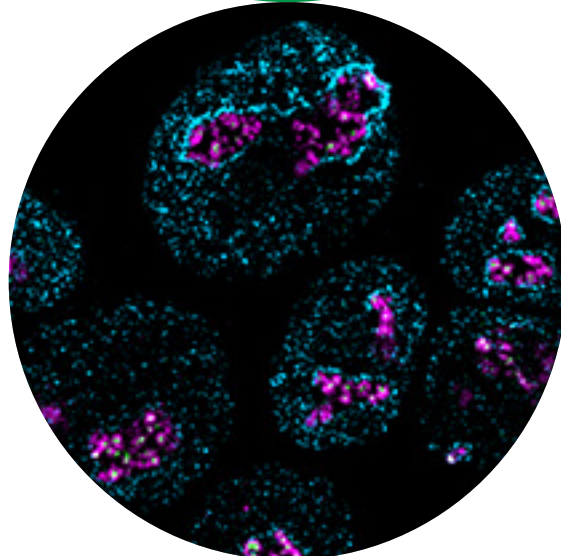
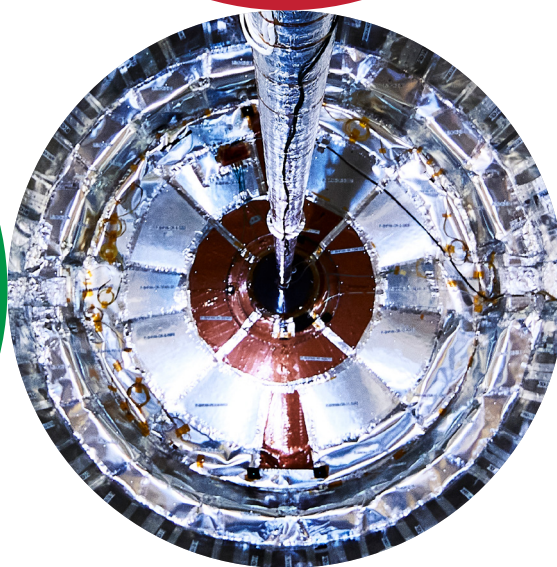
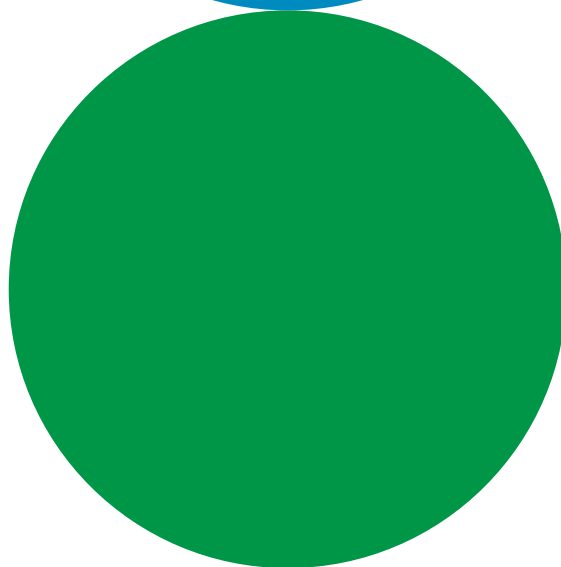


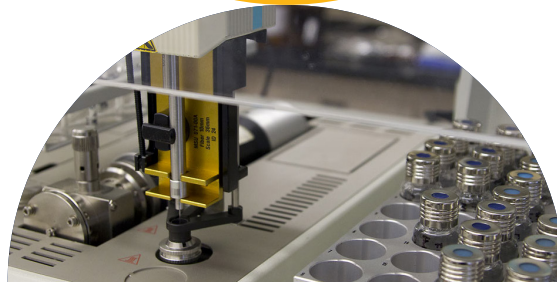
SCIENCE CONNECTION

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Mellon College
of Science



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From the Dean

Dear Alumni and Friends,

One of the great joys of serving as dean is witnessing how fundamental discovery becomes real-world impact. This year, our faculty, students and alumni continued to demonstrate that the most profound advances often begin with a simple question about how the world works.

Across MCS, researchers are tackling challenges that affect human health, technology and our understanding of the universe. In biological sciences, Drew Bridges and his team identified a vulnerability in bacteria that could help address the growing global threat of antibiotic resistance. At the same time, chemist Danith Ly and colleagues developed a highly selective strategy for targeting disease-causing RNA, opening promising avenues for treating neuromuscular and other genetic disorders.

Our researchers are also redefining how artificial intelligence can accelerate scientific discovery. Chemist Olexandr Isayev and collaborators combined machine learning with human expertise to dramatically speed the development of advanced polymer materials, illustrating the powerful synergy between computational tools and scientific creativity. This work exemplifies a defining strength of Carnegie Mellon: bringing together disciplines to solve problems that no single field can address alone.

That collaborative spirit is also shaping the future of physics and astronomy. The launch of the Keystone Astronomy & AI Visiting Fellows Program reflects Carnegie Mellon's leadership at the intersection of astrophysics, machine learning and statistics. By fostering new partnerships and approaches to data-intensive research, the program is helping advance our understanding of the universe while preparing the next generation of scientific leaders.

In neuroscience, our faculty continue to illuminate complex questions about the human brain. Eric Yttri's research revealed that hesitation is not merely indecision, but an active and essential brain process that helps us navigate uncertainty. Meanwhile, Bradford Mahon and collaborators are improving awake brain mapping techniques, advancing more personalized approaches to brain cancer surgery and helping clinicians better preserve the functions that matter most to each patient.

These advances are made possible not only by discoveries in laboratories, but also by the mathematical foundations uncovered through fundamental research. Our mathematicians — like Irene Fonseca who was elected a Fellow of the American Association for the Advancement of Science — demonstrate the extraordinary power of using mathematics to address abstract problems that shape tangible innovations.

These accomplishments are matched by recognition of our people. This year brought prestigious honors for MCS faculty, including Sloan Fellowship recognition and election to distinguished scholarly societies. We also welcomed outstanding new faculty members, invested in student success, and celebrated alumni whose leadership and achievements reflect the enduring value of a science education grounded in curiosity, rigor and collaboration.

Underlying every breakthrough is a commitment to foundational research and the belief that MCS conducts science that matters. Time and again, history shows that today's fundamental questions become tomorrow's transformative innovations.

As alumni, you are an essential part of this story. Your accomplishments extend the impact of MCS far beyond our classrooms and laboratories, and your support helps ensure that future generations of scientists can pursue bold ideas with confidence.

Thank you for your continued engagement with the Mellon College of Science. I look forward to all that we will discover together.

Barbara Shinn-Cunningham

Glen de Vries Dean, Mellon College of Science
Carnegie Mellon University

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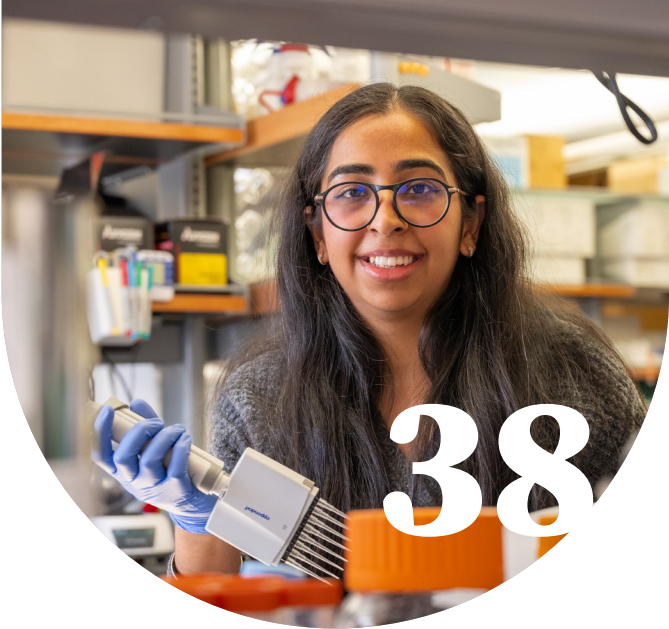
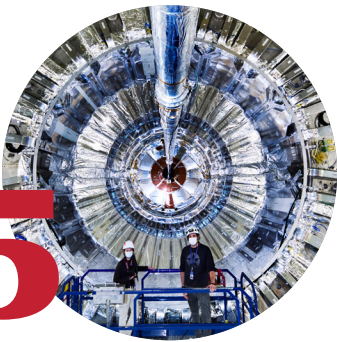
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Research Briefs

The Science of Split-Second Hesitation

BIOLOGICAL SCIENCES

Carnegie Mellon University researchers uncovered the brain mechanisms behind the split-second hesitation that can shape high stakes decisions — from sports to everyday choices. For athletes braced at the starting line or waiting for the puck to drop in a faceoff, a tiny pause could make all the difference.

Eric Yttri, associate professor of biological sciences, investigated why that hesitation occurs, focusing on how the brain acts when outcomes are uncertain. Using a decision-making task in mice, Yttri and colleague Matt Geramita found that responses reliably slowed only when signals were ambiguous. This pause wasn't indecision but an active, regulated process controlled by a specific population of neurons. When these neurons were activated through optogenetics, hesitation increased; silencing them made reactions faster.

The findings suggest hesitation is a fundamental feature of the brain, helping people avoid mistakes. The research may inform treatments for disorders involving impulsivity or disrupted timing.

CAROLINE SHEEDY

Small Models Reveal How Vision Works

NEUROSCIENCE

A new study published in Nature shows that researchers can understand the brain's visual system using models that are far smaller and more interpretable than previous machine learning approaches. The team began with a massive model that accurately predicted how neurons in the visual cortex respond to images but was too large to analyze meaningfully. Using advanced compression techniques, they created compact versions thousands of times smaller while maintaining high predictive accuracy.

These simplified models allowed researchers to see how individual neurons detect important visual features, revealing that the visual system uses specific computational patterns that can be captured without enormous networks. According to Carnegie Mellon professor Matt Smith, these smaller models offer clearer intuition into how vision works and generate testable scientific hypotheses.

The findings could also improve artificial intelligence by helping computer vision systems learn from the brain's efficient strategies. Next, the team plans to extend their models to track how the brain processes dynamic visual scenes over time.

SARA PECCHIA

Mathematician Elected IMS Fellow

MATHEMATICAL SCIENCES

Carnegie Mellon University mathematician Mykhaylo (Misha) Shkolnikov was named a 2026 Fellow of the Institute of Mathematical Statistics (IMS), one of the highest honors in the fields of statistics and probability.

Shkolnikov joins a select group of 25 statisticians and probabilists worldwide recognized for exceptional research contributions and professional achievement.

The IMS Fellowship recognizes outstanding work advancing the understanding of statistics and probability. Shkolnikov was honored for his contributions to interacting particle systems, a rapidly growing area of probability theory that studies how individual components interact to produce complex collective behavior.

His research has far-reaching applications. In mathematical finance, for example, his work can model how the failure of a small local bank might cascade into broader financial instability. Similar mathematical frameworks apply in neuroscience, where activity in a single neuron can trigger widespread signaling across the brain, and in physics, where microscopic particles help explain phase transitions.

HEIDI OPDYKE

Physicists Advance Phase Transition Theory

PHYSICS

More than 50 years after Carnegie Mellon researchers helped define the Yang-Lee critical point, CMU physicist Grigory Tarnopolskiy and collaborators have taken the landmark theory further using modern analytical and computational tools. The story began in the 1950s when Chen-Ning Yang and Tsung-Dao Lee introduced an imaginary magnetic field to study phase transitions, identifying “Yang-Lee zeros” that revealed universal behavior in complex systems. In 1971, CMU's Robert Griffiths and Peter Kortman expanded this work, demonstrating a clear pattern in these zeros and establishing the Yang-Lee critical point.

Tarnopolskiy's team has now confirmed and refined these foundational results by calculating energy levels in quantum systems that show Yang-Lee criticality, publishing their findings in Physical Review X in February 2026. Using a powerful numerical tool called the fuzzy sphere, they simulated quantum models while preserving symmetry, enabling unprecedented accuracy. Their work opens new avenues for studying non-unitary systems with applications spanning quantum computing, polymers and network behavior.

HEIDI OPDYKE

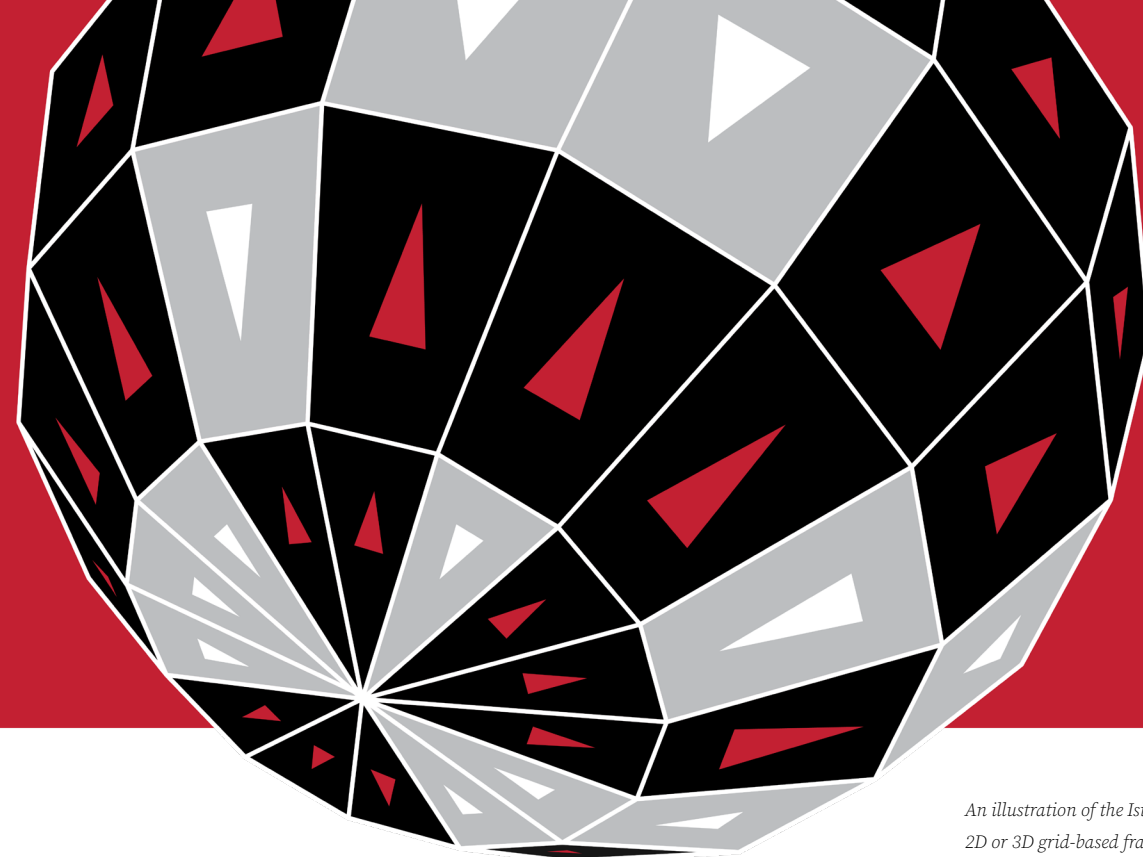
AI Helps Chemists Discover Materials Faster

CHEMISTRY

Developing new polymers — the materials behind tires, plastics and foam — can take years of trial and error. Researchers at Carnegie Mellon and the University of North Carolina at Chapel Hill have created a faster approach by combining artificial intelligence with human expertise. Their system helps design rubber-like materials that are both strong and flexible, properties that rarely appear together.

The team used a machine learning tool to suggest experiments based on desired material traits. Chemists then created and tested the polymers, feeding the results back into the model so it could improve its predictions. This human-in-the-loop process produced a polymer with unusually balanced strength and stretchiness. The AI tool also eliminated costly dead ends by ruling out ineffective methods and chemicals. Because the researchers made the software open source, other labs can use it to speed up materials discovery. The approach could accelerate innovations in medical devices, footwear, electronics and more.

KIRSTEN HEURING



An illustration of the Ising model, a simple, 2D or 3D grid-based framework in physics that simulates magnetic materials.

New Insights To Improve Brain Tumor Surgery

NEUROSCIENCE

Carnegie Mellon researchers have uncovered a new way to improve awake brain mapping, a technique neurosurgeons use during brain tumor surgery to protect a patient’s speech, movement and quality of life. Awake mapping relies on stimulating the brain while patients perform tasks, allowing surgeons to identify which areas are safe to remove.

The new study reveals that tiny, previously overlooked variations in patient behavior — including subtle response delays even without errors — can provide richer information about how language and other functions are organized in each brain. The team also found that small changes in electrical stimulation parameters, such as when the stimulation starts or stops, strongly influence patient responses.

By capturing these nuanced signals, researchers can build more personalized, predictive models to guide surgery. The work has inspired MindTrace, a clinical software platform that helps surgeons track patient performance in real time, supporting safer, more tailored operations.

JASON BITTEL

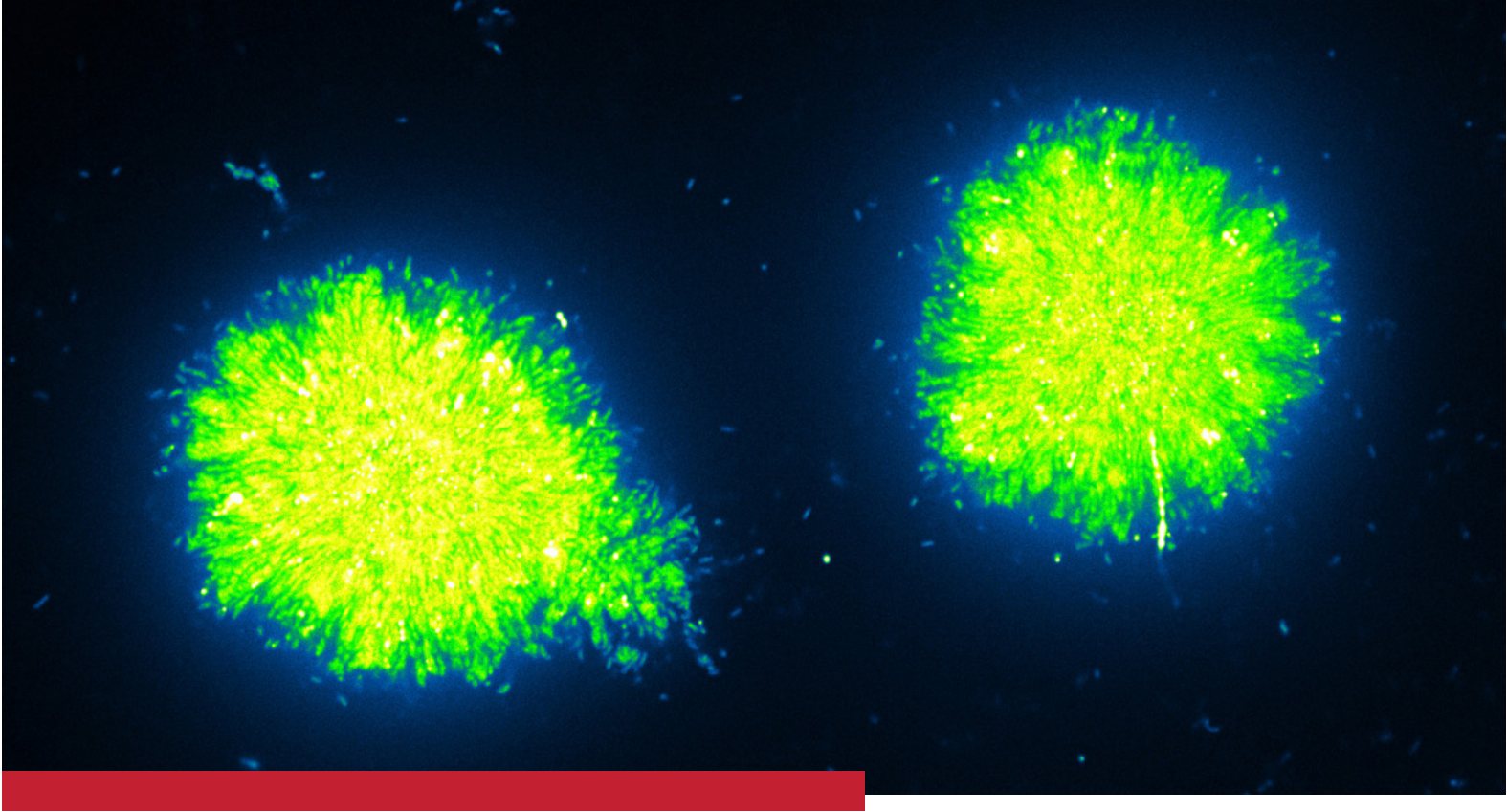
Eur Named 2026 Sloan Research Fellow

MATHEMATICAL SCIENCES

Assistant Professor Christopher Eur was awarded a 2026 Sloan Research Fellowship, one of the most prestigious awards available to young researchers. He was nominated by June Huh, a Princeton University professor and 2022 Fields Medal recipient.

Eur’s research focuses on algebraic geometry and its intersection with combinatorics, or the study of counting objects. He takes a particular interest in matroid theory, a way mathematicians describe the property of independence in a space, with uses across mathematics, physics, computer science and more.

In 2023, Eur was awarded research funding from the National Science Foundation to further understanding of matroid theory. He is delving



A mutant strain of *V. cholerae* grows sprawling biofilms — dense bacterial communities that can make infections harder to treat.

deeper into discrete structures through geometry and probes the boundary between the two.

The project, called “Positive Vector Bundles in Combinatorics,” is an example of applying algebraic geometry to understand combinatorial objects. The research seeks to understand objects like graphs and matchings through the geometric constructions called positive vector bundles.

HEIDI OPDYKE

New Strategy Could Disarm Dangerous Bacteria

BIOLOGICAL SCIENCES

Carnegie Mellon researchers have uncovered a promising new target for combating antibiotic resistance, a global health crisis that makes infections harder to treat. Instead of killing bacteria — a strategy that often leaves behind resistant survivors — Assistant Professor Drew Bridges and graduate student Emmy Nguyen identified a pathway in *Vibrio cholerae* that controls key bacterial behaviors, including biofilm formation, movement, metabolism and stress responses. By activating this pathway, the team found they could shift bacteria into a weakened, less infectious state.

A bioinformatic analysis conducted with collaborators in the lab of N. Luisa Hiller revealed that the protein module regulating this pathway is present across many bacterial species, suggesting broad therapeutic potential. Partnering with researchers at the University of Pittsburgh and Tufts University, the team demonstrated that activating the pathway hindered infection in mice. Their work lays the foundation for developing new treatments that disrupt bacterial behavior rather than kill cells outright.

CAROLINE SHEEDY

NSF Award Advances Superconductivity Theory

PHYSICS

Carnegie Mellon physicist Vlad Kozii has received an NSF CAREER Award to develop clearer, testable theories for unconventional superconductors — materials that conduct electricity without resistance but behave in ways that standard theory cannot explain. Many of these systems have unusual properties, such as extremely low electron density, strong electron interactions or topological structures, yet scientists still do not fully understand why they become superconducting.

Kozii aims to uncover the microscopic mechanisms behind these behaviors by creating models that make simple predictions that experimentalists can verify. His work will help distinguish which theoretical ideas truly explain superconductivity in these complex materials. The project could also guide the search for new states of matter, including novel topological and low-density superconductors, and potentially solve longstanding puzzles about higher-temperature superconductivity.

By bridging theory with experiment, Kozii’s research will support future materials discovery while training emerging scientists and strengthening efforts in quantum technologies, energy applications and next-generation electronics.

HEIDI OPDYKE

New Strategy Targets Harmful RNA Repeats

CHEMISTRY

Carnegie Mellon researchers have developed a precise new method for targeting disease-causing RNA, offering promise for treating myotonic dystrophy type 1 (DM1) and other RNA-repeat expansion disorders. DM1 occurs when CTG sequences in the DMPK gene repeat thousands of times, forming toxic RNA structures that trap proteins essential for normal cell function.

Professor Danith Ly and his team created highly specific nucleic acid ligands that act like “pothole fillers,” binding only to the harmful repeated RNA without disturbing healthy molecules. These ligands use a bifacial recognition mechanism, allowing them to insert themselves between RNA strands and displace trapped proteins — a more selective approach than current small-molecule or antisense therapies. In laboratory models, the lead ligand, LG2b, showed strong selectivity for disease-causing RNA.

The team is now optimizing delivery and testing the compounds in preclinical models. This strategy could lead to safer, more effective treatments for disorders caused by RNA repeat expansions.

AMY PAVLAK LAIRD

HIDDEN HELPERS

Pittsburgh's industrial past might hold the key to a cleaner future

Pittsburgh has reinvented itself from a steel powerhouse to a hub for health care and education. But the city's industrial past left a hidden legacy: toxic compounds like benzene and toluene in the soil. While most life can't survive such a contamination, some microbes adapted to use the pollutants as food.

Now, scientists at Carnegie Mellon University are exploring whether these microbes can help clean up what the steel industry left behind.

"We're taking advantage of the fact that, over generations, ecology and evolution have potentially already done a lot of the work for us in enriching microbes that might be able to assist us in doing more complete remediation," said Catherine Armbruster, assistant professor of biological sciences and a microbial ecologist. "And Pittsburgh is definitely the place for this project."

With a \$250,000 grant from the Richard King Mellon Foundation, Armbruster and her team are searching for answers at Hazelwood Green, a former steel coking site.

Western Pennsylvania is dotted with more than 250 brownfields — former industrial sites where hazardous pollutants linger. Conventional cleanup methods often involve digging up contaminated soil and burying it elsewhere. That's what was done at Hazelwood Green, transforming the former steel site into a safe, thriving hub. Today, it hosts research centers for CMU and the University of Pittsburgh, with more development underway. The remediation, however, took years and cost tens of millions of dollars.

Armbruster's team is betting on a different strategy. Their project aims to harness brownfield bacteria's innate abilities to do a less costly and more complete environmental cleanup.

But first, she must find the bacteria that break down the most common pollutants located at these sites. It's a daunting task. Just a teaspoon of soil teems with billions of bacteria and other microorganisms.

"Science is in a place now where we have the technology to sequence entire microbial

communities," Armbruster said. "And then we can use that genomic data to identify which bacterial species are there and predict whether they have the metabolisms we care about the most."

DIGGING DEEP

On a cold, rainy day in March, Armbruster headed to Hazelwood Green to collect soil samples. The ground was hard, but luckily she didn't have to do any shoveling. With the funding from the Richard King Mellon Foundation, Armbruster brought in a GeoProbe, a machine designed to collect soil samples at up to 50 feet.

Once the soil makes it back to the lab, Armbruster has assembled an interdisciplinary team to isolate the bacteria, extract its genetic sequences, comb through the vast amounts of genomic data to identify which microbes can break down the hazardous pollutants common to brownfields, and track what the break-down products become.

"I feel CMU is the right place for a project like this. The students have the interests and the aptitude to tackle these challenges," Armbruster said.

Marcus Lopez, a recent graduate who studied biological sciences and environmental and sustainability studies, led the effort to extract the bacteria from the soil along with research scientist Mara Kessler and undergraduate Charlie Stanczak. The team uses traditional lab techniques to monitor for bacterial growth: spinning down the soil/liquid mixture in a centrifuge, siphoning off the liquid and adding it to petri dishes. Once the bacterial colonies start growing, they'll isolate different strains and send them off for genomic analysis.

Meanwhile, Ethan Chen, a student in the M.S. in Automated Science program, is spearheading the effort to automate as much of the process as possible. And June Qu, a recent graduate of the M.S. in Quantitative Biology and Bioinformatics program and current research associate, is using computational methods to comb through the vast amounts of genomic data extracted from the bacteria in the soil. Her goal is to identify which microbes carry the genetic machinery to break down chemicals like benzene, toluene, ethylbenzene and xylene. To

Betsy Lewis and Catherine Armbruster work on site at Hazelwood Green, scraping soil samples collected by a GeoProbe.



find these needles in the haystack, she's developing a computational tool tailored to these genes.

"In addition to soil samples from Hazelwood Green, I'm gathering more data from oil-contaminated sites and contaminated groundwater from different parts of the world. I'm running my tool on all this data to fine tune it a little bit more to decrease the number of false positives and increase the sensitivity of detecting these genes," Qu said.

Once Armbruster's team has isolated microbes from Hazelwood Green and screened them in the lab to see how well they break down pollutants, they'll hand them off to Carrie McDonough, associate professor of chemistry. An environmental chemist, McDonough will use high-resolution chemical analysis to track what the pollutants become once they are broken down.

"We want to transform these hazardous compounds, but we want to know what we're making during that process. For that, we absolutely needed a chemist, which is where Dr. McDonough comes in," Armbruster said.

Preliminary results from the first group of soil samples from Hazelwood Green, some from the surface and some from deep in the ground, suggest that each site harbors a distinct microbial community, and that more contaminated samples had more bacteria that could degrade benzene, toluene, ethylbenzene, xylene and polycyclic aromatic hydrocarbons.

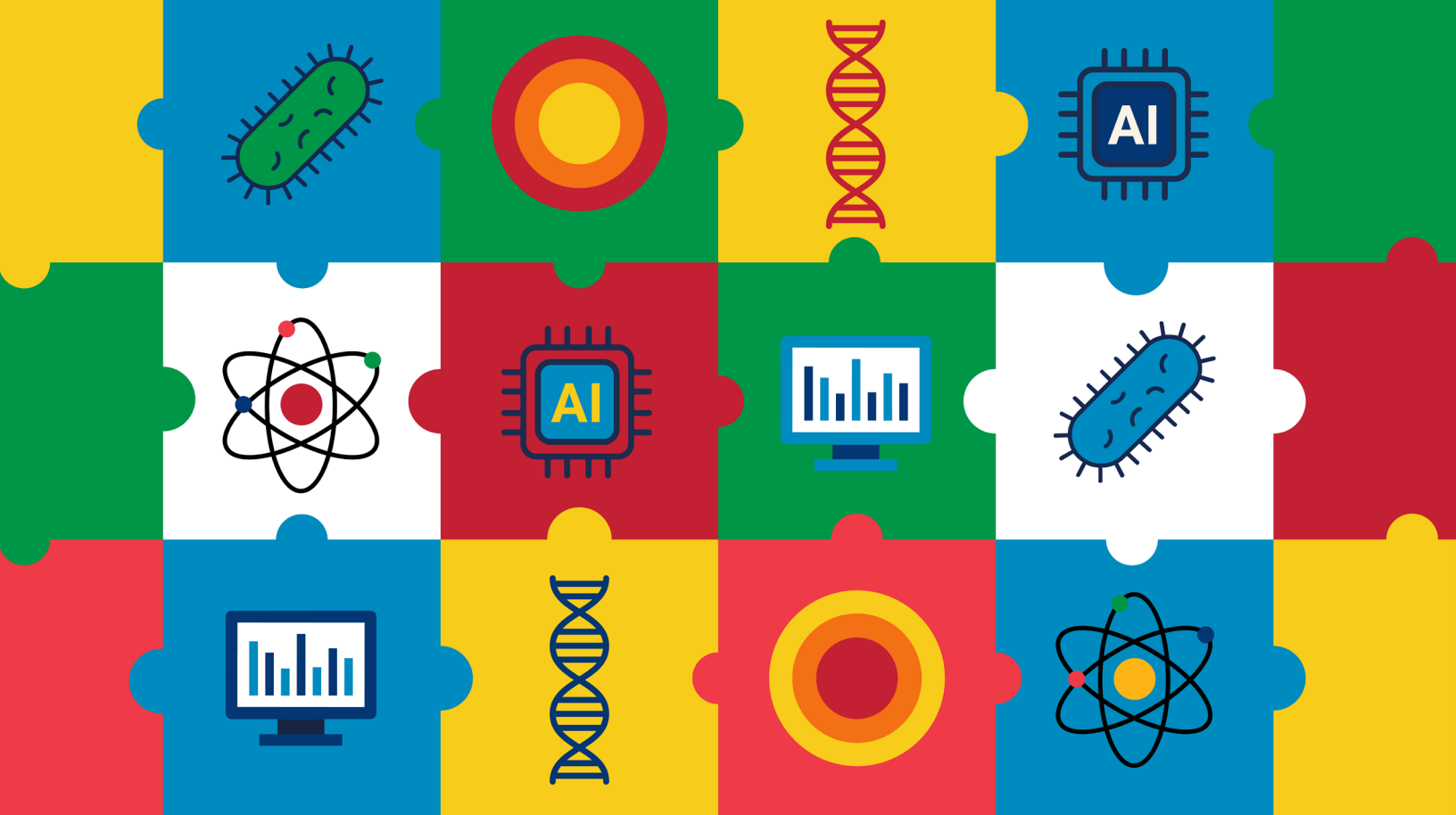
EDUCATION WITH IMPACT

The grant is also fostering STEM learning and empowering students to tackle local environmental challenges. The project connects local high school teachers and students with CMU's Pre-College program in Computational Biology and the Summer Academy for Math and Science. Each summer, about 160 students, including five recruited from Pittsburgh-area high schools, will study the Hazelwood Green site, analyze microbial communities, and gain experience in metagenomics and automated biology.

"I'm excited about this project because it's local and culturally relevant to community stakeholders," said Michael Young, associate dean for community engagement and associate professor of mathematical sciences. "My goal, particularly with students who might come from underserved schools or school districts, is very simple: I want them to learn new things and I want them to have a good experience. Academic and scientific rewards will be reaped later."

If successful, this work could turn Pittsburgh's industrial past into a model for sustainable cleanup — and inspire the next generation of scientists.

AMY PAVLAK LAIRD



SIX PROJECTS AWARDED JONES *Interdisciplinary Seed Funding*

Carnegie Mellon University research projects are pushing science at its boundaries through interdisciplinary collaborations.

Six projects are part of the inaugural cohort of recipients of the Carl & Amy Jones Endowed Interdisciplinary Fund, which supports early-stage interdisciplinary research in foundational sciences. Each project will receive \$100,000 over two years.

“Some of the most important scientific breakthroughs happen at the boundaries between disciplines,” said Barbara Shinn-Cunningham, Glen de Vries Dean of the Mellon College of Science. “The Carl & Amy Jones Endowed Interdisciplinary Fund gives our faculty the freedom to explore bold ideas where foundational science, data, and technology come together to address complex problems facing society.”

For the initial cohort nearly three dozen proposals were submitted.

“We received an impressive number of strong proposals,” said Manfred Paulini, MCS associate dean for research. “The six projects selected stood out for their scientific depth, interdisciplinary collaboration and clear potential to scale into sustained research programs.”

The projects include:

Breaking the curse of dimensionality in scientific computing

Nicholas Boffi, assistant professor in the Department of Mathematical Sciences, and Max Simchowitz, assistant professor in the Machine Learning Department, aim to adapt powerful reinforcement learning tools to better model complex phenomena such as climate events and molecular interactions while positioning CMU to lead the emerging field of scientific machine learning.

Beyond antibiotics

Drew Bridges, assistant professor in the Department of Biological Sciences, in collaboration with Oana

Carja, associate professor in the Ray and Stephanie Lane Computational Biology Department, is aiming to develop drugs that alter bacterial behavior, potentially slowing the rise of antibiotic resistance and opening a new front in infection control.

AI from particle physics to fusion — and back

Matteo Cremonesi, assistant professor in the Department of Physics, and Jeff Schneider, research professor in the Robotics Institute, aim to transfer real-time AI tools between particle physics and fusion energy research. By adapting machine learning systems the project could transform both fields and accelerate discovery.

When noncoding variants disrupt RNA

Jonathan Henninger, assistant professor in the Department of Biological Sciences, and Martin Zhang, assistant professor in the Department of Computational Biology, are exploring how genetic variants outside of genes themselves contribute to disease. By uncovering how changes in RNA influence gene regulation, the project seeks to open new avenues for understanding disease risk and developing RNA-based therapies.

Six differences in stroke recovery

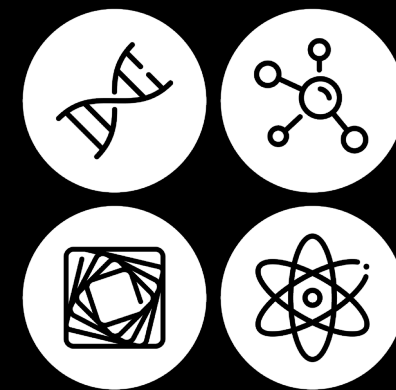
Kate Hong, assistant professor in the Department of Biological Sciences, and Pulkit Grover, professor in the Departments of Electrical & Computer Engineering, Biomedical Engineering and the Neuroscience Institute, are investigating why recovery from stroke differs between sexes. The research aims to uncover hormone-driven mechanisms of neural repair and to lay groundwork for personalized stroke therapies.

Autonomous discovery for condensate dysregulation

Huaiying Zhang, associate professor in the Department of Biological Sciences, and Jose Lugo-Martinez, assistant professor in the Department of Computational Biology, are developing a “self-driving” laboratory that combines automated experiments with machine learning to rapidly study how genetic variants disrupt cellular organization in disease.

The fund was established through a generous gift from Carl Jones, a 1956 MCS alumnus, and his wife, Amy. Their endowment also supports a professorship and an annual lecture celebrating interdisciplinary science.

HEIDI OPDYKE



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Carnegie Mellon Tackles Global Science Diplomacy in the AI Era

In an era of rapid change both in technology and global relations, Carnegie Mellon University is helping to show academia's steadfast role as a mediator and conduit for conversation. The deans and faculty of the university's seven schools and colleges often travel abroad to engage in critical discussions on the value of research and education.

In January, the American Academy of Arts and Sciences held a collaborative roundtable with the Royal Society in London, centered on science diplomacy in the modern world and the ways in which academics and advocates for knowledge must approach the concept.

The event brought together politicians and experts from around the world to discuss the value of science diplomacy. Barbara Shinn-Cunningham, Glen de Vries Dean of the Mellon College of Science, spoke as part of the event.

"For a long time, scientists enjoyed the luxury of not worrying much about policy or public debate," Shinn-Cunningham said. "Culturally, engaging with such questions was often seen as a distraction or even a sully of the scientific enterprise."

Instead, she said scientists, engineers and researchers have a growing responsibility to communicate the importance of their work to decision-makers and everyday people.

"We need to explain why science matters: how it fuels economies, trains the workforce,

mitigates or even cures disease and helps address existential challenges like climate change," she said. "And, sometimes, science is just about basic discovery whose ultimate impact is unknowable."

Shinn-Cunningham also spoke about the development of artificial intelligence and how it increases the need for clear communication from experts.

"Modern science — including my own field of neuroscience — produces data at a scale and complexity that no human could interpret alone. AI is no longer optional; it is essential to discovery," Shinn-Cunningham said. "As a tool, AI dramatically accelerates discovery, but only when it is grounded in deep domain knowledge, with constraints built into the computation."

When it comes to science diplomacy, Shinn-Cunningham said that artificial intelligence both creates opportunities for scientific advancement and reinforces the need for clear communication and trust.

"As AI becomes inseparable from science, maintaining trust requires that these systems embody the same principles that have always defined scientific progress: rigor, transparency, reproducibility, and accountability," she said.

ALEXANDER JOHNSON

Barbara Shinn-Cunningham (second from left), Dean of the Mellon College of Science, speaks as part of a panel at the Royal Society of London.



AI Meets the COSMOS in New Fellows Program

PHYSICS

Carnegie Mellon University has launched the Keystone Astronomy & AI (KAAI) Visiting Fellows Program, an ambitious international initiative designed to accelerate discovery at the intersection of artificial intelligence and astrophysics. Supported by the Simons Foundation Targeted Grants to Institutions, the new program will bring six postdoctoral researchers to the McWilliams Center for Cosmology & Astrophysics over the next three years for immersive, mentored research residencies.

Each KAAI Fellow will spend one month at Carnegie Mellon working intensively with two faculty mentors — one specializing in astrophysics and another in AI or statistics. This dual-mentorship structure is designed to spark breakthroughs in areas where modern machine learning can unlock deeper scientific understanding. Projects will target high-impact challenges such as large-scale cosmological simulations, computational modeling and the analysis of massive astronomical datasets.

"AI is changing how we do science, and astronomy is where its impact will be felt first and fastest," said Tiziana Di Matteo, director of the McWilliams Center and principal investigator for the program. "With KAAI Fellows, we're turning the McWilliams Center's cross-disciplinary strength into a global training engine — bringing visiting scholars together with our machine-learning and astrophysics teams to develop methods that move the field and the way science is done."

The program also creates significant opportunities for Carnegie Mellon graduate students, who will collaborate directly with visiting fellows and contribute to a shared ecosystem of tools, workflows and software. Di Matteo emphasized that the KAAI model pairs training with impact: each month-long residency culminates in a weeklong workshop designed to share methods, datasets and code with the international community. These workshops will help accelerate adoption of trustworthy, cutting-edge AI tools across astronomy.

The initiative draws on the McWilliams Center's deep ties with CMU's Department of Physics, the



Barnabás Póczos and Tiziana Di Matteo

School of Computer Science, and the Department of Statistics & Data Science, along with partners such as the Pittsburgh Supercomputing Center and the University of Pittsburgh. The program's interdisciplinary backbone includes the Department of Machine Learning and CMU's Statistical Methods for the Physical Sciences Research Center (STAMPS).

Barnabás Póczos, associate professor in the Machine Learning Department and the program's AI/ML director, said machine learning is redefining what scientists can uncover from astronomical data.

"It is exciting to see how the newly developed machine learning methods are transforming the way we approach science," Póczos said. "In astrophysics particularly, these tools are reshaping how we explore vast and complex datasets, enabling us to extract subtle signals, identify rare and interesting events, accelerate scientific simulations and test physical theories at unprecedented scale."

The KAAI Fellows Program aims to build a global community of scientists fluent in both astrophysics and AI, prepared to tackle the next generation of data-driven discovery.

As Di Matteo put it, "We're working to develop a global community of international experts in subfields related to AI and astronomy. Supported by Simons, the workshops will bring together experts from machine learning and astronomy to drive the field forward."

HEIDI OPDYKE

Outside Support Fuels Scientific Innovation

Breakthroughs begin with a question — but it takes support to pursue the answer.

Across Carnegie Mellon University's Mellon College of Science, discoveries are made possible in large part with resources provided by federal agencies, but also critically with the help of a network of corporate partners, private foundations and individual donors. These investments give faculty and students the freedom to push boundaries and create breakthroughs.

"External support is often the catalyst that transforms promising ideas into meaningful discoveries," said Jeff Miracle, chief advancement officer for the Mellon College of Science. "It gives researchers the flexibility to pursue high-risk, high-reward work and ensures that students can engage in hands-on learning that prepares them to lead in science and beyond."

With federal research funding more competitive than ever, partnerships with corporations and foundations have become essential to advancing new ideas from concept to impact.

As part of the MCS advancement team, Edward Dunlea, senior director of corporate and foundation relations, and Ally Jump, associate director of corporate and foundation relations, connect MCS with external stakeholders to generate partnerships, funding and collaborative opportunities.

"The groundbreaking science and next-generation talent at universities help corporations tackle real-world challenges within their organizations, and foundations

and alumni accelerate progress in fields that they care deeply about," Dunlea said. "The goal is to find the matches where those interests align with the research interests of MCS researchers."

TACKLING A GLOBAL HEALTH CHALLENGE

For Drew Bridges, assistant professor in the Department of Biological Sciences, that kind of support has been essential.

As antibiotic resistance makes infections harder to treat worldwide, Bridges studies biofilms — communities of bacteria that clump together on surfaces and make infections more resilient. His goal is to prevent infections before they begin.

Early investment from the Shurl and Kay Curci Foundation, a nonprofit dedicated to advancing scientific knowledge and medical progress, makes his work possible.

"The Curci Foundation's support gave us the financial stability and protected time we needed to pursue ambitious, high-risk experiments," Bridges said. "With that backing we could develop and refine the fluorogen activating protein imaging platform. This enabled us to capture high-resolution, long-term movies of entire biofilm communities, something that was impossible with traditional fluorescent proteins."

EARLY-CAREER FUNDING CAN FUEL INNOVATION

Chris Eur, assistant professor of mathematical sciences, was named a 2026 Sloan Research Fellow. Selected from more than 1,000 nominees, the fellowship provides

flexible funding to advance his work at the intersection of algebraic geometry and combinatorics, particularly in matroid theory.

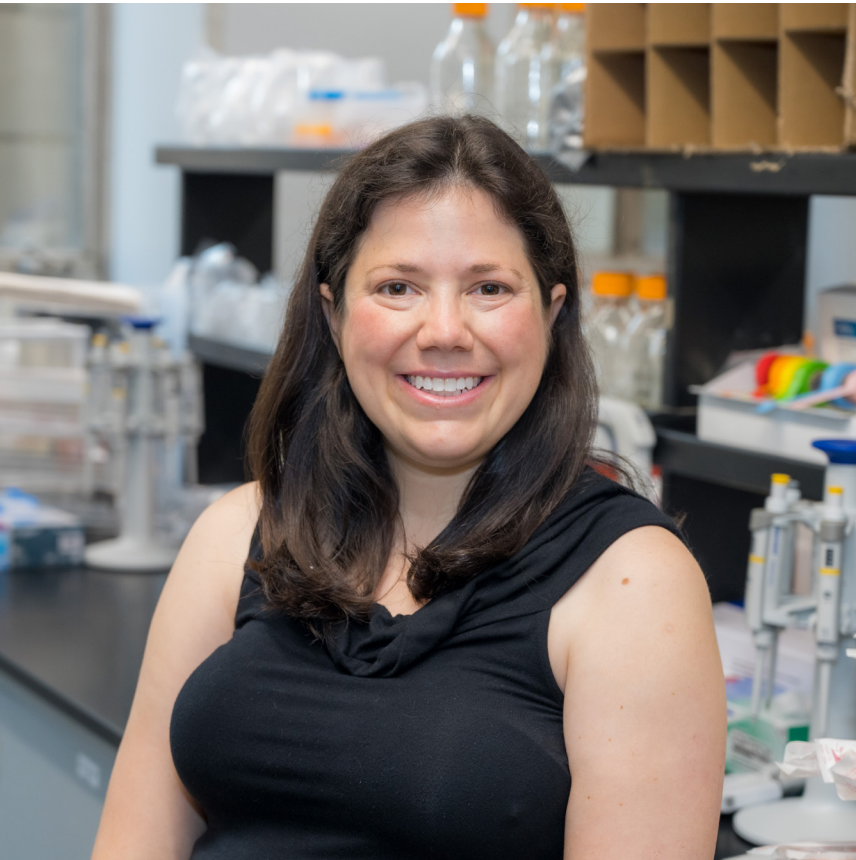
His research explores how geometric methods can illuminate discrete structures such as graphs and matchings, with applications spanning mathematics, computer science and physics. Eur was nominated by June Huh, a Princeton University professor and 2022 Fields Medal recipient, the highest honor in math.

"Chris is among the best in combinatorial algebraic geometry in terms of his ability to prove, compute, and construct," Huh said. "His contributions to recent projects highlight his growing influence in the field. Chris consistently assumes leading roles, collaborates generously, and shows exceptional promise as an emerging leader in the field."

Another early-career winner, Irene Kaplow, assistant professor in the Department of Biological Sciences and the Ray and Stephanie Lane Computational Biology Department, was named a Searle Scholar. The honor, awarded by the Searle Scholars Program, provides funding to support high-risk, high-reward research across disciplines in the biological and chemical sciences.

Kaplow's research examines how gene regulation shapes traits across species, with a focus on enhancers — noncoding regions of the genome that control when and where genes are expressed. Using machine learning, her lab identifies patterns of enhancer activity linked to evolutionary traits and improves predictive models across species.

Irene Kaplow's research examines how gene regulation shapes traits across species, with a focus on enhancers — noncoding regions of the genome that control when and where genes are expressed.



The Searle Scholars award supports her efforts to distinguish genetic signals tied to long-term evolution from those influenced by environmental factors such as diet, advancing understanding of how genetics and environment interact in health and disease.

"This award is going to be incredibly valuable in supporting my work. It will provide support for a Ph.D. student who can focus on some exciting ideas my lab has developed that we have struggled to get funded due to us being a new lab that has not yet produced much preliminary data. It will also allow us to purchase some new equipment that can help us expand cell culture work in the lab."

ADVANCING THE FRONTIERS OF QUANTUM PHYSICS

In physics, foundational support enables exploration at the smallest scales and in the new frontier of the quantum world.

With a \$1.3 million grant from the Gordon and Betty Moore

Foundation, Associate Professor Sufei Shi designs and fabricates moiré superlattices, which are structures formed by overlapping crystal layers, typically two-dimensional semiconductors. His research into the quantum properties of these two-dimensional materials could advance fundamental understanding of light-matter interaction and inform the design of next-generation quantum devices, with implications for quantum information processing and sensing.

"Our approach is unique in combining condensed matter physics and device engineering with knowledge from atomic physics, enabling a new regime of quantum information science: scalable and flexible quantum simulations," he said.

Using advanced nanofabrication and optical techniques, Shi traps and manipulates excitons within moiré structures to control their behavior. This work has the

potential to guide future advances in quantum technologies.

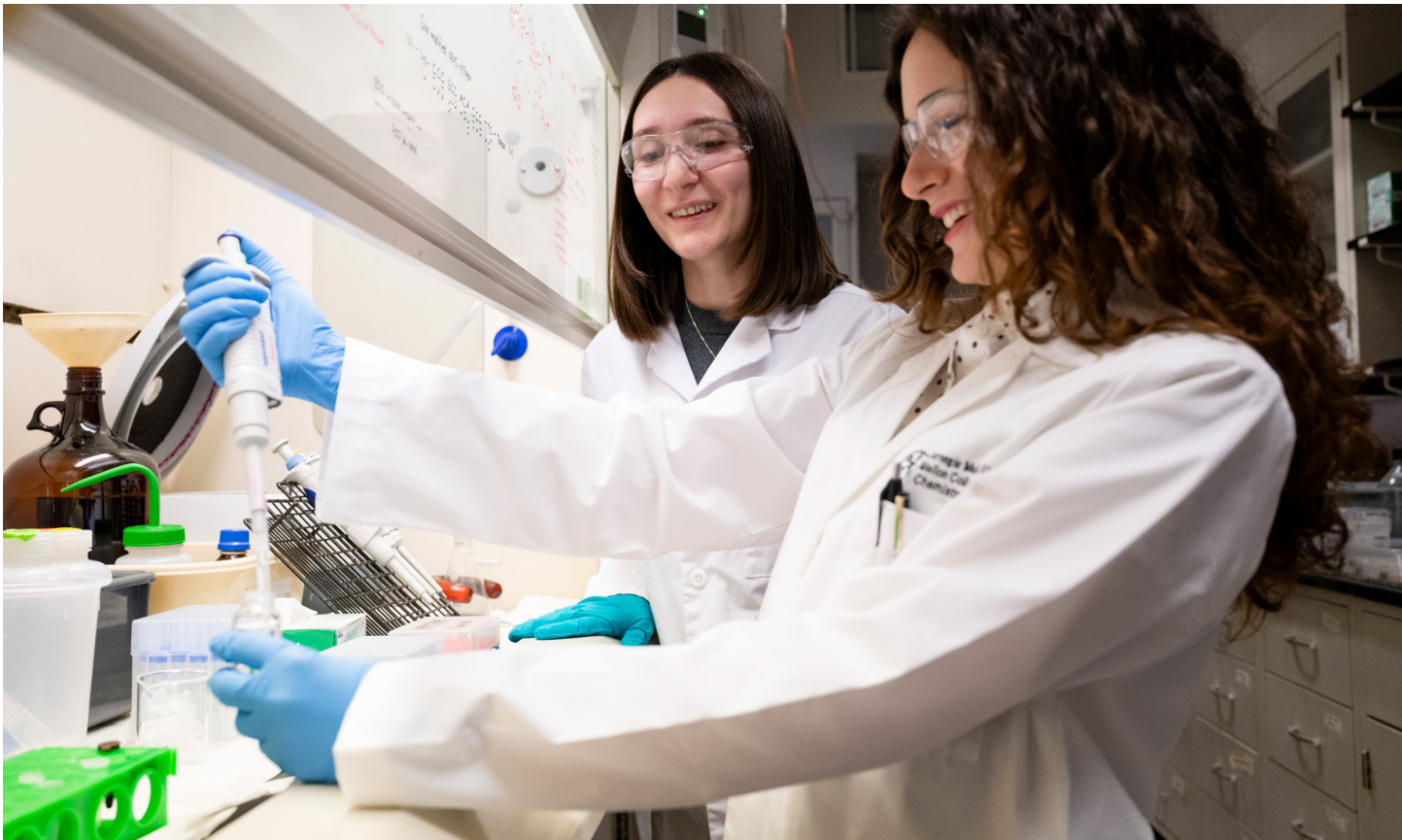
"The Moore Foundation grant has provided me critical support for hiring postdoctoral researchers," Shi said. "It allows me to explore high-risk/high-gain work that would otherwise not be possible."

TRAINING THE NEXT GENERATION OF SCIENTISTS

Foundational support fuels discovery while shaping the next generation of scientists.

In the Department of Chemistry, a gift from the PPG Foundation is creating new opportunities through the PPG Scholar Teams program. By pairing graduate mentors with undergraduate researchers, the program immerses students in collaborative, faculty-led research early in their academic careers.

"It's critical for undergraduates to learn about research in practice while graduate students are in a position to help them grow,"



said Bruce Armitage, professor, department head and co-director of the Center for Nucleic Acid Science and Technology. “The funding from PPG allows the department to support the students and faculty conducting research and build those experiences in ways that are meaningful and sustained.”

Over the summer, the first cohort included five groups, including one in Armitage’s lab. They conducted

a range of chemistry research from developing computational methods to simulate potential solvents to identifying safer ways to remove heavy metals from the bloodstream.

A SHARED INVESTMENT IN THE FUTURE

Together, these partnerships represent a shared investment in MCS faculty and their work. By connecting curiosity with

PPG Scholar Teams program participants Zeynep Yildiz, a Ph.D. candidate, and Christina Tsingi, a senior in chemistry worked on a summer project together in Bruce Armitage’s lab.

opportunity, external partners help ensure that the next generation of breakthroughs — and the scientists who drive them — can take shape at Carnegie Mellon and beyond.

KIRSTEN HEURING

CMU-Q Researchers Discover Novel Mechanism to Suppress Tumors in Breast Cancer

BIOLOGICAL SCIENCES

Researchers at Carnegie Mellon University in Qatar (CMU-Q) have discovered a genetic molecule that could provide new approaches to treating certain types of breast cancer. CMU-Q is a Qatar Foundation partner university.

The discovery is the result of a multi-year collaborative effort led by Ihab Younis, teaching professor of biological sciences at CMU-Q. The paper is co-authored by CMU-Q graduates who began the research while in their undergraduate studies: Boshra Al-Sulaiti, Mariam Elesnawy, Hana Hasna and Aisha Fakhroo, as well as Rim Elghandour, who contributed to the research as a research associate on Younis’s Qatar National Research Fund (QNRF) grant.

The findings, published in the Cell Press journal, iScience, center around a newly identified long non-coding RNA molecule the team has called PINC (PTEN Intronic Non-Coding RNA). The research reveals that PINC functions independently as a tumor suppressor, reducing the growth of endocrine-responsive breast cancer cells.

The project began as a computational screening to compare minor introns between breast cancer and non-breast cancer cells. Minor introns are segments of genetic code that account for 0.4% of human introns, and their function is less understood than other parts of the gene. While studying the tumor suppressor gene PTEN, the team determined that when the intron is prevented from splicing normally, it generates the PINC molecule.

Though the PTEN gene has been studied globally for decades, this specific mechanism had not been previously identified.

“Carnegie Mellon’s research mission is to address real-world issues that will impact people and



Ihab Younis with Mariam Elesnawy and Hana Hasna, two of the alumni co-authors.

societies,” said Michael Trick, dean of CMU-Q. “The Qatar campus has an additional goal to engage our undergraduate students in research as a teaching tool.

“This is an achievement on both fronts: for years, Dr. Younis guided his students through this complex set of questions. Together they discovered a mechanism that could impact how doctors treat certain types of breast cancer. It is truly extraordinary work.”

Younis has been a faculty member at CMU-Q since 2016, and today leads the biological sciences program as area head.

“I treat undergraduate researchers like graduate students,” Younis said. “They take true ownership of the science. Most of these graduates are now pursuing careers in research, and I am so proud that we published this paper and they can see the tangible results of their exceptional hard work.”

Younis is now working on a new phase of the project, studying PINC levels in cells to evaluate potential therapeutic applications, and expanding the project to evaluate three other target genes identified during the initial screening.

Research is part of the fabric of Carnegie Mellon, and the Qatar campus encourages all undergraduates to participate in faculty-led or student-initiated projects. The biological sciences program emphasizes laboratory and research skills, and most graduates pursue careers in research and health sciences.

ANGELA FORD

Partner with the **Mellon College of Science**

Corporate and foundation partners help accelerate discovery and connect with leading researchers and emerging talent. Individual donors play a vital role in advancing innovation and student success.

Start the conversation

CORPORATE AND FOUNDATION PARTNERSHIPS: Edward Dunlea | edunlea@andrew.cmu.edu
INDIVIDUAL GIVING: Jeff Miracle | jeffmiracle@cmu.edu

Inside MCS: Science That Matters, NOW MORE THAN EVER

Walking through Carnegie Mellon University's Mellon Institute on a quiet morning, one might find a researcher watching a set of experiments unfold that could shape new therapies or more sustainable materials. On another floor, chemists are orchestrating algorithms trained to recognize patterns in molecules, accelerating discoveries with implications in medicine and industry. At Wean Hall, mathematicians are refining the logic that underpins those algorithms, helping to power advances in technology and data-driven decision-making, while physicists parse signals from the farthest reaches of the universe, expanding our understanding of fundamental science in ways that often ripple into everyday innovation.

Though their questions differ, their work shares a common purpose: to understand, to solve and to improve.

This is Science that Matters — the Mellon College of Science's commitment to discovery that expands human knowledge while strengthening society.

"Science is essential to understanding our world — from the smallest biological process to the vast expanse of the universe," said Barbara Shinn-Cunningham, Glen de Vries Dean of the Mellon College of Science. "It drives the innovations that improve lives, fuels economic progress and prepares the next generation of talent."

At MCS, discovery begins with fundamental questions: How do molecular interactions within cells give rise to health and disease? How does the brain produce thought and behavior? What mathematical structures govern complexity and uncertainty? What is the universe made of — and how did it evolve? How can we design chemicals that are both effective and environmentally responsible?

From these questions, researchers move toward solutions that improve health, enable new technologies, protect the environment and deepen our understanding of the world.

Understanding life, advancing health

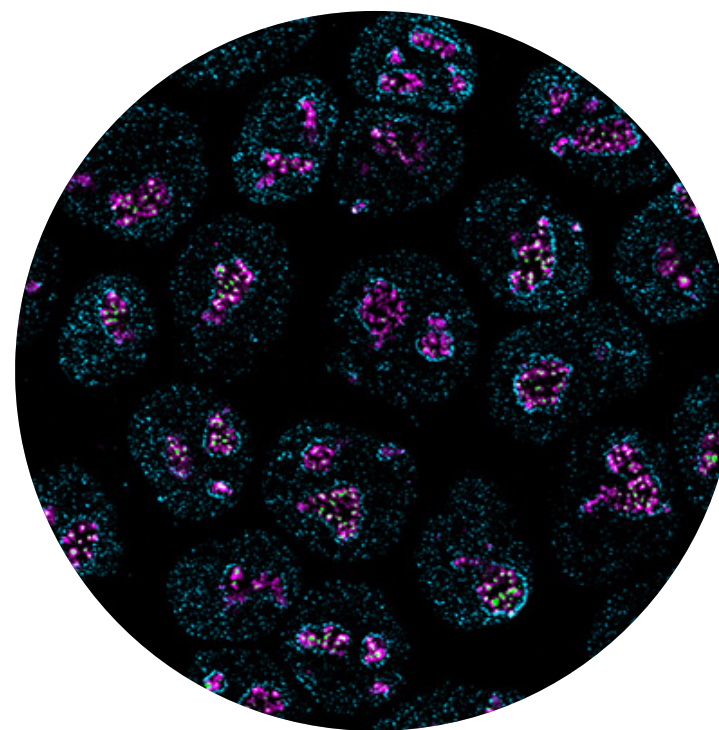
In the biological sciences, MCS researchers investigate life across scales — from molecules to organisms — revealing the mechanisms that drive development, evolution and disease. Their work uncovers how infections spread, how cancers grow, how resistance to antibiotics emerges and how complex cellular systems function and fail.

These insights form the groundwork for new diagnostics, therapies and strategies for prevention.

Increasingly, discovery is powered by the integration of data-rich experimentation with artificial intelligence, advanced imaging and quantitative analysis. This convergence accelerates the pace of research and enables predictive models that shift biology from observation to anticipation.

One example is the work being conducted by Jonathan Henninger, assistant professor in biological sciences. His laboratory, in collaboration with labs at MIT, recently identified a mechanism that controls how biomolecular condensates — tiny liquid-like droplets inside a cell that acts like a specialized compartment to organize and group molecules — form patterns that can be disrupted in diseases like cancer and neurodegeneration.

"This research speaks to an entirely new field of studying how condensates are patterned in a cell," Henninger said. "Many condensates show very different patterns throughout cells, but we're



This microscope image shows many cell nuclei. Within each nucleus, the pink color marks the nucleolus, where ribosomes are initially produced. The green dots inside of the nucleolus are biomolecular condensates, which organize into distinct patterns.

"The goal sounded almost simple," she said. "Make two proteins interact exclusively with each other. But of course, it was not simple at all."

The project, which spanned years and multiple experimental systems, sits at the intersection of protein engineering, cell biology and neuroscience. At the center of the work are gap junctions, natural protein channels that allow neighboring cells to directly exchange electrical and chemical signals.

Ransey and colleagues built upon these channels to develop LinCx (Long-term Integration of Neural Circuits using Connexins), to synchronize target neural circuits in living animals. Natural gap junctions are difficult to control because they form broadly and unpredictably across cells. LinCx instead uses a paired, two-component system: two modified gap junction proteins that selectively dock with one another, allowing researchers to create electrical connections selectively between target neural cell populations.

"One of the most important developments was showing that this kind of engineered specificity can work in mammalian systems," she said. "The proteins largely ignore native mammalian connexins, allowing us to introduce new connections without broadly interfering with existing communication networks."

Understanding the brain

In neuroscience, researchers seek to understand one of science's greatest frontiers: the human brain. At MCS, this work spans molecular, systems, cognitive and computational levels — linking cells to circuits, and circuits to perception, learning and behavior.

That integration is yielding tangible progress. Today, researchers are significantly closer to new treatments for disorders such as Parkinson's disease, epilepsy, Alzheimer's disease and autism than they were just a few years ago.

In a recent paper, Elizabeth Ransey, an assistant professor in biological sciences, demonstrated precision control over neuronal communication by engineering artificial electrical connections between specific types of brain cells. The work has potential applications for treating neurological and psychiatric disorders where faulty communication between brain regions play a key role.

Achieving that level of precision required engineering the molecular machinery that connects cells: channel forming proteins.

Mathematical discoveries shape the world around us

Behind advances in image processing, financial trading, global logistics and even Spotify's ad targeting systems is the same essential foundation: mathematics.

Mathematics is an engine of modern discovery — providing the language, tools and structure behind breakthroughs across science and technology. Faculty are advancing the frontiers of applied analysis, discrete mathematics, logic, computation, finance and probability, while deepening strengths in areas like number theory and algebraic geometry. Together, this work powers innovation in AI, finance, materials science, public policy and beyond.

Researchers also are redefining how mathematics itself is practiced. Efforts in AI-assisted reasoning and formal proof verification are enabling mathematical knowledge to be encoded, tested and trusted in entirely new ways. At the same time, advances in stochastic modeling and computational mathematics are helping scientists better understand uncertainty, risk and complexity in real-world systems — from supply chains to digital platforms where optimization algorithms ensure the right content reaches the right audience at the right time.

“Clearly AI is going to be disruptive, but exciting too,” said Prasad Tetali, the Alexander M. Knaster Professor and head of the Department of Mathematical Sciences. “The progress in AI technology is too rapid to predict the precise extent of how research and education in math will evolve in the next few years. We are constantly discussing and taking steps to adapt what and how we ‘do the math’, but also what we should be teaching without compromising on the rigor.”

Designing the molecules of the future

In chemistry, MCS researchers are designing the building blocks of modern life — molecules and materials that drive advances in sustainability, medicine and advanced manufacturing.

Their work spans catalytic processes, recyclable polymers, nucleic acid chemistry and environmental and analytical techniques. Increasingly, it also includes the “lab of the future,” where automation, robotics and AI accelerate discovery and improve safety.

By connecting quantum theory with computation and experiment, MCS chemists are creating pathways to cleaner energy, innovative therapeutics and environmentally responsible materials.

More than 10,000 synthetic chemicals are used to make plastic products. Advancing sustainable chemistry requires the capability to predict what changes chemicals may undergo and what happens to the resulting transformation products.

Ryan Sullivan, associate director of Carnegie Mellon University’s Institute for Green Science and professor of chemistry and mechanical engineering; Carrie McDonough, assistant professor of chemistry; Olexandr Isayev, the Carl & Amy Jones Professor of Interdisciplinary Science;

and Ana Torres, assistant professor of chemical engineering, are working to change that.

The researchers are developing high-throughput experimental and computational methods that acquire the chemical data needed to inform environmental molecular lifecycles. They said that these environmental and biological chemical reaction networks will screen for transformation products that are likely persistent or prone to bioaccumulation. This more rapid chemicals analysis will then guide sustainable chemical assessment such that likely harmful chemicals can be identified much earlier in their development lifecycle.

“Our big focus is to assess the ability to predict the fate of a molecule under environmental and biological conditions. What does it turn into? And where does it go?” Sullivan said.

Sullivan said that by understanding how molecules can transform and how quickly under different conditions, the data can inform how long they’ll exist in the environment.

“It’s an understudied — but important — topic,” he said. “We need to work to connect the world of environmental chemistry and what we know and how we use that information to better evaluate and design chemicals and materials that are more sustainable in nature.”

Exploring matter, energy and the cosmos

In physics, MCS scientists investigate the fundamental laws that govern the universe — from the smallest particles to the largest cosmic structures.

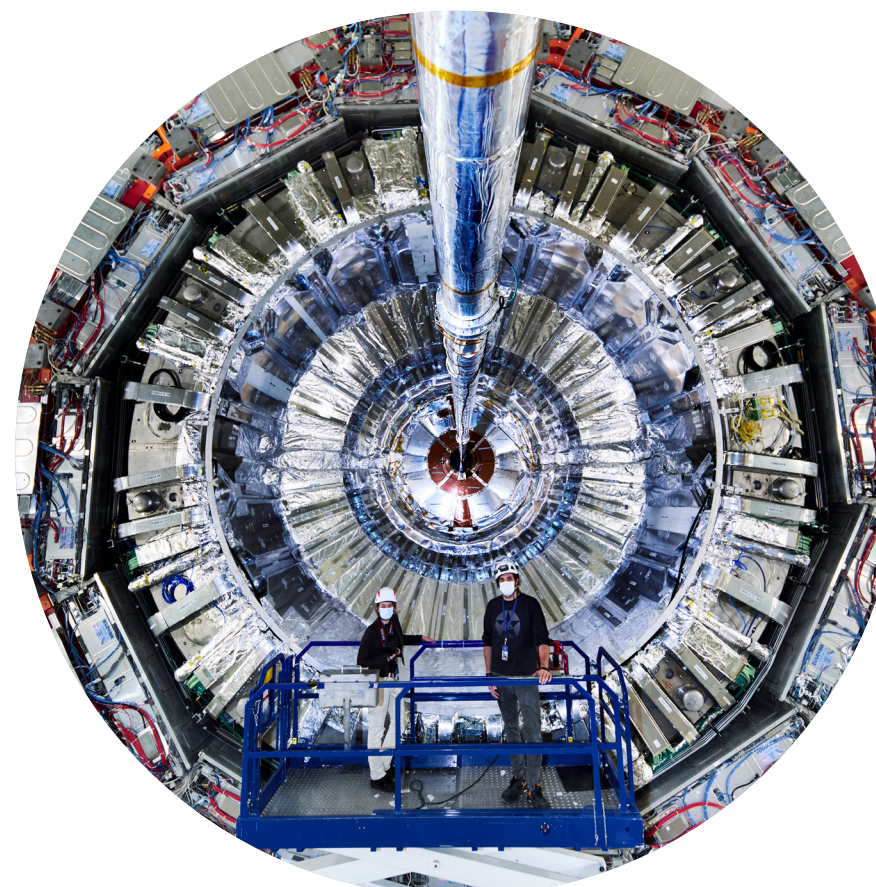
Their research ranges from gravitational waves and multi-messenger astrophysics to quantum materials and technologies. Through collaborations such as the McWilliams Center for Cosmology & Astrophysics and the Pittsburgh Quantum Institute, they work across disciplines to tackle some of science’s most profound questions: What is the universe made of? How did it evolve? What laws govern it?

Using advanced instrumentation, large-scale simulations, theoretical models and AI-driven analysis, they are expanding the boundaries of what we can observe and understand — while enabling next-generation sensing, computing and modeling capabilities.

“Advancing the frontiers of physics requires a global effort, one that brings together major collaborations, advanced computational efforts together with AI,” said Manfred Paulini, associate dean for research and professor of physics. “At Carnegie Mellon, we contribute deep expertise in data analysis, instrumentation and AI to international initiatives such as the CMS experiment at CERN and the Vera C. Rubin Observatory, along with other international collaborations that expand our understanding from the smallest particles to quantum materials, living cells and the universe.”

Paulini said what makes this especially powerful is how closely research and education are linked: MCS students are directly engaged in these efforts, gaining hands-on experience with the most ambitious scientific projects in the world.

Recent doctoral graduate Kyungmin Park helped scientists make faster, smarter decisions about which particle collisions to study at CERN, the world’s largest particle physics laboratory located near Geneva. Her work is part of the Next Generation Trigger (NextGen) project, which aims to revolutionize how data is filtered and analyzed at the Large Hadron Collider (LHC).



“By integrating global partnerships with CMU’s strengths in science, engineering, and AI, we not only accelerate discovery but also prepare the next generation of scientists to lead it,” he said.

Convergence for impact

What unites this work is not just excellence within disciplines, but the deliberate integration of discovery, application and innovation across them. At MCS, theory, experimentation, computation, automation and AI form a continuous ecosystem — one in which fundamental insights inform applied research and technological advances, in turn, open new frontiers for discovery. This convergence reflects a distinctly Carnegie Mellon approach: bringing together scientists, engineers and technologists to accelerate progress in ways no single approach could achieve alone. The result is a model of science that becomes more predictive, efficient and responsive — linking curiosity-driven inquiry with the tools to translate knowledge into societal impact.

“The most important scientific advances today happen at the boundaries between disciplines,” Shinn-Cunningham said. “At the Mellon College of Science, we intentionally position ourselves at that intersection and bring together expertise in science, engineering and artificial intelligence to tackle problems no single field can solve alone. By building on Carnegie Mellon’s unique strengths across those areas, we create an environment where collaboration drives discovery and where new ideas can move seamlessly from fundamental insight to application and real-world impact.”

A purpose-driven future

“Science that Matters” has become a guiding principle for MCS, Shinn-Cunningham said — not as a departure from foundational research, but as an extension of its value. By advancing fundamental knowledge while cultivating pathways to application, MCS researchers ensure that discovery is part of a larger continuum. Ideas evolve into solutions, technologies and deeper understanding, reinforcing the essential role of science as both a driver of innovation and a public good. Together, this integrated approach helps build a world that is safer, healthier and more resilient.

EDWARD DUNLEA & HEIDI OPDYKE

Faculty Awards



GILLIAN RYAN

2026 Julius Ashkin Teaching Award

The Julius Ashkin Teaching Award recognizes unusual devotion and effectiveness in teaching undergraduate students in the Mellon College of Science.

TOM BOHMAN

2026 Richard Moore Education Award

The Richard Moore Education Award recognizes MCS faculty members who have made substantial and sustained contributions to the educational mission of the college, particularly faculty members whose educational contributions to the college have extended over a substantial portion of their academic careers.



MICHAEL YOUNG

2026 Mark Gelfand Award for Educational Outreach

The Mark Gelfand Award for Educational Outreach recognizes a member of the CMU community who has combined sustained, effective community service with academic coursework and a deliberate process of student reflection to enhance the learning experience, teach social responsibility and improve life in the community.



Vyas Thinks Through Neuroscience Research

Saurabh Vyas wants to learn how people think, and he's using a combination of engineering, cognitive science and artificial intelligence to find out.

The brain can absorb new information and use it to navigate unfamiliar situations. In school, people learn skills like multiplying numbers, and later, in everyday life, they can apply those same methods to solve problems — such as calculating the tip on a restaurant bill.

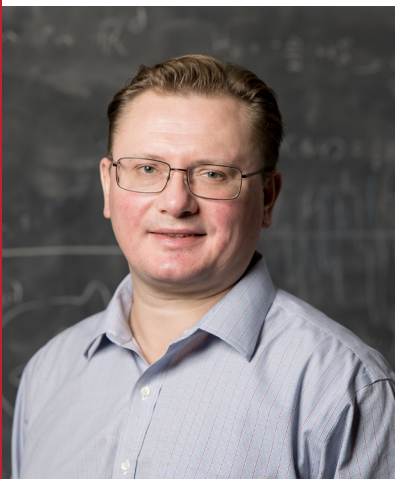
Vyas, who joined Carnegie Mellon University's Neuroscience Institute and Department of Biomedical Engineering as an assistant professor in January 2026, aims to understand how the brain encodes information during learning and later retrieves it in new contexts.

Vyas investigates how the brain learns and recalls skills through an iterative cycle, beginning with artificial intelligence models and gradually integrating insights from biological experiments. He starts by training and testing AI models to solve new tasks. As these models learn, Vyas analyzes their behavior and refines their structure until they accurately reflect current understanding of the brain.

"In an artificial system, you have access to everything; you know exactly what that system is trying to do, and critically, how exactly it's doing it. That gives us an unusually good starting hypothesis for what to look for in real brain data," Vyas said.

Vyas joined Carnegie Mellon after completing a postdoctoral fellowship at Columbia University. He has started building his lab at Carnegie Mellon — the Laboratory of General Intelligence and Computation (LOGIC) — and will begin teaching graduate computational neuroscience courses in Spring 2027.

KIRSTEN HEURING



Mathematical Finance Expert Nadtochiy Joins CMU

Equations and probabilities are part of everyday work for Sergey Nadtochiy. Joining Carnegie Mellon University's mathematical finance group was a logical next step.

Nadtochiy's work is at the intersection of mathematical finance, probability and partial differential equations. He uses the mathematical tools from probability and differential equations to describe how quantities change over time and space — to examine systems that may or may not have some level of randomness in them, such as the stock market.

An example of Nadtochiy's research is the study of how an initial shock in a system affects other parts of the same system, such as how one bank defaulting can lead to a larger financial crisis. The equation demonstrates cascading effects that are very similar to those appearing in many other physical and biological phenomena, such as the synchronization of neurons.

"The beauty of mathematics is that very often you start working on a problem that has a clear interpretation in one discipline, but then you realize the mathematical structure behind it is actually so general, you can find applications in completely different disciplines," Nadtochiy said.

Nadtochiy earned his Ph.D. in operations research from Princeton University. Among his awards, he received an NSF CAREER Grant in 2017, NSF Grants in 2014 and 2021 and was awarded SIAM Activity Group on Financial Mathematics and Engineering Junior Scientist Prize in 2012 from the Society for Industrial and Applied Mathematics.

KIRSTEN HEURING

Badre Leads Carnegie Mellon’s Neuroscience Institute

Renowned cognitive neuroscientist David Badre joined Carnegie Mellon University as director of the Neuroscience Institute beginning July 1, 2026.

“David Badre is a world-class neuroscientist whose work has deepened our understanding of how the brain supports planning, decision-making and goal-directed behavior,” said Barbara Shinn-Cunningham, Glen de Vries Dean of the Mellon College of Science and former Neuroscience Institute director. “But even more importantly, he is an exceptional leader who communicates complex ideas clearly and builds strong interdisciplinary communities. I’m thrilled for the Neuroscience Institute to have a dynamic leader like David who will champion our research community and advocate for neuroscience — and for science more broadly.”

Badre is the second director for the Neuroscience Institute, which was established in 2018 under Shinn-Cunningham. Tim Verstynen served as the interim director since January 2025. The institute — administered by the Mellon College of Science and the Dietrich College of Humanities and Social Sciences — unites faculty, researchers and students from across nearly every college at Carnegie Mellon to advance brain science and real-world applications.

Richard Scheines, former Bess Family Dean of the Dietrich College, said neuroscience at Carnegie Mellon is truly interdisciplinary.

“We are examining the brain through collaborations among biologists, computational biologists, machine learning faculty, cognitive neuroscientists, biomedical engineers, roboticists and medical researchers,” Scheines said. “In his own research on how human brains support making plans and then acting to implement these plans, David Badre practices exactly this kind of interdisciplinary neuroscience. I don’t think we could have found someone better suited to take the Neuroscience Institute to the next level.”

As the Neuroscience Institute director, Badre leads interdisciplinary teams of neuroscientists, psychologists, data scientists, computer scientists and engineers who are driving the next wave of innovation — advancing brain-computer interfaces, machine learning for mental health and new insights into human cognition.

Badre was a professor of cognitive and psychological services at Brown University, which he joined in 2008



and where he served as department chair since 2022. He was an affiliate of the Carney Institute for Brain Science and a trainer in the Neuroscience Graduate Program.

A Fellow of the Association for Psychological Science and the Cognitive Science Society, Badre has served as editor or on the editorial boards of several journals. He is a former chair of the Cognition and Perception Study Section of the National Institutes of Health (NIH) and former co-chair of the NIH Director’s New Innovator Award Editorial Board.

Badre’s research focuses on cognitive control, which concerns how the brain translates goals and plans into concrete behaviors. His work is supported by the NIH and through the Office of Naval Research.

Among his accolades are an Alfred P. Sloan Foundation Fellowship in Neuroscience, a James S. McDonnell Scholar Award in Understanding Human Cognition and the Cognitive Neuroscience Society Young Investigator Award. He was awarded Brown’s Mid-Career Achievement Award in 2022 and was a finalist for the PROSE Award from the Association of American Publishers for his 2020 book, “On Task.” He is currently working on a book about the neuroscience of human error.

HEIDI OPDYKE

Scan the QR code to view the video series about Mindy and how she assists our grad students in career development.



MCS Welcomes First Career Consultant Dedicated to Graduate Students

Mindy Somerville has spent her career empowering students to succeed. Now, she’s bringing that passion to the Mellon College of Science, where she is helping master’s of science and doctoral students build the skills and confidence they need to thrive in their careers.

Somerville is the first dedicated career consultant for MCS graduate students. She joins Rachel Rosenfeld, who serves as a career consultant for MCS undergraduate students, and Marcie Foy, who assists with doctoral students.

“Students of all ages are navigating transitions, new experiences, and skill development that supports their future goals,” said Somerville, who began at Carnegie Mellon’s Career and Professional Development Center as an associate director in July 2025. “This is an exciting group of people to work with as they are experiencing so many emotions and changes all at once, and getting access to support and guidance is often the difference between those who succeed versus struggle.”

In her role at MCS, Somerville offers a wide range of services tailored to the career development needs of master’s students. She meets individually with students to review resumes, CVs, cover letters and statements of purpose. She also is available to help students strategize job, internship or Ph.D. searches as well as conduct mock interviews.

HEIDI OPDYKE

When Abstract Problems Take Shape

MATHEMATICIAN FLORIAN FRICK LOOKS AT PROBLEMS AS SHAPES, REVEALING SOLUTIONS INVISIBLE FROM A SINGLE PERSPECTIVE

Magic Eye posters from the 1990s hid three-dimensional images in what looked like a swirl of dots and colors. At first glance, you see only noise. Change your focus, and suddenly a shape appears.

Carnegie Mellon University mathematician Florian Frick studies something similar in mathematics. His work explores how problems related to fairness, arrangements and patterns can reveal hidden geometric structure when viewed from the right perspective.

“Mathematics is a kind of mapmaking for abstract worlds,” Frick said. “I enjoy the process of taking an abstract problem and translating it into something that I can reason about visually.”

Frick, an associate professor of mathematical sciences, works at the intersection of geometry, topology and combinatorics. Geometry is the study of shape. Topology looks at the features of shapes that stay the same when they are stretched or bent. Combinatorics studies discrete structures like arrangements, selections and patterns. By bringing these fields together, Frick turns problems that don't seem geometric into questions about spaces, symmetry and overall structure. He describes it as geometry in action.

This idea is already familiar in everyday language.

“People talk about a ‘political landscape’ to describe a complicated arrangement of views, alliances and tensions. The phrase suggests that you may want to understand the terrain as a whole, because it may not be enough to look at one position at a time,” Frick said.

Frick’s research puts this concept into mathematical terms. For many problems, all possible solutions can be organized into a kind of geometric space. Once that space is built, its shape can reveal information that is not visible from any single point of view.

“I enjoy the process of taking an abstract problem and translating it into something that I can reason about visually.”



THE SHAPE OF FAIRNESS

Consider the problem of fairly dividing rent among roommates. Imagine several roommates are sharing an apartment with different-sized bedrooms. Each room has its own advantages, and each person may value those features differently. The question is: Can the rent be divided among the rooms so that everyone gets a room they prefer without anyone feeling envious?

At first glance, this sounds like a practical problem. But if you look at it mathematically, it takes on a geometric shape. If a point represents one way of assigning prices to the rooms, in a three-roommate case, the possible rent divisions form a triangle. If there were four roommates, it would form a tetrahedron. More generally, they form a higher-dimensional simplex.

Instead of checking one rent split at a time, mathematicians study the entire space of possibilities

at once. “A single proposed rent split may fail. Many proposed splits may fail. But the overall shape of the space of possible splits may force a fair solution to exist somewhere,” Frick said.

Frick and his collaborators explored a twist on this classical problem: what if the preferences of one roommate are unknown? They showed that a fair rent division exists, even without knowledge of the preferences of one of the roommates. Their proof is constructive, providing a recipe for how to actually compute an envy-free rent division. Frick’s work was featured in an episode of PBS’s Infinite Series called Splitting Rent with Triangles.

GEOMETRY BEYOND THE VISIBLE

This type of problem reflects a broader theme in Frick’s research.

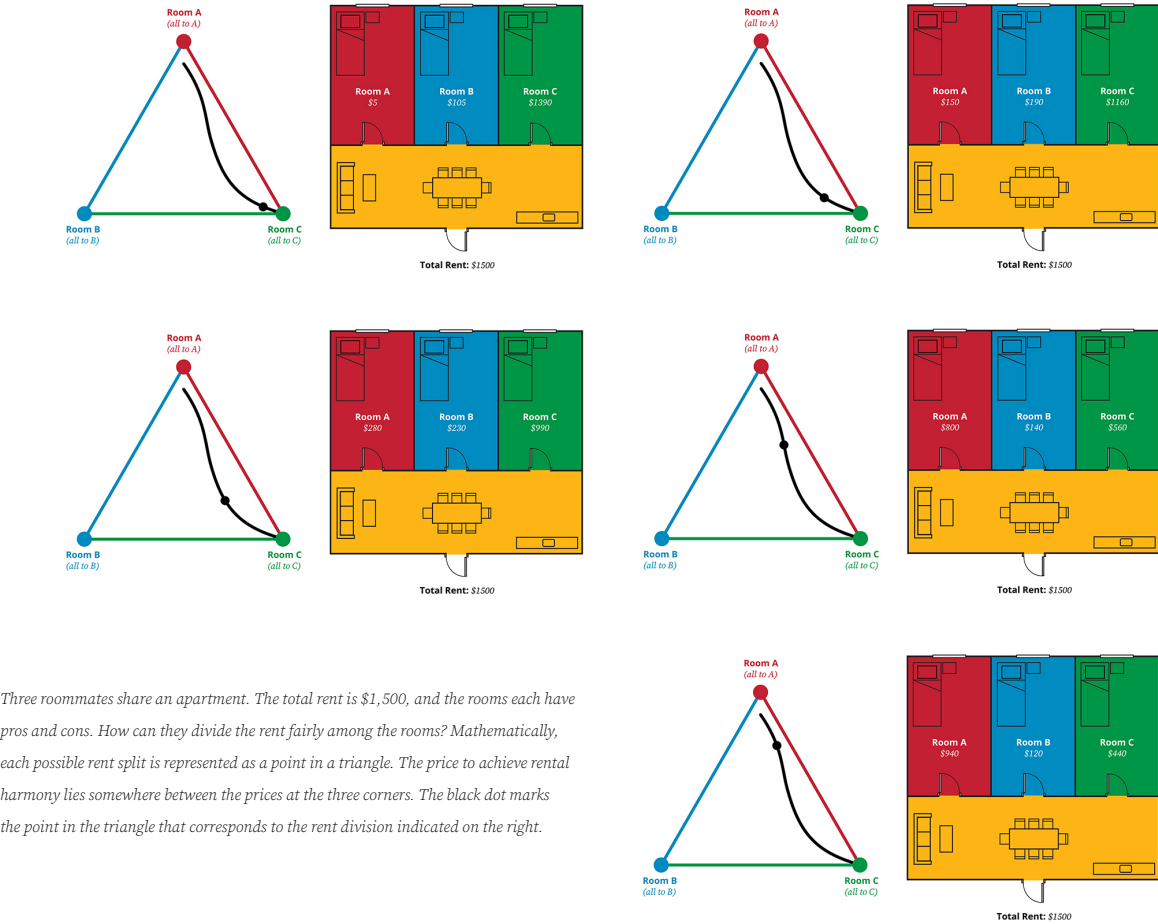
“When I look at a problem, I parameterize the space of all possible solutions. I use the word space because it is a geometric object,” Frick said. “And on this geometric object I use geometric and topological tools

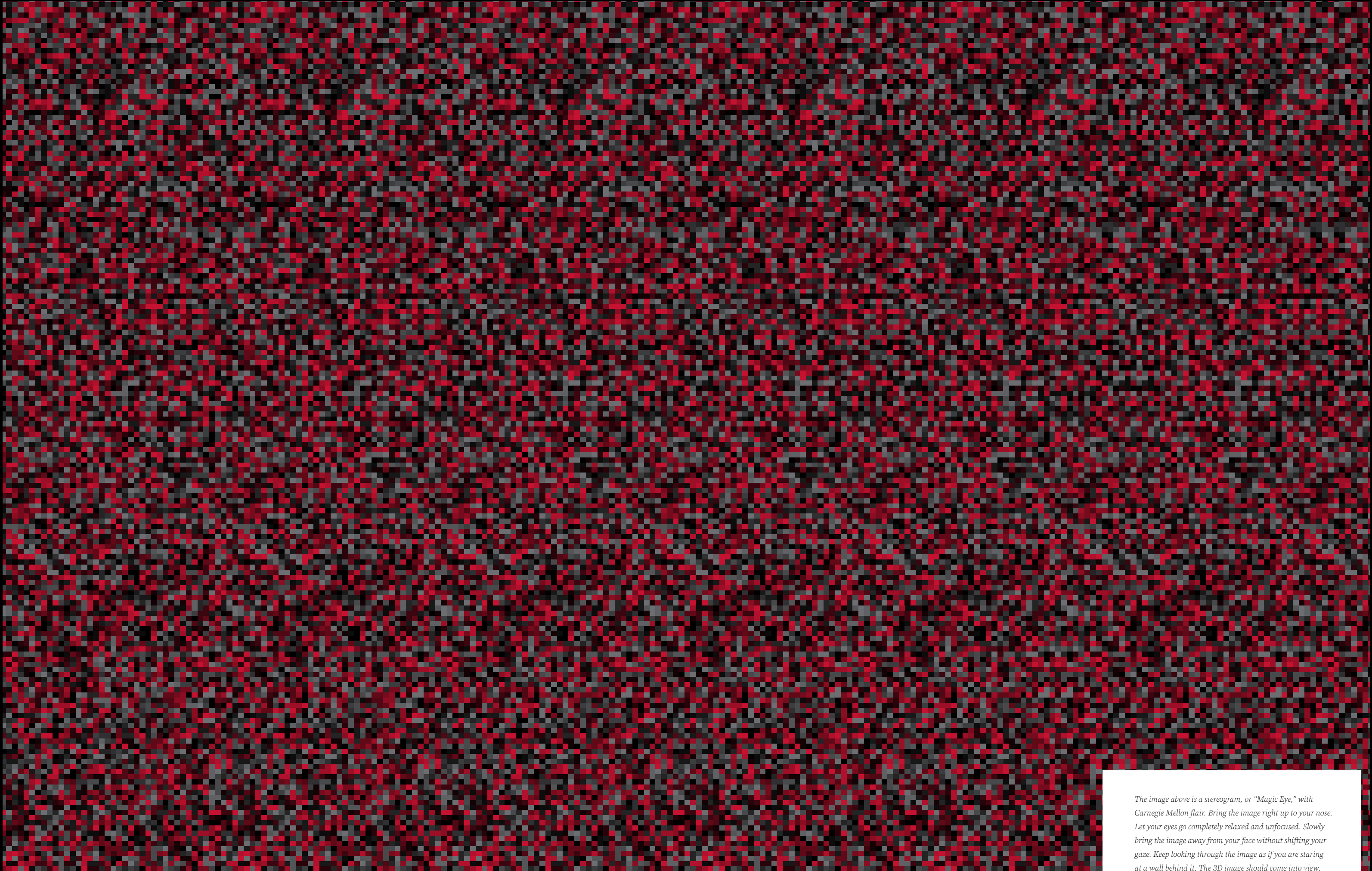
to find an actual solution. This is particularly powerful because geometry keeps track of global phenomena.”

Numerous problems across mathematics and its applications are global in this sense, ranging from data science to economics. Frick develops topological and geometric methods to tackle problems further afield. He studies questions about how shapes can be divided, how high-dimensional objects must intersect, how discrete structures can be partitioned and how local constraints can force global behavior. His work connects fair division, combinatorics, convexity, topological methods and related questions in theoretical computer science. A through line in this work is not that the problems come from physical geometry, but that a geometric viewpoint reveals hidden constraints within them.

In that sense, geometry acts like a shift in focus. By giving abstract problems a geometric form, Frick’s work helps uncover the hidden shapes that govern them — and shows how much those shapes can tell us.

AMY PAVLAK LAIRD





The image above is a stereogram, or “Magic Eye,” with Carnegie Mellon flair. Bring the image right up to your nose. Let your eyes go completely relaxed and unfocused. Slowly bring the image away from your face without shifting your gaze. Keep looking through the image as if you are staring at a wall behind it. The 3D image should come into view.

Hendrich Builds Tools as Well as Knowledge

Michael Hendrich spent his career pushing the limits of magnetic resonance spectroscopy. Over 32 years at Carnegie Mellon, the chemistry professor transformed how scientists study metalloproteins, developing both the instruments and the analytical tools needed to probe the metal centers that drive life's essential reactions.

Roughly one-third of proteins in the human body contain metals, including enzymes that are indispensable to nearly all forms of life. These metalloenzymes power processes ranging from energy conversion and DNA replication to detoxification and oxygen transport. But studying the transition metals at their core is notoriously difficult. Traditional biochemical methods often fall short. Hendrich built his career tackling that challenge.

Early on, he pioneered the use of parallel-mode electron paramagnetic resonance (EPR), a variation that aligns the oscillating magnetic field parallel to the applied field. Used alongside conventional (transversemode) EPR, the technique allows researchers to detect metal centers with both odd and even numbers of unpaired electrons, broadening what scientists can observe. His expertise extended across complementary methods, including Mössbauer spectroscopy and SQUID magnetometry, which together allow scientists to characterize metalloproteins at the atomic level.

But Hendrich didn't stop at instrumentation. He also built the computational tools needed to interpret complex data, developing a custom software package, SpinCount, to simulate spectroscopic signals. The combination of experiment and computation helped establish quantitative EPR as a powerful approach for studying metal-containing enzymes.

Using this broad approach, Hendrich has contributed to a greater understanding of

multiple biochemical systems, including multiheme proteins involved in electron transport, manganese-dependent oxygenases, biological iron-sulfur clusters, and both heme and non-heme iron enzymes. He identified and characterized reactive intermediates — short-lived states that form as enzymes carry out chemical reactions. By spectroscopically characterizing these intermediates, scientists can identify chemical steps involved in an enzymatic transformation.

Hendrich also worked closely with synthetic chemists, studying model metal complexes designed to mimic enzyme function. These collaborations connected carefully controlled laboratory systems with complex biological ones, helping validate proposed reaction pathways.

His career stands out for its breadth. Hendrich moved fluidly between spectroscopy, instrument design, computation and biochemistry. As he retires, his work continues to drive the field forward — from the discoveries he made to the tools, methods and ways of thinking he helped build, leaving researchers better equipped to take the next steps.

Alongside his research, Hendrich maintained a strong commitment to teaching and mentorship. He guided undergraduate, graduate and postdoctoral researchers, many of whom have gone on to establish their own careers. And he taught a wide range of courses, from physical chemistry, math for chemists and physical chemistry laboratory for undergraduates, to graduate-level physical inorganic chemistry. In the classroom, he was known for making complex ideas accessible, using simple, memorable demonstrations — such as rope tricks to illustrate eigenfunctions — to bring abstract concepts to life.



Models, Iron & Insights: Visualizing Bominaar's Legacy

For more than three decades, Associate Research Professor Emile Bominaar developed theoretical frameworks behind breakthroughs in bioinorganic chemistry alongside experimental research in the Department of Chemistry at Carnegie Mellon University. At the end of the 2026 spring semester, Bominaar retired.

"The Mellon Institute and the environment here played an important role in my life," Bominaar said. "I very much appreciate all the wonderful people I met here and the collaborations I was able to have."

Bominaar joined Carnegie Mellon in 1993 as a research scientist on the invitation of Eckard Münck, professor of chemistry. Münck pioneered the application of ^{57}Fe Mössbauer spectroscopy, a form of imaging that focuses on changes in the nucleus of iron, to bioinorganic chemistry, a subfield that studies how metals play a role in biological processes.

Bominaar, who trained as a theoretical physicist, conducted research in physical chemistry. He provided expertise in the interpretation of spectroscopic data through electronic structure theory, which focuses on how electrons in an atom interact.

Over the course of his career, Bominaar worked with researchers from U.S. and European academic institutions and shaped new research directions into the molecular mechanisms of metalloproteins. He contributed to more than 100 research papers, advancing the field of bioinorganic chemistry.

His work at Carnegie Mellon went beyond the Münck laboratory, and he engaged in projects with other Carnegie Mellon professors, including Terry Collins, Teresa Heinz Professor in Green Chemistry; Michael Hendrich, emeritus professor of chemistry; and Yisong (Alex) Guo, professor of chemistry.

Bominaar worked with Collins on the identification of a reactive intermediate in TAML chemistry, which is key in the catalytic breakdown of water pollutants and with Hendrich on uncovering the catalytic mechanisms of some of the most challenging metalloenzymes.

Electron spin has always been a central theme in Bominaar's research and the publications he co-authored on clusters with multiple paramagnetic transition-metal sites have been widely cited.

Together with Professor James (Jim) Peterson at the University of Pittsburgh, he worked on the development of magneto-optical spectroscopies, which analyze the influence of magnetic fields on polarized light as a tool for investigating the electronic structure of molecules. Together, they were the first to apply magnetic linear dichroism spectroscopy to metalloproteins showing the method could extend beyond studying atoms.

"Jim had the instrument and the spectroscopic expertise," Bominaar said. "I provided the theory."

More recently, Bominaar worked with Guo on finding new ways for iron-sulfur clusters can catalyze reactions.

"I'm very happy that Alex will continue the work on bioinorganic chemistry," Bominaar said. "I could hardly imagine a better person to take the lead of this work."

As an emeritus professor, Bominaar plans to continue doing research, interacting with colleagues and complete unfinished projects. Outside of the lab, he looks forward to pursuing various interests and endeavors with family, friends and wildlife.

KIRSTEN HEURING

POWERING THE FUTURE OF COSMOLOGY WITH AI

A CMU-led project will make it easier for scientists to combine data from different telescopes to explore fundamental questions about the cosmos

PHYSICS

Researchers at Carnegie Mellon University and partners at the University of Washington are collaborating with the U.S. Department of Energy's SLAC National Accelerator Laboratory on a new Genesis Mission-funded project to help scientists use artificial intelligence to better understand the universe.

Modern astronomy is producing more data than ever before. Powerful telescopes and instruments from around the world are collecting detailed information about billions of stars, galaxies and other cosmic objects. These observations help researchers investigate some of the biggest mysteries in science, including the nature of dark matter and dark energy, how the universe evolved over time and what it is made of.

Projects such as the NSF-DOE Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST), the Dark Energy Spectroscopic Instrument (DESI), and future cosmic microwave background experiments are expected to generate enormous amounts of information in the coming years.

But there is a challenge: much of that data is stored in different formats, housed at different institutions and difficult to combine.

As a result, scientists often spend significant time preparing data before they can begin analyzing it.

"The scientific opportunities and the data analysis challenges are incredible," said Rachel Mandelbaum, head of Carnegie Mellon's Department of Physics and a member of the McWilliams Center for Cosmology and Astrophysics.

Mandelbaum is the principal investigator for a project to create a shared data service to allow researchers to seamlessly access and combine information from multiple astronomy experiments. Rather than moving massive datasets from one location to another, the system will allow the data to remain where it is stored while making it available through a unified platform.

The data infrastructure developed as part of this project will be available to the astronomical community at the SLAC-hosted Rubin Observatory's U.S. Data Facility (USDF) and via the American Science Cloud, which integrates the nation's most advanced high-performance computing systems, scientific facilities, data resources and production capabilities into a single, coordinated AI-driven discovery system.

In addition to Mandelbaum, co-investigators include: Jeremy Kubica, director of engineering for LSST Interdisciplinary network for Collaboration and Computing (LINCC) Frameworks at Carnegie Mellon; Andrew Connolly, associate vice provost for data science, professor in the department of astronomy and director of the eScience Institute at the University of Washington; Neven Caplar, research scientist/engineer at the University of Washington; and Adam Bolton, Senior Staff Scientist at SLAC and at Stanford's/SLAC's Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) and lead for the USDF. Additional modeling will be provided by Francois Lanusse of the French National Centre for Scientific Research. Their work is an extension of the Schmidt Sciences-supported LINCC Frameworks program, a partnership led jointly by CMU and UW.

HEIDI OPDYKE

CMU researchers and partners are working to create a shared data service to allow researchers to seamlessly access and combine information from multiple astronomy experiments. Credit: NSF-DOE Vera C. Rubin Observatory/NOIRLab/SLAC/AURA

Fonseca Joins the Ranks of AAAS Fellows, Named 2026 Fields Institute Fellow

MATHEMATICAL SCIENCES

Carnegie Mellon University mathematician Irene Fonseca is shaping the future of materials science, imaging and engineering through mathematical frameworks that reveal how complex systems behave. Named a recent Fellow of the American Association for the Advancement of Science (AAAS) and a 2026 Fields Institute Fellow, Fonseca is internationally recognized for research that transforms abstract mathematical ideas into real-world innovation.

As the Kavčić-Moura University Professor of Mathematics and director of CMU's Center for Nonlinear Analysis, Fonseca bridges rigorous theory with practical applications. Her work in materials science helps researchers understand how advanced materials bend, break and transition under stress — insights that guide the creation of technologies from minimally invasive surgical tools to sustainable energy systems.

"That's the beauty of math," Fonseca said. "It's this abstraction where you're not wedded to concepts or exact formulations. I get motivation from applications, and I bring them into the math context to try to formalize them."

Fonseca's contributions also extend to computer vision, where the same mathematical structures used to describe fractures or sharp transitions help computers interpret images, detect features and reduce noise.

Her research tackles systems too complex for classical tools, developing new methods that account for abrupt changes, multiscale behavior and competing forces. This work supports advances in medical imaging, flexible electronics and next-generation materials.

A fellow of multiple scientific academies and a leader in global applied mathematics, Fonseca is equally committed to mentorship, training young researchers whose work now spans fields from physics to imaging science.

HEIDI OPDYKE

Remembering *Susan Armstrong Henry*

BIOLOGICAL SCIENCES

Susan Armstrong Henry, a distinguished molecular biologist and visionary academic leader, died on March 7, 2026. She was 79.

A pioneer in yeast genetics and lipid metabolism, she dedicated her life to groundbreaking research and the stewardship of higher education.

Henry's academic journey began at the University of Maryland, where she earned a B.S. in Zoology (Phi Beta Kappa) in 1968, followed by a Ph.D. in Genetics from UC Berkeley in 1971. After completing postdoctoral research at Brandeis University, she joined the faculty at the Albert Einstein College of Medicine in 1972, rising to the rank of Professor. Her transition into institutional leadership began at Carnegie Mellon University, where she served as head of Biological Sciences from 1987 to 1991 and later as dean of the Mellon College of Science from 1991 to 2000. In 2000, she was appointed the Ronald P. Lynch Dean of the College of Agriculture and Life Sciences at Cornell University. A Professor of Molecular Biology and Genetics throughout her tenure, she led the college until 2010 and remained a vital part of the Cornell community as Dean Emerita until her retirement in 2020.

Throughout her career, Henry contributed to the field of molecular biology. She is most widely recognized for her pioneering research into the genetic regulation of lipid metabolism in yeast, a study that led to the discovery of the "Henry Regulatory Circuit." This fundamental mechanism dictates whether lipids are used for cellular growth or stored as fat. Her work provided a critical framework for understanding human lipid-based conditions, offering vital insights into the molecular roots of diseases such as obesity and cancer.

Henry transformed the study of lipids and membranes by placing forward genetic analysis at the center of her work. Her pioneering use of baker's yeast to define lipid synthesis genes and enzymes provided the essential blueprint for researchers worldwide to map these same pathways in humans. A prolific scholar, her findings were published in the field's most prestigious journals, including



Science, Proceedings of the National Academy of Sciences and the Journal of Biological Chemistry.

Henry's professional stature was reflected in her decades of continuous research funding from the National Institutes of Health (NIH) and her frequent service on prestigious national and international advisory boards. Her leadership extended to the editorial boards of top-tier journals published by the American Society for Biochemistry and Molecular Biology (ASBMB) and American Society of Microbiology (ASM). Among her most significant honors were the NIH MERIT Award (1991), the ASBMB Avanti Award in Lipids (2013) and Cornell University's Alice H. Cook Award (2013). Her peers further recognized her contributions by electing her as a Fellow of both the American Academy of Microbiology and the American Association for the Advancement of Science.

Henry was preceded in death by her husband, Peter Henry. She is survived by her younger brother, David Armstrong; her daughter, Rebecca Alice Henry (Chris Schafer); her son, Joshua Armstrong Henry (Cheryl Deane); and her four grandchildren, Fiona, Liam, Minerva and Pearl.

Remembering *William "Bill" Hrusa*

MATHEMATICAL SCIENCES

William "Bill" Hrusa, 71, passed away peacefully on April 10, 2026, in Boca Raton, Florida, after a life shaped by intellectual curiosity, devotion to his family and a lifelong love of the water.

Hrusa was born on January 16, 1955, in Darien, Connecticut, to Nancy and John Hrusa, the eldest of three brothers. Even as a boy, the qualities that would define him were already there: a sharp mind, a steady work ethic and a pull toward the outdoors. He marched in the school band, spent hours at the local marina and took to everything he did with focus.

His academic path was a remarkable one. He earned dual bachelor's degrees in mathematics and mechanical engineering from Syracuse University, followed by a master's degree and a Ph.D. in applied mathematics from Brown University.

In 1982, he joined the faculty of Carnegie Mellon University as an assistant professor, beginning a career that would span more than four decades and shape generations of students. Mathematics was never just a job to Hrusa. It was something he genuinely loved, and that love came through every time he stepped into a classroom.

Along with teaching, Hrusa served in administrative positions in the Department of Mathematical Sciences including as interim head, associate head and director of graduate studies. He most recently directed the Bachelor of Science in Computational Finance (BSCF) program.

Hrusa retired from Carnegie Mellon in 2025 and moved to Florida to be closer to his daughter, son-in-law and granddaughter. He spent his final year doing exactly what he had hoped to do: be surrounded by family.

When he wasn't teaching, Bill was happiest on the water. Summer weekends at Conneaut Lake, with the boat in and the sun out, were some of the best days of his life.



Most of all, he was a father. His children, Sarah and Daniel, were the center of his world, and the arrival of his granddaughter Mia brought him such joy.

Bill was preceded in death by his parents, Nancy and John Hrusa, and his beloved brother, Tom Hrusa. He is survived by his daughter, Sarah Hrusa (Adam Castro); his son, Daniel Hrusa (T Mackey); his granddaughter, Mia Castro; his brother, Brooks Hrusa (Kelli Kole); his sister-in-law, Denise Farley (Mark Farley); and his nephews, Chris Hrusa and Rex Hrusa.

Hrusa lived a full life of learning, love and time on the open water. He will be deeply missed.

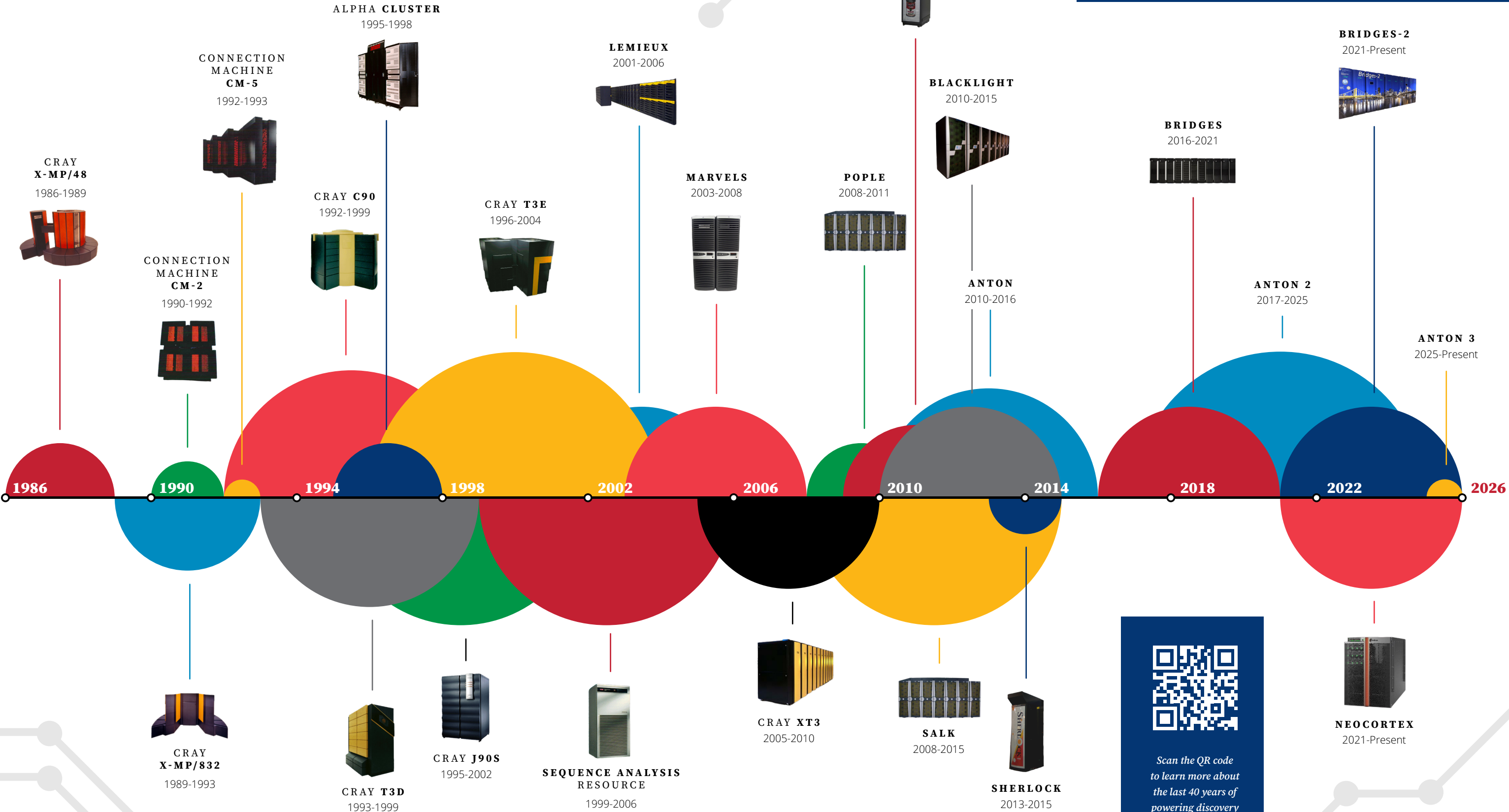
Hrusa's passion for education and commitment to teaching and mentoring generations of students is simply unparalleled. His dedication to his students' education, personal welfare, and career development was well beyond anyone's imagination. In recognition of Bill Hrusa's sustained contribution to excellence in education, CMU recognized him with the 2023 Doherty Award. He previously won the university's William H. and Frances S. Ryan Award for Meritorious Teaching and Barbara Lazarus Award as well as the Mellon College of Science's Julius Ashkin Award and the Richard Moore Award.



A research and education fund has been set up to honor the academic legacy of Bill Hrusa. Scan the QR code to support the William J. Hrusa Research and Education Fund.

40 YEARS of Computing

The first PSC supercomputer, the Cray X-MP/48, was a gamechanger for research — but today's smartphones would out-compute it! The Pittsburgh Supercomputing Center is celebrating 40 years of cutting-edge platforms that provided groundbreaking advancements in science.



Scan the QR code to learn more about the last 40 years of powering discovery

2025-2026 HIGHLIGHTS



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6. Students put away their books, if for one-night-only, and donned their finest attire to bust a move during this year's masquerade-themed MCS Ball. 7. Department of Mathematical Sciences graduate shows off her exquisitely customized cap and gown during Commencement Weekend. 8. A bagpiper led the procession to begin the Department of Biological Sciences diploma ceremony during Commencement Weekend. 9. Eric Yttri, associate professor of biological sciences, provides the soundtrack for the epic tug-of-war showdown with none other than his flaming tuba on MCS Pride Day.



8



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1. Chemistry doctoral student Willough Sloan talks about how RNA and DNA work during Pittsburgh's Celebrating Science in the Steel City event. 2. Glen de Vries Dean Barb Shinn-Cunningham makes a splash, flippers and all, during the 2026 CMU Spring Carnival Douse-A-Dean fundraiser event. 3. Prasad Tetali, Mathematical Sciences Department Head and professor, introduces Karel Janeček at the 2025 Victor M. Bearg Science and Humanity Lecture. 4. Manfred Paulini, associate dean for research and professor of physics, shares a laugh and his caricature during the circus-themed MCS Graduate Student Appreciation Event last fall. 5. Emily Toal, development associate for MCS Advancement, and Aimee Dorney, MCS Dean's executive assistant, proudly showing off some branded swag during CMU Spring Carnival Buggy Watch alumni event.

Lee Awarded 2025 Sutherland-Merlino Fellowship

NEUROSCIENCE

CMU's Neuroscience Institute awarded Elizabeth Lee, a second-year Ph.D. student in the Program in Neural Computation (PNC), the 2025 Sutherland-Merlino Fellowship. The fellowship provides financial support to one incoming Ph.D. student each year who demonstrates academic promise, eagerness to learn and an enthusiastic spirit.

Lee joined CMU after earning her bachelor's degree in brain and cognitive sciences from Massachusetts Institute of Technology (MIT), where she studied how language is processed in the brain with Evelina Fedorenko. That experience sparked her interest in computational approaches and convinced her to pursue graduate training at the intersection of neuroscience and data science.

"I was especially drawn to the PNC program because of its interdisciplinary community and the strong focus on using quantitative methods to study the brain across multiple levels of analysis — from individual neurons and circuits to whole-brain networks and behavior," Lee said. "It's an exciting time in neuroscience with both the rise of large-scale datasets and increasingly powerful computational models. I'm passionate about the work, and I felt that CMU and Pitt together offered a unique environment to bridge these two areas."

During her first-year, Lee explored different research directions through lab rotations including the Feather's Laboratory for Computational Perception.

"Elizabeth jumped right into her rotation with curiosity and dedication," said Jenelle Feather, assistant professor of psychology and member of the Neuroscience Institute. "She asks thoughtful questions, brings fresh ideas and has quickly become a valued member of the lab. I'm excited to see how her interests in perception, language, computation and neuroscience evolve over the course of her graduate training."

In addition to her academic achievements, Lee has demonstrated a strong commitment to expanding access in STEM. As an undergraduate, she co-developed and taught workshops through MITxHarvard Women in AI, encouraging students from underrepresented backgrounds to pursue interests in science and engineering.

The Sutherland-Merlino Fellowship was established in 2021 by Nancie Merlino, a 1964 alumna of Carnegie Mellon University's Margaret Morrison Carnegie College, in honor of her late husband, Thomas Merlino, and her father, James Sutherland, both CMU alumni.

GERRY BALBIER

Chawla Encodes Biochemistry Breakthroughs

CHEMISTRY

Avleen Chawla is opening pathways toward potential therapies.

A Ph.D. student in CMU's Department of Chemistry, Chawla studies circular RNA and G-quadruplexes — structures that play a growing role in how cells function and malfunction. While scientists have long focused on linear RNA, circular RNA just recently emerged as a critical player in biology.

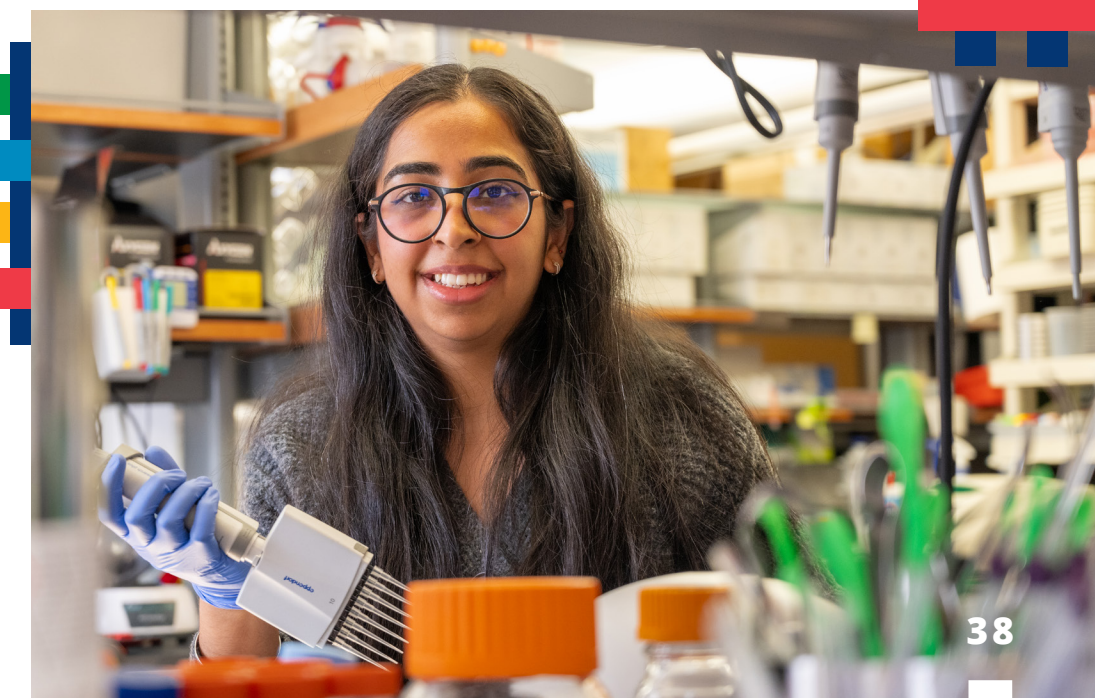
"We didn't really understand why cells were producing circular RNA or what it was doing," Chawla said. "That opened up so many avenues we'd never explored."

Working with Anna Kietrys, assistant professor of chemistry, Chawla helped show that circular RNA exists not only in human cells but also in bacteria, challenging assumptions about its evolutionary origins. The team also made a first-of-its-kind discovery: circular RNA can act as a catalyst during transcription, helping generate proteins essential for cell function.

Chawla further found that circular RNA is more stable than linear RNA under stress. Linear RNA often forms G-quadruplexes — tangled structures linked to misfolded proteins implicated in cancer and neurodegenerative diseases. In Parkinson's disease, such errors can lead to buildup of the protein alpha-synuclein in the brain. Circular RNA, Chawla's work suggests, may be less prone to these harmful tangles.

"Circular RNA definitely has an implication in disease regulation," Chawla said. "We want to see if we can use it as a diagnostic tool along with a therapeutic application, and we hope with these new insights, we can better identify potential treatments for Parkinson's disease."

KIRSTEN HEURING





Ashley Hackney

Hackney Builds Community Through Science and Service

Ashley Hackney wants to make scientific discovery accessible for everyone. At Carnegie Mellon University, she paired research excellence with a strong commitment to mentoring, making an impact as a scholar, professional, citizen and community member.

Originally from Philadelphia, Hackney was drawn to CMU for its emphasis on undergraduate research. She found a home in the biophysics lab of Stephanie Tristram-Nagle, research professor emerita of physics, where she studied antimicrobial peptides — molecules with the potential to combat antibiotic-resistant infections. The group collaborates with the University of Pittsburgh, and one peptide under study is in clinical trials.

“This research is vital because of the urgent need for alternative strategies to combat antibiotic resistance, which is a growing global health crisis,” Hackney said.

Through the Summer Undergraduate Research Apprenticeship, Hackney conducted X-ray research at the Cornell High Energy Synchrotron Source (CHESS), contributing to a forthcoming paper on peptide effectiveness.

Hackney’s passion for access also shaped her teaching and mentorship. Inspired by early support from faculty, she served as a teaching assistant for multiple biology courses, a Tartan Ambassador and a mentor to pre-college students. She emphasized helping others feel supported and confident in STEM.

Beyond academics, Hackney took on leadership roles in student organizations, danced with Endpoint Ballet and volunteered in community healthcare efforts.

Recognized with the MCS Gilman Award, Hackney plans to pursue a biomedical master’s degree at the University of Pittsburgh before attending medical school, continuing her mission to inspire future scientists.

KIRSTEN HEURING

Learning to Listen: Xu Brings Humanity to Medicine

On a quiet afternoon at UPMC Shadyside, Jingjing Xu sits beside a patient, gently painting her nails — a small act that reflects a larger philosophy of care. Moments like this are integral to Xu’s path at Carnegie Mellon University.

A recent graduate, Xu earned dual Bachelor of Arts degrees in chemistry and biological sciences, along with an additional major in health humanities and a minor in gender studies. “My true academic niche is at the intersection of science and humanities,” Xu said.

Originally from Baltimore, Xu wanted a strong connection between scientific theory and real-world impact, which led her to health humanities, where she explored medicine through communication, equity and lived experience.

Working with Dr. Judy Chang at Magee Women’s Research Institute, Xu studied patient-provider interactions, analyzing interviews and clinical encounters to understand how communication shapes trust, autonomy and outcomes. Her research on endometriosis — informed by her own experience with the condition — was published in Women’s Reproductive Health in early 2026 and presented internationally.

“She is already engaging with the questions that will define how she practices medicine,” said adviser Gizelle Sherwood.

Outside the lab, Xu volunteers through UPMC’s Hands Down We Nailed It program, offering manicures to patients while building meaningful connections. She also served as co-president of the Mellon College of Science Student Advisory Council and led the National Alzheimer’s Buddies chapter.

Recognized for her impact, Xu received the MCS Gilman Award and the Carnegie Mellon Women’s Association Award.

HEIDI OPDYKE



Jingjing Xu



Coding the Cosmos

Mark Martinez Learns the Language of Stars

PHYSICS

Mark Martinez didn’t expect to be an interpreter when he started studying astrophysics, but that’s what his research required: translating the clues observers gather from deep space into physics-based rules that power a computer simulation designed to model billions of stars.

Martinez, who graduated in December 2025 with a bachelor of science degree in physics with an astrophysics concentration and a minor in computer science, embraced the challenge.

“Sifting through simulation data was pretty instructional for learning about our understanding of how stars live and die,” Martinez said. “My skill set definitely started with the coding, but then it helped me learn the science.”

The summer before his junior year, Martinez joined Assistant Physics Professor Katie Breivik’s research group.

“Every week he was teaching us new things from the literature that we hadn’t yet figured out. He very quickly became the group expert on supernova types and how the assumptions scientists make about their physics impact what comes out of our code. He’s really remarkable,” said Breivik.

At the center of Martinez’s research is COSMIC, a tool developed by Breivik that generates huge synthetic populations of stars and tracks how they evolve, interact, merge and explode.

“There are a ton of knobs to turn with something like COSMIC,” Martinez said. “A big part of it was figuring out which knobs, when you turn them, make our simulations look the most like observations.”

His first assignment was to improve how COSMIC models binary star systems. Because massive stars are more likely to form with companions, Martinez wrote new code that used stellar mass to better determine when stars exist in pairs. The update made the entire simulation behave more like the real universe.

What Breivik and McWilliams Postdoctoral Fellow Anna O’Grady expected to take all summer, Martinez completed in two weeks. He then turned to a far more complex task: exploring how changes in simulation assumptions — such as how mass is transferred between stars or how often binaries merge — affect the types of supernovae produced.

His broader goal was to align COSMIC’s internal physics with what astronomers observe in the sky. To do that, Martinez generated 2,048 distinct stellar populations, simulating billions of stars from birth to death. The effort produced several terabytes of data that revealed how frequently stars merge and how those events shape observable supernovae. COSMIC didn’t contain the code to characterize supernovae, specifically core-collapse supernovae, until Martinez added it.

“He has opened up a new research avenue and made an opportunity for students here at CMU to continue making impacts that build off of his excellent software and his very, very careful characterization and summary of the state of the field,” Breivik said.

Martinez presented his work at the American Astronomical Society meeting, where his poster drew steady attention and earned a Chambliss Astronomy Achievement Student Award. He was one of just 25 winners chosen from 485 submissions.

“When you go into research like this, being on that cutting edge, walking out to where people have not asked these questions before or doing it concurrently with other groups, that’s Ph.D.-level research. And Mark was doing that,” O’Grady said.

AMY PAVLAK LAIRD



BUILT FOR DISCOVERY

How New Lab Spaces Will Elevate Undergraduate Biology

Teaching Professor Carrie Doonan has shepherded thousands of students through the biology laboratories at Carnegie Mellon University's Mellon Institute.

"Our lab courses typify active learning, which is a hallmark of CMU education. We empower our students in these labs," said Doonan, director of undergraduate laboratories in the Department of Biological Sciences. "Students practice skills, solve problems, struggle with complex questions, make decisions and explain their ideas and solutions in their own words through writing and discussion."

Doonan follows the approach started by the late Bill Brown, former head of the Department of Biological Sciences. More than two decades ago, the curriculum was designed to immerse students in scientific inquiry through active, hands-on learning, rather than "cookbook" experiments with predictable outcomes.

"When students come to me their junior and/or senior year, they have taken the core courses. My job is to improve their analytical and critical thinking skills," Doonan said. "We train our scientists to be able to work anywhere they want to: industry, graduate school, medical school, you name it."

Miwa Shirai remembers Doonan's lab courses. She graduated from Carnegie Mellon with a bachelor's degree in biology and a minor in environmental science. She earned her Ph.D. in botany from the University of California, Riverside.

"CMU pushes you in the labs to be a critical and methodical thinker — biology can be confusing and seemingly messy at times, but that's what makes it exciting," said Shirai, now an assistant project manager at GeneGoCell in San Diego, where she oversees experimental design of next-generation sequencing projects, data analysis and project execution.

The labs in the Mellon Institute have shaped the education of decades of students, but their age is starting to show. On any given day, Doonan and lab instructors move 30 to 50 people through a series of three classrooms because none are large enough to hold all of the students at the same time. Wet lab work involves hands-on experimentation to test scientific theories using liquids, chemicals and biological matter. The work requires specialized equipment such as autoclaves, fume hoods and refrigeration units. Classes rotate among microscopes, centrifuges and gel imagers with limited space while the instructors repeat lessons throughout the class to groups of 5 or so students at time.

These constraints require a different approach to teaching, such as demonstrating techniques repeatedly to small groups of students instead of teaching the entire class at once. With student enrollment at maximum capacity, the current configuration leaves no room to grow.

Some of the constraints include no projection capabilities in any of the rooms, which would allow instructors to do a demonstration once while allowing a large number of students to watch; limited storage for equipment and materials; and insufficient bench space for lab work or note taking. Students leave their personal belongings in plastic totes in the hallway during classes to make more room.

"It's not ideal, but we make the best of what we have. We have an amazing team," Doonan said.

The opening of the Richard King Mellon Hall of Sciences represents a transformative opportunity to pair CMU's world-class instructors with laboratories worthy of their innovation. By investing in spaces that match the ambition of the curriculum and the curiosity of the students, the university is ensuring that the Department of Biological Sciences' hands-on, inquiry-driven approach not only endures but also empowers the next generation of scientists and innovators.

Dedicated microscope rooms will house 16 phase-contrast microscope setups, while a separate fluorescence microscopy room will allow multiple students to work simultaneously on fluorescent imaging projects.

For the first time, courses like Quantitative Cell and Molecular Biology Laboratory will have three

interconnected, dedicated spaces: one for wet lab bench work, one for phase-contrast microscopy and one for fluorescence microscopy. The result is a seamless learning environment that eliminates bottlenecks and expands access.

RKM Hall of Sciences also will include four large lab classrooms, each with a 24-student capacity. Two of these classrooms will combine dedicated wet lab benches with collaborative workspaces for computer-based analysis, data interpretation and group discussion. Every lab classroom will feature full projection capabilities, allowing all students to clearly observe techniques and demonstrations in real time.

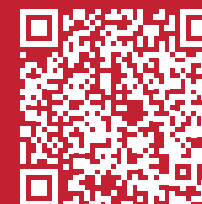
Equally transformative are the behind-the-scenes improvements:

- *Expanded storage will accommodate modern equipment, supplies and materials.*
- *Students will have lockers for personal items.*
- *A large lab preparation room and a dedicated sterilization space will streamline workflows for instructional staff.*
- *A centralized equipment room will support multiple lab classes, while a dedicated cell culture room — with six permanent cell culture hoods — will replace the portable UV hoods that now consume valuable bench space.*

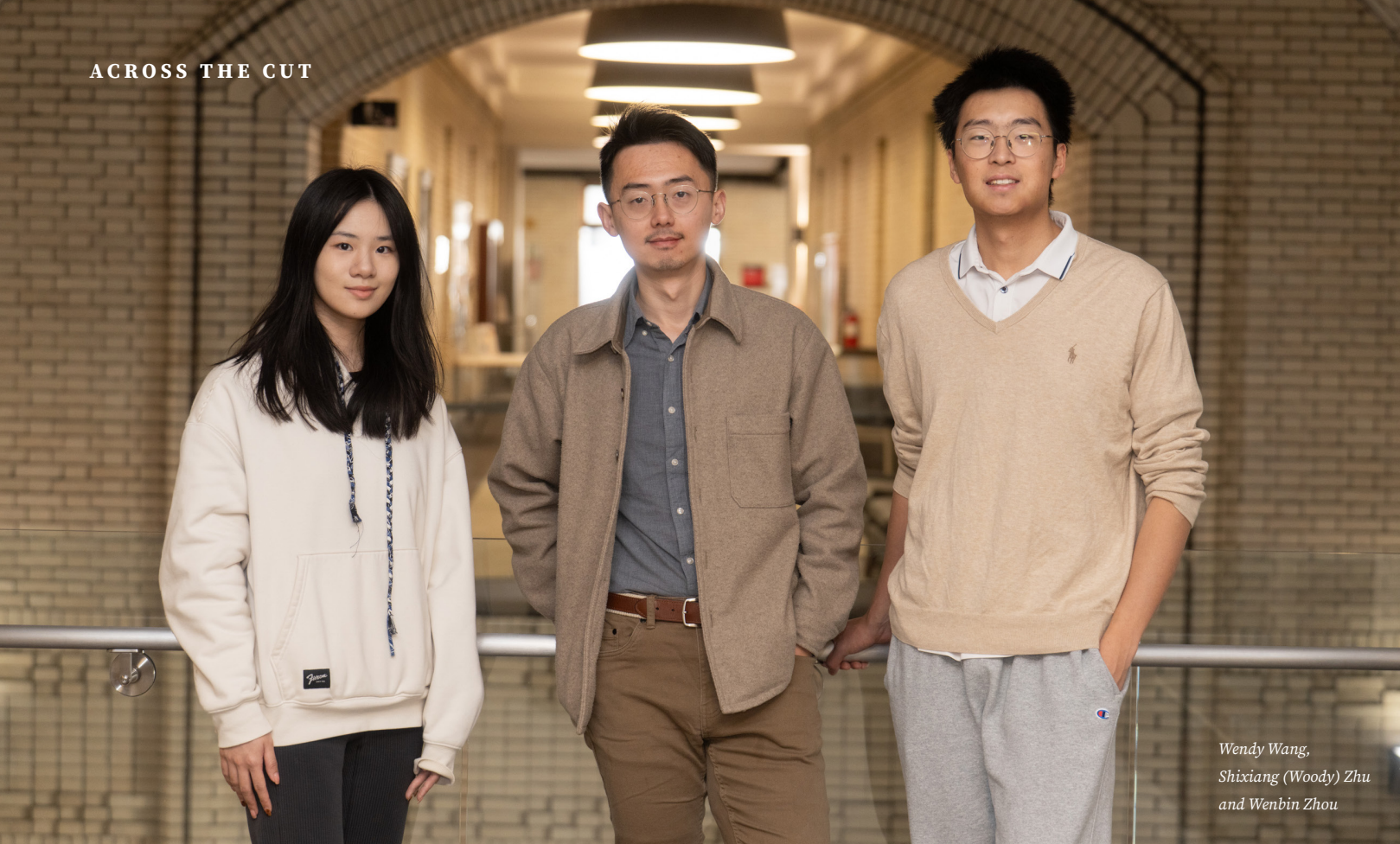
For Doonan and her colleagues, the Richard King Mellon Hall of Sciences is an essential investment in the future of undergraduate biology education.

"When students have the space, the tools, and the visibility to truly understand what they're doing, everything changes," Doonan said. "That's when curiosity turns into confidence — and confidence turns into discovery."

HEIDI OPDYKE



Scan the QR code to learn how you can support the Richard King Mellon Hall of Sciences



Wendy Wang,
Shixiang (Woody) Zhu
and Wenbin Zhou

CMU Researchers Help Reduce Energy Grid Uncertainty

As renewable energy grows rapidly, utilities face new challenges in keeping electric grids reliable. At Carnegie Mellon University, undergraduate researcher Wendy Wang played a role in helping one city prepare for that future.

Wang, a senior majoring in mathematical sciences in the Mellon College of Science, joined a research project led by Shixiang (Woody) Zhu, an assistant professor of data analytics, and Ph.D. student Wenbin Zhou. They focused on how cities can better plan for increases in rooftop solar, wind power and other distributed energy resources. The work was conducted in partnership with AES Indiana, the primary electricity provider for Indianapolis, and has already informed the utility's long-term planning.

"I chose to pursue mathematics and statistics because they are the fundamental languages for understanding many more complex systems," Wang said. "It gives me the tools to model real-world, messy problems, which truly excites me."

Wang's work was supported by a Summer Undergraduate Research Fellowship.

Wang began by reviewing research on renewable energy forecasting, grid planning under uncertainty and causal analysis. She then explored statistical methods that could improve how the team modeled future growth in renewables. Her work helped shift the project beyond traditional approaches that rely only on historical trends.

For Wang, the experience showed how mathematical thinking can shape real decisions.

"This framework helps utilities make smarter, more targeted upgrades," she said. "It supports more renewable energy by building a smarter, more resilient grid around it."

ALEXANDER JOHNSON

Rales Fellow Takes Green Chemistry Personally

Growing up in rural Pennsylvania, Elizabeth Smith witnessed firsthand how hydraulic fracking can affect a community. Now a Ph.D. student in CMU's Department of Chemistry, she is channeling those experiences into research that aims to protect communities and their water.

When Smith was a teenager, her family learned that a wastewater disposal injection well — used to store fracking byproducts — might be built near their homes. The community relied entirely on private well water, and leaks from similar wells elsewhere had contaminated groundwater. Smith's grandmother, Judy Wanchisn, began researching the issue, uncovering risks not only to human health but also to native hellbender salamanders. The community ultimately sued to stop the project, and while the court did not rule in their favor, public opposition meant the well was never built.

"That experience showed me how chemistry, law and the environment intersect," Smith said.

At Allegheny College, Smith studied organic synthesis but sought more direct environmental applications through NSF-funded Research Experiences for Undergraduates at Michigan State University and the Université de Lorraine in France. These projects deepened her interest in environmentally focused chemistry and led her to pursue doctoral research.

At CMU, Smith joined the lab of Carrie McDonough, associate professor of chemistry, and was selected as a Rales Fellow, a program that provides full funding and mentorship for graduate students in the sciences. With that support, Smith now studies chemicals associated with fracking, including developing methods to test drinking water near leaking injection wells.

"Chemists created this problem," Smith said. "Chemists should be the ones to fix it."

KIRSTEN HEURING

Elizabeth Smith and Jim
Garrett, CMU Provost &
Chief Academic Officer

The Carnegie Mellon University Rales Fellows Program is dedicated to cultivating the next generation of STEM leaders and driving innovation by increasing access to a life-changing graduate education. By removing financial barriers to obtaining advanced degrees and providing Fellows with holistic support, the Rales Fellows Program empowers and connects scholars with others who share a passion for progress and innovation.



The Science Behind A Scene

The Mellon Institute Auditorium became an immersive intersection of science and art this spring with Quantum Theatre's production of "10 out of 12," a comedy that captures the intricate systems behind a marathon technical rehearsal. Audience members donned headsets, tuning into overlapping conversations, backstage cues and the hidden rhythms of production — like tapping into a live experiment in creativity.

BY THE NUMBERS

Attendance: 2,845
Headsets: 160
Rehearsals: 24
Performances: 23
Actors: 10
CMU affiliates: 8
Special events: 5
Weeks to build set: 4
Designers: 4
Director: 1
Memories: **Incalculable**

"10 out of 12" cast members (from left) Olivia Ruhnke, José Pérez IV, Melessie Clark, Corey Rieger, Shammen McCune, Tim McGeever, Evan Vines, Mark August, Jamie Agnello and Conor McCanus





2026 Class of *Tartans on the Rise*

Tartans on the Rise recognizes CMU alumni who graduated in the last 10 years and are using their knowledge, talents and leadership skills to meaningfully advance their fields or professions.



Accelerating drug discovery with AI and chemistry

Rebecca Alford (MCS 2016) loves watermelon and she approaches picking the perfect one with a scientist's eye. It's a careful process of observation and inference, not unlike how she uncovers promising directions for new medicines as a principal scientist specializing in structure-based drug design at Johnson & Johnson.

At J&J, Alford develops computational methods to design complex molecules, including peptides and RNAs. She uses computer models and AI to explore what is possible long before a molecule is ever made in the lab. She then works closely with chemists and biologists to test these molecules.

"If you know what features to look for in a watermelon, like the coloring, you know it will be great," Alford said. "I use the same idea in my work, identifying features of molecules that increase their chances of becoming a successful drug."

The number of possible molecules Alford could search is 10 to the 60th power. The sheer volume of options makes drug discovery time consuming, expensive and fraught with dead ends.

"Developing a drug the existing way takes at least 10 years and costs billions of dollars. By infusing algorithms with chemistry, physics and AI, I'm accelerating the search process," she said.

Alford's work is also deeply personal. Motivated in part by her own experience living with a rare genetic disorder, she is driven by the urgency of patients waiting for new treatments.

"We do this work because there are people suffering and we are trying to deliver better therapies," she said.

Targeting cancer at the source

Delivering drugs with surgical precision — directly to diseased tissue while sparing the rest of the body — is a longstanding goal of medicine. Antonina "Tonia" Simakova (MCS 2015) believes polymer chemistry can help make that goal a reality.

As executive vice president of research and co-founder of Myris Therapeutics, a Carnegie Mellon University spin-off founded with several CMU faculty members, Simakova is developing biologically targeted drug delivery systems using atom transfer radical polymerization (ATRP). The company's work focuses on improving how pharmaceuticals are transported and released inside the body.

Myris is building a platform that pairs polymers with antibodies, which naturally seek out disease. Polymers act as a molecular glue, attaching drugs — or payloads — to antibodies that carry them directly to affected tissue. By carefully controlling how and when those payloads are released, Simakova's work improves delivery specificity and helps keep toxic treatments away from healthy cells.

The approach could unlock the use of highly potent medicines that are currently too dangerous to administer safely.

"Some of the most effective molecules already exist, but they're too toxic for patients to tolerate," Simakova said. "What excites us is that we don't need to invent new small molecules. We can use polymers to load antibodies with existing drugs, send them directly to diseased tissue, and keep them away from healthy tissues."

Cancer is the initial focus for Myris, but Simakova sees broad potential beyond oncology.

"As the company matures, I envision opening more opportunities to apply this technology," she said, "and demonstrating meaningful clinical impact, one step at a time."

Sarah Gaffen

Honored with Alumni Achievement Award

A leader in immunology and cytokine research, Sarah L. Gaffen's trailblazing work has led to a better understanding of the role that certain cells play in human immunity and inflammation.

Her research on T cell cytokines, which are proteins that regulate the body's immune response, led to the discovery that the interleukin-17 (IL-17) cytokine is the central regulator of immune defense against oral thrush, a fungal infection in the mouth.

She is a recognized expert on the IL-17 cytokine family, and her research has made a significant impact in other scientific areas of study, such as oral mucosal immunity and fungal immunity.

Professor Gaffen began her research in 1999 when she held a faculty position at the State University of New York at Buffalo Dental School. While there, she examined how immune cytokines function in AIDS-associated opportunistic infections, setting the stage for her future discoveries.

Her lab has been funded by the National Institutes of Health for nearly 25 years, and she was honored with the prestigious NIH MERIT award in recognition of her work on IL-17 in oral immunity. Together,

she and her team have authored more than 150 scientific papers and their findings have been published in journals such as *Mucosal Immunology*, *JEM*, *Cell Host Microbe*, *Jl* and *Science Immunology*.

In addition to her research, Professor Gaffen is highly involved in peer organizations. She is an honorary Fellow of the American Association for the Advancement of Science and the American Academy of Microbiology, and recently completed a two-year term as president of the International Cytokine and Interferon Society, of which she has been a member for more than 20 years. She is also an accomplished mentor, training many Ph.D. students and postdoctoral fellows to successful careers in science.

She earned a bachelor's degree in biological sciences from Carnegie Mellon in 1988 and a Ph.D. in molecular and cellular biology from the University of California, Berkeley, in 1994. She is currently a professor of medicine and rheumatology and holds the Gerald P. Rodnan Endowed Chair in the Division of Rheumatology and Clinical Immunology at the University of Pittsburgh.

Gaffen received the 2025 Alumni Achievement Award from CMU.



“ ‘Science means simply the aggregate of all the recipes that are always successful. All the rest is literature,’ said Paul Valéry. This felt appropriate as someone like me who loves both science and poetry. Speaking personally, my CMU education and experiences not only gave me the arsenal to succeed as a practitioner of science, but the capacity to leverage my skills and experience as a mentor for young scientists and to serve as a leader in the scientific community. ”

Genetic Testing Offers Answers — and Hope — for Horse Owners

BIOLOGICAL SCIENCES

Muscle disease affects hundreds of thousands of horses each year, causing pain, stiffness, and a reluctance to move. Owners search for answers, running countless tests and spending thousands of dollars, but often don't get a clear diagnosis.

For Carnegie Mellon alumnus Paul Szauter, a career spent in genomics pointed toward a better solution — one rooted in tools already transforming human health. In 2015, he founded EquiSeq to bring genomic diagnostics to the stable.

"When we started, there were genetic tests for more than 5,000 inherited diseases in humans. In horses, there were only 16," said Szauter, EquiSeq's chief scientific officer.

For hundreds of years, horses have been bred for speed, strength, sprinting power or endurance. While selecting for genes that enhance muscle performance has its advantages, it also has a downside — a surprisingly large number of heritable muscle diseases.

"Horses are bred deliberately," Szauter said. "If we had a genetic test that predicted the onset of these diseases, we could, over several generations, breed it out. And that's what we're trying to do."

EquiSeq, based in New Mexico, develops and sells DNA tests that identify genetic variants linked to muscle disease in horses. The company's current test detects damaging variants across six different horse genes, all predictive of muscle disease. Since entering commercial use in 2017, the tests have been used in more than 15,000 horses worldwide and are sold directly to consumers, including horse owners and breeders. The company has two U.S. patents with extensive international coverage.

Keeping pace with a rapidly changing field

Szauter's path to founding EquiSeq began at Carnegie Mellon, where he graduated with a bachelor's degree in biology in 1976.

"I had a fantastic time as a bio major," Szauter said. He went on to earn his Ph.D. in genetics from the University of Washington before undertaking postdoctoral research in molecular biology at the Massachusetts Institute of Technology. Following several academic positions as a fruit fly geneticist, he transitioned to genomics and bioinformatics at the Jackson Laboratory, a hub for mouse genetics. The Human Genome Project was underway, and DNA sequencing became faster and cheaper. Szauter saw genetics shift from slow, hands-on lab work to powerful data analysis.

"In genomics — my gosh — the field changes much faster than any one person's career," Szauter said. "It's been fantastic to watch."

Human medicine benefited first. Szauter saw an opportunity to apply the advances made in human genetics to horses.

Harnessing ancient muscle genes for modern diagnosis

EquiSeq's early work focused on polysaccharide storage myopathy type 2 (PSSM2), a progressive muscle disease that can cause chronic pain, exercise intolerance, and an unpredictable decline. Through online communities, including Facebook groups dedicated to PSSM, Szauter encountered horse owners who were frustrated and exhausted.

"People put all this time and love into a horse, and then it just goes to pieces," he said. "They'd been through all the diagnostic testing, spent thousands of dollars, and still didn't have a clear answer. Everyone was asking for help."

Szauter knew he and his team had something to offer. The science behind EquiSeq's genetic test is based on the fact that, at the microscopic level, muscle tissue from a human, a mouse or a horse is nearly identical.

"Muscle genes are very old, and we can use everything that we've learned from human disease or studying human disease in mice and apply that to the horse," Szauter said. "We've identified a set of horse mutations that affect genes that are associated with muscle disease in human patients."

EquiSeq's test detects mutations in six different genes, and the results report whether a horse has two normal copies, two mutant copies or one normal and one mutant copy for each of the six genes.

For horse owners, the test offers something that had long been missing. While muscle diseases such as PSSM are progressive and cannot be cured, early genetic diagnosis can guide training and dietary changes that significantly improve quality of life.

"I've found EquiSeq results to be extremely reliable for making decisions about diet and performance management," said Stephanie Carter, a functional nutritional therapy practitioner. "I've never had EquiSeq results mislead me in creating appropriate training and dietary recommendations to prevent or manage symptoms."

Passing on the reins

Szauter and his team at EquiSeq continue to push the research on horse genetics forward, with the goal of discovering additional genetic variants. They are building an automated pipeline that compares horse genomes with known human muscle-disease genes to identify potentially damaging variants for further testing. That simply wouldn't have been possible even five years ago, Szauter points out.

"The science is really exciting," he said. "And to watch what's happening to the tools that are available right now is amazing."

Now 71, Szauter jokingly describes himself as a recovering academic, but one thing hasn't changed.

"I've never gotten over the fun of working with young people," he said. "What we've started here — the people we've trained — they're going to take it the rest of the way."

For Szauter, science is more than a career.

"There's no joy in human civilization better than scientific discovery," he said. "Very few people get to do it. It's an enormous privilege."

With EquiSeq, that discovery is offering a way to improve equine health — now and for generations to come.

AMY PAVLAK LAIRD



FINDING SIGNALS IN NOISE ACROSS AI AND BEYOND

MATHEMATICAL SCIENCES

Nicholas Yoder's lifelong connection to Carnegie Mellon University began the day he graduated kindergarten, when his parents offered him a small reward. He asked to see an electron microscope.

Captivated by Carl Sagan's *Cosmos*, Yoder was fascinated by instruments that revealed hidden worlds. His father took him to the University of Pittsburgh first, but they had no luck in finding a lab with the device. So, they tried CMU's campus next door.

At Wean Hall, they were in luck. A staff member treated the Yoders to not one, but three electron microscopes and patiently answered every question from the six-year-old.

"That was one of the best days of my life," Nicholas Yoder recalled.

Yoder went on attend Carnegie Mellon and study computational finance. He graduated in 2009.

Fifteen years later, Yoder has returned to a CMU classroom, this time as a lecturer. He taught a weeklong course on the mathematical foundations and architectures of large language models (LLMs). More than 100 students enrolled to hear about the topic and Yoder's unconventional path.

Teaching LLMs through first principles

The course was designed with what he calls "a low intercept and high slope." Students didn't need a deep specialization to begin, but the pace accelerated quickly.

Over the week they moved through information theory, high-dimensional geometry, reinforcement learning, scaling laws and the limits of current AI systems.

But the real draw wasn't just the content, but the framing.

His goal was to show that LLMs are not an isolated breakthrough, but part of a broader mathematical story.

"I've been surprised by how many times a new area has similar underpinnings," Yoder said. "Quantitative and math training helps me be able to deal with random variables, noise and thinking in high-dimensional spaces where you see the same patterns time and time again."

Statistics, condensed matter physics, computer science and pure mathematics, he said, often describe similar structures using different language. AI is simply another lens with which to view them.

Pattern-seeking in the real world

Growing up in a rural part of southwestern Pennsylvania, he served as a firefighter with the Pittsburgh Fire Department in high school and his first two years at Carnegie Mellon, applying analytical thinking in high-stakes, real-world situations like structure fires and vehicle extrications.

As a mathematical sciences and finance student at Carnegie Mellon, he balanced coursework with physically demanding work for Tepper Academic Services.

"It was largely a moving job from 8-5 Monday through Friday, and I would go to classes in between the work," he said.

His academic interests ranged widely, from discrete time finance to history courses on subjects like the Beatles or Latin America. Beneath it all, a consistent pattern emerged: very different systems often shared the same underlying structure.

That realization first found professional expression on Wall Street.

At Morgan Stanley, Yoder traded derivatives on the dispersion and exotics desk, working with volatility, correlation and complex option structures tied to the S&P 500.

Dispersion trading — comparing the behavior of the index to individual stocks — revealed persistent inefficiencies. For Yoder, it reinforced a core idea: different views of the same system create gaps, and mathematics can expose — and leverage — them.

Over more than a decade, he expanded into portfolio management and machine learning, and he launched the hedge fund Fayette Capital. Across strategies and markets, his focus remained consistent: navigating noisy, high-dimensional environments to uncover meaningful structure.

From markets to power grids

That mindset eventually carried him beyond finance into energy markets and a new business. He turned to ERCOT, the operator of Texas' electrical grid, an environment defined by volatility. Supply and demand must balance in real time, yet both fluctuate dramatically, which, when looked at systematically, can open up the door for some creative solutions.

"There is such variability in energy demand with consumption up during the day and down at night, and when it gets very hot everyone turns on their air conditioning," Yoder said.

Yoder identified an unconventional solution: offering flexible, large-scale consumers such as crypto miners — which finalize blockchain

transactions — discounted rates for power during low-demand periods and having those customers shut down during peak times of usage.

"Crypto miner's revenue is relatively constant across time of day and power demands," Yoder said. "Whereas the power utility would be deeply strained during extreme weather events and other high demand periods. That mismatch creates the embedded optionality."

By working with large-scale consumers to fluctuate their use, Yoder and his team helped to make available more than 3 gigawatts of power capacity at peak times, which would be the equivalent of adding 5 or 6 large coal power plants, in under 18 months.

The approach helped stabilize the system while enabling new capacity — an example of how computation itself can help manage physical infrastructure. A later iteration of his business, Bitooda Holdings, was acquired by the German energy company RWE in 2023.

Biology, AI and the next frontier

After stepping back from business to pursue interests like flying and travel, Yoder turned to human health, immersing himself in computational biology and collaborating with researchers at Mount Sinai.

Despite the new domain, the underlying problems felt familiar: predicting disease from protein signals, modeling immune responses and extracting structure from complex biological systems.

This led him to transformer architecture, which powers modern generative AI and large language models and deep learning.

"That's what changed everything," Yoder said. "I was using a type of transformer that works with proteins, and I'm not OK using something I don't understand. So I spent time learning how transformer language models work from first principles."

Today, his work spans new AI architectures inspired by biological systems and methods to ensure powerful models remain interpretable and safe.

"I'm exploring new architectures that borrow heavily from biology," Yoder said. "If it's possible to create artificial general intelligence [a hypothetical form of AI that can match or exceed human's abilities], neural networks and biomimicry may be part of the solution."

Why students show up

Across every chapter — from a Wean Hall basement to trading floors, power grids, research labs and back to CMU — the through line is consistent: Yoder looks for the hidden structure that unifies complex systems.

That perspective helped fill a classroom during finals week.

Students learned from Yoder how to recognize patterns across disciplines and connect theory with application. They also learned to connect AI to a deeper mathematical continuum.

It's that same curiosity that began with an electron microscope — the desire to look beneath the surface and make sense of what others might miss.

In a sense, Yoder is still doing exactly that.

HEIDI OPDYKE

Alum Uses AI to Advance CERN's Search for New Particles

PHYSICS

Carnegie Mellon University alumna Abhirami Harilal is helping physicists hunt for new particles that could unlock one of the universe's biggest mysteries: dark matter.

While working at CERN for four years, Harilal applied machine learning to improve how scientists detect rare particle signatures, sharpening the Large Hadron Collider's ability to uncover new physics. She also upgraded CERN's detector technology by developing algorithms now deployed within the Compact Muon Solenoid (CMS) experiment to autonomously identify anomalies during live data collection.

"There are still many fundamental questions about the universe that current physics can't fully explain," said Harilal, who graduated from Carnegie Mellon with a Ph.D. in physics. "At the Large Hadron Collider, we're searching for signs of new particles that could help answer them."

Only about 5 percent of the universe is made of matter, which people can see with their own eyes or detect using scientific equipment. The rest of the universe consists largely of dark matter and dark energy, which researchers are unable to observe through traditional methods. Though these forces are unseen, they affect the movement of galaxies, stars and planets.

One major breakthrough came in 2012 with the discovery of the Higgs boson, a particle associated with a fundamental field that gives mass to other particles. Harilal's research built on this discovery by exploring whether the Higgs boson might decay into an as-yet-undetected particle known as the A particle, which could be linked to dark matter or other hidden sectors.

"The Higgs boson plays a special role in our understanding of fundamental particles," Harilal

said. "Many theories suggest that if new particles exist, they may be connected to the Higgs boson."

To pursue this question, Harilal used machine learning and computational modeling to simulate thousands of particle collisions like those produced at the Large Hadron Collider. These models improved CMS's sensitivity to rare and unconventional particle signatures, enabling researchers to better detect signals that might otherwise be overlooked.

Beyond her own physics research, Harilal also made lasting contributions to CERN's detector operations. When she arrived, CMS monitored data quality using criteria that could miss subtle or evolving anomalies, often requiring researchers to manually compare unusual data against known reference samples.

Harilal developed a machine learning model that automated this process, flagging unusual behavior while identifying how the data differed from expected patterns. Her system has since been deployed during live data taking, making it easier for scientists to diagnose issues in real time.

"I'm particularly proud of that work because it was actually used during live operations," Harilal said.

Her advisor Manfred Paulini, professor of physics and Mellon College of Science Associate Dean for Research, said that Harilal's work advanced both particle physics and machine learning.

"Abhirami operates at the forefront of developing machine learning algorithms while conducting cutting-edge physics research," he said. "She cultivated a skill set that is directly transferable to real-world challenges."

KIRSTEN HEURING

Richard King Mellon Hall of Sciences ENTERS NEW PHASE OF CONSTRUCTION



On a sunny June afternoon, the Richard King Mellon Hall of Sciences entered its next phase of construction as the last steel beam was hoisted into place, "topping off" the facility's structural phase.

With topping off completed, the Hall of Sciences' "bones" are in place and interior and exterior finishing of the around 340,000-square-foot facility will begin.

When completed in 2027, the Richard King Mellon Hall of Sciences will be a place where science, technology, art and creativity converge at CMU in new and exciting ways. Extending CMU's campus westward, the facility will house researchers and educators from the Mellon

College of Science, School of Computer Science and the Institute for Contemporary Art (ICA) Pittsburgh, fostering a collaborative atmosphere that enables partnerships across disciplines. It will also create a new iconic gateway to campus, connecting CMU more closely to its Oakland neighbors, and include an expanded location for the ICA Pittsburgh that will elevate its role as a hub of art, culture and exchange.



Scan QR code to
view livestreams
of the building
construction.

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