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ELEMENTS OF SCIENCE

INTO THE QUANTUM REALM:

Harnessing the power of uncertainty

THE UNIVERSITY OF MASSACHUSETTS LOWELL

UMASS LOWELL

Dear Alumni, Colleagues and Friends:

Welcome to a new issue of Elements of Science, the magazine of the Kennedy College of Sciences. I hope that you will appreciate the amazing and impactful research and activities of our students, faculty and alumni. In these pages, you will find an update on our faculty's work to advance quantum computing and a look at an innovative program that supports students from underrepresented groups on their path to earning advanced degrees in health care disciplines, among other stories.

I am happy to report that we are fully back on campus, and we could not be more excited to see each member of our community in person.

One of the lessons that COVID-19 has taught us is the importance of science in our everyday lives. In the Kennedy College of Sciences, we strive to inspire students and encourage them to address major global problems, such as diseases and climate change. We also encourage them to follow their curiosity and interests, whether it's understanding the signals from faraway stars or grasping the underlying logic behind artificial intelligence. None of this would be possible without your continued support.

Should you have any suggestions or comments, please do not hesitate to contact me at sciences@uml.edu. I am always happy to hear from you.

I send my best wishes to you and your families for good health and continued success.

Sincerely,

NOUREDDINE MELIKECHI, D.PHIL.
Fellow, American Association for the Advancement of Science
Fellow, Optical Society of America
Fellow, American Physical Society
Professor of Physics and Dean, Kennedy College of Sciences
University of Massachusetts Lowell

In this issue

ELEMENTS OF SCIENCE

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Animation Demonstrates Power of Tonga Volcanic Eruption

The Jan. 15 volcanic eruption on Hunga Tonga-Hunga Ha'apai in the South Pacific released a force of energy equivalent to about 10 million tons of TNT and generated an atmospheric shockwave that traveled across the globe at more than 650 miles per hour.

People across the world got a view of how the shockwave unfolded—like a ripple spreading on the surface on a pond—thanks to Prof. Mathew Barlow of the Department of Environmental, Earth and Atmospheric Sciences, who created an animation with infrared data from the National Oceanic and Atmospheric Administration's GOES-West satellite.

"I was surprised that the wave showed up that clearly in the satellite images," Barlow says.

GOES-West normally takes high-resolution images of Earth from visible light to near-infrared, but Barlow was able to use the data to detect differences in atmospheric pressure.

His work quickly gained notice. The news agency Reuters used the animation in a story, which was picked up by news outlets worldwide.

STUDENT-BUILT SATELLITE NOW ORBITING THE EARTH

A student-built satellite was successfully deployed into space and is now orbiting the Earth every 90 minutes.

The 12-inch-long, 9-pound satellite, a first for UML, was released into orbit from the International Space Station in October. It is based on the cube satellite model that is used worldwide for low-Earth orbit space research.

SPACE HAUC (pronounced "Space Hawk")—which stands for Science Program Around Communications Engineering with High-Achieving Undergraduate Cadres—was designed, built and tested by more than 100 students from the Kennedy College of Sciences and the Francis College of Engineering.

While it's in orbit, students are maintaining a communication link between the satellite and two ground stations—one on campus and the other at the MIT Haystack Observatory in Westford, Massachusetts.

Researchers Cast a Net on Net-casting Spiders

Researchers from UMass Lowell, Cornell University and the American Museum of Natural History have won a $1.4 million grant from the National Science Foundation to study some of the unique characteristics of net-casting spiders, a family of arachnids known for their super-stretchy webs and their large, prominent eyes, which can function in near-total darkness.

The researchers are seeking to gain insight about the spiders' specialized sensory system and their ingenious use of webs to capture prey. The study aims to understand the genomic basis of evolutionary adaptations of the spiders.

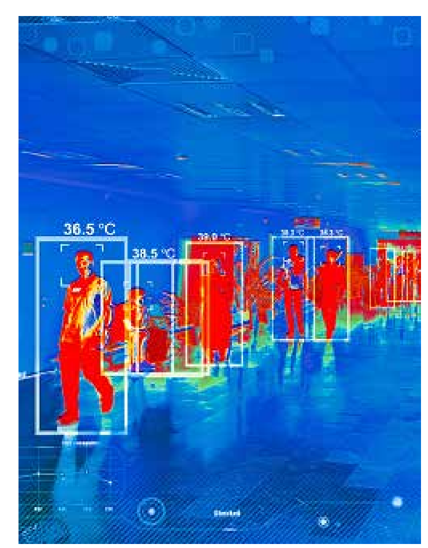
Biology Assoc. Prof. Jessica Garb is the principal investigator on the project for UML. Biology alum Sandra Correa-Garhwal '10, '12 is the principal investigator for the American Museum of Natural History.

Computer Scientist Hailed for Introducing AI Concepts to K-12 Students

Computer Science Prof. Fred Martin, associate dean for teaching, learning and undergraduate studies in the Kennedy College of Sciences (above, second from left), received a 2022 Outstanding Educator Award for his work with the Artificial Intelligence for K-12 initiative (AI4K12.org).

Martin was recognized for his work developing the educational framework that introduces the study of robotics and artificial intelligence to K-12 students.

The award is presented annually by the Association for the Advancement of Artificial Intelligence and the Educational Advances in Artificial Intelligence Conference to individuals or teams who have made major contributions to AI education.



Physics Professor Pioneers New Class of Semiconductors

Physics Prof. Viktor Podolskiy is leading a project to create a new class of faster, more powerful semiconductors for enhanced wireless communication and digital imaging.

Podolskiy heads a research team that is working to improve semiconductors used in infrared optoelectronic devices to boost their performance. The project is a launching pad for new products with enhanced capabilities in intracellular imaging, night vision and quantum and 5G communication that could also better serve the Internet of Things.

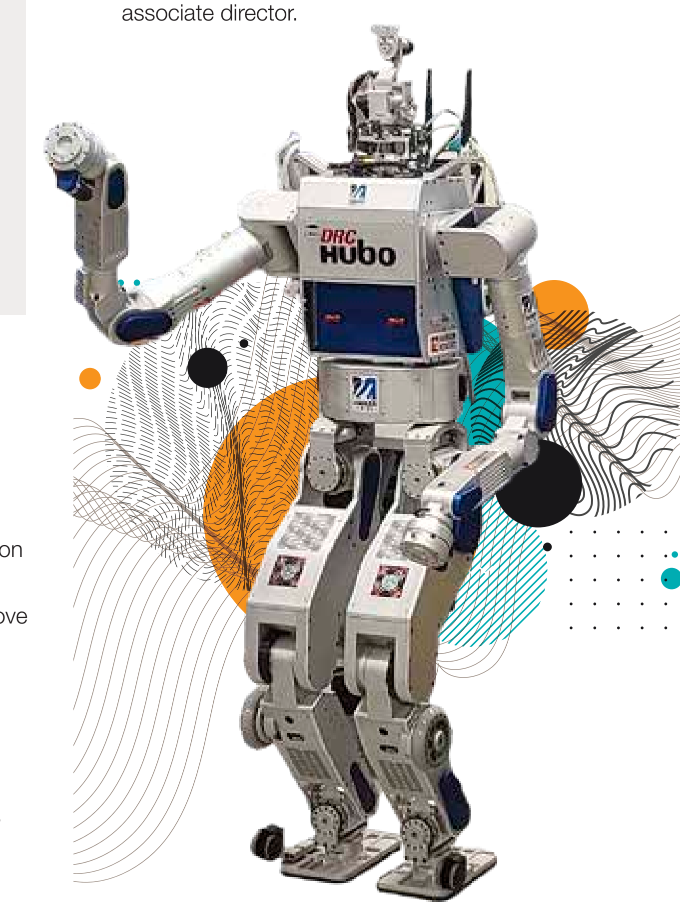
A $1.7 million grant from the National Science Foundation's Designing Materials to Revolutionize and Engineer Our Future program is funding the four-year project.

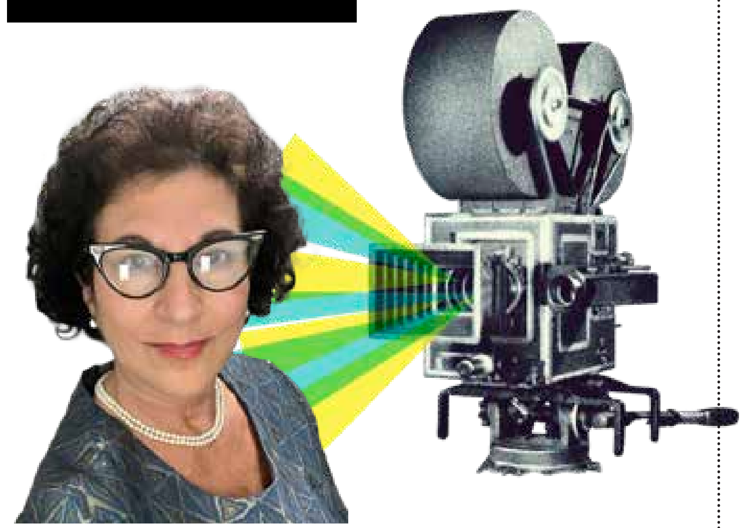
THERE'S A NEW (ROBOTIC) KID IN TOWN

Say hello to DRC-Hubo, the lastest addition to the family of robots at the New England Robotics Validation and Experimentation (NERVE) Center at UMass Lowell.

Made by Rainbow Robotics, DRC-Hubo will be used to investigate the use of legged robots in performing tasks such as firefighting and maintenance aboard ships. The research is funded by a $1.8 million grant from the Office of Naval Research. UML's collaborators on the project include Brown University, the Naval Research Lab and the Naval Undersea Warfare Center.

The UML research team includes Prof. Holly Yanco and Asst. Prof. Reza Ahmadzadeh, both of the Department of Computer Science; Asst. Prof. Paul Robinette of the Department of Electrical and Computer Engineering; Asst. Prof. Yan Gu of the Department of Mechanical Engineering and Adam Norton, NERVE Center associate director.



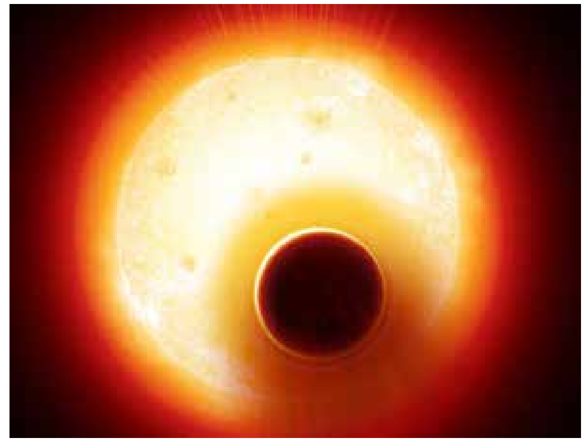


Lights! Camera! Action! Alum Launches Acting Career

During the pandemic, Lisa Panagopoulos '84, '88 (above, in vintage clothing for an upcoming production) decided to launch a second career—on the silver screen. Her credits now include a major role in the holiday movie, "Twas the Night," a recurring part in the Discovery reality series "Power of Attorney: Don Worley" and other television roles.

"At this point in my life, I'm very lucky to be able to pursue this passion," says Panagopoulos, who earned a B.S. in computer science and an M.S. in computer engineering at UML.

She worked full time as the university's director of faculty development for online learning for more than a decade before retiring in June 2020 to pursue acting seriously. She continues teaching online computer science classes as an adjunct faculty member.



RESEARCHERS DETECT MAGNETIC FIELD ON FARAWAY PLANET

An international team of researchers has detected, for the first time, evidence of a magnetic field surrounding a planet outside our solar system.

According to UML Physics Asst. Prof. Ofer Cohen, who is a member of the research team, magnetic fields play a crucial role in the evolution and retention of the atmospheres of exoplanets. And, he says, "a planet with a significant atmosphere is more likely to be habitable."

The research team, which included scientists from the Institut d'Astrophysique de Paris, the University of Arizona, NASA, MIT, the Harvard-Smithsonian Center for Astrophysics and other institutions, used ultraviolet observations by the Hubble Space Telescope to study HAT-P-11b, a Neptune-sized exoplanet located 123 light-years from Earth in the constellation Cygnus.

Students Get a Head Start on College Life

Computer science major Maddie Emond signed up for the First to Launch program last summer because she could take a calculus class for free before starting school in September.

But the biggest incentive for Emond? The program's on-campus workshops that would teach her how to navigate college and introduce to other students. After 16 months of mostly remote learning, Emond couldn't wait.

Emond was one of about 30 members of the class of 2025 that got a jump on college through the First to Launch program, which is designed to give first-generation college students a head start on classes.

The pilot program is run by the River Hawk Scholars Academy, a university support program for first-generation college students. It will be held again this summer, from July 5 to Aug. 16.

UBIQUITOUS BUT MYSTERIOUS ROTIFERS SUBJECT OF RESEARCH STUDY

The National Science Foundation has awarded a team of researchers from UMass Lowell, the University of Texas at El Paso and Ripon College in Wisconsin a four-year grant, worth more than $1.5 million, to understand the biology and life cycle evolution of rotifers—microscopic invertebrate animals that are a key link in the aquatic food chain.

Rotifers are found anywhere there is water, from ephemeral basins in the desert to melt-water puddles on glaciers, says Biology Assoc. Prof. Rick Hochberg, the project's principal investigator.

Despite their ubiquity, not much is known about how the life cycle of these creatures has changed over time, says Hochberg.

FAST TRACK TO SUCCESS

Senior environmental science major Izzy Giesing is on a roll. A standout member of the UML women's track and field team, Giesing recently became the second River Hawk to ever qualify for the NCAA Division I indoor championships, held at the University of Alabama at Birmingham.

Competing in the women's 800-meter event, Giesing finished 13th overall to earn Second Team All-American honors. She placed second in the 800 at the America East Championships and also set a new UML record for the event this season.

Giesing's winning ways extend beyond the track. She was a member of the team that won the third annual Rist Institute for Sustainability & Energy Climate Mitigation Challenge. Giesing and teammates Stefanie Sganga and Marileidy Tejeda, who are also environmental science majors, developed a proposal to trim energy use in residence halls.

The students projected their plan would reduce carbon dioxide emissions on campus by 120,000 pounds in 10 weeks.

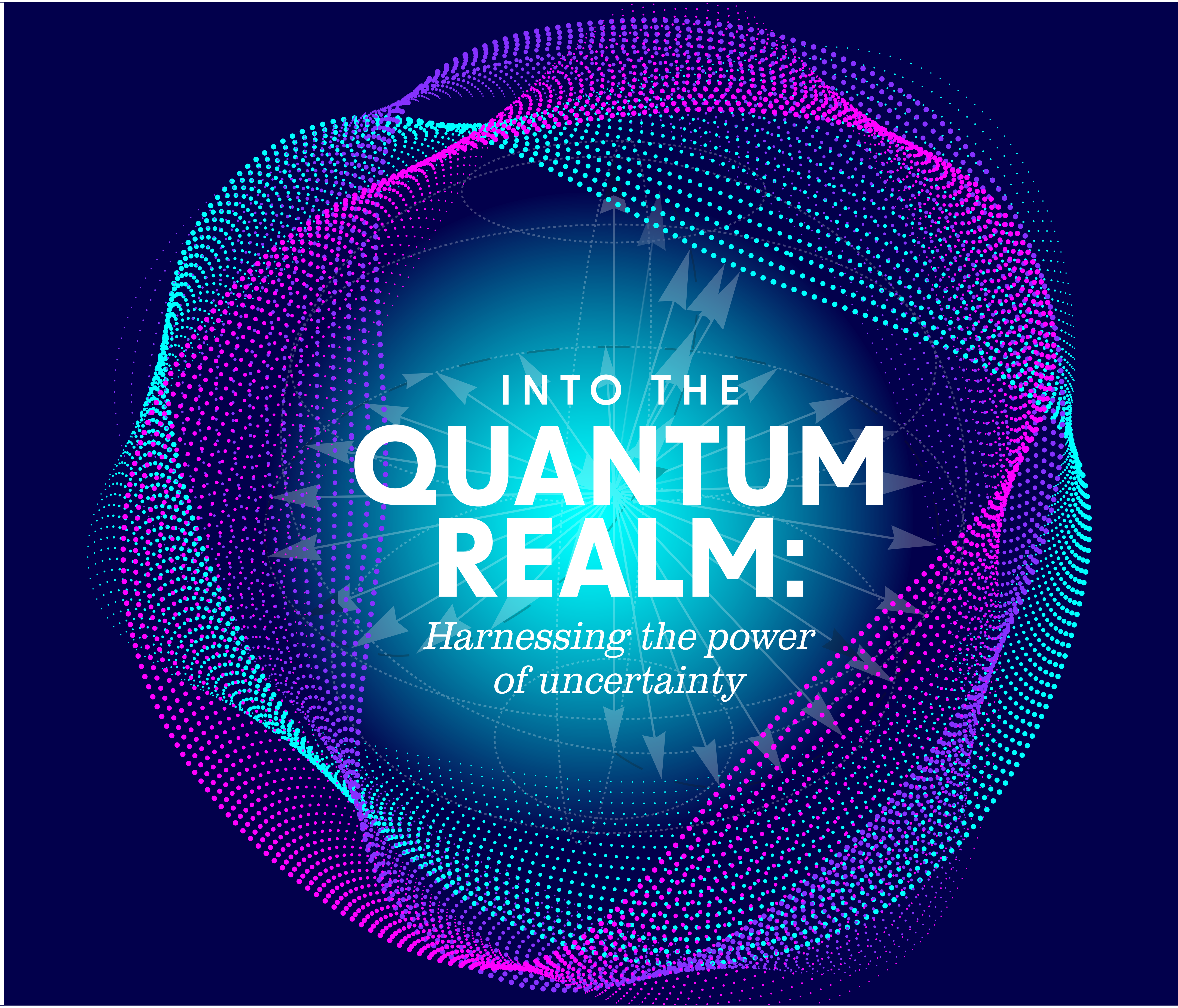
Chemistry Professor Awarded Grant to Recycle Greenhouse Gas

Many people are focused on reducing greenhouse gases. Chemistry Asst. Prof. Michael B. Ross is researching how to recycle them.

Ross was awarded a two-year, $290,000 grant by the Office of Naval Research to recycle carbon dioxide from the atmosphere into valuable fuels and chemicals using renewable energy, such as wind and solar.

"We are developing materials called electrocatalysts that can hold CO_2 near the surface of the catalyst and convert the greenhouse gas into useful fuels and chemicals for making plastics and storing energy as fuel," says Ross, who is the project's principal investigator.

He is also collaborating on another Office of Naval Research-funded project to develop batteries that can store energy both using flow solutions and hydrogen fuel. That project is led by UML Mechanical Engineering Asst. Prof. Ertan Agar.



INTO THE QUANTUM REALM:

Harnessing the power of uncertainty

Physicist Archana Kamal Is Leading UML's Efforts to Advance Quantum Computing

BY MICHAEL BLANDING

There's another world beneath our fingertips. You can't see it—it's far too tiny for that. But beneath the level of cells and molecules, beneath even the level of atoms, the quantum realm obeys a completely different set of laws. Principles we take for granted in the visible realm of classical physics, such as the idea that we can know where an object is at any moment in time, completely break down in quantum physics.

"Quantum information tells us that the way nature processes information is actually very different from the way we think of information processing," says Archana Kamal, assistant professor of physics. "You can't know where something is at a given time with absolute precision, because nature doesn't process information like that. It's not deterministic—it only lets you do just enough to predict something with a very high probability."

The discovery of quantum mechanics nearly a century ago was one of the most disturbing and revolutionary advances in science. "It may be a humbling experience for human beings to know that they are not the masters of the universe who can control everything," Kamal says. "On the other hand, it allows you to have a completely new outlook on the world."

Recently, quantum physicists and computer scientists have begun to harness that outlook, simulating quantum mechanics with classical materials to create quantum computers, which theoretically have power exponentially greater than even the most advanced supercomputer. These quantum processing systems use quantum's uncertainty to its advantage: Instead of laboriously calculating the states of bits and bytes of information at every moment, they can use probability to estimate them, shortcutting vast swaths of calculations and allowing quantum computers to operate at lightning-fast speeds.

The resulting computers could precisely optimize the most complicated transportation system, create new vaccines with machine learning in record time or discover vastly more efficient new materials for creating solar power. Companies including Google, Microsoft, Intel, and IBM—as well as venture-funded startups—are all racing to capitalize on the technology. The White House, meanwhile, held a summit on quantum computing last fall, and the Biden administration is investing $180 million in R&D to develop advanced computing infrastructure.

Quantum computing could not only reshape the future, but it could also help us understand the past: The ability to simulate the quantum realm could help us unlock the nature of how the universe was created, and allow us to create exotic quantum matter beyond basic elements that appear on the Periodic Table. "It's not just about computational power, it is about understanding the most fundamental processes that underlie everything we see—or don't see—around us," says Kamal.

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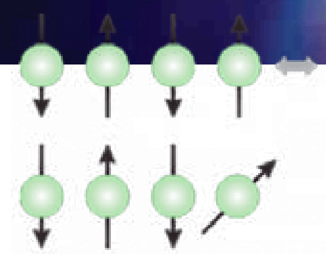

QUANTUM COMPUTING COULD NOT ONLY RESHAPE THE FUTURE, IT COULD ALSO HELP US UNDERSTAND THE PAST.

Of course, nothing comes without a catch, and beyond the hype, nature hasn't been willing to give up its secrets so easily. Despite the incredible progress that has been made with quantum computing over the past decade, scientists have been faced with a fundamental problem: Simulating quantum states with materials traditionally used in computing is inherently unnatural. While researchers have been able to put a handful of quantum bits—or qubits—into quantum states long enough to perform some impressive calculations, they tend to fall out of those states easily, and noise and errors prevent them from reaching anywhere near their full potential.

That's where Kamal comes in. As a theoretical physicist, she has come up with new techniques to harness the power of quantum information. Her unique methods for getting quantum and traditional computers to talk with each other earned her a spot on MIT Technology Review's prestigious list of "35 Innovators Under 35." And her research group QUEST (Quantum Engineering Science and Technology) has scored some impressive government grants—totaling almost $5 million in all—to pursue a new form of error correction that could finally keep qubits in line long enough to work.

Quantum computers don't look anything like the kind of hardware we are used to. In their most common form, they consist of a solid-state chip that at extremely low temperatures (say, below -270 degrees Celsius/-454 degrees Fahrenheit) becomes superconducting and begins to take on quantum characteristics. Among those qualities is the ability to stay in "superposition," the state of uncertainty between a 1 and 0 that gives quantum computing its power.

Additionally, qubits can enter into a state of "entanglement" with another qubit, so it's impossible to describe the state of one without the other. The more qubits that are entangled, the stronger the quantum computer's power. In 2019, Google released a computer with 54 qubits that the company claimed passed the point of "quantum supremacy"—solving a mathematics problem that would be impossible on a classical computer. The current leader in the quantum computing race, IBM, just released a new computer with 127 qubits. At 300 qubits, a quantum computer could theoretically perform more calculations per second than the number of known atoms in the universe.

The looming question is whether these computers will overcome the challenges and live up to the hype. Their tendency to fall out of quantum state, become disentangled and produce errors significantly slows down their speed and efficacy. Another challenge has been how to route and amplify the weak quantum signal to be read by a comparatively big classical computer. In the past, scientists have solved that problem by using powerful magnetic devices that break bilateral symmetry. "But you can't integrate such magnetic devices on the same chip as superconducting qubits being used by companies such as IBM and Google," Kamal says. "In fact, it leads to the introduction of a very complicated magnetic shielding apparatus to protect superconducting qubits from magnetic fields, which all leads to a prohibitively large measurement and control chain for even a few-qubit system. Essentially, such conventional ways of symmetry breaking turn out to be a nonstarter for scalable quantum processors."

All that complicated machinery, says Kamal, creates a lot of noise that interferes with the signal being transmitted—like a loudspeaker creating static. "The system loses its 'quantumness' in the presence of noise, so you cannot do any kind of information processing," says Kamal, who sought to produce a more elegant solution to boost the signal on the chip itself, without the need for such complicated machinery.

Originally from India, Kamal studied theoretical physics at the Indian Institute of Technology in Delhi and earned a master's degree and Ph.D. in physics at Yale. It was there that she encountered quantum information processing, which at the time had a different name. "We used to call it mesophysics, because the systems were large enough that you could control them, but small enough that they were still quantum," she says. The potential of the new field spurred her curiosity: "It defies boundaries by construction and gives you a lot of breakthroughs to explore."

At Yale, Kamal focused on experiments using quantum circuits. As a postdoc at MIT, however, she gravitated to the theoretical, giving her the background to tackle problems from both an abstract and concrete perspective. "I just found myself doing more and more theory, but I maintained very close connections with experimental groups," she says. The combination of perspectives allowed her to conceive of a new way to boost the quantum signal without using bulky magnets—using light instead.

Unlike electricity, light doesn't flow in a particular direction—it travels in both directions at once. "That's a big problem for us, since any loss of information leads to decoherence," says Kamal. The challenge was making sure there is a unidirectional flow, since the goal is for the signal to have a clean one-way route from quantum computer to classical computer. Kamal came up with an elegant solution, setting up an interference phenomenon that is not only direction-dependent but also simultaneously amplifies the number of photons flowing in the chosen direction, making it easier to read quantum information. Essentially, such directional amplification of photons allows a classical user to access information in the quantum realm with minimum corruption or noise. Her proposed solution has quickly become a standard functionality used by leading quantum computing companies and research labs.

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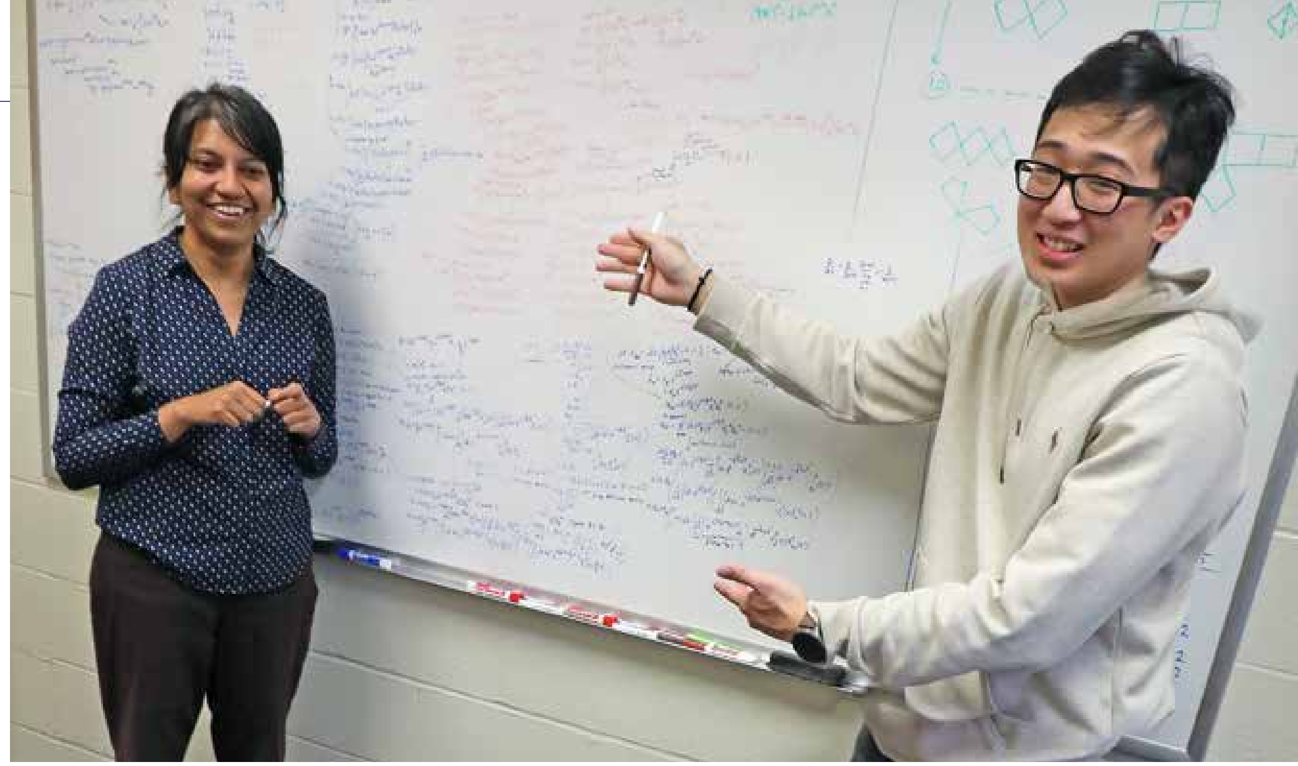
"IT IS NOT JUST ABOUT COMPUTATIONAL POWER, IT IS ABOUT UNDERSTANDING THE MOST FUNDAMENTAL PROCESSES THAT UNDERLIE EVERYTHING WE SEE—OR DON'T SEE—AROUND US."

—ARCHANA KAMAL, ASSISTANT PROFESSOR OF PHYSICS



Archana Kamal (left) with graduate student Alvin Kow

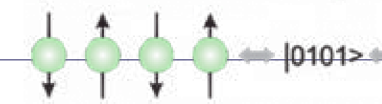
Since joining UMass Lowell's faculty in 2016, Kamal has won a series of government grants to investigate new techniques to address decoherence, which is also known as dissipation. The phenomenon refers to the tendency for qubits to fall out of entanglement, thus limiting their computing power and introducing errors into calculation. "Entanglement is a very fragile thing, because the information isn't contained in either place, but in the relationship between the two," she says. "If anything happens to either of them, the information goes away."

Quantum computer scientists typically solve this problem by implementing error correction codes that detect and discard errors within the quantum logic gates of the circuit. However, such techniques slow down speed and power, especially as the number of qubits increase. With the help of her QUEST group, Kamal is exploring a very different approach to the problem–asking "What if the qubits never decohered in the first place?" In 2019, the U.S. Department of Energy awarded her a $1.5 million grant to pursue the question, supplemented by an additional $1.85 million grant in 2021. That same year, she also won a $450,000 Young Investigator Program grant from the U.S. Air Force and a $557,000 CAREER grant from the National Science Foundation to support her research.

Instead of applying an after-the-fact code to correct errors, Kamal's approach relies on manipulating qubits with tiny pulses of microwave radiation that can keep them entangled. "We're not directly controlling the qubit itself, but you are controlling the environment around it and basically changing the way it behaves," she says. Done the right way, such a system could become self-correcting: "It's not the user, it's the environment around the qubit that detects something is wrong and nudges the qubit in the right direction."

As an analogy, imagine trying to get a ball into a hole during a game of miniature golf. Current error correction approaches are like a person aiming for the hole with a series of precise taps to correct its motion, while Kamal's approach is more like designing the course with a wide trough that sends the ball into the hole no matter how the player hits it.

Graduate student Emery Doucet '22 compares it to a physics tool called Kapitza's pendulum, which is able to balance a pencil on its point by applying a vibrating driving force. "If you are bored in class, you can spend as much time as you want trying to balance a pencil on its point, and it will never stand up right," he says. "Using microwaves or lasers to turn the quantum system into a driven system is like taking that pencil and shaking it up and down really fast, so it can stand up despite all the little air currents and people walking by and cars shaking the building that make it fall."



Doucet began his research at UMass Lowell in nuclear physics and expected to continue in that area in graduate school, until he was inspired by a class he took with Kamal. "I find it really interesting that there is this application of quantum mechanics that isn't just studying it for its own sake, but finding something constructive you can do with it," he says. Doucet collaborates with Kamal on the theoretical approach to the research, coming up with formulas to explain the kinds of forces to apply to qubits to keep them entangled.

The experimental research, meanwhile, happens at the government's NIST Boulder Laboratory in Colorado, as well as at Raytheon BBN Technologies in Cambridge, Massachusetts. There, graduate student Tristan Brown '22 helps Kamal's collaborator, experimental quantum physicist Leonardo Ranzani, apply the microwave drives to the qubit systems. "It's very gratifying to make a prediction theoretically, and then see it play out in actual hardware," says Brown.

The system consists of a blue metal barrel suspended upside down from the ceiling, in which the qubits are kept in their supercooled superconducting environment. That is connected through a tangle of multicolored wires to various electronic components that are able to apply the microwaves through the housing. Already, the team has achieved some success with this approach. "We've been able to create an entangled state of two qubits and preserve it indefinitely," Kamal says. "The question is if we can make this entanglement spread to 10 or 20 qubits to create really large entangled states."

Kamal is the ideal collaborator for the research, says Ranzani, given her background in both experimental and theoretical quantum physics. "She has a very good understanding of the theoretical, as you would expect, but also has the ability to understand where the limits are and what you can actually do in the lab," he says.

If those limits are overcome and quantum computing delivers on its promise, then it will be due to the effort of Kamal and others, who have been able to wrestle the tiny but powerful invisible forces and make their mysteries work for us. Ⓔ

Understanding the Origins of the Universe

In addition to her work on quantum error correction, Asst. Prof. of Physics Archana Kamal has received another grant of $360,000 from the Department of Energy that lifts her gaze from the tiniest of quantum forces to the furthest reaches of the universe. For this research, she collaborates with UMass Lowell Asst. Prof. of Physics Nishant Agarwal (pictured in inset), who also happens to be her husband. A high-energy physicist with a background in theoretical cosmology, Agarwal had long contemplated the origins of the known universe, stretching back from its beginnings before the Big Bang to the expansion immediately after that scattered matter in every direction.

"There is reasonable evidence that in the early universe, there were quantum fluctuations in the spacetime fabric that caused some disturbances, and then gravity was able to bring these disturbances together to form galaxy clusters," Agarwal says. Some of those fluctuations, he adds, remain in what scientists call the cosmic microwave background. "Essentially it's like an overglow or remnant radiation from after the Big Bang," he says.

That radiation isn't uniform throughout the sky, lending credence to the theory of these long-ago quantum fluctuations. However, that theory is still not definitive. Together, Agarwal and Kamal are using techniques from quantum information physics to look for vestiges of quantum coherences in the early universe that might still be preserved. "We think there must have been some quantum-to-classical transition, where the quantumness disappeared and classical mechanics were sufficient to describe the universe at later times," says Agarwal. "So how did this universe, which started out as a quantum baby, become the classical universe of today?" asks Kamal. "Maybe we can get inspiration from quantum information concepts to actually think about how these kind of quantum-to-classical transitions happen."

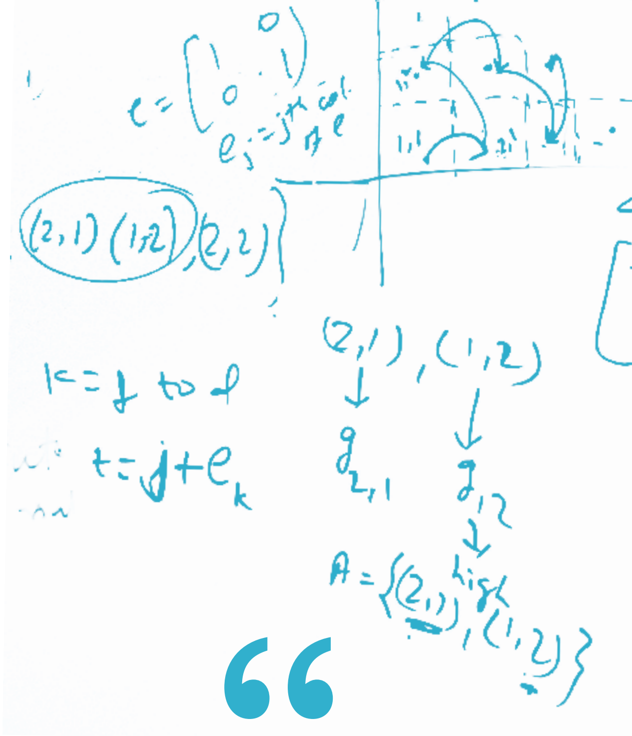
Since they started the research a few years ago with their collaborator from Penn State University, the project has grown to include researchers from about 10 other universities. As for Kamal and Agarwal, their different perspectives, stretching from the smallest particles to the largest galaxies, allow them to zoom in and out of phenomena in their discussions. "Our dinner conversations are very interesting," Kamal says. *—MB*

Chemistry Professor Works *Magic* with Students

Program Helps Underrepresented Students Succeed in Pursuing Medical Careers

BY KATHARINE WEBSTER

Honors biology major Dorcas Ruhamya says MAGIC is boosting her chances of getting into medical school.



Chemistry Assoc. Teaching Prof. Khalilah Reddie, who founded MAGIC to help underrepresented students, holds a model of a molecule.

“In MAGIC, you meet people who understand your journey. In fact, you’re on the same journey with them. Prof. Reddie built this community, and she just put me in there, in that room, believing that I would learn enough.”

—DORCAS RUHAMYA

Dorcas Ruhamya was terrified when Assoc. Teaching Prof. Khalilah Reddie asked her to come to her office after organic chemistry class.

When Ruhamya, an honors and premed biology major, arrived, Reddie quizzed her about the grades she’d earned in her first-year premed classes—and told her she needed to do better if she wanted to get into medical school.

“I was asking myself, ‘How is my mother on campus?’” Ruhamya jokes.

Reddie then invited Ruhamya to join MAGIC—the Medical Profession Admission Gap Initiative and Collaboration—a program that Reddie started to support students from underrepresented groups succeed in earning advanced degrees that lead to careers as doctors, dentists, pharmacists and physician assistants.

Together, they outlined a plan of study. Ruhamya would go for tutoring in Organic Chemistry I every day. She would also attend MAGIC’s meetings and extra organic chemistry tutoring sessions—and ace her other science classes. If she succeeded in raising her GPA to 3.2 or better, Ruhamya could apply to the UMass Baccalaureate M.D. Pathway Program at UMass Chan Medical School, a program that prepares undergraduates from underrepresented groups for medical school—and Reddie would write her a letter of recommendation.

“I used everything Prof. Reddie recommended, and it came out great,” says Ruhamya, who hopes to become a pediatric oncologist. “She was really the pivotal point of my education journey.”

Ruhamya (left) with organic chemistry tutor Sophie Wieselquist.

Reddie, an immigrant from Jamaica, earned her Ph.D. at the University of Georgia and went on for postdoctoral research and teaching fellowships at the University of Michigan and Georgia Tech. Throughout her education and career, she struggled to find mentors and a community.

So, she decided to dedicate herself to teaching and mentoring. Reddie was hired in fall 2012 by UMass Lowell to improve the teaching of organic chemistry, a required course for premed students and for many science and engineering majors.

She did everything she could to help all of her students master the material. Yet all too often, as at every place she’d taught, she saw students from disadvantaged racial and ethnic groups—Black, Hispanic and Southeast Asian Americans—struggling so much academically that they gave up on their dreams of going to medical or dental school.

Many were first-generation college students. Others were not steered into AP science classes in high school. Some spoke English as a second or third language. “These kids aren’t given a fair chance from the get-go,” Reddie says. “They are playing catch-up from the day they start college. Most of them are behind on every metric—their reading, their chemistry skills.”

Biology graduate Rameez Shaikh ’21, who spent most of his middle and high school years at an Islamic boarding school in Buffalo, N.Y., was one such student. When Shaikh decided midway through his sophomore year at UML that he wanted to be a dentist, he asked Reddie, his professor in Organic Chemistry I, how he should prepare for Organic Chemistry II the following fall.

She invited him to audit her summer class, which he did every day after work. Over the next two years, she advised him on getting experience in patient care, helped him find study materials for the Dental Admission Test and wrote a letter of recommendation for him.

Shaikh, who has won acceptance to seven dental schools for fall 2022, says Reddie was a critical mentor. “She was the only Black professor I met, and she has a special place in her heart to help people who are underrepresented in health care,” he says. “Being able to see someone who looks like you and talks like you in a position of power—it’s huge.”

But Shaikh was the exception. Reddie wanted to give more students from marginalized groups targeted support. So, with financial and logistical backing from the Kennedy College of Sciences and the provost’s office, she started MAGIC in fall 2019.

“We can give these students a fair shot,” Reddie says. “We can provide equity in their educational pathway.”

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‘River Hawk Review’ Classes Give Students a Second Chance

Sophomore Julia Measmer has severe ADHD and sometimes gets overwhelmed.

That’s what happened last fall when she took Organic Chemistry I, a challenging class that’s required for her major, biomedical engineering. Despite going to group tutoring sessions, Measmer fell behind and failed.

But instead of having to repeat the course this spring, Measmer received an invitation to take a “River Hawk Review” course during the two-week winter intersession. Measmer attended the online review class with Assoc. Teaching Prof. Khalilah Reddie for two hours every day and spent another hour-and-a-half working with a tutor who had only two other students.

She did all the homework and took another final exam—and earned a grade of C+, which replaces the F on her transcript. She says the small class size, the personal attention from tutor Deepshikha Ananthaswamy, and the chance to focus on just one subject made all the difference.

“My favorite thing was the small-group tutoring sessions every day,” she says. “We worked through a lot of problems, and Deepshikha explained everything in the most straightforward, concise way possible. And I got to ask whatever questions I had.”

River Hawk Review debuted five years ago after a conversation between Kennedy College of Sciences Dean Noureddine Melikechi and Associate Dean Fred Martin about how to improve first-time pass rates for certain required “gateway” classes. Melikechi mentioned that in Europe, students who fail a final can often take a make-up exam. Could UMass Lowell offer a similar second chance and keep students on track for their degrees?

Martin took the concept and ran with it, lining up faculty to teach “River Hawk Review” classes during the summer and winter intersessions. The classes offered intensive support to students who had put in a strong effort during the semester, but who didn’t earn the grade they needed to progress toward their degree.

“Students pay a flat fee that’s one-quarter the cost of a full online class, and if they pass, their original grade is replaced with their new grade,” Martin says. “The idea is to save them time and money—and keep them from having to repeat the class.”

The first review classes—in first-year biology, chemistry and physics; sophomore organic chemistry; and second- and third-year computer science courses—piloted in summer 2017. Students said they appreciated getting extra time to master the material and to focus on especially difficult concepts. They also valued the extra time with professors. About half of students earn a passing grade after a River Hawk Review class, Martin says.

Sophomore biology major Prospera Kuupiel Nibenee is among them. She failed Organic Chemistry I by one point last fall because, like Measmer, she struggled with key concepts. Over the winter, she mastered those concepts through lots of problem-solving and quizzes. “The winter class was more personal, and because we’re closer with the teacher, it felt more comfortable to ask questions,” she says.

As faculty and departments have refined the program, Martin says that River Hawk Review is moving from a pilot effort to an established option for several core courses. “We consider it a diversity, equity and inclusion initiative. It’s often our first-generation, women and underrepresented students who need this,” Martin says.—*KW*

> “The thing I got out of it most was the relationship with the kids in the group. We studied with each other and checked in with each other. Through MAGIC, I saw that we could help each other. That’s where I got a community.”
> —JOSÉ ARCHILA QUEZADA

Clockwise from top left: Former MAGIC tutor and honors chemistry major Benedicta Agyemang-Brantuo in the lab; students in MAGIC listen to guest speaker Dr. George Agyapong ’14; Reddie helps biology student Ali Shaikh after an organic chemistry class; applied biomedical sciences major José Archila Quezada says MAGIC gave him a community; honors public health major Lawreta Kankam “graduated” from MAGIC to the UMass Baccalaurete M.D. Pathway Program.

The MAGIC Begins

Francine Coston, associate director of Multicultural Affairs, and Shontae Praileau, coordinator of College-based Advising, helped Reddie identify new first-year students and rising sophomores who showed academic promise and a strong interest in pursuing medical careers.

Forty students enrolled in the first MAGIC cohort, and Reddie hired tutors to assist them with Chemistry I and II and Organic Chemistry I and II. She also invited speakers who could talk to students about the medical school admissions process and what they should focus on besides their GPAs: patient care experience, research with faculty and community service.

Lawreta Kankam, a premed and honors public health major who immigrated with her father from Ghana just before starting high school, at first despaired of passing college chemistry. She says the tutors for MAGIC helped and encouraged her. Then a speaker Reddie invited to the university in winter 2020—Dr. George Agyapong ’14, a native of Ghana who earned a master’s degree in biology at UML and later graduated from Harvard Medical School—inspired Kankam to believe in herself and redouble her efforts.

“I could relate to his story,” says Kankam, an aspiring emergency room doctor. “Seeing a person from Ghana becoming a physician, I thought, ‘OK, this is possible for me. I can do this now.’”

Opening up Access to Resources

Reddie encouraged Kankam and two other sophomores in the first MAGIC cohort—applied biomedical sciences major José Archila Quezada and honors chemistry major Benedicta Agyemang-Brantuo—to apply to the UMass Baccalaureate M.D. Pathway Program in spring 2020. Reddie also wrote letters of recommendation.

That program accepts a small number of UMass undergraduates each year who are low income, first generation, or from underrepresented racial and ethnic groups. In spring 2020, all three UMass Lowell students who had applied were accepted as “Medical Scholars,” and Reddie brought a cake to their next meeting to celebrate. “She was jumping up and down for us, she was so excited,” Kankam says. “I’ll never forget that moment.”

As juniors, all three students won provisional acceptance to the medical school. If their MCAT scores are high enough, admission is guaranteed. Recently, Reddie helped some of the first MAGIC participants apply for scholarships to an online MCAT prep program offered through Clemson University Chemistry Prof. Rhett Smith’s website (protonguru.org).

Smith first created a free, online organic chemistry course after his public university students told him they couldn’t afford the standard textbook. Then last summer, he and a group of similarly dedicated colleagues from other universities launched the online “MCAT Ladder” test prep program to level the playing field for low-income premed students from diverse backgrounds.

The complete package costs $1,000, compared to as much as $10,000 for elite MCAT prep programs. “I was working at McDonald’s during college and couldn’t have afforded anything like that,” Smith says. And he uses the $1,000 fee to fund scholarships for students who can’t pay, including Kankam.

Kankam graduated from UML in December and is now studying for the MCAT while working part time as a medical scribe at UMass Chan Medical Center. She is grateful for the MCAT Ladder scholarship and says the prep program is well-designed because it helps students identify their strengths and weaknesses from the start “They give you a schedule and tell you how you need to study,” she says.

Connecting is the Real MAGIC

Students say that the real magic in MAGIC is the community.

When Archila Quezada was a first-year student at UMass Lowell, he almost gave up on his dream of becoming a doctor. He saw the other students as competitors in the zero-sum game of winning admission to medical school. “I felt like everyone was getting better grades than me, and that was pushing me down,” he says.

MAGIC, which he joined as a sophomore, changed everything. “The thing I got out of it most was the relationship with the kids in the group. We studied with each other and checked in with each other,” he says. “Through MAGIC, I saw that we could help each other. That’s where I got a community.”

That community is growing as MAGIC “graduates” go on to become tutors and informal mentors. Biology major Shakira Fedna, a first-generation college student who had Shaikh and Agyemang-Brantuo as organic chemistry tutors last year and counts Kankam as a friend and mentor, won admission to the Baccalaureate M.D. program a year ago. “MAGIC brought in that community component and the extra help I wasn’t used to as a first-gen student,” she says.

Now a junior, Fedna is helping her younger friends in MAGIC who are on the same path. Ruhamya is one of them.

“In MAGIC, you meet people who understand your journey. In fact, you’re on the same journey with them,” Ruhamya says. “Prof. Reddie built this community, and she just put me in there, in that room, believing that I would learn enough.”

And what a difference that has made.

Says Ruhamya: “I’m on fire now.” Ⓔ

DAVID SHULMAN ’85, ’87

AFTER 25 YEARS, COMPUTER SCIENCE ALUM LOGS OFF AT MICROSOFT

BY ED BRENNEN

David Shulman (center) returned to UML in 2018 for the dedication of the Shulman Library on North Campus. Joining him, from left, are Dean Noureddine Melikechi, computer science alumna Amy Mazzucotelli ’20, Chancellor Jacquie Moloney and Assoc. Prof. Haim Levkowitz, chair of the Computer Science Department.

> “The stuff you learn in class like data structures and algorithms is super-important and builds a good foundation, but the collaboration experience and being able to work on your own project is very beneficial for early in your career.”
>
> –DAVID SHULMAN

“What are you going to do next?” It’s a question computer science alum David Shulman ’85, ’87 has been hearing a lot lately.

Still only in his late 50s, Shulman retired from Microsoft last May after a 25-year career that featured two acts with the tech behemoth, sandwiched around a six-year hiatus that led to a job with Motorola.

“I wanted to get my 25 years of service in at Microsoft,” says Shulman, who, to answer the question, hopes to do more traveling with his husband, Erik now that he’s retired. He also plans to focus more on his philanthropy, whether it’s volunteering as the “unofficial IT director” at his church or continuing to grow the generous financial gifts he’s made to his alma mater over the past three decades.

“If students could do the work, I always wanted to make sure that money didn’t stand in the way for them to have an opportunity,” says Shulman, who started The Shulman Fund for Excellence in Computer Science with a $100,000 gift in the late 1990s. Since then, he’s endowed the David E. Shulman ’85, ’87 Computer Science ACM Leadership Award (to support UML’s student chapter of the Association of Computer Machinery) and contributed to the Computer Science Department’s 25th anniversary fund. In 2018, he returned to campus for the dedication of the Shulman Library on the fourth floor of the renovated Dandeneau Hall.

“I got a chance to tour the (Lawrence Lin) MakerSpace, which I thought was so cool. It made me kind of wish that I was a student again,” says Shulman, who was a bit sad to see that his old dorm, Smith Hall, had given way to the Mark and Elisia Saab Emerging Technologies and Innovation Center. “But I’m impressed with the new buildings and the way the campus is being developed.”

Shulman joined Microsoft as a software design engineer in 1989—just as it was ascending to new heights with the launch of Microsoft Office and Windows 3.0. He spent his first seven years working on email software that would become Microsoft Exchange.

“The industry has obviously evolved a lot. The internet wasn’t really a thing in the early ’90s, and then came the move to the cloud,” says Shulman, whose role with the company evolved as well, from hands-on engineer to more senior-level management. “Software has gotten so much more complex, with millions of lines of code. I became a big proponent of automated testing and really designing software for testability. Now, you see it everywhere with open-source places like GitHub. I saw a lot of them being born over the years.”

He also saw the corporate culture evolve. “We had our own offices way back when; that was the thing,” he says. “Now, of course, things have moved to more open team spaces that allow for more collaboration.”

On TV and in the movies, computer programmers are often wearing headphones and hoodies as they type away in trance-like solitude. But in reality, Shulman has noticed “a big shift” toward more collaborative software programming and development design. “Even so much as ‘pair programming,’ where you and a fellow engineer will sit together at the screen as you sketch out things,” he says.

Thanks to technology, Shulman says it’s easier than ever for computer science students today to learn how to work collaboratively, even when developing their own projects—something that he also sees as critically important.

“The stuff you learn in class like data structures and algorithms is super-important and builds a good foundation, but the collaboration experience and being able to work on your own project is very beneficial for early in your career,” he says. “With open-source tooling and things like GitHub, you can work with other developers and code-review your stuff … You can publish a mobile game or put something on an app store.”

UML’s Computer Science Department was basically in version 1.0 when Shulman arrived from Peabody, Massachusetts, as a freshman in 1981. In his senior year, he started working part-time at North East Research Associates, a company led by one of his computer science professors, David Korff. As a defense industry subcontractor, the Woburn, Massachusetts-based company did laser physics analysis for the “Star Wars” missile defense system in the 1980s.

After graduating summa cum laude in 1985, Shulman became the company’s director of software development while working on his master’s degree at night. But by 1989, he was ready for a new challenge. Korff had died unexpectedly a year earlier, and the defense industry was slumping. One day, while skimming the pages of Byte, a popular computer magazine, Shulman saw a small help wanted ad for a software design engineer position at Microsoft. He was soon invited to fly out west for an interview.

There was just one problem, however: Microsoft used a lot of C, a programming language that Shulman “knew nothing about.” So, he read a book about C on the six-hour flight from Boston to Seattle—and was hired.

While it was an exhilarating time to work for Microsoft, the long hours and changing nature of his role eventually left Shulman feeling burned out. “I ended up managing managers who were managing managers. I discovered that at that time in my career, I didn’t enjoy that as much as debugging and writing code and designing,” he says.

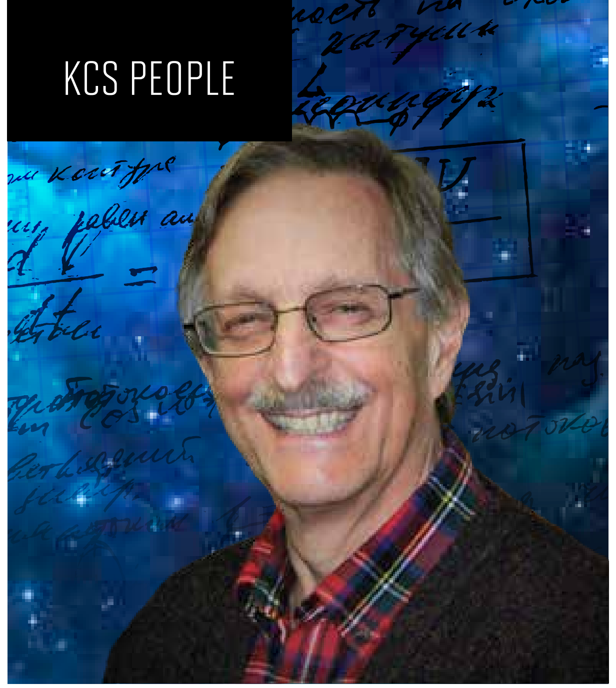
He stepped away in 2002 to try his hand at consulting and to focus on personal projects, such as designing and building his own tech-savvy smart home. That project led to a connection with Motorola and a new job in 2004. When he was laid off in 2008, he was lured back to Microsoft, this time as a senior software engineer.

One thing that he appreciated about both Microsoft and Motorola is that they matched his charitable contributions to UML, enabling him to help more students. In 2020, Shulman joined UML’s Circle of Prestige, which recognizes donors whose lifetime giving exceeds $500,000.

“I think it’s important to give back. The young people there are the future,” says Shulman, who gets thank-you letters from his scholarship recipients every year. “It’s really heartening to hear about the struggles that they have, and how important school is to them and their families.”

So, when it comes to his philanthropic endeavors, what is Shulman planning to do next?

“My dream eventually is to have more full-ride scholarships in my endowments, not just the one-off kind of thing,” he says. “That’s my goal.” Ⓔ



LOUIS K. MANSUR ’66

STRONG FOUNDATION POSITIONED PHYSICS ALUM FOR SUCCESS

BY MADELINE BODIN

Someday, when humans rocket through space toward Mars, they will experience the effects of galactic cosmic radiation in a way no humans have before.

If their spacecraft is made of aluminum alloys or the other light materials currently favored by space programs, the travelers may be subjected to even more harm, as the cosmic rays will fragment the structural material’s nuclei, flinging even more atomic bits at the people inside.

But if the spacecraft uses a shield of hydrogen-rich polyethylene, a common plastic used in bottles and bags, to protect its precious human cargo, it will reflect the work of nuclear physicist Louis K. Mansur ’66.

Mansur spent most of his career researching the effects of radiation on materials, particularly metals, working for 35 years at Oak Ridge National Laboratory in Oak Ridge, Tennessee, before retiring in 2009.

At Oak Ridge, his research was both theoretical and practical. For example, Mansur and his team researched the best materials to use as a target to produce as many neutrons as possible for Oak Ridge’s high-energy, high-power particle accelerator, which is used to study atomic structures too small to explore with light or X-rays.

Mansur nurtured his chosen field of research by spending 25 years as the chief editor of the Journal of Nuclear Materials. From 1976, when he first had an article published in the journal, until he retired from the editing position in 2015, his work helped advance the field of nuclear materials to encompass the behavior of atomic defects, interactions of energetic atoms and the performance of engineered components.

Mansur’s ability to nurture his field of research may spring from the similar blossoming he experienced in his own life. He grew up in Lowell, and his years of studying physics at Lowell Technological Institute, a UML predecessor institution, provided a well-crafted framework for his future.

His earliest memories include hours spent on woodworking projects with his father and grandfather. He loved the craftsmanship and the feel of the tools in his hand—so much so that at the age of 7, he asked his father for his own block plane. When he was 12, his father died, and his large and loving extended family embraced him, his mother and his three brothers.

After a childhood spent with the angles, planes and levers of woodworking, Mansur gravitated to physics in high school. “There’s a lot of similarity between solving a physics problem and designing a nice piece of furniture,” he says. “You have to figure out what your approach is going to be, and not work yourself into a corner because you forgot a step.”

He attended what is now UMass Lowell, following in the footsteps of an uncle who was about 10 years older. The family connection continued when Mansur’s younger brother Bob enrolled at the university and earned a degree in electrical engineering.

For Mansur, physics is not a set of formulas to be memorized; rather, it is a vivid description of the world around him. At UMass Lowell, he says, he learned how to phrase a problem so he could choose the right approach to solving it. “You need to get at what the problem is,” he says. It was a lesson he continues to draw upon.

He was recruited into a U.S. Atomic Energy Commission management training program straight from the Physics Department. That program sent him to Cornell University for a master’s degree in engineering physics.

But Mansur could not see himself as an administrator, so after he fulfilled his obligation to the program, he returned to Cornell for a doctorate in nuclear science, materials science and engineering. His doctoral research made him the perfect fit for a position that opened up at Oak Ridge, the famous nuclear energy research facility, where he remained for the rest of his career.

Mansur has remained involved with the university. He established the Mansur Physics Scholarship, an endowed fund, in memory of his parents. He recently visited campus to assist the Kennedy College of Sciences with its Academic Quality Assessment and Development process, which is a component of the UMass performance measurement system and is required of all academic units. He was happy to help, he says.

Mansur says he wanted to help the physics department continue providing a solid framework for students’ futures in science. If his career is any indication, deep experience in physics means those students will be prepared for wherever their careers take them, whether it’s a regulatory agency, a laboratory or on a spacecraft to Mars.

IJEBUSONMA AGUNDU ’22

PREMED STUDENT LEADS THE WAY BY ADVOCATING FOR OTHERS

BY KATHARINE WEBSTER

Ijebusonma “Sonma” Agundu was 17 when she emigrated from Nigeria to pursue her dream of becoming a doctor.

She earned an associate degree at Middlesex Community College, where she made an impact as a campus leader, and transferred to UMass Lowell to study biology. She wants to be an obstetrician and gynecologist and, one day, to open a clinic in Nigeria with her sister, who plans on becoming a pediatrician.

Agundu has continued her campus involvement at UMass Lowell. She is a student ambassador for Multicultural Affairs and co-founder of the Minorities in Health Science Club. She is also a Student Government Association senator, tutors organic chemistry and is an advocate for prevention education, talking to other students about sexual violence and mental health. In recognition of her work on behalf of others, she was a 2022 recipient of the university’s Martin Luther King Jr. Award.

“I’m always interested in advocating for people, because when you have to do something for yourself, you always want to make life easier for others who come after you,” she says.

She is working with Prof. Tim Ford, chair of the Public Health Department, to research cholera in Nigeria, where it is endemic in half the country. She spent her recent winter break talking with government health officials there to determine how to best address basic sanitation problems.

After earning her bachelor’s degree, Agundu plans on taking a gap year to continue that research and to apply to medical schools.

“When you have a dream of being something, you just keep striving to get it,” she says.

KARINA PROVOST ’22

SCHOLARSHIPS ARE PART OF THE EQUATION FOR MATH STUDENT

BY ED BRENNEN

With two younger sisters also in college, mathematical sciences major Karina Provost appreciates every scholarship she’s gotten.

“My parents are both schoolteachers, so there’s only so much they can do,” says Provost, a native of Dudley, Massachusetts, who received the Kennedy Family Merit Scholarship heading into her senior year at UML. She has also received the John and Abigail Adams Scholarship and a Dean’s Scholarship from the Kennedy College of Sciences.

“Scholarships have been really helpful. They let me focus more on school,” she says.

With her focus on her coursework, Provost has distinguished herself academically. She has also gotten involved on campus, serving as president of the UML chapter of Active Minds, a national nonprofit organization that supports mental health awareness and education for young adults.

Provost has worked to help pay for her education and to gain experience. She is a grader for the Math Department and picked up a job as a data processor for the Office of Research Administration.

“It’s more of an analyst thing. But it’s interesting, and I’m learning a lot,” she says.

As a sophomore, Provost landed a work-study job with the Jumpstart Early Education Program. Twice a week, she would visit a preschool in Lowell and read to children.

“I love working with kids,” says Provost, who is open to the possibility of someday becoming a teacher like her parents.

But first, she wants to explore other options and is leaning toward work that involves statistics. “Statistics are thrown around so often on the news, so it’s cool to understand where that’s coming from,” she says.

BY ED BRENNEN

FACULTY BRING THE SCIENCE TO COP26 IN GLASGOW

Rooney-Varga, Vivancos Join UML Contingent at U.N. Global Climate Summit

"The summit is a place to get inspired. We find out that things we didn't think are possible back home are possible in other countries."

—JULIETTE ROONEY-VARGA

When traveling by rail in the United Kingdom, passengers are warned to "mind the gap" between the platform and train as they board.

The phrase stuck with Environmental, Earth and Atmospheric Sciences Prof. Juliette Rooney-Varga after returning home from COP26, the United Nations global climate summit held last November in Glasgow, Scotland.

"To me, it was a story of gaps," says Rooney-Varga, who joined Asst. Prof. of Chemistry Juan Artes Vivancos and five other members of UMass Lowell's Climate Change Initiative in Glasgow, where the university had "provisional observer status" for the two-week COP, or Conference of the Parties. UML was given full observer status for COP27 this year in Egypt.

"We know there's an emissions gap between how far emissions need to come down and how far we expect them to come down. And there's an ambition gap between what we say we want to do and what we're actually doing," she says. "But a credibility gap also emerged at COP26, where there were pledges made to achieve net-zero greenhouse gas emissions by 2050 that people don't think are very credible."

Among them were pledges by more than 100 countries to cut methane emissions by more than 30% by 2030 and to end deforestation in 85% of the world's forests by decade's end. While encouraging, Rooney-Varga says governments will need to be held accountable, and additional policies will be needed, to make them a reality.

State Sen. Mike Barrett, second from right, met with UML faculty members, from left, Dave Turcotte, Juliette Rooney-Varga, Meg Sobkowicz-Kline and Jarrod Hayes at COP26 to discuss how the Climate Change Initiative can better inform policymakers.

"Do I believe that they're going to do that? Well, I'm certainly going to use those pledges to advocate here at home," she says.

Attendees at the summit were disappointed to see the Glasgow Climate Pact language watered down at the last minute—with the "phasing out" of coal and fossil fuel subsidies changed to "phasing down" at the behest of India, but Rooney-Varga says the fact that coal and fossil fuels were even included was a victory.

"They weren't mentioned in the Paris Agreement, so it's a big deal," she says.

This was the second COP for Rooney-Varga, who attended the 2015 summit in France that led to the Paris Agreement, which set a goal of limiting the rise in global temperatures to just 1.5 degrees Celsius, or 2.7 degrees Fahrenheit, above pre-industrial levels. The world has already warmed by 1.1 C.

"The summit is a place to get inspired. We find out that things we didn't think are possible back home are possible in other countries," says Rooney-Varga, who shared the En-ROADS climate simulator with COP attendees through her partnership with Climate Interactive, an MIT-based nonprofit. The simulation allows participants to test out public policy scenarios that would limit global warming.

It was the first COP, meanwhile, for Artes Vivancos, whose research interests are in biochemistry and biophysics. He was struck by the diversity of the summit, which drew more than 40,000 participants from 196 countries.

"It feels like multiple COPs at the same time," Artes Vivancos says. "You can be attending a big event with politicians, then go into another room and hear from indigenous people from Peru. There are multiple languages spoken—as well as the language of politicians."

During the summit, UML joined the Action for Climate Empowerment coalition, which is part of the U.N. Framework Convention on Climate Change.

"The core idea is that the right to information about climate change, and the right to participate in decision-making and climate action, is a universal human right," says Rooney-Varga, who hopes students will be part of the UML delegation at COP27 in Egypt.

While much of the debate about how to slow global warming centers around economics, it's still a scientific issue at heart. Take, for instance, the issue of a carbon trading system, whereby developing countries can reduce their emissions and sell carbon "credits" to developed countries.

"A carbon trading system is economically efficient, but it could also open the door for a lot of nonsense," Rooney-Varga says. "That's where a lot of the science and technology will come into play in the coming decades. We need people to be well-informed enough to call B.S. when they see it."

Someone to mind the gap.

"It feels like multiple COPs at the same time. You can be attending a big event with politicians, then go into another room and hear from indigenous people from Peru. There are multiple languages spoken — as well as the language of politicians."

—JUAN ARTES VIVANCOS

UNDER THE LENS

Turning Up the Radiochemistry with Asst. Prof. Erin Bertelsen

BY EDWIN L. AGUIRRE

Erin Bertelsen is an assistant professor in the Department of Physics & Applied Physics. She joined UMass Lowell's faculty in 2020. Her work focuses on radiochemistry research and course development.

Q. What is radiochemistry, and why is it important?

A. Radiochemistry is, simply, chemistry with radioactive materials. Radiochemists use this radioactivity to study chemical reactions or the chemical and physical properties of the radioactive materials themselves. Radiochemistry has applications in radiopharmaceuticals, radioactive waste treatment and environmental decontamination. Each of these areas has broad impact on our society, such as diagnosing and treating diseases, managing spent nuclear fuel for disposal, reducing hazard from radioactive waste and tracking how radioactive materials behave in our environment in the event of a leak or contamination.

Q. There is currently a worldwide shortage of radiochemists. What's causing that?

A. The increasing demand for radioactive forms of elements such as technetium, thallium, gallium, iodine and xenon, particularly in nuclear medicine, as well as new developments in the nuclear energy industry, have created a need for a pipeline of qualified radiochemists. There are very few universities that offer this specialty, either through coursework or research.

Q. How does UMass Lowell help in addressing this workforce shortage?

A. UMass Lowell offers radiochemistry and related courses at undergraduate and graduate levels through the Radiological Sciences program under the Department of Physics & Applied Physics. The university is on track to have a new radiochemistry lab this fall. Additionally, the university was recently awarded a faculty development grant by the U.S. Nuclear Regulatory Commission that provides $450,000 over three years to help teach radiochemistry-related courses and mentor students in radiochemical research.

Q. Your research aims to improve analytical methods for characterizing waste streams from spent nuclear fuel, nuclear fuel reprocessing and nuclear forensics. Why is this study important?

A. My research focuses on understanding the chemistry happening in separation processes applied to rare earth elements [REEs], nuclear fuel waste streams and reprocessing, and nuclear forensics. The more we know about the interactions of these elements in these types of processes, the better we can rationally design separation processes. This will help decrease the radioactivity in our used nuclear fuel repositories, increase the speed of our separations for forensic analyses and enhance the purity of REE separations necessary for our modern technologies. REEs are an essential component of many consumer products, such as cellphones, computer hard drives, electric and hybrid vehicles, and flat-screen monitors and televisions, as well as in defense applications, such as guidance systems, lasers, and radar and sonar systems.

Q. How can nuclear forensics help with homeland security?

A. Nuclear forensics can act as a deterrent against nuclear attacks and smuggling of illicit nuclear materials. Nuclear materials can be analyzed for trace elements, and their bulk composition would help determine their origin and history. These investigations could assist the U.S. government in determining what actions need to be taken against the responsible parties and identifying any shortcomings in the country's national security.

MATH PROFESSOR TRIES TO SPEED UP INTERACTION MODEL COMPUTATION

BY EDWIN L. AGUIRRE

Interaction models are becoming a powerful mathematical tool for researching problems in science, engineering and other fields. To help advance the use of this tool, last year the National Science Foundation awarded a three-year grant worth nearly $200,000 to Assoc. Prof. Min Hyung Cho of the Department of Mathematical Sciences to resolve computational challenges in simulating interaction models. Cho is an expert on computational and applied mathematics, electromagnetics, numerical solutions of partial differential equations and scientific computing. Here, he shares some insight into his work.

Q. What is an interaction model, and why is it important?

A. In a very broad sense, an interaction model is a mathematical equation that describes a relationship between two or more objects. Examples of these models include electromagnetic and gravitational interactions in physics; interactions between atoms, molecules or cells in biology; and more general fractional differential equations and network models in materials science, quantum theory, ecology and social science.

Direct evaluation of these interaction models is very expensive in terms of computing time, even on a state-of-the-art, high-performance computer. However, by analyzing interaction models, some of the interactions can be compressed and accurately approximated by using different representations. One good example is an image-processing algorithm called "fast Fourier transform," which is used in a wide range of applications, such as analysis, filtering, reconstruction and compression of digital images.

Q. What are the fundamental challenges in interaction models, and how do you resolve them?

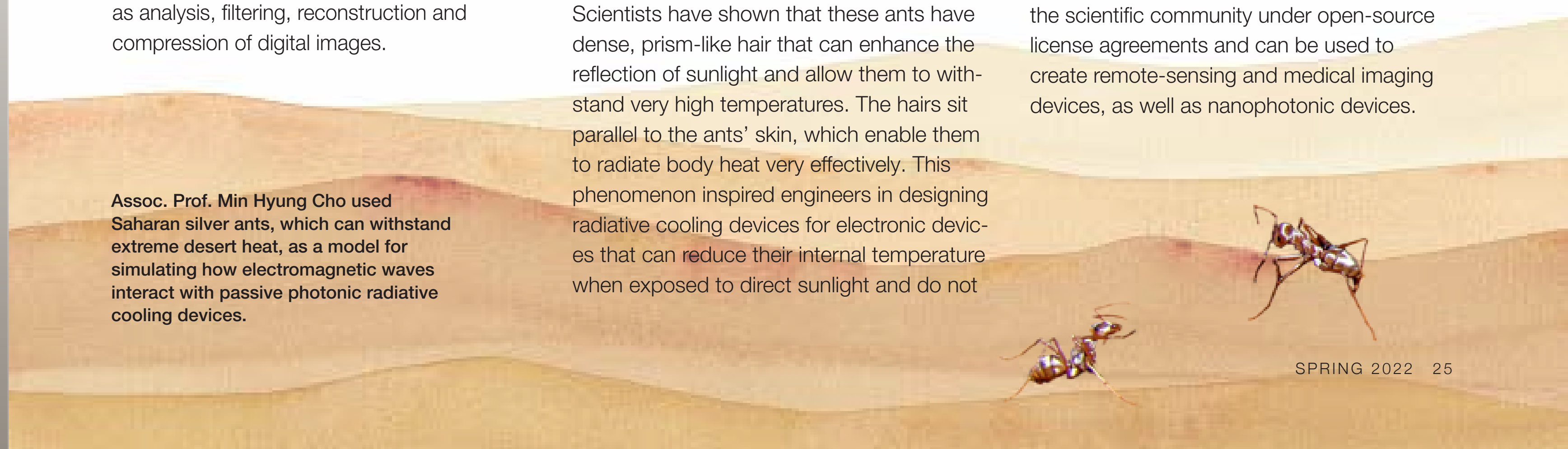
A. Today's interaction models are becoming more complex, due to the massive amounts of data involved, and require faster, more accurate and more efficient computational methods to handle simulations of large-scale interactions on high-performance computers. Our project will introduce novel representations of interaction models that are suitable for accelerated computation.

Q. As part of your research, you used Saharan silver ants as an example of a specific kind of interaction model. What's the significance?

A. I am using an interaction model, called the "layered media Green's function," to simulate how electromagnetic waves interact with passive photonic radiative cooling devices based on Saharan silver ants. Scientists have shown that these ants have dense, prism-like hair that can enhance the reflection of sunlight and allow them to withstand very high temperatures. The hairs sit parallel to the ants' skin, which enable them to radiate body heat very effectively. This phenomenon inspired engineers in designing radiative cooling devices for electronic devices that can reduce their internal temperature when exposed to direct sunlight and do not require external power. My research aims to help optimize the efficiency of these devices. The technology can potentially save on energy consumption, and thus benefit society and the environment.

Q. Are you developing software for simulating interaction models as part of your study?

A. Yes. My research team—which includes Djeneba Kassambara and Jared Weed, who are both Ph.D. students in computational mathematics, and undergraduate math major Mark Vaccaro—will design efficient algorithms for evaluating interactions. They are currently implementing a prototype software to demonstrate our idea. Ultimately, the algorithm will be implemented for many CPUs that can run both on workstations and clusters, such as the Massachusetts Green High Performance Computing Center in Holyoke. The software will be released to the scientific community under open-source license agreements and can be used to create remote-sensing and medical imaging devices, as well as nanophotonic devices.



Assoc. Prof. Min Hyung Cho used Saharan silver ants, which can withstand extreme desert heat, as a model for simulating how electromagnetic waves interact with passive photonic radiative cooling devices.

Faculty Success

ASST. PROF. REZA AHMADZADEH, Department of Computer Science, was:
–awarded a $1.5 million grant from the Army Research Lab for the project "Trust-NEARCHAT: Trust Network Emergence Amongst Resource-Constrained Human-Agent Teams." His PIs include Kshitij Jerath (Mechanical Engineering) and Paul Robinette (Electrical and Computer Engineering).
–awarded $177,665 (subaward) from the Army Research Lab for the project "CHATS: Computational HAT model of status sensitivity to facilitate team trust and performance under suboptimal conditions." His PIs include Kshitij Jerath and Paul Robinette.
–awarded $99,507 from the Army Research Lab for the project "Individualized Adaptations to Calibrate Multi Human Multi Agent Team Trust." His PIs include Paul Robinette and Kshitij Jerath.
–awarded $750,506 from National Science Foundation (NSF) for the project "Collaborative Research: Legible Co-Adaptation of Wearable Devices for As-Needed Motion Assistance." His PIs include: Holly Yanco (Computer Science) and Yan Gu (Mechanical Engineering).
–awarded $2.4 million from NSF for the project "AI Institute: Collaborative Assistance and Responsive Interaction for Networked Groups." His PIs include: Holly Yanco, Fred Martin, Paul Robinette and Adam Norton.
–awarded $1.8 million from the Office of Naval Research for the project "Humanoid Robots in Complex Unstructured Environments." His PIs include: Holly Yanco, Paul Robinette.

ASST. PROF. FRÉDÉRIC CHAIN, Department of Biological Sciences, was awarded a $1.35 million CAREER award from the NSF for his research project, "Epigenetic Dynamics Shaping the Early Evolution of Duplicate Genes."

ASSOC. PROF. JESSICA GARB, Department of Biological Sciences, was awarded a $156,000 grant from the NSF for the project "Collaborative Research: Evolutionary and Functional Trade-offs in Extreme Sensory Capabilities of a Remarkable Clade of Nocturnal Predators."

ASST. PROF. JAMES HEISS, Department of Environmental, Earth and Atmospheric Sciences, was awarded a $679,494 NSF CAREER grant for the project "Hydrodynamic controls on flluid and solute exchanges across the aquifer-estuary interface."

ASSOC. PROF. RICK HOCHBERG, Department of Biology, was awarded $783,239 from the NSF for the project "Collaborative Research: Life Cycle Evolution in Rotifera: The Influence of Sexual Reproduction on Contemporary Systematics of Monogononta."

ASST. PROF. ARCHANA KAMAL, Department of Physics & Applied Physics:
–was named AFOSR Young Investigator 2021.
–received the NSF-Career 2021 Award.

ASST. PROF. SILAS LAYCOCK, Department of Physics & Applied Physics, received the 2021 Faculty Honors Committee Award for Outstanding Campus Engagement.

ASST. PROF. TERESA LEE, Department of Biological Sciences, was:
–awarded a $374,000 grant from the National Institutes of Health for the project "Linking Transgenerational Epigenetic Inheritance to Gene Expression and Lifespan in C. Elegans."
–awarded a $74,000 subcontract for a grant to Marist College from the National Institutes of Health for the project "Chromatin-mediated Maintenance of Genomic Integrity in Germ Cells."

ASST. PROF. GKIKAS MANOS, Department of Chemistry, was:
–awarded a $591,000 grant from the Massachusetts Life Science Center's Women's Health program for the project "Breast Cancer Detection Empowered by Contrast Agents, Spectral CT, and Machine Learning."
–awarded a $210,000 grant from MARS Bioimaging Ltd. for the project "Breast Cancer Detection Empowered by Contrast Agents, Spectral CT, and Machine Learning."
–awarded a $44,771 grant as a co-PI from CCDC-U.S. Army for the project "Fabrication of Breathable Elastomer with Chemical/Biological Protection."

ASSOC. DEAN FRED MARTIN, Department of Computer Science, received a 2022 AAAI/EAAI Outstanding Educator Award for his work with the Artificial Intelligence for K-12 Initiative.

ASST. PROF. SASHANK NARAIN, Department of Computer Science, was awarded a $932,500 grant from the DARPA Young Faculty Award program for the project "Secure Privacy Preserving Access to Networks with Machine Learning."

ASST. PROF. FARHAD POURKAMALI, Department of Computer Science, working with Assoc. Prof. of Mechanical Engineering Scott Stapleton, was awarded a $518,172 grant from NASA for the project "Multi-Scale Models Based on Machine Learning and a Fiber Network Model."

ASST. PROF. JAMES REUTHER, Department of Chemistry, was named a co-PI on a $2.9 million grant from NSF's Division of Graduate Education for the project "NRT- Sustainable Water Innovations in Materials: Mentoring, Education and Research (SWIMMER)."

ASST. PROF. MICHAEL B. ROSS, Department of Chemistry, was:
–named Emerging Investigator, Nanoscale.
–named winner of the "NASA Centennial CO_2 Conversion Challenge."
–awarded Honorable Mention (with Maria Fonseca Guzman), Student-Preceptor Award for Undergraduate Research, American Chemical Society Division of Inorganic Chemistry.
–named Invited Author, 125 Years of the Journal of Physical Chemistry.
–awarded a $290,000 grant from the Office of Naval Research for energy resiliency for the project "Renewably-Powered CO_2 Recycling for Zero-Carbon On-Demand Fuel Generation."
–awarded a $15,000 Acorn grant by MassVentures for the project "Nanostructured SERS Architectures for Handheld PFAS Detection in Water."
–awarded a $290,000 grant from the Office of Naval Research for energy resiliency as a Co-PI for the project "Dual-Layer Energy Storage: Combining Redox Flow Batteries with Renewable Hydrogen Generation on Demand."
–awarded a $71,500 grant from the Associated Industries of Massachusetts as a Co-PI for the project "A Study on the Viability of Implementing Hydrogen in Massachusetts."

PROF. YUYU SUN, Department of Chemistry, was awarded a two-year, $421,335 grant from the National Institute of Nursing Research, National Institutes of Health, for "Novel Reactive Sorbents to Sorb, Immobilize, and Transform Malodorous Molecules for Palliative Management of Malignant Fungating Wounds."

UML's Student Government Association and MASSPIRG chapter recognized faculty members who use digital textbooks with the 2021 OERScars awards. Faculty honored from the Kennedy College of Sciences were **REZA AHMADZADEH** (Computer Science); **JOHANNA CHOO** (Biological Sciences); **LESLIE FARRIS** (Chemistry); **JENNIFER GONZALEZ-ZUGASTI** (Mathematical Sciences); **KENNETH LEVASSEUR**; (Mathematical Sciences); **MICHAEL ROSS**; and **SUZANNE YOUNG** (Chemistry).

Publications

ASST. PROF. REZA AHMADZADEH, Department of Computer Science:
–"Similarity-aware Skill Reproduction Based on Multi-representational Learning from Demonstration," IEEE International Conference on Advanced Robotics.
–"Learning from Successful and Failed Demonstrations via Optimization," IEEE/RSJ International Conference on Intelligent Robots and Systems.
–"Methods for Combining and Representing Non-Contextual Autonomy Scores for Unmanned Aerial Systems," International Conference on Automation, Robotics, and Applications.
–co-author, "Modeling Trust in Human-Robot Interaction: A Survey," in Social Robotics, Eds. R. Wagner, et al., Springer.

ASST. PROF. HADI AMIRI, Department of Computer Science, co-author:
–"Attentive Multiview Text Representation for Differential Diagnosis," Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics.
–"Embedding Time Differences in Context-sensitive Neural Networks for Learning Time to Event," Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics.
–"Machine Learning of Patient Characteristics to Predict Admission Outcomes in the Undiagnosed Diseases Network," Journal of the American Medical Association.

PROF. VALERI BARSEGOV, Department of Chemistry:
–"Microtubule Assembly and Disassembly Dynamics model: Exploring Dynamic Instability and Identifying Features of Microtubules," Computational and Structural Biotechnology Journal.

ASST. PROF. DIONYSIOS CHRISTODOULEAS, Department of Chemistry: "Sink/Float Magnetic Immunoassays for In-Field Bioassays," Angewadte Chemie.

ASSOC. PROF. MATTHEW GAGE, Department of Chemistry, co-author:
–"Identification of the Domains Within the N2A Region of Titin That Regulate Binding to Actin," Biochemical and Biophysical Research Communications.
–"Protein Unfolding: Denaturant vs. Force," Biomedicines
–"Solution NMR Structure of Titin N2A Region Ig Domain I83 and Its Interaction With Metal Ions," Journal of Molecular Biology.
–"Protein Source and Muscle Health in Older Adults: A Literature Review," Nutrients.
–"Understanding Drivers of Variation and Predicting Variability Across Levels of Biological Organization," Integrative and Comparative Biology.

PROF. PETER GAINES, Department of Biological Sciences:
–"Expression Levels of Lamin A or C Are Critical to Nuclear Maturation, Functional Responses, and Gene Expression Profiles in Differentiating Mouse Neutrophils," ImmunoHorizones.

ASST. PROF. RICHARD GASCHNIG, Department of Environmental, Earth & Atmospheric Sciences, co-author:
–"Behavior of the Mo, Tl, and U Isotope Systems During Differentiation in the Kilauea Iki Lava Lake," Chemical Geology.
–"The Impact of Primary Processes and Secondary Alteration on the Stable Isotope Composition of Ocean Island Basalts," Chemical Geology.
–"Thallium Behavior During High-pressure Metamorphism in the Western Alps, Europe," Chemical Geology.
–"Zirconium Isotopic Composition of the Upper Continental Crust Through Time," Earth and Planetary Science Letters.

PROF. HWAI-CHEN GUO, Department of Biological Sciences, co-author:
–"ERAP1 Binds Peptide C-termini of Different Sequences and/or Lengths by a Common Recognition Mechanism," Immunobiology.
–"Enhanced Recombinant Expression and Purification of Human IRAP for Biochemical and Crystallography Studies," Biochemistry and Biophysics Reports.

ASST. PROF. JAMES HEISS, Department of Environmental, Earth & Atmospheric Sciences:
–"Methods in Capturing the Spatiotemporal Dynamics of Flow and Biogeochemical Reactivity in Beach Aquifers: A Review," MDPI.
–"Climate and Seasonal Temperature Controls on Biogeochemical Transformations in Unconfined Coastal Aquifers," JGR: Biogeosciences.

ASST. PROF. CHRISTINA KWAPICH, Department of Biological Sciences:
–"Cicada Nymphs Dominate American Black Bear Diet in a Desert Riparian Area," Ecology and Evolution.
–"Green Anole (Anolis carolinensis) Eggs Associated with Nest Chambers of the Trap Jaw Ant, Odontomachus brunneus," Southeastern Naturalist.

ASST. PROF. NICOLAI KONOW, Department of Biological Sciences, co-author:
–"Modelling the Complexity of the Foot and Ankle During Human Locomotion: the Development and Validation of a Multi-segment Foot Model Using Biplanar Videoradiography," Computer Methods in Biomechanics and Biomedical Engineering.
–"Next Steps in Integrative Biology: Mapping Interactive Processes Across Levels of Biological Organization," Integrative and Comparative Biology.
–"Thermal Sensitivity of Axolotl Feeding Behaviors," Integrative and Comparative Biology.
–"Protein Source and Muscle Health in Older Adults: A Literature Review," Nutrients.
–"Modeling Muscle Function Using Experimentally Determined Subject-Specific Muscle Properties," Journal of Biomechanics.
–"Effect of Muscle Stimulation Intensity on the Heterogeneous Function of Regions within an Architecturally Complex Muscle," Journal of Applied Physiology.

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ASST. PROF. TERESA LEE, Department of Biological Sciences, co-author: "Caenorhabditis Elegans Establishes Germline Versus Soma by Balancing Inherited Histone Methylation," Development.

ASST. PROF. GKIKAS MANOS, Department of Chemistry, co-author:
–"Optomechanic Coupling in Ag Polymer Nanocomposite Films," The Journal of Physical Chemistry.
–"Sub-Rouse Dynamics in Poly(isobutelene) as a Function of Molar Mass," Macromolecules.

ASSOC. DEAN MATT NUGENT, Department of Biological Sciences, co-author:
–co-author, "Heparin-Avastin Complexes Show Enhanced VEGF Binding and Inhibition of VEGF-Mediated Cell Migration," International Journal of Translational Medicine.
–co-author, "Lipid Raft Association Stabilizes VEGF Receptor 2 in Endothelial Cells," International Journal of Molecular Science.

PROF. DANIEL OBRIST, Department of Environmental, Earth & Atmospheric Sciences, co-author: "Previously Unaccounted Atmospheric Mercury Deposition in a Mid-latitude Deciduous Forest," Proceedings of the National Academy of Sciences.

ASST. PROF. JAMES REUTHER, Department of Chemistry, corresponding author on:
–"Orthogonal Synthesis and Modification of Polymer Materials," Journal of Polymer Science, Part A: Polymer Chemistry.
–"PhotoATRP-Induced Self-Assembly (PhotoATR-PISA) Enables Simplified Synthesis of Responsive Polymer Nanoparticles in One-pot," Macromolecules.
–"Helical Polymer Self-assembly and Chiral Nanostructure Formation," Polymer Chemistry.
co-author:
–"Electrostatic and Covalent Assemblies of Anionic Hydrogel-coated Gold Nanoshells for Detection of Dry Eye Biomarkers in Human Tears," Nano Letters.
–"Thermal Regeneration of Spent Granular Activated Carbon Presents an Opportunity to Break the Forever PFAS Cycle," Environmental Science and Technology.

ASST. PROF. MICHAEL B. ROSS, Department of Chemistry, co-author:
–"Material Strategies for Function Enhancement in Plasmonic Architectures," Nanoscale.
–"Lattice dynamics and Optoelectronic Properties of Zero-dimensional Perovskite Cs2TeX6 (X= CL-, Br, I-), Single Crystals," Journal of Physical Chemistry C.
–"Radiative Contributions Dominate Plasmon Broadening in Post-transition Metals in the Ultraviolet," Journal of Physical Chemistry C.
–"The Viability of Implementing Hydrogen in Massachusetts."

PROF. MARINA RUTHS, Department of Chemistry, co-author:
–"Stability and Collapse of Amphiphilic Copolymer Aggregates in Contact with Hydrophilic Mica Surfaces," Journal of Dispersion Science and Technology.

PROF. MENGYAN SHEN, Department of Physics and Applied Physics: "Study the Plasmonic Property of Gold Nanorods Highly Above Damage Threshold via Single-pulse Spectral Hole-burning," Scientific Reports.

ASST. PROF. JUAN ARTES VIVANCOS, Department of Chemistry, corresponding author:
–"RNA BioMolecular Electronics: Toward New Tools for Biophysics and Biomedicine," Journal of Materials Chemistry B 2021, Emerging Investigators Issue 2021.
–"Single-molecule Cconductance of Double-stranded RNA Oligonucleotides," Nanoscale 2022, Emerging Investigators Issue 2022.

Presentations

ASSOC. PROF. MATTHEW GAGE, "Pooled Specimen Testing at UMASS Lowell for Faster Return to Campus Life," Data Innovation Webinar.

ASST. PROF. TERESA LEE, Department of Biological Sciences, selected talk, "Repressive H3K9me2 Enables Longevity and its Inheritance in C. Elegans," Northeast Society for Developmental Biology.

ASST. PROF. GKIKAS MANOS, Department of Chemistry, "Ligand-Specific X-ray Nano-Contrast Agents for Enhancement of Breast Cancer Detection," 13th Hellenic Polymer Society International Conference.

ASST. PROF. MICHAEL B. ROSS, Department of Chemistry:
–"Data-Driven Vibrational Spectroscopy as A Portable Aqueous Detection Platform," DEVCOM Solder Center Water Sensors Symposium, Natick, Massachusetts.
–"Designing Functional Nanomaterials for Photonics, Detection, and Energy," DEVCOM Soldier Center, Natick, Massachusetts.
–"The Viability of Implementing Hydrogen in Massachusetts," Future of Hydrogen, Lowell, Massachusetts.

PROF. MARINA RUTHS, Department of Chemistry:
–"Interaction Forces and Nanotribology of Tunable, Bioinspired Polymer Coatings," 95th ACS (American Chemical Society) Colloid and Surface Chemistry Summer Symposium.
–"Textured Polymer Surfaces Formed by Self-assembly: Preparation and Tribological Characterization," ACS National Meeting.
–"Interaction Forces and Nanotribology of Surfaces Modified with Bioinspired Polymer Coatings," Seminar, Department of Chemical Engineering, University of California, Davis.
–Presenter/facilitator of STLE (Society of Tribologists and Lubrication Engineers) "Industry Insights" on Biotribology (online discussion event).
–Invited guest in STLE Podcast series "Perfecting Motion: Tribology and the Quest for Sustainability." Episode 4: Nanotribology.

New Faculty

COMPUTER SCIENCE
Asst. Prof. Maria Cabrera
Asst. Prof. Paul Downen
Research Scholar Yimin (Ian) Chen
Asst. Prof. Anitha Gollamudi

ENVIRONMENTAL, EARTH AND ATMOSPHERIC SCIENCES
Asst. Prof. Joy Winbourne

MATHEMATICAL SCIENCES
Asst. Teaching Prof. Carly Briggs
Asst. Teaching Prof. Abiti Adili

PHYSICS
Asst. Prof. Hugo Ribeiro

PARTING SHOT

Collaboration has long been a hallmark of the work done at the Kennedy College of Sciences. This photo, which appeared in the 1969 yearbook "Pickout," captures that spirit of cooperation among students in a North Campus lab.