrote a letter and sent it to the White House. He thanked President Obama for taking the time to speak at his graduation and shared that he would be working in the air quality space immediately after graduation.

"I told him he probably wouldn't get a response," Katzenstein recalled saying. Indeed, over a year passed and Chen all but forgot about the letter. Then he got a call from the White House. The person on the phone thanked him for his letter and invited him to a White House state dinner where President Obama would be hosting dignitaries like the President of China, Xi Jinping and Facebook co-founder Mark Zuckerberg.

"I was so surprised," said Chen, who now works as a Strategy Consultant in New York City. Chen later found out he was the first person invited to a state dinner due to a letter. Chen's employer at the time, environmental engineering firm HDR, covered nearly all travel expenses for Chen and his mom. "I give a lot of credit to that mentor program," said Chen.

Such is the magic of mentoring. It's part design, where a mentor like Katzenstein shares wisdom with a mentee he knows is useful, and it's part alchemy, where a mentee like Chen takes that wisdom to heart and uses it to create a future that neither he nor Katzenstein could've imagined.

PSUM fosters the transfer of inspiration between generations of Physical Sciences anteaters. Perhaps the most important ingredient in finding the kind of success PSUM can help create is to "just show up," Chen said. "Be present in what you do, and don't turn away opportunities because you want to be comfortable."

New Mental Health Workshop Series Lends a Helping Hand

Everything from family history to workplace demands has an impact on mental health – but mental health remains one of the least-supported areas of health in modern societies. To overcome this, the UCI School of Physical Sciences' Office of Access, Outreach and Inclusion (AOI) launched a new mental health workshop series in January 2024 dedicated to shining a light on different aspects of mental health. The three workshops focused on identifying symptoms of mental health problems and ways of offering support to those struggling, how to support women of color in STEM fields, as well as how mental health relates to neurodiversity.

"For every workshop, I invited a licensed psychologist from the UCI counseling center to give a presentation about the topic," said Ash Hormaza, AOI program coordinator in the School of Physical Sciences. "The series evolved from the need for a school-wide, in-depth conversation about mental health and how it can impact students in STEM, especially those who come from marginalized communities." Hormaza knew they had tapped into a common need at the school when, after workshops, students expressed the need for more workshops covering additional mental health needs. "I felt very happy that they expressed a desire for more workshops, and that they felt safe to share which topics would support them," Hormaza said. ●

UC Irvine Community Gathers for Partial Solar Eclipse

On April 8, the School of Physical Sciences hosted nearly 700 UCI students, faculty, staff and community members to watch the partial solar eclipse – something that won't be visible from California again until 2045. The event was hosted in partnership with the UCI Astronomy Club and NASA Eclipse Ambassador Evelyn Castaneda, an undergraduate student in the Physics & Astronomy department. Attendees were given solar eclipse viewing glasses and had the opportunity to get a close-up look at the celestial event through telescopes with special solar filters.

"It speaks to the universality of the phenomena of nature," said Professor Paul Robertson of the UCI Department of Physics & Astronomy as he held up his nearly opaque solar viewing lens and peered at the eclipse. "It's one of the most beautiful vistas that nature gives us, and it brings people together."

The Astronomy Club's vice president, undergraduate physics major Bianca Murphy, stood in awe not just at the site of the eclipse, but at the event turnout. "I'm blown away by how many people are this excited about astronomy," said Murphy, who intends to join the Navy upon graduating from UCI so she can train to become a NASA astronaut. "I can't believe we all get to see this event in our lifetime."

Photo: Steve Zylius/UC Irvine

The eclipse in Southern California was not total – just about 50% of the sun disappeared from view. Nevertheless, you could feel a sense of awe in the air at UCI. Sandy Mitchell, an Orange County resident, drove to UCI after reading about the event in the LA Times. "I'm grateful that UCI was generous enough to invite the public," said Mitchell. "It's a moment to step back and appreciate nature." ●

UC Irvine and Los Alamos Partnership Drives Scientific Excellence

The UC Irvine School of Physical Sciences continues to grow its partnership with Los Alamos National Laboratory (LANL) by providing invaluable research opportunities for graduate students through the UCI-LANL-SoCal Hub graduate fellowship program. The partnership, driven by a shared commitment to scientific innovation, is producing groundbreaking research at the lab where J. Robert Oppenheimer developed the atomic bomb.

The UCI-LANL-SoCal Hub graduate fellowship program allows UC Irvine graduate students to work directly with leading scientists at LANL. Over the past two years, five students in the School of Physical Sciences have participated, immersing themselves in high-impact research projects alongside their UC Irvine faculty advisors and LANL mentors. Each fellow receives one year of funding to support their research with LANL.

“Our graduate students in the School of Physical are strongly motivated to solve the toughest problems that the world faces, being able to provide an opportunity for them to both gain access to some of the nation’s best scientists and infrastructure at LANL not only sets them up for success for their doctoral work but provides them with unique career opportunities and professional development as well,” said Associate Dean of Graduate Studies Franklin Dollar.

The 2023-2024 UCI-LANL-SoCal Hub graduate fellows from the School of Physical Sciences are:

Brandon Momanyi, Department of Physics & Astronomy

Elisa Olivas, Department of Chemistry

Juan Tolento, Department of Earth System Science

The inaugural 2022-2023 cohort of fellows included:

Marshall Campbell, Department of Physics & Astronomy

Austin Green, Department of Chemistry

Each fellow’s story and their research with LANL highlight the opportunities fostered by the program. Below are some exemplary instances of pioneering research endeavors that have resulted from the strong partnership between UC Irvine and Los Alamos National Laboratory.

From left: Brandon Momanyi, Juan Tolento, Marshall Campbell, Austin Green and Elisa Olivas

Pioneering Climate Research

UCI Department of Earth System Science Ph.D. student **Juan Tolento** exemplifies the program's impact. This past winter, Tolento worked with LANL sea ice modeling experts Andrew Roberts and Erin Thomas to refine computer models that simulate Earth's climate. "Making a small change in the atmospheric component could easily cause errors in other areas of the model," Tolento explained. His work aims to improve the representation of how snow reflects sunlight, a critical factor in climate projections.

"Juan's time at LANL helped us create a valuable collaboration with him that we will continue to nurture for the remainder of his Ph.D. candidature," said Roberts. "It is also important that we learn from students like Juan who bring fresh ideas to this field of research."

Innovations in Chemistry

Elisa Olivas, a Ph.D. student in UC Irvine's Department of Chemistry, is another fellow making strides in her research with LANL. Under the mentorship of John Watt at LANL, Olivas is exploring how enzymes function within metal-organic frameworks (MOFs). Using state-of-the-art electron microscopy, she aims to understand enzyme behavior to improve industrial processes, like those in food and drug processing. The support she has received from LANL scientists is one reason she's returning in the summer to continue her research. "They always take the time to help you out with something," said Olivas. "They're very nice people."

Advancing Quantum Computing

Marshall Campbell, a Ph.D. student in the Department of Physics & Astronomy, is using his time at LANL to advance his research on controlling the properties of quantum materials. His research at LANL involves optical measurements at cryogenic temperatures to measure the changes in the material's crystal structure and electronic properties. His work is being compiled into a first-author paper that will feature several co-authors from LANL.

"Next, I plan to explore dynamic strain in my study materials using surface acoustic waves – another method to possibly control the electronic properties of quantum materials," he explained. Campbell will continue his work over the next two years as a UC-National Lab In-Residence Fellow.

Looking Ahead

The UCI-LANL partnership is providing world-class research opportunities for UC Irvine graduate students and is one of many ways that the School of Physical Sciences is fostering long-term collaborations to drive basic research and innovations important to national security. The School of Physical Sciences has plans to expand the fellowship program and deepen collaborative ties in future years.

New **Faculty**

Laszlo Bardoczi, Ph.D.
Assistant Professor
Department of Physics & Astronomy
Before joining UC Irvine, Professor Bardoczi was a research scientist at General Atomics in the Department of Magnetic Fusion Experiment. He completed his Ph.D. at the University of California, Los Angeles in the Department of Physics and Astronomy. Professor Bardoczi leads the Magnetic Diagnostician group in the DIII-D National Fusion program. His UCI research team studies magnetohydrodynamic instabilities limiting the performance of experimental nuclear fusion plasmas.

Research areas: Magnetohydrodynamic instabilities, microturbulence, transport and energetic particle confinement in high-performance fusion plasma experiments.

Henri F. Drake, Ph.D.
Assistant Professor
Department of Earth System Science
Professor Drake received his Ph.D. in Physical Oceanography from the MIT/WHOI Joint Program in Oceanography in 2021. Before joining UCI, he was a NOAA Climate and Global Change Postdoctoral Fellow at Princeton University and NOAA's Geophysical Fluid Dynamics Laboratory. His group applies methods from math and physics to advance understanding of oceanic flows and their role in climate dynamics. He is committed to making science more open, collaborative, and reproducible; improving diversity and inclusion in science; and producing basic and applied science that benefits the public good.

Research areas: The dynamics and kinematics of multiscale ocean turbulence; theoretical models of the large-scale ocean circulation, the ocean's role in climate change, and the development of Earth System computer models.

Matthew Griffin, Ph.D.
Assistant Professor
Department of Chemistry
Professor Griffin originally hails from the heart of Cajun Country in Louisiana and obtained his B.S. in Biological Chemistry, B.A. in French, and B.F.A. in Music Performance from Tulane University. He earned his Ph.D. in Chemistry at the California Institute of Technology as an NSF Graduate Research Fellow in the laboratory of Linda Hsieh-Wilson. He then trained in the laboratory of Howard Hang at Rockefeller University and Scripps Research as a Hope Funds for Cancer Research and Melanoma Research Foundation Postdoctoral Fellow before joining UC Irvine in July 2022. At UCI, the Griffin lab aims to decipher the molecular language of host-microbiota interactions and focuses on carbohydrates as key signaling molecules between microbes and the immune system.

Research areas: Developing chemical tools to understand carbohydrate signaling from our microbiota, identifying molecular mechanisms for probiotic and postbiotic activity on host immunity, controlling microbiota activity to alter cancer progression and immunotherapy treatment.

Shirley Li, Ph.D.
Assistant Professor
Department of Physics & Astronomy
Professor Li obtained her Ph.D. from the Ohio State University in 2017. She was then a postdoctoral researcher at SLAC National Lab between 2017-2020 and at Fermilab between 2020-2022. She joined the UCI Physics Department in the summer of 2022. Professor Li's research goal is to understand how elementary particles behave, what their masses are, how they interact, etc.

Research areas: Neutrinos, one of the least understood elementary particles. Exploring what can be learned about neutrinos and physics beyond the Standard Model from current and future experiments.

Anna Ma, Ph.D.
Assistant Professor
Department of Mathematics
Prior to joining UC Irvine, Ma was a UC Chancellor's Postdoctoral Fellow in the Department of Mathematics at UC San Diego. She received her PhD in Computational Science from Claremont Graduate University and the Computational Science Research Center at San Diego State University, where she worked on algorithmic approaches and guarantees of stochastic iterative methods for solving large-scale linear systems. Ma's research interests are in the relationship between problems arising in data science and their mathematical underpinnings, specifically when problems involve large-scale matrix and tensor data.

Research areas: Mathematics of data science, numerical linear algebra, visualization, large-scale data.

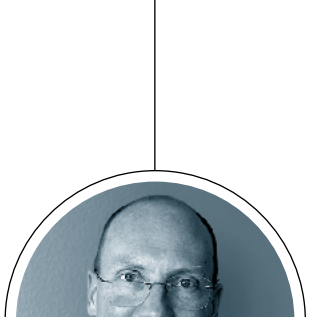
Angela Rigden. Ph.D.
Assistant Professor
Department of Earth System Science
Before joining UC Irvine, Rigden was a postdoctoral researcher at Harvard University in the Department of Earth and Planetary Sciences with a fellowship from the Planetary Health Alliance. She completed her Ph.D. at Boston University in the Department of Earth and Environment with a certificate in Biogeoscience. Professor Rigden leads the Rigden Group which uses multi-scale data and models to understand how changes to our water cycle affect ecosystems and society.

Research areas: Interactions between the biosphere and atmosphere using multi-scale data and models, understanding the implications of a changing water cycle on agriculture across the globe.

Thomas Scaffidi, Ph.D.
Assistant Professor
Department of Physics & Astronomy

Thomas Scaffidi is a theoretical physicist working in condensed matter. After receiving his bachelor's in engineering sciences from UCLouvain in his native Belgium, he was awarded a scholarship to move to Paris to do his Masters in theoretical physics at the Ecole Normale Superieure. He then obtained his PhD from the University of Oxford, where he was funded as a Clarendon Scholar and a Prize Scholar. He also visited the Kavli Institute for Theoretical Physics as a Graduate Fellow during his PhD. His doctoral thesis on superconductivity was published in the Springer Thesis Award series. After his PhD, Prof. Scaffidi moved to UC Berkeley as a Moore Foundation Postdoctoral Fellow. After three years in Berkeley, he was an Assistant Professor at the University of Toronto for three years before moving to the Department of Physics and Astronomy at UC Irvine in 2022. At UCI, Thomas Scaffidi leads a research group devoted to the study of emergent properties of quantum matter. Prof. Scaffidi also held Visiting Professor positions at the AWS Centre for Quantum Computing from 2020 to 2021, and at IST Austria in 2024.

Research areas: Electron hydrodynamics, the dynamics of quantum information, unconventional superconductivity, and the interplay between topology and quantum criticality.



Matthew Sheldon, Ph.D.
Associate Professor
Department of Chemistry

Before joining UC Irvine, Sheldon started his independent career as an assistant professor in the Department of Chemistry at Texas A&M University. Before that, he was a postdoctoral fellow at Caltech in the Department of Applied Physics and Materials Science. He completed his Ph.D. in Physical Chemistry at the University of California, Berkeley. Professor Sheldon's research laboratory at UC Irvine studies how nanoscale optical phenomena can be applied to challenges in energy science.

Research areas: Nanofabricated materials, optical energy conversion, nanophotonics, plasmonic and inorganic nanoscale materials, and light-powered heat engines.

FACULTY ACHIEVEMENTS

Named/Elected Fellows

Steven Allison
Professor of Ecology and Evolutionary Biology
Professor (Joint Appt) of Earth System Science
Professor, Center of Environmental Biology
Fellow of the American Academy of Microbiology
Fellow of the Ecological Society of America

James Bullock
Dean, UCI School of Physical Sciences
Professor of Physics & Astronomy
Fellow of the American Physical Society

Filipp Furche
Professor of Chemistry
Fellow of the American Association for the Advancement of Science

Howard Lee
Associate Professor of Physics & Astronomy
Fellow of the International Society for Optics and Photonics (SPIE)

Qing Nie
UCI Distinguished Professor of Mathematics
UCI Distinguished Professor of Developmental & Cell Biology
American Mathematical Society (AMS) Fellow
2024-2025 UC Presidential Chair (five-year period)

Michael Prather
Associate Professor of Earth System Science
Fellow of the American Meteorological Society (AMS)

James Smith
Professor of Chemistry
Fellow of the American Association for Aerosol Research (AAAR)

Timothy Tait
Professor of Physics & Astronomy
Fellow of the American Association for the Advancement of Science

Isabella Velicogna
Professor of Earth System Science
Fellow of the American Meteorological Society (AMS)

Huolin Xin
Chancellor's Fellow and Professor of Physics & Astronomy
Fellow of the Microscopy Society of America

Jenny Yang
Chancellor's Fellow and Professor of Chemistry
Fellow of the American Association for the Advancement of Science

Awards

Henri Drake
Assistant Professor of Earth System Science
NASA Earth Career Investigator Award

Hamid Hezari
Associate Professor of Mathematics
Frontiers in Science Award in Mathematics from China's International Congress of Basic Sciences

Matthew Griffin
Assistant Professor of Chemistry
Beckman Young Investigator Award

Howard Lee
Associate Professor of Physics & Astronomy
NSF Partnerships for Innovation award

Eric Rignot
Professor of Earth System Science
2023/2024 Research.com Earth Science in United States Leader Award

Javier Sanchez-Yamagishi
Assistant Professor of Physics & Astronomy
2024-2025 Hellman Fellow

Virginia Trimble
Professor of Physics & Astronomy
2024 Pais Prize from the American Physical Society

Jenny Yang
Chancellor's Fellow and Professor of Chemistry
Beall Innovation Award in the Physical Sciences

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Creating Quantum Culture at UC Irvine

The **Eddleman Quantum Institute** is fostering the next generation of quantum scientists

Photo: Steve Zylius/UC Irvine

Professor William Evans of the UC Irvine Department of Chemistry was on a bus at the 2017 Rare Earth Research Conference in Ames, Iowa when he bumped into a journalist named Stephen Ritter, contributor to *Chemical & Engineering News*. The encounter led Ritter to write a story featuring quotes from Evans, and, after the story was published, an entrepreneur named Roy Eddleman happened to read it. The story inspired Eddleman to travel to the UC Irvine campus to meet with Evans.

At the end of their meeting, Eddleman told Evans he wanted to support his work. It was the start of what would become the Eddleman Quantum Institute (EQI) at UC Irvine, the Eddleman Center for Quantum Information at UC Santa Barbara and the Roy T. Eddleman Quantum Information Fund at Caltech – all institutions dedicated to pushing the boundaries of quantum science, a field that deals with how the most fundamental building blocks of the natural world, like atoms and the particles that comprise them, behave.

The list of scientific breakthroughs coming out of EQI is ever-growing. From creating a material that can take the temperature of nanoscale objects to discovering a new method that transforms everyday materials into conductors for quantum computers. But to achieve such advances, you first need a research environment that fosters the education and training of the next generation of quantum scientists. Creating a culture where that can happen is, according to Evans, who is now the director of EQI, one of the main aims of the institution.

"EQI has expanded the quantum science curriculum at UCI," said Evans. "We're addressing the need for a pipeline for quantum jobs." And that all begins with its students. Each year since 2020, EQI has awarded fellowships to graduate students to support their research. This year, there were 11 EQI graduate student fellows. One of those fellows is Steven Crisostomo, a Ph.D. candidate in the lab of Professor Kieron Burke in the UC Irvine Department of Physics & Astronomy. According to Crisostomo, his research benefits greatly from his interactions with other students. "Sometimes we can get lost in our subfields," said Crisostomo. "But when you meet people that have skills adjacent to yours, you learn a ton and it makes your world bigger. It's also a welcomed surprise to find the overlap."

A recognition of the unexpected insights that can come from informal chats led to the creation of a discussion group called "Condensed Chatter." The name is a play on the term "condensed matter," a subfield in quantum science. Condensed chatter is a student-led and students-only weekly seminar where graduate and under- graduate students meet to talk about and swap ideas about quantum research. "I think that's the key to doing interdisciplinary research," Crisostomo said. "For me, and a lot of my friends in the physics department, we get along well and enjoy chatting, and I think that's the ideal case: When you enjoy supporting your friends and peers, then it naturally invites those deeper conversations. It makes research, which is already fun work, into something more rewarding."

It's an energy that works its way back into Crisostomo's research, which deals with developing methods for modeling the properties of solids and molecules. Being able to bounce ideas off others, Crisostomo explained, helps him come up with approaches to his research that he may not have considered otherwise. "It feels a lot like creative writing," said Crisostomo. "You come up with an idea, or you have an inkling about what might work, and you mess around with it on paper, until you hit a point where you need a computer." Crisostomo isn't the only fellow to benefit from EQI's burgeoning research culture.

Ian Sequeira, a soon-to-graduate Ph.D. student in the lab of Professor Javier Sanchez-Yamagishi who studies atomically thin layers of materials, is a part of the EQI graduate student council. "Being on the EQI council has exposed me to a diverse background in quantum science including topics in physics, chemistry, and math. I've interacted with students from various universities, including Caltech, UCSB, Stanford, UCI, UCLA, UC Beckley, and professionals from national labs like the Air Force research lab and Los Alamos national lab," said Sequeria. "Being a part of EQI has helped stimulate my research by exposing me to diverse backgrounds of researchers, which has forced me to think more broadly about my work in the context of advancing quantum science." It's an experience that's helping Sequeira design a device that lets him manipulate the single layers of atoms he studies.

Back in Condensed Chatter, the group's welcoming attitude was one reason that Kaustubh Simha, a third-year undergraduate majoring in physics, decided he wanted to study quantum science in the lab of Professor Luis Jauregui. "I got involved in Condensed Chatter on week four of freshman year," said Simha. "I was a wide-eyed freshman asking all kinds of questions." When he started, Simha wasn't set on studying one subject. However, the welcoming and engaging culture at EQI made him want to go down a quantum science path. "I love my work, I love challenging things, and I love meeting all the cool people at EQI," said Simha, who's busy helping Jauregui fabricate new kinds of quantum materials in his lab, and who recently received an EQI-funded grant that's helping him continue his research over the summer at Harvard University.

At left: A "bending station," a device crafted in the laboratory of Luis Jauregui, UCI professor of physics and astronomy, can change the electrical characteristics of materials at the atomic scale.

A New Era for the UC Irvine Nuclear Reactor Facility

The UC Irvine Nuclear Reactor Facility (UCI NRF) opened in 1969 under the leadership of Nobel laureate and founding chair of the UCI Department of Chemistry Professor Frank Sherwood "Sherry" Rowland.

Professor George Miller operates the reactor's console, UC Irvine Nuclear Reactor Facility, 1969

Reactor Facility Manager John Keffer at the reactor's console, UC Irvine Nuclear Reactor Facility, 2024

Professor George Miller and Pat Grant check the reactor's console, UC Irvine Nuclear Reactor Facility, 1969

Assistant Professor Sarah Finkeldei and Facility Manager John Keffer check the reactor's console, UC Irvine Nuclear Reactor Facility, 2024

The reactor once helped analyze the bullets that killed President John F. Kennedy, and today Assistant Professor Sarah Finkeldei of the UC Irvine Department of Chemistry, alongside Reactor Facility Manager John Keffer, is ushering in a new era for the facility.

UCI NRF recently collaborated with nuclear energy company Serva Energy, which last year succeeded in creating an isotope at UCI NRF — Actinium 225 — that carries immense promise as a treatment for certain types of cancer, including late-stage cancers. It is a collaboration Finkeldei hopes will open the door for similar projects in the future.

UCI NRF is also helping support the training of the next generation of nuclear scientists through Department of Energy funding for undergraduate involvement in facility activities.

Undergraduates involved at UCI NRF include Cristian Bautista Triana, Jacqueline Ferrer, Lauren O'Brian and Jack Shire of the Departments of Chemistry, Chemical and Biomolecular Engineering, and Physics & Astronomy, respectively.

"Having undergraduate students there to help with the project allows for the training of the next generation of nuclear scientists right here at UCI," said Finkeldei. Undergraduates "get industry contacts, and they work hands-on at the reactor. There aren't many places in the U.S. or the world, where you can do that."

Finkeldei sees UCI NRF student involvement as a key part of what the facility will be able to achieve in the years to come. "It is essential to continue expanding our nuclear capabilities at UC Irvine to enable new research directions, including the recent medical isotope developments," Finkeldei said.

For their work at UCI NRF, undergraduate student Jack Shire won a $10,000 scholarship from the Department of Energy's Office of Nuclear Energy as part of the University Nuclear Leadership Program (UNLP). Funding for the scholarship came from a DOE grant awarded to Finkeldei, enabling UCI students to apply for scholarships and fellowships over the next 10 years. ●

Photos: University of California, Irvine Special Collections and Archives / Lucas Van Wyk Joel/UC Irvine

The Enduring Legacy of Chemistry Alumnus Michael E. Gebel

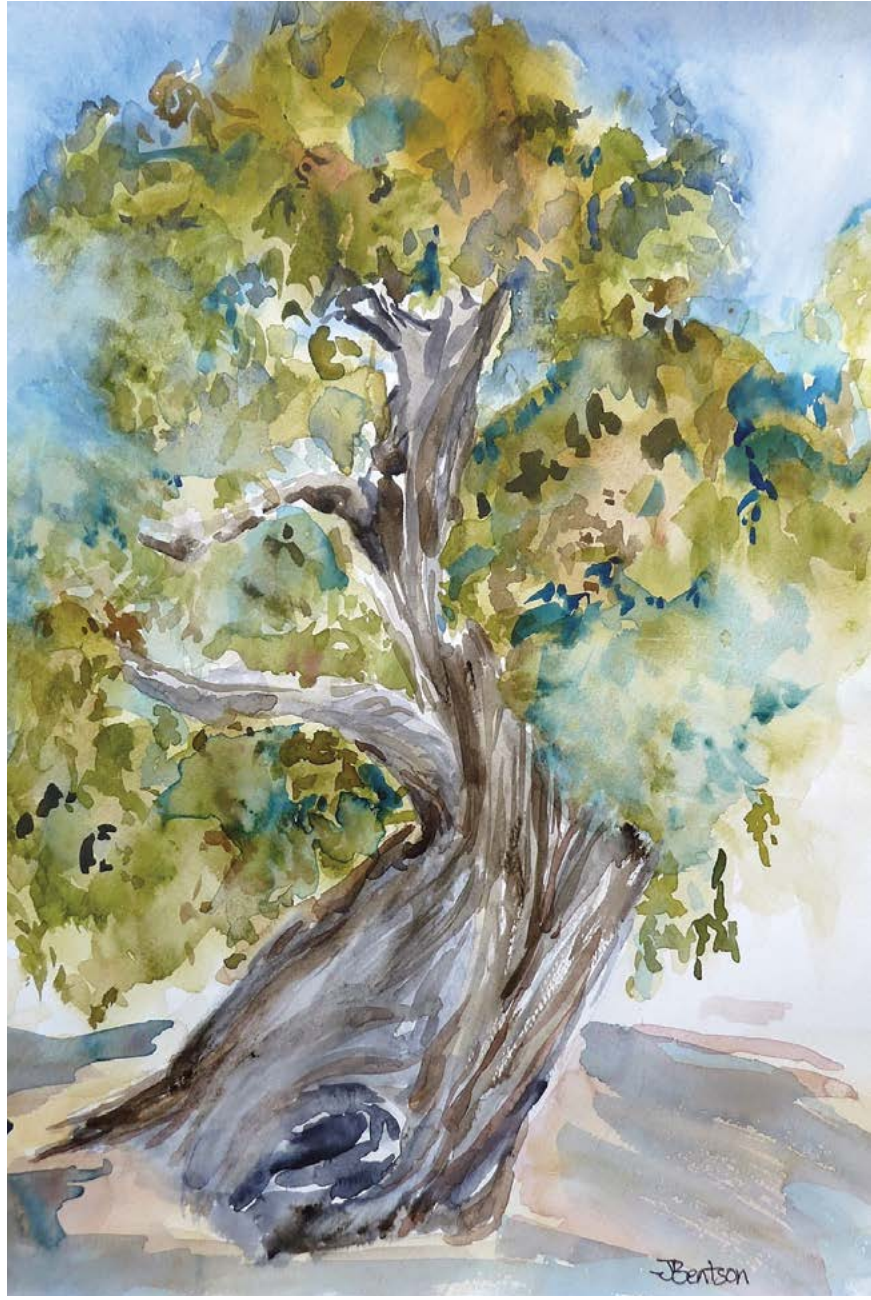
Jennifer Bentson-Gebel is the creative force behind the Michael E. Gebel Award in the UC Irvine Department of Chemistry, which supports grad students who take atypical routes to graduate school.

When Jennifer Bentson-Gebel was an undergraduate at the University of Arizona, she wanted to take pictures. “I got into hiking the mountains all around Tucson, and wanted to take photos of everything I saw,” Bentson-Gebel said.

But at the time cameras were too expensive, so instead Bentson-Gebel bought a small watercolor paint box that she carried with her on her hikes. She painted the mountains, and she still paints to this day; if you visit her website, you’ll discover watercolor paintings of oak trees from all over California.

If Bentson-Gebel painted a mural depicting her life story, you would notice many different species of oak, and underneath one of the oaks, you may spot the beaming figure of a man. The man is Michael Gebel, Bentson-Gebel’s late husband.

You may then see what looks like a costume parade – it’s the Halloween party where Bentson-Gebel met Gebel. Elsewhere on the canvas, you might spot Gebel at work in the lab of Professor Barbara Finlayson-Pitts, which is where he earned his Ph.D. in 2005 studying atmospheric pollutants in the lab of Finlayson-Pitts before moving on to become the manager of the Organic Analysis Section at the California Air Resources Board (CARB). Earning his doctorate was a crowning accomplishment in part because Gebel struggled significantly as a student due to a congenital seizure disorder.



Art by: Jennifer Bentson-Gebel

Then there’s the part of the painting where Michael and Jennifer are getting married – but only a few months later, Bentson-Gebel was diagnosed with terminal breast cancer. “I had a mastectomy, chemotherapy and stem cell treatments,” she said, adding that her doctor at the time told her she did not have much longer to live, that she had only a two percent chance of surviving.

Wanting him to continue working for the life he wanted, Bentson-Gebel encouraged her husband to apply to graduate programs in chemistry after several years working as an air conditioning and heating technician.

Gebel got into and decided to come to UC Irvine because, Bentson-Gebel recalled, Finlayson-Pitts' lab felt like a good fit for him.

As a graduate student, Gebel helped develop methods still in use today that help atmospheric chemists understand the role sea salt aerosols play in creating air pollution when they react with trace gases like methane and carbon dioxide.

Gebel worked late nights throughout his Ph.D., but he still found time for fun.

Sometimes, Gebel would sneak out of his lab at Rowland Hall and head to a friend's place over in Middle Earth housing so he could play the card game Magic: The Gathering. Before he'd go he'd tell his lab mates not to tell his advisor where he was. "Say I'm at the library," he'd tell them.

"He was just a fun guy," Bentson-Gebel said with a chuckle.

Then, on a sunny day in 2006, Gebel went sailing in Orange County with some friends, and Bentson-Gebel met the group later for dinner. Afterward, the pair drove home, and Bentson-Gebel parked the car and went inside. Gebel didn't immediately follow her inside, and after some time passed Bentson-Gebel went back to the car and found her husband unresponsive on the ground. He had had a seizure, and he had hit his head on the pavement.

Paramedics rushed Gebel to the hospital, but he was unresponsive. A day later, Bentson-Gebel made the heart-wrenching decision to end life support.

In the wake of the tragedy, Bentson-Gebel created the Michael E. Gebel Award in the UC Irvine Department of Chemistry. "Barbara helped me set up the fund," she said.

The award is not a typical scholarship – its purpose is to support a student who has overcome some kind of hardship, or who took an unconventional, non-linear path to becoming a graduate student, just as Gebel did.

Michael and Jennifer in front of Michael's poster at a research symposium.

"I didn't want to give this scholarship to straight-A students," said Bentson-Gebel. "I said: Let's set up this scholarship for people who are not fast-tracked."

One recent award recipient, Jessica Granger-Jones, is a Ph.D. student in the lab of Professor Sarah Finkeldei in the UC Irvine Department of Chemistry.

Granger-Jones, after graduating from UC Berkeley with a degree in nuclear chemistry, knew she needed to take time away from school before deciding what she wanted to do next.

That's when she joined the Peace Corps and lived in Mozambique for almost three years helping with foster kids' science education.

Years after graduating, Granger-Jones decided to return to graduate school to study nuclear chemistry – a return that took some getting used to.

"I think it's harder to come back," said Bentson-Gebel. "And that's the spirit behind Michael's award."

Granger-Jones came back, just as Gebel did, and just as Bentson-Gebel did.

Recently, Bentson-Gebel visited the now-retired doctor who, decades ago, told her upon her cancer diagnosis that she had only a two percent chance of living.

"I think it's time you see someone who lived," she told the doctor.

If you're ever on campus and want to brush up against the spirits of two anteaters who lived, you can visit the Michael E. and Jennifer B. Gebel library in Rowland Hall. The library serves the research unit – Atmospheric Integrated Research (AirUCI) – where Gebel did his work.

Bentson-Gebel hopes that memorializing her husband through the award and the library will remind others that, despite life's inevitable challenges, there's always a way to aim for your goals while you still have the time.

"You realize today is tomorrow," Bentson-Gebel said.

"I didn't want to give this scholarship to straight-A students. Let's set up this scholarship for people who are not fast-tracked."

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Image credit: NASA
The famous image of the blue planet from the Apollo 8 mission changed the perspective of everyone on Earth. It inspired us to see our planet in a new light and work towards a brighter future for all.

UCI Eddleman Quantum Institute

Matching Gift Funds

Roy T. Eddleman was a pioneer and philanthropist who had a lifelong passion for helping others. Roy dedicated his life to discovery and believed that "quantum science holds significant promises for humanity."

The UC Irvine School of Physical Sciences is proud to present Eddleman Quantum Institute Matching Gift Funds, a matching gift opportunity to establish:

Qualifying gifts of $50,000 to $99,999
Named endowment in support of general quantum science and will support all areas of the UCI Eddleman Quantum Institute.

Example: [Your Name] Endowed Fund in Quantum Science

Qualifying gifts of $100,000 to $1,000,000
Named endowments in quantum science with customized preferences. Customized preferences include graduate student fellowships, postdoctoral fellowships, faculty research, endowed chairs, or physical space/equipment.

Example: [Your Name] Endowed Fund for Graduate Student Fellowships in Quantum Chemistry

Pledges are payable over a maximum of five years. The UCI Eddleman Quantum Institute will match endowment distributions for qualifying gifts for five years, after the endowment has accrued earnings for one year, at a 1:1 match. Only cash gifts and pledges will be matched. (Deferred planned gifts are not eligible for the match). Eddleman Quantum Institute Matching Gift Funds are limited and available on a first-come, first-served basis. Matching funds will not be included in donor recognition gift amounts.

To learn more about the Eddleman Quantum Institute and its Matching Gift Funds, contact Sharon Chang, Executive Director of Development, at sharon.chang@uci.edu or 657-640-7031.

UCI Eddleman Quantum Institute

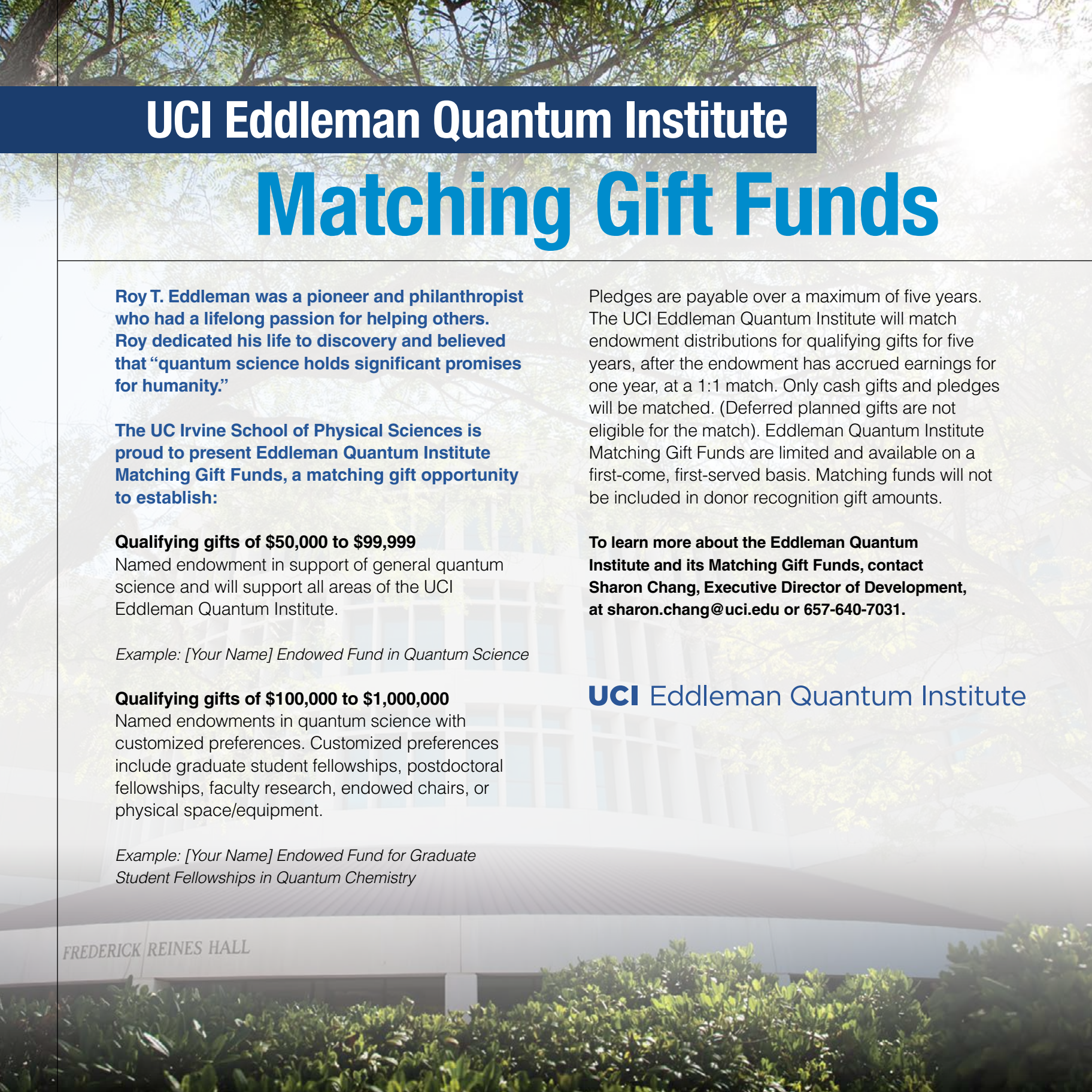

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Photo: UC Irvine