Science AT MIT

Summer 2024 | Published twice yearly

Reflecting synergy: MIT's new interdisciplinary hub for climate science

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The Tina and Hamid Moghadam building's facade is responsive to the surrounding environment, which depending on the time of day and quality of light, makes the glass alternately reflective and transparent. *Photo: Paige Brown*

MIT School of Science

TABLE OF CONTENTS

Letter from the Dean

My dear fellow alumni and friends,

The summer 2024 issue of *Science@MIT* explores the grand opening of the new climate hub at MIT, Building 55, the Tina and Hamid Moghadam Building. Not only is the building visually stunning — transparent and open in contrast to the brutalist tower above — but it is also functionally a new era for climate research here at MIT. One based on collaboration with the Woods Hole Oceanographic Institution, the Environmental Solutions Initiative, and all the players and partners within the Department of Earth, Atmospheric and Planetary Sciences. If you have the opportunity when you're next on campus, I urge you to take a walk through the entrance of the glass facade and into the intriguing and inviting space of our newest building.

Additionally, the Green Building's interior received an impressive restyling with the renovation of the 54-100 auditorium, now proudly named for MIT's first degree recipient in geology, Dixie Lee Bryant, Class of 1891. She was one of MIT's many trailblazing women in her field, in a time before women's suffrage in this country. And if you turn to the end of this issue, you can read about innovators like her, including this year's advanced degree ceremony speaker, Lydia Villa-Komaroff. She and others are featured in the MIT Libraries' exhibition, entitled "Under the Lens: Women Biologists and Chemists at MIT 1865–2024."

If you couldn't join us for reunion or Commencement this spring, I urge you to visit our website and listen to Villa-Komaroff's speech for this year's graduates.

This issue also brings you profiles of modern-day biology researchers, including Professors Yadira Soto-Feliciano and Seychelle Vos, who are both studying different aspects of gene regulation and expression. Leading researchers in their labs include graduate students Annette Jun Diao and Renee Barbosa, two recipients of the Cleo and Paul Schimmel Scholars award through the MIT Schimmel Family Program for Life Sciences. This transformative $50 million pledge supports the training of our graduate students — the vital network of researchers that drives our discoveries here at MIT.

Other research profiles include those of Mark Harnett, an associate professor in the Department of Brain and Cognitive Sciences and the McGovern Institute for Brain Research. Mark is looking at the brain's "silent synapses" — neurons that remain inactive and immature until they are called into service to engrain memories or learn. This new finding runs against a prevailing understanding of memory as a rewriting or rewiring of mature synapses between neurons.

In the Department of Physics, Professor Netta Engelhardt is also pushing on the central tenets of her field, asking what happens to information when black holes evaporate (and how), and what about a black hole's quantum gravity? She is investigating how many pillars of gravitational physics need a closer look.

In the Department of Chemistry, our issue delves a bit deeper into the connections between discoveries and industries. You can learn about chemist Brad Pentelute's delivery systems that may revolutionize the development of therapeutics. You can also learn about how Nobel Prize winner Moungi Bawendi backed into the revolution of quantum dots with a lot of trial and, not error, but failure.

Professor Nuno Loureiro too sees a field on the verge of transformation as the new director of the MIT Plasma Science and Fusion Center (PSFC). These coming years will produce, Nuno says, a "watershed moment" as experiments such as those in collaboration with PSFC and SPARC produce a burning plasma that yields more energy than it consumes — the holy grail for fusion power.

Finally, and certainly no less important, is an article acknowledging our most recent recipients of the MIT Open Data Prize. The brainchild of Associate Dean Rebecca Saxe and MIT Libraries director Chris Bourg, these awards encourage our research community to create infrastructure and excellence in open data sharing. The research we describe in this issue can only be enhanced and furthered with a commitment to scholarship characterized by the norm of open sharing.

In closing, I want to honor a member of my team who is retiring from MIT this summer — Associate Dean for Development Elizabeth Chadis. I will miss her wise counsel and fiery advocacy. Her passion for science and scientists has enabled us to recruit and retain faculty and support our graduate students with fellowships, including the Schimmel Scholars Fund. The School of Science is in excellent shape in no small part because of Elizabeth's efforts. Please do reach out to her and join me in wishing her well (echadis@mit.edu).

With my very best wishes,

Dean Nergis Mavalvala PhD '97

A bright hub for climate

The new Moghadam Building and refurbished Green Building have created a vibrant new center to tackle pressing global concerns of sustainability and climate change

Michael Blanding | EAPS

Seen from a distance, MIT's Cecil and Ida Green Building (Building 54) — designed by renowned architect and MIT alumnus I.M. Pei '40 — is one of the most iconic buildings on the Cambridge skyline. Home to the Department of Earth, Atmospheric and Planetary Sciences (EAPS), the 21-story concrete structure soars over campus, topped with its distinctive, spherical radar dome. Close up, however, it was a different story.

A sunless, two-story, open-air plaza beneath the tower previously served as a nondescript gateway to the department's offices, labs, and classrooms above. "It was cold and windy — probably the windiest place on campus," EAPS Department Head Robert van der Hilst, the Schlumberger Professor of Earth and Planetary Sciences, told a packed auditorium inside the building in March. "You would pass through the elevators and disappear into the corridors never to be seen again until the end of the day."

> "In its lightness, in its transparency, it calls attention not to itself, but to the people gathered inside it."

Photo: Steph Stevens

Van der Hilst was speaking at a dedication event to celebrate the opening of the renovated and expanded space, 60 years after the Green Building's original dedication in 1964. In a dramatic transformation, the perpetually-shaded expanse beneath the tower has been filled with an airy, glassed-in structure that is as inviting as the previous space was forbidding.

Designed to meet LEED-platinum certification, the newly-constructed Tina and Hamid Moghadam Building (Building 55), seems to float next to the brutalist tower, its glass facade both opening up the interior and reflecting the sunlight and green space outside. The 300-seat auditorium within the original tower has been similarly transformed, bringing light and space to the newly dubbed Dixie Lee Bryant (1891) Lecture Hall, named after the first person to earn a geology degree at MIT.

Catalyzing collaboration

The project is about more than updating an overlooked space. "The building we're here to celebrate today does something else," MIT President Sally Kornbluth said at the dedication.

"In its lightness, in its transparency, it calls attention not to itself, but to the people gathered inside it. In its warmth, its openness, it makes room for culture and community. And it welcomes in those who don't yet belong ... as we take on the immense challenges of climate together," she continued, referencing the recent launch of The Climate Project at MIT — an Institute-wide initiative to innovate bold solutions to climate change. In MIT's famously decentralized structure, the Moghadam Building provides a new physical hub for students, scientists, and engineers interested in climate and the environment to congregate and share ideas.

■ Part of Julian Charriere's installation: "Everything Was Forever Until It Was No More." *Photo: Steph Stevens*

Hui Sun, a postdoc working with professors Tanja Bosak and Ed Boyden, presents her research at the building dedication poster session.
Photo: Steph Stevens

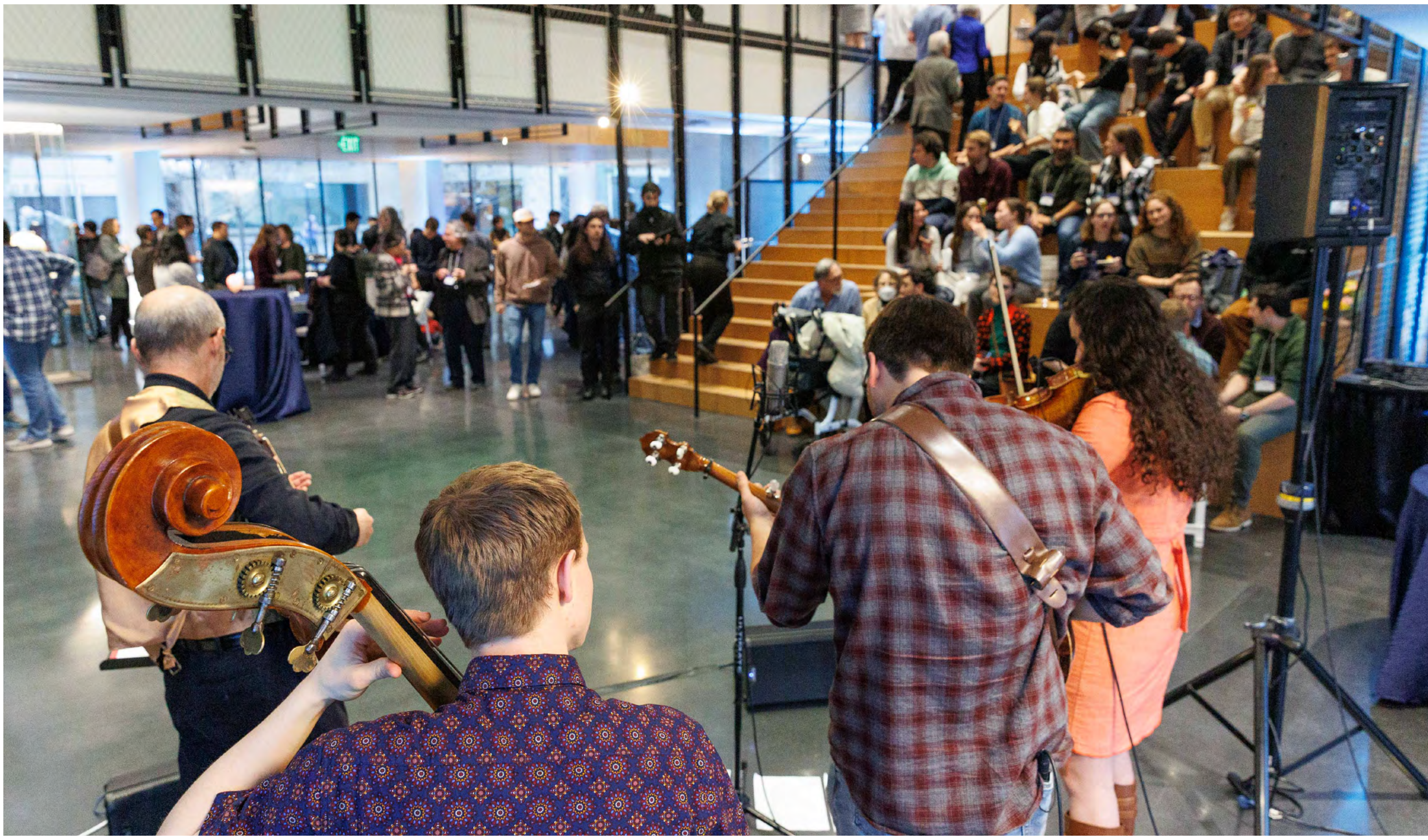
From the start, fostering this kind of multidisciplinary collaboration was part of Van der Hilst's vision. In addition to serving as the flagship location for EAPS, Building 54 has long been the administrative home of the MIT-WHOI Joint Program in Oceanography/Applied Ocean Science and Engineering — a graduate program in partnership with Woods Hole Oceanographic Institution. With the addition of Building 55, EAPS has now been joined by the MIT Environmental Solutions Initiative — a campus-wide program fostering education, outreach, and innovation in Earth system science, urban infrastructure, and sustainability — and will welcome closer collaboration with Terrascope — a first-year learning community which invites its students to take on real-world environmental challenges.

A shared vision comes to life

The building project dovetailed with the long-overdue refurbishment of the Green Building. After a multi-year fundraising campaign where Van der Hilst spearheaded the department's efforts, the project received a major boost from lead donors Tina and Hamid Moghadam '77, SM '78 allowing the department to break ground in November 2021.

In Moghadam, chairman and CEO of Prologis which owns 1.2 billion square feet of warehouses and other logistics infrastructure worldwide, EAPS found a fellow champion for climate and environmental innovation. By putting solar panels on the roofs of Prologis buildings, the company is now the second largest on-site producer of solar energy in the United States. "I don't think there needs to be a trade-off between good sound economics and return on investment and solving climate change problems," Moghadam said at the dedication. "The solutions that really work are the ones that actually make sense in a market economy."

Architectural firm AW-ARCH designed the Moghadam Building with a light touch, emphasizing spaciousness in contrast to the heavy concrete buildings that surround it. "The kind of delicacy and fragility of the thing is in some ways a depiction of what happens here," said architect and co-founding partner Alex Anmahian at the dedication reception, giving a nod to the study of the delicate balance of the Earth system itself. The sense is further illustrated by the responsiveness of the facade to the surrounding environment, which depending on the time of day and



Live music performed at the Building 55 dedication ceremony that took place on March 21, 2024. *Photo: Steph Stevens*

quality of light makes the glass alternately reflective and transparent.

Inside, the 11,900-square foot pavilion is highly flexible and serves as a showcase for the science that happens in the labs and offices above. Central to the space is a 16-foot by 9-foot video wall featuring vivid footage of field work, lab research, data visualizations, and natural phenomena — visible even to passersby outside. The video wall is counterposed to an unpretentious set of stair-step bleachers leading to the second floor that could play host to anything from a scientific lecture to a community pizza-and-movie night.

Van der Hilst has referred to his vision for the atrium as a "campus living room," and the furniture throughout is intentionally chosen to allow for impromptu rearrangements, providing a valuable public space on campus for students to work and socialize.

The second level is similarly adaptable, featuring three classrooms with state-of-the-art teaching technologies that can be transformed from a single large space for a hackathon to intimate rooms for discussion.

"The space is really meant for a yet unforeseen experience," Anmahian says. "The reason it is so open is to allow for any possibility."

The inviting, dynamic design of the pavilion has also become an instant point of pride for the building's inhabitants. At the dedication, School of Science dean Nergis Mavalvala quipped that anyone walking into the space "gains two inches in height."

Van der Hilst quoted a colleague with a similar observation: "Now, when I come into this space, I feel respected by it."

The perfect complement

Another significant feature of the project is the List Visual Arts Center Percent-for-Art Program installation by conceptual artist Julian Charrière entitled "Everything Was Forever Until It Was No More."

Consisting of three interrelated works, the commission includes: "Not All Who Wander Are Lost," three glacial erratic boulders which sit atop their own core samples in the surrounding green space; "We Are All Astronauts," a trio of glass pillars containing vintage globes with distinctions between nations, land, and sea removed; and "Pure Waste," a synthetic diamond embedded in the foundation, created from carbon captured from the air and the breath of researchers who work in the building.

Known for themes that explore the transformation of the natural world over time and humanity's complex relationship with our environment, Charrière was a perfect fit to complement the new Building 55 — offering a thought-provoking perspective on our current environmental challenges while underscoring the value of the research which happens within its walls.

Physicist Netta Engelhardt is searching black holes for universal truths

She says one question drives her work: "Which pillars of gravitational physics are just not true?"

Jennifer Chu | MIT News

Photo: Adam Glanzman

As Netta Engelhardt sees it, secrets never die. Not even in a black hole.

Engelhardt is a theoretical physicist at MIT who is teasing out the convoluted physics in and around black holes, in search of the fundamental ingredients that shape our universe. In the process, she's upending popular ideas in the fields of quantum and gravitational physics.

One of the biggest revelations from her work to date is the way in which information that falls into a black hole can avoid being lost forever. In 2019, shortly before coming to MIT, she and other physicists used gravitational methods to demonstrate that whatever might happen to the information inside a black hole can in principle be undone as the black hole evaporates away.

The team's conclusion stunned the physics community, as it constituted the most quantitative direct advance toward resolving the longstanding black hole information paradox — a conundrum raised in the work of physicist Stephen Hawking. The paradox pits in opposition two theories that both appear to be true: one, the pillar of "unitarity," which is the principle that information in the universe is neither created nor destroyed; and two, a calculation by Hawking from standard gravitational physics showing that information can indeed be destroyed, specifically, when radiating out from an evaporating black hole.

"Imagine you had a diary and you set it on fire in the lab," Engelhardt explains. "According to unitarity, if you knew the fundamental dynamics of the universe, you could take the ashes and reverse engineer them to see the diary and its contents. It would be very difficult, but you could do it. But Hawking's calculation shows that, even if you knew the fundamental dynamics of the universe, you still couldn't reverse engineer the process of black hole evaporation."

Engelhardt, then at Princeton University, and her colleagues showed that, contrary to Hawking's calculation, it is possible to use gravitational physics to see that the process of black hole evaporation does in fact conserve information.

As a newly tenured member of the MIT faculty, Engelhardt is now tackling other longstanding questions about gravity, hoping to fill the last, largest gaps in physicists' understanding of the universe at the most fundamental scales.

"At the end of the day, I'm driven by questions about nature and how the universe works," says Engelhardt, who is now an associate professor of physics. "Answering these questions is a vocation."

Gateway to gravity

Engelhardt was born in Jerusalem, where she developed an early interest in all things science. When she was 9, she and her family moved to Boston, partly so that her mother could enroll in a visiting scholars program in MIT Linguistics. New to America, and having only learned to read in Hebrew, Engelhardt spent those first weeks reading every book the family brought with them, some of them atypical for a 9-year-old.

"I read all the books we had left in Hebrew, until at long last, there was just one left, which was Stephen Hawking's 'A Brief History of Time.'"

Hawking's book was Engelhardt's first introduction to black holes, the Big Bang, and the fundamental forces and building blocks that shape the universe. What she found especially exciting were the missing pieces to physicists' understanding.

"People can spend their entire life searching for answers to these very foundational questions that I just found completely fascinating," Engelhardt says. "Where does the universe come from? What are the fundamental building blocks? Those are questions I realized I just wanted to know the answer to. And from that point on, I wasn't just set on physics — I was set on quantum gravity at 9."

She fed that early spark through college, double majoring in physics and math at Brandeis University. She went on to the University of California at Santa Barbara, where she pursued a PhD in physics and really began to dig into the puzzle of quantum gravity, a field that seeks to describe the effects of gravity according to the principles of quantum mechanics.

The theory of quantum mechanics is a remarkably good blueprint for describing the interactions in nature at the scale of atoms and smaller. These quantum interactions are governed by three of the four fundamental forces that physicists know of. But the fourth force, gravity, has eluded quantum mechanical explanation, particularly in situations where the effect of gravity is overwhelming, such as deep inside black holes.

In such extreme regimes, there is no prediction for how matter and gravity behave. Such a theory would complete physicists' understanding of the universe's workings at the most fundamental scales.

For Engelhardt, quantum gravity is also a gateway to other mysterious questions to be answered. For example, the way in which space and time emerge from something even more fundamental. Engelhardt spent much of her graduate work focused on questions about the geometry of space-time, and how its curvature may emerge from something more basic as described by quantum gravity.

"Those are big questions to tackle," Engelhardt admits. "The largest bulk of my time is spent thinking, hmm, how do I take this vague intuition and condense it into a question that can be concretely answered, quantitatively? That's a large part of the progress you can make."

A black hole imprint

In 2014, midway through her PhD work, Engelhardt honed one of her questions about quantum gravity and space-time emergence to a specific problem: how to compute the quantum corrections to the entropy of gravitating systems.

"There are surfaces (in space-time) that are sensitive to gravitational (curving) called extremal surfaces," Engelhardt explains. "There already was a formula that used such surfaces to compute the entropy of gravitational systems in the absence of quantum effects. But in realistic quantum gravity, there are quantum effects, and I wanted a formula that took that into account."

She and postdoc Aron Wall worked to construct a general equation that would describe how entropy of gravitating regions should be computed when quantum effects are taken into account. The result: quantum extremal surfaces, a quantum generalization of the old classical surfaces.

At the time, the exercise was purely theoretical, as the quantum effects from most processes in the universe are too small to even slightly wobble the surrounding space-time. Their new equation, therefore, would land on similar predictions as the purely classical counterpart.

But in 2019, as a postdoc at Princeton, Engelhardt and others realized that this equation might give a very different prediction for what a quantum extremal surface might do, and what the corresponding quantum gravitational entropy would be, in one specific situation: as a black hole evaporates. What's more, what the equation predicts could be the key to resolving the longstanding black hole information paradox.

"This was a very dramatic moment," she recalls. "Everyone was working around the clock to try to figure this out, not really sleeping at night because we were so excited."

After three sleep-deprived weeks, the physicists were convinced that they had made a dramatic step toward resolving the paradox: As a black hole evaporates and releases radiation in a scrambled form of the information that originally fell into it, a new, completely nonclassical quantum extremal surface emerges, resulting in a gravitational entropy that shrinks as more information radiates away. They reasoned that this surface can serve as an imprint of the radiated information, which could in principle be used to reconstruct the original information, which Stephen Hawking had shown would be lost forever.

"That was a Eureka! moment," she says. "I remember driving home, and thinking, and maybe even saying out loud, 'I think this is it!'"

It's not yet clear what Hawking was actually calculating to assume the contrary. But Engelhardt considers the paradox close to resolved, at least in broad strokes, and her team's work has held up to repeated checks and careful scrutiny. In the meantime, she set her sights on other questions.

Testing pillars

Engelhardt's breakthrough came in May 2019. Just two months later, she headed to Cambridge to start her faculty position at MIT. (She first visited the campus and interviewed for the position in 2017.)

"There was a palpable sense of excitement about science in the Center for Theoretical Physics, and you feel it everywhere — it permeates the Institute," she recalls. "That was one of the reasons I wanted to be at MIT."

> **"I read all the books we had left in Hebrew, until at long last, there was just one left, which was Stephen Hawking's 'A Brief History of Time.'"**

She was offered the position, which she accepted and chose to defer for a year to complete her postdoc at Princeton. In July 2019, she started at MIT as an assistant professor of physics.

In the early days on campus, as she set up her research group, Engelhardt followed up on the black hole information paradox, to see if she could find out not only how Hawking got it wrong but what he was actually calculating, if not the entropy of the radiation.

"At the end of the day, if you really want to resolve the paradox, we have to explain what Hawking's mistake was," Engelhardt says.

Her hunch is that he was in a way computing a different quantity altogether. She believes Hawking's work, which raised the paradox to begin with, might have been computing a different type of gravitational entropy, that appears to result in information loss when run forward as a black hole evaporates. However, this other form of gravitational entropy does not correspond to information content, and so its increase would not be paradoxical.

Today, she and her students are following up on questions related to quantum gravity as well as a thornier concept having to do with singularities — instances when an object such as a star collapses into a region so gravitationally intense as to destroy space-time itself. Physicists historically have predicted that singularities should only be present behind a black hole's event horizon, though others have seen hints that they exist outside of these gravitational boundaries.

"A lot of my work now is going into understanding how many pillars of gravitational physics are just not true as we currently understand them," she says. "Answering these questions is the ultimate motivation."

Schimmel Scholars Annette Jun Diao and Renee Barbosa

Professor Emeritus of Biology Paul Schimmel PhD '67 and his wife Cleo Schimmel are among the biggest champions and supporters of graduate students conducting life science research in the Department of Biology at MIT, as well as in departments such as the Department of Brain and Cognitive Sciences, the Department of Biological Engineering, and the Department of Chemistry, and in cross-disciplinary degree programs including the Computational and Systems Biology Program, the Molecular and Cellular Neuroscience Program, and the Microbiology Graduate Program. In addition to the Cleo and Paul Schimmel (1967) Scholars Fund to support graduate women students in the Department of Biology, in 2021, the Schimmels established the MIT Schimmel Family Program for Life Sciences.

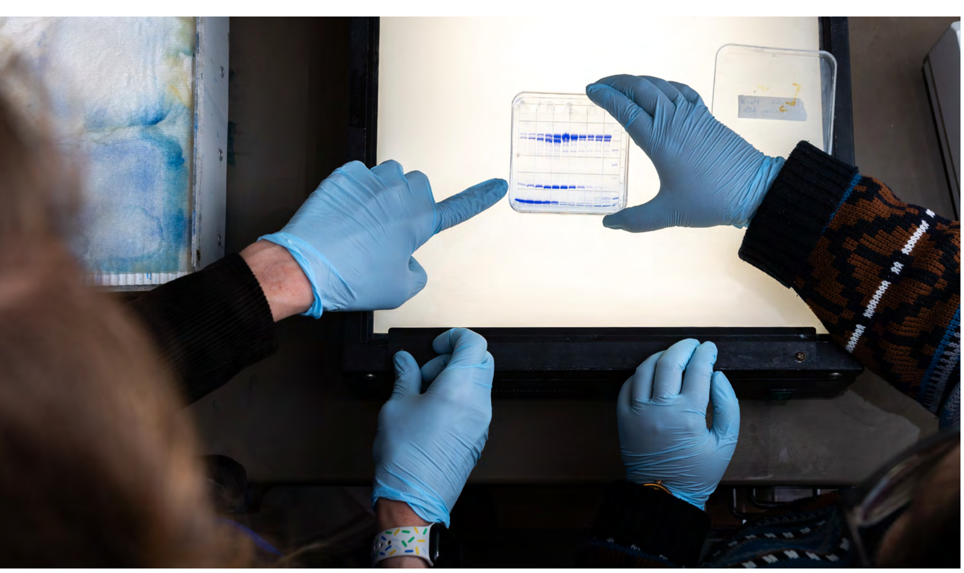
Their generous pledge of $50 million in matching funds called for other donors to join them in supporting the training of graduate students who will tackle some of the world's most urgent challenges. Driven by their unwavering belief that graduate students are the driving force behind much life science research and witnessing a decline in federal funding for graduate education, the Schimmel family established their one-to-one match program. They reached the ambitious goal of $100 million in endowed support in just two years.

Back to the basics of gene regulation

Graduate student and Schimmel Scholar Annette Jun Diao uses a minimal system to parse the mechanisms underlying gene expression

Lillian Eden | Biology

Annette Jun Diao's mother loves to tell the story of Diao's childhood aversion to the study of life — the gross and the squishy. Unlike some future biologists, Diao wasn't the type to stomp through creeks or investigate the life of frogs. Instead, she was interested in astronomy and only ended up in a high school biology class because of a bureaucratic snafu. The physics course she'd been hoping to take was canceled due to low enrollment, and she was informed molecular biology was being offered instead.



She attended the University of Toronto and joined the molecular genetics department because of the numerous opportunities for hands-on research. She's now a third-year graduate student in the Department of Biology at MIT.

"I'm fascinated by the mechanisms that underlie the regulation of gene expression," Diao says. "All of our genetic information is in DNA, and that DNA is an actual molecule with chemical properties that allow it to be passed from one generation to the next."

Every cell in our bodies contains a genome of approximately 20,000 genes, but the cells in our retinas are vastly different than the cells in our hearts — not all genes are in action simultaneously, and cell fates vary depending on how which genes are active.

"What is really awesome about the department — and what was attractive to me when I was applying to graduate school — is that I wasn't sure exactly what methods I

■ Graduate student Annette Jun Diao and Seycelle Vos, a professor of biology, work on the science of gene regulation. *Photo: Steph Stevens*

wanted to use to answer the questions I was interested in," Diao says. "A huge advantage of the program was that I had a lot to choose from."

Diao chose to pursue her thesis work with Seychelle Vos, the Robert A. Swanson (1969) Career Development Professor of Life Sciences and HHMI Freeman Hrabowski Scholar. Diao has been recognized with a Natural Sciences and Engineering Research Council of Canada Fellowship, which is similar to a National Science Foundation graduate fellowship in the United States.

Vos's lab is generally interested in understanding how transcription is regulated, the interplay of genome organization and gene expression, and the molecular machinery involved. Diao has been working with an enzyme called RNA polymerase II (RNAP II), the molecular machine that reads DNA and creates an RNA copy called mRNA. That mRNA goes on to be read by ribosomes to create proteins.

Many questions remain about RNAP II, including what signals instruct it to begin transcription and, once engaged, whether it will transcribe and how quickly it moves.

RNAP II doesn't work alone. Diao is working to understand how a transcription factor called negative elongation factor associates with RNAP II and whether the DNA sequence affects that interaction.

Within the broader context of the genome, DNA is packaged extremely tightly; if it were allowed to unfold, its total length could stretch from Cambridge to Connecticut. What RNAP II has access to at any given time is therefore quite restricted, which Diao is also exploring.

She has been exploring this topic in what she refers to as a "reductionist approach." By creating a minimal system — a strand of DNA and the precise addition of certain other isolated components — she can potentially parse out what

> **"A huge advantage of the program was that I had a lot to choose from."**

ingredients and what sequence of events are essential "in order to really get to the nitty-gritty of how genes are regulated."

Outside of her work in the lab, Diao is part of BioREFS, a peer support group for graduate students, and gwiBio. Both organizations bring members of the department together for scientific talks and socializing activities outside of the lab, and gwiBio also participates in community outreach.

Diao is also a Schimmel Scholar, supported by Professor Emeritus of Biology Paul Schimmel PhD '67 and his wife Cleo Schimmel.

"It was really great to learn that I was being supported by a scientist who has done a lot of awesome work that's relevant to my world," Diao says.

"It is awesome that they are so committed to supporting the graduate program at MIT, especially when federal resources have become more limited," Vos says. "With their support, our lab can train basic scientists who can then use their knowledge to transform our study of disease. I hope others follow Paul and Cleo's example."

RNA processing and gene expression governing

Graduate student and Schimmel scholar Renee Barbosa studies chromatin's role in gene expression

Bendta Schroeder | Koch Institute

The discovery that mutations in genes can drive cancer revolutionized cancer research. In the decades following the identification of the first "oncogene" in a chicken retrovirus in 1970 and the first human oncogene in 1982 by Robert Weinberg at MIT's Center for Cancer Research, scientists uncovered hundreds more oncogenes, transformed our understanding of how cancer begins and progresses, and developed sophisticated gene-targeted cancer therapies.

Photo: Steph Stevens

A majority of oncogenes were identified in factors controlling cell signaling, proliferation, and differentiation. However, a growing understanding of epigenetics has shown that many cancers, such as some leukemias and sarcomas, are not driven by mutations to these factors themselves, but by disruptions to the molecular pathways that regulate their expression. About 10 percent of all leukemias are driven by abnormal versions of the protein MLL1, one cog in the epigenetic machinery controlling these factors.

Renee Barbosa, a graduate student in the laboratory of Howard S. (1953) and Linda B. Stern Career Development Professor Yadira Soto-Feliciano in the Department of Biology, is joining this next wave of research, using leukemia as a model. A member of MIT's Koch Institute for Integrative Cancer Research, Soto-Feliciano and her lab study chromatin, the densely coiled structures of DNA and scaffolding proteins that make up our genomes and help ensure genes are expressed at the right times and in the right amounts.

Barbosa focuses on the role of RNA processing and the precisely choreographed alterations to chromatin that govern gene expression. RNA molecules serve as messengers between DNA and its final product, protein, and are subject to extensive processing and regulation. However, not much is known about the interplay between RNA processing and epigenetic machinery, particularly in cancer.

"I hope that my work will uncover additional layers of complexity in the dynamic landscape of gene regulation," says Barbosa. "It might also identify new mechanisms that can be targeted to help treat leukemia and other cancers."

Before Barbosa arrived at the Soto-Feliciano Lab, she was already steeped in the molecular intricacies of cancer. While at the University of Pennsylvania, she earned a BA in biochemistry and biophysics concurrently with a master's degree in chemistry. Early on, she joined the lab of Ronen Marmorstein, which used molecular approaches to characterize MEK and ERK, two cancer-relevant members of a class of signaling proteins. Upon starting graduate school, she was excited to branch out into other disciplines.

Barbosa has always taken every opportunity she can to learn. Beginning in grade school, science and math were her favorite subjects, but she also explored music, dance, and foreign languages. At the University of Pennsylvania, she even squeezed in a minor in neuroscience.

With its interdisciplinary approach, the Soto-Feliciano Lab provides Barbosa ample opportunities to learn. Because epigenetic factors can elude traditional approaches, the Soto-Feliciano Lab uses a multidisciplinary strategy, ranging from molecular, to large-scale omics analyses, to disease modeling.

Yadira Soto-Feliciano, a professor of biology, and graduate student Renee Barbosa use a multidisciplinary approach to understand the epigenetic factors in gene expression. *Photo: Steph Stevens*

"When I was a grad student, we saw the arrival of powerful new massive sequencing and gene editing technologies — and were enabled to ask big new questions," says Soto-Feliciano. "I am excited that Renee will have even more resources and opportunities, as we enter the next stage of cancer genetics and epigenetics."

With the support of a Schimmel Fellowship, Barbosa will be ready to take advantage of new developments in her field.

"Support for research early on in graduate school is an incredible opportunity," says Barbosa. "It means time to delve deep into the literature of the field and identify challenging open questions that I can pursue in my project. Though exploring these unknown areas requires taking bigger risks, I hope that we will get invaluable insight from an understanding of these nuanced and complex mechanisms."

From neurons to learning and memory

Mark Harnett investigates how electrical activity in mammalian cortical cells helps to produce neural computations that give rise to behavior

Anne Trafton | MIT News

Photo: Adam Glanzman

Mark Harnett, an associate professor at MIT, still remembers the first time he saw electrical activity spiking from a living neuron.

He was a senior at Reed College and had spent weeks building a patch clamp rig — an experimental setup with an electrode that can be used to gently probe a neuron and measure its electrical activity.

"The first time I stuck one of these electrodes onto one of these cells and could see the electrical activity happening in real time on the oscilloscope, I thought, 'Oh my God, this is what I'm going to do for the rest of my life. This is the coolest thing I've ever seen!'" Harnett says.

Harnett, who recently earned tenure in MIT's Department of Brain and Cognitive Sciences, now studies the electrical properties of neurons and how these properties enable neural circuits to perform the computations that give rise to brain functions such as learning, memory, and sensory perception.

"My lab's ultimate goal is to understand how the cortex works," Harnett says. "What are the computations? How do the cells and the circuits and the synapses support those computations? What are the molecular and structural substrates of learning and memory? How do those things interact with circuit dynamics to produce flexible, context-dependent computation?"

"We go after that by looking at molecules, like synaptic receptors and ion channels, all the way up to animal behavior, and building theoretical models of neural circuits," he adds.

Influence on the mind

Harnett's interest in science was sparked in middle school, when he had a teacher who made the subject come to life. "It was middle school science, which was a lot of just mixing random things together. It wasn't anything particularly advanced, but it was really fun," he says. "Our teacher was just super encouraging and inspirational, and she really sparked what became my lifelong interest in science."

When Harnett was 11, his father got a new job at a technology company in Minneapolis and the family moved from New Jersey to Minnesota, which proved to be a difficult adjustment. When choosing a college, Harnett decided to go far away, and ended up choosing Reed College, a school in Portland, Oregon, that encourages a great deal of independence in both academics and personal development.

"Reed was really free," he recalls. "It let you grow into who you wanted to be, and try things, both for what you wanted to do academically or artistically, but also the kind of person you wanted to be."

While in college, Harnett enjoyed both biology and English, especially Shakespeare. His English professors encouraged him to go into science, believing that the field needed scientists who could write and think creatively. He was interested in neuroscience, but Reed didn't have a neuroscience department, so he took the closest subject he could find — a course in neuropharmacology.

"That class totally blew my mind. It was just fascinating to think about all these pharmacological agents, be they from plants or synthetic or whatever, influencing how your mind worked," Harnett says. "That class really changed my whole way of thinking about what I wanted to do, and that's when I decided I wanted to become a neuroscientist."

For his senior research thesis, Harnett joined an electrophysiology lab at Oregon Health Sciences University (OHSU), working with Professor Larry Trussell, who studies synaptic transmission in the auditory system. That lab was where he first built and used a patch clamp rig to measure neuron activity.

After graduating from college, he spent a year as a research technician in a lab at the University of Minnesota, then returned to OHSU to work in a different research lab studying ion channels and synaptic physiology. Eventually he decided to go to graduate school, ending up at the University of Texas at Austin.

For his PhD research, he studied the neurons that release the neuromodulator dopamine and how they are affected by drugs of abuse and addiction. However, once he finished his degree, he decided to return to studying the biophysics of computation, which he pursued during a postdoc at the Howard Hughes Medical Institute Janelia Research Campus with Jeff Magee.

A broad approach

When he started his lab at MIT's McGovern Institute in 2015, Harnett set out to expand his focus. While the physiology of ion channels and synapses forms the basis of much of his lab's work, they connect these processes to neuronal computation, cortical circuit operation, and higher-level cognitive functions.

Electrical impulses that flow between neurons, allowing them to communicate with each other, are produced by ion channels that control the flow of ions such as potassium and sodium. In a 2021 study, Harnett and his students discovered that human neurons have a much smaller number of these channels than expected, compared to the neurons of other mammals.

This reduction in density may have evolved to help the brain operate more efficiently, allowing it to divert resources to other energy-intensive processes that are required to perform complex cognitive tasks. Harnett's lab has also found that in human neurons, electrical signals weaken as they flow along dendrites, meaning that small sections of dendrites can form units that perform individual computations within a neuron.

> "What are the molecular and structural substrates of learning and memory? How do those things interact with circuit dynamics to produce flexible, context-dependent computation?"

Harnett's lab also recently discovered, to their surprise, that the adult brain contains millions of "silent synapses" — immature connections that remain inactive until they're recruited to help form new memories. The existence of these synapses offers a clue to how the adult brain is able to continually form new memories and learn new things without having to modify mature synapses.

Many of these projects fall into areas that Harnett didn't necessarily envision himself working on when he began his faculty career, but they naturally grew out of the broad approach he wanted to take to studying the cortex. To that end, he sought to bring people to the lab who wanted to work at different levels — from molecular physiology up to behavior and computational modeling.

As a postdoc studying electrophysiology, Harnett spent most of his time working alone with his patch clamp device and two-photon microscope. While that type of work still goes on his lab, the overall atmosphere is much more collaborative and convivial, and as a mentor, he likes to give his students broad leeway to come up with their own projects that fit in with the lab's overall mission.

"I have this incredible, dynamic group that has been really great to work with. We take a broad approach to studying the cortex, and I think that's what makes it fun," he says. "Working with the folks that I've been able to recruit — grad students, techs, undergrads, and postdocs — is probably the thing that really matters the most to me."

Future science at the molecular level

Brad Pentelute and his lab compel the anthrax delivery system to deliver antibody and peptide variants into cells to treat cancer

Daniel de Wolff | MIT Industrial Liaison Program

Since joining the MIT faculty in 2011, Brad Pentelute has continued working on anthrax, hoping to develop it as a possible vehicle for delivering drugs across not only cell membranes but also the blood-brain barrier. *Photo: Jared Charney*

Innovating at the intersection of chemistry, biology, and engineering, Professor Brad Pentelute and the Pentelute Lab at MIT invent new chemistry, platforms, and techniques that might revolutionize therapeutics. Their formula in brief: nature-inspired research that begins at the molecular level, infused with state-of-the-art machine learning and automation, aimed at solving real-world problems.

Take, for example, biotechnology's longstanding protein delivery problem. Effective intracellular protein delivery has vast potential for improving human health and curing disease. The key challenge is delivering large molecules (e.g., peptides, proteins, and oligonucleotides) into cells.

Pentelute and his team of researchers decided to see what they could learn from nature's delivery systems for large molecules. More specifically, they investigated anthrax. The deadly toxin happens to be very good at inserting proteins into cells, explains Pentelute, whose postdoctoral work at Harvard Medical School looked at how infectious agents infiltrate cells at the molecular level.

> “Our discovery will significantly aid in the development of durable cell-based protein therapeutics.”

Pentelute and his team modified the deadly toxin into a vehicle for delivering antibody and peptide variants that can be used to treat cancer. As Pentelute explains, “We essentially hijack the anthrax delivery system to get proteins into the cell. Our discovery will significantly aid in the development of durable cell-based protein therapeutics.”

Meanwhile, he has spent 12 years building an automated protein printing machine, which started in collaboration with MIT professor Klavs Jensen. Their innovation borrows its design from nature’s ribosome, which stitches together amino acids to create proteins in just minutes. And while their human-made version is not as fast as its inspiration — not yet, anyway, according to Pentelute — it does help to accelerate the scientific experiment and drug discovery process.

“We’ve built the world’s fastest and most efficient machine of its kind; it is capable of producing thousands of amide bonds an order of magnitude faster than commercially available instruments,” says Pentelute. Meaning it might just accelerate the manufacturing of on-demand personalized therapies like cancer vaccines. To date, the platform is used by labs across MIT’s campus. It is also the basis for Amide Technologies, a startup Pentelute helped launch to scale his creation.

He and his group at MIT have built other platforms, too, including one that discovers new biologically active peptides and proteins capable of disrupting the spread of cancer. Based on affinity selection mass spectrometry, Pentelute says their invention proved particularly useful at the height of the Covid-19 pandemic. It allowed them to be among the first to discover numerous peptidomimetics that can bind to the ACE2 receptor, which is necessary for SARS-CoV-2 to enter cells. They also discovered some of the first peptides that bind to the coronavirus spike protein.

These discoveries led Pentelute and his group to the realization that they were building a rapid response platform that, as Pentelute puts it, “can look at a protein or some biology of interest and rapidly identify new ligands, new binders that could eventually be used either for assays or potential starting points for drugs.”

Based on the technology, Pentelute helped launch a pharmaceutical startup called Decoy Therapeutics. Pentelute says, “Today, Decoy is working to build a nasal formulation based on a peptide that we’ve designed that can inhibit viral progression and transmission. We’re testing that right now, and it looks quite exciting.”

As well-versed as he is in translating ideas from the lab to the real world, it is no surprise that Pentelute credits industry wants and needs as an important driver of innovation in his research program. It is also why he believes the MIT Industrial Liaison Program (MIT ILP), well established as industry’s most comprehensive portal to the Institute, is an essential aspect of the MIT innovation ecosystem. “MIT ILP has been a phenomenal partner to my lab,” he says. “We’ve put together at least 10 sponsored research agreements that started with the ILP introductions. It’s a great way to network, connect, and try new approaches to problem-solving.”

Ask Pentelute about the future of his research, and he will tell you he and his group are hard at work generating molecular data to establish systems capable of training algorithms to design molecules with new functions. In reference to the work, he says, “We were the first people in the world to use machine learning to design miniature abiotic (not designed by nature) cell-penetrating proteins.”

One of their collaborators on the new project is Professor Manolis Kellis of the MIT Computer Science and Artificial Intelligence Laboratory. Kellis is well known for his groundbreaking work exploring genome-level changes as causal drivers of disease. “We’re building knowledge trees to understand what is driving, for instance, obesity,” Pentelute explains, “and then we’re going to come over to my laboratory and figure out how to rapidly make and test these molecules.”

Joining the MIT professors in their endeavor is Harvard Medical School’s Marinka Zitnik. She is at the forefront of building the Therapeutic Data Commons, which gathers data to build machine learning models to accelerate drug development. “With Marinka’s help, before we do experiments, we can ask questions about how a molecule, given its particular design, might work within a human,” says Pentelute.

“This is a critical moment in terms of the way we do science,” says Pentelute. “We’re converging to build a new paradigm of thinking through the AI-driven design of molecules to interact with humans. In the future, we’ll be able to design molecules as needed to impact not just human health, but everything that we experience here on Earth. We’re leapfrogging into a new space of innovation — that’s what drives me, and that’s what we’re trying to build here at the Pentelute Lab.”

A nano-world of opportunities

Breakfast with Nobel Laureate Professor Moungi Bawendi

Sarah Costello and Jesse Feiman | School of Science

Dean of Science Nergis Mavalvala talks with Nobel Prize winner and MIT Professor Moungi Bawendi at the Dean's Breakfast talk on April 18, 2024.
Photo: Allegra Boverman

"You've seen so many of these pictures, I'm sure," said Lester Wolfe Professor of Chemistry Moungi Bawendi, projecting a photo of bright, rainbow-colored vials against a black background onto the wall. "I've seen so many of these pictures!"

Along with Louis Brus and Alexei Ekimov, Bawendi won the 2023 Nobel Prize in chemistry "for the discovery and synthesis of quantum dots," the nanoparticles depicted in the photo. Quantum dots are particles of semiconductor materials so small that their physical characteristics are determined by the laws of quantum mechanics. They fluoresce brightly in ultraviolet light and the colors of light the dots emit depends on the sizes of the particles. On the morning of April 18, he presented a talk entitled, "A Synthesis of Quantum Dots Unlocks a Nano-World of Opportunities," to the donors, friends, and students assembled for breakfast.

The presentation chronicled the development of quantum dots from early discoveries in the 1980s, when Ekimov observed changing colors from nanoparticles frozen in glass, and Brus from nanoparticles suspended in liquid — rudimentary and "ugly" particles — to today's iteration, refined by Bawendi, that has upgraded LED and bioimaging technology. Bawendi moved on to a slide of a transparency that he dated to the late 1980s or early 1990s, full of measurement data from early research.

During Bawendi's postdoc with Brus at Bell Labs, he experimented with preparing the particles in pyridine and other Lewis bases, growing crystal structures. Of 20 vials, "19 were ugly; nothing happened. And one of them was magic." An attempt using trioctylphosphine oxide created something "really sharp and beautiful."

Bawendi then continued his work on the method at MIT as an assistant professor. "At Bell Labs, it worked some of the time. Here, it just didn't work," he recalled. What's more, the materials were expensive, and the lab couldn't afford to keep going through them at the rate they were without getting results. "By necessity, we had to reinvent the process."

Bawendi and his students turned to longer chain phosphates, which were affordable and available, "not just in the truckload — in the trainload." They eliminated an initial step of growing very little particles, instead using a rapid injection method at 300 degrees Celsius for immediate nucleation. This innovation led to Bawendi's first paper as an assistant professor.

■ Jen Park '95 listens to the Nobel Prize breakfast talk. *Photo: Allegra Boverman*

"At Bell Labs, it worked some of the time. Here, it just didn't work. ... By necessity, we had to reinvent the process."

Initially, the dots had a quantum yield of 20 percent, meaning that of 100 photons absorbed by a particle, 20 were reemitted as a different colored light. "We thought that was amazing because before it was 0 percent," Bawendi noted. The group quickly increased their success rate from 10 percent to 100 percent. Before, the colloidal quantum dots were protected by a metaphorical plastic bag. Now, with scientists' ability to better control particles, build crystals, and produce materials, they could be protected by a metaphorical hard shell and a plastic bag.

With their new method, Bawendi and his students synthesized quantum dots uniform in size and color.

"They're really bright and they're really small and they make light. They've got to be good for something," said Bawendi. And indeed they were — in addition to a Nobel Prize, the quantum dots have already led to advances in biomedical imaging, cell labeling, and lighting displays like televisions, with potential advances in solar cells, electronics, photocatalysts, and spectrometers on the horizon.

Nuno Loureiro named director of MIT's Plasma Science and Fusion Center

A lauded professor, theoretical physicist, and fusion scientist, Loureiro is keenly positioned to advance the center's research and education goals

Julianna Mullen | Plasma Science and Fusion Center

Nuno Loureiro, professor of nuclear science and engineering and of physics, has been appointed the new director of the MIT Plasma Science and Fusion Center (PSFC), effective May 1.

Loureiro is taking the helm of one of MIT's largest labs: more than 250 full-time researchers, staff members, and students work and study in seven buildings with 250,000 square feet of lab space. A theoretical physicist and fusion scientist, Loureiro joined MIT as a faculty member in 2016, and was appointed deputy director of the Plasma Science and Fusion Center in 2022. Loureiro succeeds Dennis Whyte, who stepped down at the end of 2023 to return to teaching and research.

Stepping into his new role as director, Loureiro says, "The PSFC has an impressive tradition of discovery and leadership in plasma and fusion science and engineering. Becoming director of the PSFC is an incredible opportunity to shape the future of these fields. We have a world-class team, and it's an honor to be chosen as its leader."

Loureiro's own research ranges widely. He is recognized for advancing the understanding of multiple aspects of plasma behavior, particularly turbulence and the physics underpinning solar flares and other astronomical phenomena. In the fusion domain, his work enables the design of fusion devices that can more efficiently control and harness the energy of fusing plasmas, bringing the dream of clean, near-limitless fusion power that much closer.

Photo: Jake Belcher

Plasma physics is foundational to advancing fusion science, a fact Loureiro has embraced and that is relevant as he considers the direction of the PSFC's multidisciplinary research. "But plasma physics is only one aspect of our focus. Building a scientific agenda that continues and expands on the PSFC's history of innovation in all aspects of fusion science and engineering is vital, and a key facet of that work is facilitating our researchers' efforts to produce the breakthroughs that are necessary for the realization of fusion energy."

As the climate crisis accelerates, fusion power continues to grow in appeal: It produces no carbon emissions, its fuel is plentiful, and dangerous "meltdowns" are impossible. The sooner that fusion power is commercially available, the greater impact it can have on reducing greenhouse gas emissions and meeting global climate goals. While technical challenges remain, "the PSFC is well poised to meet them, and continue to show leadership. We are a mission-driven lab, and our students and staff are incredibly motivated," Loureiro comments.

"As MIT continues to lead the way toward the delivery of clean fusion power onto the grid, I have no doubt that Nuno is the right person to step into this key position at this critical time," says Maria T. Zuber, MIT's presidential advisor for science and technology policy. "I look forward to the steady advance of plasma physics and fusion science at MIT under Nuno's leadership."

Over the last decade, there have been massive leaps forward in the field of fusion energy, driven in part by innovations like high-temperature superconducting magnets developed at the PSFC. Further progress is guaranteed: Loureiro believes that "The next few years are certain to be an exciting time for us, and for fusion as a whole. It's the dawn of a new era with burning plasma experiments" — a reference to the collaboration between the PSFC and Commonwealth Fusion Systems, a startup company spun off of the PSFC, to build SPARC, a fusion device that is slated to turn on in 2026 and produce a burning plasma that yields more energy than it consumes. "It's going to be a watershed moment," says Loureiro.

He continues, "In addition, we have strong connections to inertial confinement fusion experiments, including those at Lawrence Livermore National Lab, and we're looking forward to expanding our research into stellarators, which are another kind of magnetic fusion device." Over recent years, the PSFC has significantly increased its collaboration with industrial partners such as Eni, IBM, and others. Loureiro sees great value in this: "These collaborations are mutually beneficial: they allow us to grow our research portfolio while advancing companies' R&D efforts. It's very dynamic and exciting."

Loureiro's directorship begins as the PSFC is launching key tech development projects like LIBRA, a "blanket" of molten salt that can be wrapped around fusion vessels and perform double duty as a neutron energy absorber and a breeder for tritium (the fuel for fusion). Researchers at the PSFC have also developed a way to rapidly test the durability of materials being considered for use in a fusion power plant environment, and are now creating an experiment that will utilize a powerful particle accelerator called a gyrotron to irradiate candidate materials.

Interest in fusion is at an all-time high; the demand for researchers and engineers, particularly in the nascent commercial fusion industry, is reflected by the record number of graduate students that are studying at the PSFC — more than 90 across seven affiliated MIT departments. The PSFC's classrooms are full, and Loureiro notes a palpable sense of excitement. "Students are our greatest strength," says Loureiro. "They come here to do world-class research but also to grow as individuals, and I want to give them a great place to do that. Supporting those experiences, making sure they can be as successful as possible is one of my top priorities." Loureiro plans to continue teaching and advising students after his appointment begins.

MIT president Sally Kornbluth's recently announced Climate Project is a clarion call for Loureiro: "It's not hyperbole to say MIT is where you go to find solutions to humanity's biggest problems," he says. "Fusion is a hard problem, but it can be solved with resolve and ingenuity — characteristics that define MIT. Fusion energy will change the course of human history. It's both humbling and exciting to be leading a research center that will play a key role in enabling that change."

"A key facet of [our] work is facilitating our researchers' efforts to produce the breakthroughs that are necessary for the realization of fusion energy."

Rewarding excellence in open data

MIT researchers who share their data recognized at second annual awards celebration

Brigham Fay | MIT Libraries

The second annual MIT Prize for Open Data, which included a $2,500 cash prize, was recently awarded to 10 individual and group research projects. Presented jointly by the School of Science and the MIT Libraries, the prize highlights the value of open data — research data that is openly accessible and reusable — at the Institute. The prize winners and 12 honorable mention recipients were honored at the Open Data@MIT event held this past fall at Hayden Library.

Conceived by Chris Bourg, director of MIT Libraries, and Rebecca Saxe, associate dean of the School of Science and the John W. Jarve (1978) Professor of Brain and Cognitive Sciences, the prize program was launched in 2022. It recognizes MIT-affiliated researchers who use or share open data, create infrastructure for open data sharing, or theorize about open data. Nominations were solicited from across the Institute, with a focus on trainees: undergraduate and graduate students, postdocs, and research staff.

Photo: Bryce Vickmark

"The prize is explicitly aimed at early-career researchers," says Bourg. "Supporting and encouraging the next generation of researchers will help ensure that the future of scholarship is characterized by a norm of open sharing." The 2023 awards were presented at a celebratory event held during International Open Access Week. Winners gave five-minute presentations on their projects and the role that open data plays in their research.

Winners were chosen from more than 80 nominees, representing all five MIT schools, the MIT Schwarzman College of Computing, and several research centers across the Institute. A committee composed of faculty, staff, and graduate students made the selections, which included the following from the School of Science:

> "Supporting and encouraging the next generation of researchers will help ensure that the future of scholarship is characterized by a norm of open sharing."

Director of MIT Libraries Chris Bourg (first row, center) and Associate Dean Rebecca Saxe (seated on Bourg's left) celebrate with the recent winners of the MIT Open Data Prize. *Photo: Bryce Vickmark*

Adam Atanas, postdoc in the Department of Brain and Cognitive Sciences (BCS), and Jungsoo Kim, graduate student in BCS, created WormWideWeb.org. The site, allowing researchers to easily browse and download *C. elegans* whole-brain datasets, will be useful to *C. elegans* neuroscientists and theoretical/computational neuroscientists.

Undergraduate student Daniel Kurlander created a tool for planetary scientists to rapidly access and filter images of the comet 67P/Churyumov-Gerasimenko. The web-based tool enables searches by location and other properties, does not require a time-intensive download of a massive dataset, allows analysis of the data independent of the speed of one's computer, and does not require installation of a complex set of programs.

Halie Olson, postdoc in BCS, was recognized for sharing data from a functional magnetic resonance imaging study on language processing. The study used video clips from "Sesame Street" in which researchers manipulated the comprehensibility of the speech stream, allowing them to isolate a "language response" in the brain.

Melissa Kline Struhl, research scientist in BCS, was recognized for Children Helping Science, a free, open-source platform for remote studies with babies and children that makes it possible for researchers at more than 100 institutions to conduct reproducible studies.

A complete list of winning projects and honorable mentions, including links to the research data, is available on the MIT Libraries website.

New exhibits showcase trailblazing MIT women

Materials from MIT's Distinctive Collections reveal stories of women at the Institute

Brigham Fay | MIT Libraries

This spring, two new exhibits on campus shined a light on the critical contributions of pathbreaking women at the Institute. They are part of MIT Libraries' Women@MIT Archival Initiative in the Department of Distinctive Collections. Launched in 2017, the initiative not only adds to the historical record by collecting and preserving the papers of MIT-affiliated women, it shares their lives and work with global audiences through exhibits, multimedia projects, educational materials, and more.

"Under the Lens"

"Under the Lens: Women Biologists and Chemists at MIT 1865–2024," examines the work of women in science and engineering at MIT beginning with Ellen Swallow Richards, the Institute's first female student and instructor, through the present day, when a number of women with backgrounds in biology, biological engineering, chemistry, and chemical engineering — the subjects of focus in this exhibit — hold leadership positions at the Institute, including President Sally Kornbluth, Vice Provost for Faculty Paula Hammond, and Professor Amy Keating, who heads the Department of Biology.

Exhibit curator Thera Webb, Women@MIT project archivist, explains the exhibit title's double meaning: "The women featured in 'Under the Lens' are scientists whose work engages with the materials of our world on a molecular

> "[W]omen's ability to work as scientists and academics has been scrutinized through the lens of public opinion since Victorian-era debates about co-education."

Photograph of Margaret Hutchinson, wife of MIT President Karl Compton, at the FDA. Image on Wikimedia, from National Archives FDA records series 88.11

level, using the lens of a microscope," she says. "The title also plays on the fact that women's ability to work as scientists and academics has been scrutinized through the lens of public opinion since Victorian-era debates about co-education."

Items for the exhibit, selected from Distinctive Collections, demonstrate the experiences of women students, research staff, and faculty. They include the 1870 handwritten faculty meeting notes admitting Richards, then Ellen Henrietta Swallow, as MIT's first female student, stating "the

Faculty are of the opinion that the admission of women as special students is as yet in the nature of an experiment." Materials from alumna and late professor ChoKyun Rha's "Rheological Characterization of Printing Ink," circa 1979, include images of the development process of ink and data from experiments. Also on display was a lab coat and rodent brain tissue slides from the neuroscience laboratory of Susan Hockfield, MIT's 16th president.

"The collections we have related to women at MIT not only show us what their academic and professional interests were, with items like lab notebooks and drafts of papers, but also how our MIT community has been actively supporting women in science," says Webb. "Many of our alumnae and faculty have been involved with the founding of groups like the Association of American University Women, the MIT Women's Association, the Association for Women in Science, and the Women in Chemistry Group."

"Under the Lens: Women Biologists and Chemists at MIT 1865–2024" was on view in the Maihaugen Gallery (Building 14N-130) from February 20 to June 21. There is an accompanying digital exhibit available on the MIT Libraries' website.

Lydia Villa-Komaroff in laboratory in the 1970s. *Photo courtesy of MIT Museum*

"Sisters in Making"

"Sisters in Making: Prototyping and the Feminine Resilience" (December 20, 2023 to April 8, 2024 in Rotch Library), explores the unseen women, often referred to as "weavers," who were instrumental to the development of computers. The exhibit, the work of Deborah Tsogbe SM '23 and Soala Ajienka, a current architecture graduate student, spotlights the women who built the core rope memory and magnetic core memory for the Apollo Guidance Computer.

"While we ultimately know the names of the first men on the moon, and of those who spearheaded the engineering initiatives behind the Apollo 11 mission, the names of the countless women who had a vital hand in realizing these feats have been missing from historical discourse," Tsogbe and Ajienka write. "The focus of our work has been to uncover the names and faces of these women, who held important positions including overseeing communications, checking codes, running calculations, and weaving memory."

Working in the archives, Tsogbe and Ajienka sought to identify the women involved in this endeavor, going through personnel logs, press releases, and other historical artifacts. Originally focused on the women working on rope memory, they broadened the scope of women involved in the journey to the moon and were able to name 534 women across 29 classes of work and nine organizations. Tsogbe and Ajienka fabricated a core memory prototype with the names of some of these women stored; they were technicians, data key punchers, engineers, librarians, and office staff from MIT, Raytheon, and NASA. Called the "memory dialer," the prototype is intended to be a living archive.

Tsogbe and Ajienka created "Sisters in Making" as 2023 Women@MIT Fellows. This fellowship invites scholars, artists, and others to showcase materials from Distinctive Collections in engaging ways that contribute to greater understanding of the history of women at MIT and in STEM. The project also received a grant from the Council for the Arts at MIT.

"Deborah and Soala's exhibit shows the variety of ways that the rich materials in the Women@MIT collections can be used," says Webb. "Projects like these really highlight the value of historical collections in ways outside of traditional scholarly publications."

School of Science

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The March 5, 2024 graduation of Marcos Berríos ’06 (third from right), Christina Birch PhD ’15 (second from left), and Christopher Williams PhD ’12 (third from left) brings the total number of MIT astronaut alumni to 44 of the 360 selected by NASA to serve as astronauts since the original Mercury Seven in 1959.

Photo: Courtesy of NASA