Dean, School of Science

School of Science researchers seek to answer fundamental questions about nature, ranging from the microscopic—a neuroscientist might isolate the electrical activity of a single neuron—to the telescopic—an astrophysicist might scan hundreds of thousands of stars to find Earth-like planets in the stars' orbits. Fundamental research opens the way to a better understanding of the nature of our universe. It will also help us to address major challenges to improving and sustaining our quality of life, such as developing viable resources of renewable energy or unraveling the complex mechanics of Alzheimer's and other diseases of the aging brain.

These profound questions often require collaboration across departments or schools within the Institute. They are facilitated by affiliations with MIT's numerous laboratories, centers, departments, and institutes, as well as through participation in interdisciplinary initiatives, such as the Quest for Intelligence, the Aging Brain Initiative, or the Transiting Exoplanet Survey Satellite. The faculty's participation in the Undergraduate Research Opportunities Program, established in 1969 by Professor Margaret MacVicar of the Department of Physics, enables students to work across departmental and disciplinary boundaries and gain hands-on experience in basic research.

Similarly, our faculty's commitment to teaching and mentorship is not constrained by lines between schools or departments. School of Science faculty members teach General Institute Requirement subjects in biology, chemistry, mathematics, and physics that provide the conceptual foundation of every undergraduate student's education at MIT. The School faculty solidify cross-disciplinary connections through participation in graduate programs established in collaboration with the School of Engineering, such as the programs in biophysics, microbiology, molecular and cellular neuroscience, and statistics. Through the School's contributions to edX, our faculty's commitment to excellence in education reaches beyond the walls of MIT's classrooms and laboratories to students around the world.

Initiatives and Programs

Aging Brain Initiative

Spearheaded by Li-Huei Tsai, Picower Professor and director of the Picower Institute for Learning and Memory, and Michael Sipser, Donner Professor of Mathematics and dean of the School of Science, the Aging Brain Initiative was established to support interdisciplinary research on Alzheimer's disease and other diseases of the aging brain. The number of Americans with Alzheimer's disease is predicted to increase from 5.1 million people at the present time to 13.5 million by 2050, and there is now neither a cure for Alzheimer's disease nor an effective means of slowing its progress. Until we know more about what causes brain functions to change with age, we will be no closer to a cure or a disease-modifying therapy. The Aging Brain Initiative seeks to address this gap in knowledge through collaborative efforts by researchers in neuroscience, bioengineering, biology, computer science, artificial intelligence, medicine, and health policy.

Center for Brains, Minds, and Machines

The Center for Brains, Minds, and Machines (CBMM), a multi-institutional collaboration with headquarters at MIT, has established a new field—the science and engineering of intelligence—by bringing together computer scientists, cognitive scientists, and neuroscientists to work in close collaboration. Led by Tomaso Poggio, Eugene McDermott Professor in the Brain Sciences, the vision of this multi-institutional collaboration is to develop a deep understanding of intelligence and the ability to engineer it. The center also intends to train the next generation of scientists and engineers in this emerging field and to catalyze progress in, and cross-fertilization between, computer science, mathematics and statistics, robotics, neuroscience, and cognitive science.

Quest for Intelligence

Launched on February 1, 2018, the MIT Quest for Intelligence is a campus-wide initiative to discover the foundations of intelligence and to drive the development of technological tools that can positively influence society. Researchers in the School of Science have played active roles in leading the quest through their long-standing commitment to understanding the science and engineering of intelligence. James DiCarlo, Peter de Florez Professor of Neuroscience, head of the Department of Brain and Cognitive Sciences (BCS), and investigator at the McGovern Institute for Brain Research, was named director of one of the Quest's two linked entities, the Core. The Core is designed to advance research in both human and machine intelligence. Daniela Rus, the Andrew (1956) and Erna Viterbi Professor of Electrical Engineering and Computer Science (EECS) and director of the Computer Science and Artificial Intelligence Laboratory (CSAIL), was named associate director of the Core.

Tomaso Poggio, a member of CSAIL and an investigator at the McGovern Institute, was named the founding scientific advisor of the Core. The Core's scientific directors include Josh Tenenbaum, professor of computational cognitive science in BCS, research leader at CBMM, and a member of CSAIL; and Leslie Kaelbling, the Panasonic Professor of Computer Science and Engineering and a member of CSAIL.

With the creation of the Stephen A. Schwarzman College of Computing announced in spring 2019, The Quest's efforts will be overseen by incoming dean of the college Dan Huttenlocher SM '84, PhD '88.

Institute for Data, Systems, and Society

Launched in 2015 with the participation of all five MIT schools, the Institute for Data, Systems, and Society (IDSS) brings together researchers working in the mathematical, behavioral, and empirical sciences to capitalize on their shared interest in tackling complex societal problems. Led by Munther Dahleh, the William A. Coolidge Professor in EECS, IDSS offers a range of cross-disciplinary academic programs that use tools and methodologies in statistics, information and decision systems, and social sciences to address challenges and opportunities in complex systems. IDSS research encompasses a variety of domains, including finance, social networks, urbanization, energy systems, and health analytics.

Transiting Exoplanet Survey Satellite

The Transiting Exoplanet Survey Satellite (TESS) will monitor more than 200,000 stars in search of exoplanets capable of supporting life. Faculty members in the Departments of Aeronautics and Astronautics, Physics, and Earth, Atmospheric and Planetary Sciences participated in the first MIT-led NASA mission, with support from staff in Lincoln Laboratory. Managed by NASA's Goddard Space Flight Center, the TESS mission is led by George Ricker, a senior research scientist at the MIT Kavli Institute for Astrophysics and Space Research.

TESS uses an array of wide-field cameras, designed and fabricated at Lincoln Laboratory, to survey the entire sky, looking for the transient dimming of stars that indicates that planets may be passing in front of them. Since TESS began scientific operations in July 2018, it has reported more than 750 objects of interest with more than 20 confirmed discoveries of exoplanets. The satellite detected its first Earth-sized world this past April and in June discovered a world whose size was between those Mars and Earth. Although these recent discoveries were of exoplanets that lie outside the habitable zone (defined as a zone where liquid water would be possible on the planet's surface), the detections demonstrate TESS's ability to pick out small planets revolving around nearby stars. In the future, the TESS team expects the probe to reveal planets with conditions suitable for the potential to host life. Although all recent exoplanets' sizes, orbits, and masses are known, further study with other telescopes will be needed to determine if they have atmospheres and, if so, which gases are present. One of the goals of the TESS mission is to build a catalog of small, rocky planets on short orbits around very bright, nearby stars for atmospheric study by NASA's upcoming James Webb Space Telescope.

Further statistical analysis is needed to confirm the existence of the candidate exoplanets. The data are now shared publicly in real time to facilitate efforts by telescopes and other instruments around the world to validate the data.

Additional partners include Northrop Grumman, based in Falls Church, VA; NASA's Ames Research Center in California's Silicon Valley; the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA; and the Space Telescope Science Institute in Baltimore, MD. More than a dozen universities, research institutes, and observatories worldwide participate in the TESS mission.

Education

MIT is exceptional among major research institutions for its dedication to undergraduate education. MIT puts great emphasis on hiring and promoting young faculty members and using undergraduate teaching as an important criterion for promotion and tenure. It is not uncommon for Nobel Prize winners and others among MIT's best researchers to teach first-year subjects. Committed to providing undergraduates with a strong science base for studies in their majors, the School and its departments participate in and support a variety of programs designed to create more active, student-centered learning environments in the classroom.

With growing interest in computing across all disciplines, many departments are opening programs and courses designed for interdisciplinary studies, complementing

the new College of Computing. The Department of Mathematics has offered Course 18-C Mathematics with Computer Science, for several years. In 2016, the Departments of Biology and EECS collaborated to form Course 6-7 Computer Science and Molecular Biology. The Departments of Chemistry and Physics have flexible major options that allow students to focus on computational physics or chemistry, respectively, or on hardware development in nanotechnology. Starting in fall 2019, Course 6-9 Computation and Cognition, will be launched by BCS.

Interdisciplinary Graduate Programs

The School of Science has worked to expand educational and training opportunities for graduate students, collaborating with other schools and centers within the Institute to create innovative graduate programs in fields in which MIT shows strength. These programs exemplify the Institute-wide goal of reducing boundaries between disciplines and allow MIT to attract the most talented students in their respective fields. The programs integrate educational resources across participating departments, build connections among faculty with shared interests, and create an educational and research community for training students.

In fall 2019, doctoral students in BCS will have the opportunity to pursue an interdisciplinary statistics program with courses such as 6.804/9.66 Computational Cognitive Science, 9.19/9.190 Computational Psycholinguistics, and HST.583/9.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis. In addition, the Department of Earth, Atmospheric, and Planetary Sciences (EAPS) is the latest to participate in the Computational Science and Engineering Program, allowing graduate students to analyze complex Earth and planetary systems, leveraging cutting-edge computing and data science.

Biophysics

The Biophysics Program trains graduate students in the application of the physical sciences and engineering to fundamental biological questions at the molecular, cellular, and systems levels. The program spans the Schools of Science and Engineering and includes the Departments of Biology, Biological Engineering, BCS, Chemical Engineering, Chemistry, Civil and Environmental Engineering, EECS, Health Sciences and Technology, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Physics.

Microbiology

The Microbiology Program is an interdisciplinary doctoral program in microbial science and engineering with more than 50 faculty members from several departments in the Schools of Science and Engineering. Students receive training in a wide range of approaches to microbiology, including biochemistry, biotechnology, cell and molecular biology, chemical and biological engineering, computational biology, ecology, environmental biology, evolutionary biology, genetics, genomics, geobiology, immunology, pathogenesis, structural biology, synthetic biology, systems biology, and virology.

Molecular and Cellular Neuroscience

The Molecular and Cellular Neuroscience Doctoral Program provides critical bridges from the molecular and cellular neuroscience field to neuro-engineering, systems neuroscience, genomics, optogenetics, and neurochemistry. The program provides elective offerings in key cross-discipline courses, such as neuro-engineering, biochemistry, genetics, systems neuroscience, neuroimaging, cell biology, neural networks, quantitative biology, and neuronal dynamics. The program graduates students who can solve complex problems in basic neuroscience and neuropsychiatric disease.

Statistics and Data Science

The Interdisciplinary Doctoral Program in Statistics and Data Science is designed for currently enrolled doctoral students who wish to develop their understanding of 21st-century statistics using concepts of computation and data analysis as well as elements of classical statistics and probability. Participating departments include Aeronautics and Astronautics, Economics, Mathematics, and Political Science, as well as the interdisciplinary PhD program offered through IDSS in social and engineering systems.

EdX

Krishna Rajagopal, the William A. M. Burden Professor of Physics and former chair of the faculty, is the dean for digital learning, giving him oversight of Residential Education, MITx, OpenCourseWare (OCW), and the Digital Learning Laboratory.

In order to support MIT's goal of establishing leadership in online education, School of Science departments continue to add to MITx curricula on edX, massive open online courses (MOOCs), and OpenCourseWare. Over the past few years, the School's departments have worked diligently to translate General Institute Requirement science requirements into MITx curricula, benefiting the school's enrolled students immensely. These subjects include 8.01 Physics I, 8.02 Physics II, 18.01 Calculus I, 18.02 Calculus II, and the Course 7 Biology subjects, including MIT's introductory biology courses, along with its rigorous competency examination certificate.

Three new subjects in Biology, covering topics in cancer, disease, and biomaterials, were offered in fall 2018 by researchers at the Koch Institute for Cancer Research. A postdoctoral associate in the Department of Mathematics introduced 18.S097 Applied Category Theory. Professor and MacVicar Faculty Fellow Barton Zwiebach in the Department of Physics offered an extension to the online quantum physics subjects in spring 2018 with 8.06 Quantum Physics III. Another subject, 18.A34 Mathematical Problem Solving (Putnam Seminar), was developed by Yufei Zhao, an assistant professor of mathematics, to help students prepare for competition-level mathematics.

MathWorks Professor Gilbert Strang continues to teach 18.06 Linear Algebra, which has surpassed 10 million views on OCW and has been in the top 10 most-viewed courses since OCW's launch. His lectures, posted on YouTube, have more than three million views. Strang offers several variations on this subject, including a new offering in spring 2019, 18.065 Matrix Methods in Data Analysis, Signal Processing, and Machine Learning.

For his subject 10.50.1x Analysis of Transport Phenomena Mathematical Methods, first offered in fall 2018, Martin Bazant, professor of mathematics and the E. G. Roos (1944) Professor of Chemical Engineering, was awarded a 2019 MITx Prize for Teaching and Learning in MOOCs. Bazant developed the course to break up long calculations into understandable portions with tips and tutorials for a diverse student body. He is offering a new follow-up course in fall 2019.

Co-sponsored by MIT Open Learning and the Office of the Vice Chancellor, the Teaching with Digital Technology Awards are student-nominated awards for faculty and instructors who have improved teaching and learning at MIT with digital technology. This year, John Belcher, Class of 1922 Professor of Physics, was lauded for his well-reviewed design and use of animated videos to explain concepts such as magnetic fields.

Education

To reward individual faculty members for supporting the Institute's mission to foster excellence in teaching, the School honors student-nominated professors with the School of Science Prizes in Undergraduate and Graduate Teaching. This year, two faculty members shared each prize.

Kerstin Perez, assistant professor in the Department of Physics, was awarded the prize for undergraduate education for her role in 8.13 Experimental Physics and 8.02 Electricity Magnetism and for her excellent mentorship of undergraduates, particularly women and students of color. William Minicozzi, the Singer Professor in the Department of Mathematics, was also awarded the prize for undergraduate education for his teaching of 18.03 Multivariable Calculus.

Ankur Moitra, the Rockwell International Career Development Associate Professor in the Department of Mathematics, was awarded the prize for graduate education for designing the course 18.S996/18.409 Algorithmic Aspects of Machine Learning. The second recipient of the prize for graduate education was Paul O'Gorman, a professor in EAPS, for 12.810 Atmospheric Dynamics.

In addition, Ibrahim Cisse, the Class of 1922 Career Development Assistant Professor in the Department of Physics, received MIT's Everett Moore Baker Award for Undergraduate Teaching, the only award in which the nomination and selection are done entirely by students.

Research

Department of Physics Professor Pablo Jarillo-Herrero's research on "magic angle" graphene is this year's biggest discovery in physics. Jarillo-Herrero and his collaborators found that graphene, a two-dimensional layer of carbon atoms with a honeycomb-like lattice, can behave at two electrical extremes when rotated at a certain angle: as an insulator, in which electrons are completely blocked from flowing, and as a superconductor, in which electrical current can stream through without resistance. By rotating graphene sheets by 1.1 degrees, the configuration induces strongly correlated interactions between electrons. In any other stacked configuration, graphene interacts very little, electronically or otherwise, with its neighboring layers. This discovery led to the development of "twistronics," a promising field focused on adjusting the electronic properties of graphene.

Astrophysics Research

Anna Frebel, associate professor in the Department of Physics and member of the MIT Kavli Institute for Astrophysics and Space Research, along with Rana Ezzeddine, a postdoctoral fellow in her research group, have determined that the supernovae explosions during the Big Bang may have blown apart in a powerful, asymmetric fashion, spewing forth jets that were violent enough to eject heavy elements into neighboring galaxies. The results may explain irregularly distributed elements that ultimately served as seeds, marking the locations of the second generation of stars, some of which can still be observed today. This finding may shift scientists' understanding of how galaxies took shape.

Researchers from MIT's Laser Interferometer Gravitational-Wave Observatory (LIGO) and international partners within the LIGO scientific collaboration continue to detect new phenomena. This year, the observatories, including the Virgo observatory in Italy, received upgrades making the instruments even more sensitive to detecting gravitational waves. One of the scientists who helped develop these upgrades is Nergis Mavalvala, the Curtis and Kathleen Marble Professor of Astrophysics in the Department of Physics. She is also a member of the Kavli Institute. When scientific operations resumed in early April, the researchers detected a possible neutron star–black hole collision estimated to have taken place 1.2 billion light years away. If confirmed, this would be the first detection of a new type of collision. The LIGO and Virgo observatory network has also recorded evidence for two neutron star mergers and 13 black hole mergers since the first detection in 2015. In other astrophysical phenomena, an international team of more than 200 astronomers, including scientists from Haystack Observatory, captured the first direct images of a black hole. The team coordinated eight major radio observatories on four continents to function together as a virtual, Earth-sized telescope. The observatories, together called the Event Horizon Telescope (EHT), each gathered a petabyte of data that was fed into a supercomputer at MIT and the Max Planck Institute in Germany and correlated into an image of light-emitting plasma material swirling around a black hole.

Quantum Information Science

MIT is one of 12 institutions to receive the support of the Simons Foundation to establish the Simons Collaboration on Ultra-Quantum Matter. Of the 17 faculty members in the interdisciplinary collaboration, more than half have MIT affiliations, including Professor of physics Senthil Todadri and Cecil and Ida Green Professor of Physics Xiao-Gang Wen. Both scientists are members of the Condensed Matter Theory group in the Department of Physics and Materials Research Laboratory. The aim of this four-year award is to classify possible forms of ultra-quantum matter, understand their physical properties, and provide key ideas to enable new realizations of ultra-quantum matter in the lab, including distributed storage of quantum information, fractional quantum numbers, and perfect conducting boundaries.

Alan Guth, the Victor F. Weisskopf Professor of Physics, and David Kaiser, the Germeshausen Professor of the History of Science and Professor of Physics, used light emitted by quasars to confirm the existence of quantum entanglement. The distant quasars, 7.8 billion and 12.2 billion light years old, provided correlations among more than 30,000 pairs of photons—strong evidence that quantum mechanics, and not classical physics mechanisms, are the explanation for the result.

Quest for Intelligence

Middleton Career Development Assistant Professor of Neuroscience Mark Harnett, an investigator at the McGovern Institute of Brain Research, determined that dendrites—the branching extensions that connect neurons in the brain—play a far more important role than previously thought in how signals are converted into electrical activity. The MIT team now plans to investigate how dendritic activity contributes to overall neuronal function and whether it evolves when a new task is learned.

James DiCarlo, Peter de Florez Professor of Neuroscience and head of BCS, along with colleagues in the department, have found evidence that feedback improves recognition of hard-to-recognize objects in the primate brain and in artificial neural network systems used for vision applications, for example in deep convolutional neural networks. These networks have a general architecture inspired by primate brain regions that progressively build an accessible and refined representation of viewed objects; they can recognize objects in less than 100 milliseconds. By building in feedback loops to these networks, object recognition in images that were once challenging for artificial neural networks is vastly improved.

A new program-writing Artificial Intelligence (AI), "SketchAdapt," was developed by Josh Tenenbaum in collaboration with a colleague in CSAIL. A professor in BCS, Tenenbaum is a member of the Computer Science and Artificial Intelligence Laboratory and the Center for Brains, Minds, and Machines. This program enables computers to write their own code using deep learning, broadening access to programming to a wider user base, including those who may not have strong coding knowledge. For example, it can convert mathematical problems from English into code and then calculate the answer.

To support further study in AI and machine learning through the Quest for Intelligence, MIT signed a $25 million five-year collaboration with Liberty Mutual to support artificial intelligence research in computer vision, computer language understanding, data privacy and security, and risk-aware decision making, among other topics.

Aging Brain Initiative

Li-Huei Tsai, director of the Picower Institute for Learning and Memory and Picower Professor in BCS, continues to produce seminal research on the study of Alzheimer's disease. Since 2016, the Tsai laboratory has shown that a flickering light at 40 Hz can greatly reduce the amyloid plaques seen in mice with Alzheimer's disease. Recent research has demonstrated that this treatment, including 40 Hz auditory treatment, has widespread effects at the cellular level, helping not just neurons but also immune cells called microglia. Overall, these effects reduce inflammation, enhance synaptic function, and protect against cell death in mice that are genetically programmed to develop Alzheimer's disease. The 40 Hz treatment boosts cognitive function in mice, which perform much better on tests of spatial memory than untreated mice do. The treatment also produces beneficial effects on spatial memory in older, healthy mice.

Kathleen and Curtis Marble Professor in Cancer Research Angelika Amon, a professor in the Department of Biology and a member of the Koch Institute for Integrative Cancer Research, along with her colleagues has shown that aneuploidy—an incorrect number

of chromosomes—is a feature of aggressiveness in primary prostate cancers that are more likely to become lethal. Prostate cancer is an ideal model in which to explore the link between aneuploidy and cancer aggressiveness because, unlike most other solid tumors, nearly a quarter of prostate cancers are not aneuploid or have only a few altered chromosomes. This allows researchers to assess the impact of aneuploidy on cancer progression more easily.

Amon and Tsai will be the co-directors of the new Alana Down Syndrome Center, a research endeavor, technology development initiative, and fellowship program launched in March 2019 with a $28.6 million gift from the Alana Foundation. In the first four years, the new center will study Down syndrome in the brain with two main focuses: systems and circuits as well as genes and cells.

New Technologies

A family of DNA sequences known as clustered regularly interspaced short palindromic repeats (CRISPR), and technologies developed on the basis of those sequences, are helping researchers make advances in many areas of science. A team led by researchers at the Eli and Edythe L. Broad Institute of MIT and Harvard and the McGovern Institute for Brain Research has characterized and engineered a gene-editing system that can precisely and efficiently insert large DNA sequences into a genome. The system, called CRISPR-associated transposase, is harnessed from cyanobacteria and allows efficient introduction of DNA while reducing potential errors. Lead investigator Feng Zhang—the James and Patricia Poitras Professor of Neuroscience in BCS, investigator at the McGovern Institute, and a core institute member of the Broad Institute—had previously engineered another CRISPR system, using the enzyme Cas12b, which has been shown to edit genomes efficiently in primary human T cells. This is an important initial step for therapeutics that target or leverage the immune system. Guoping Feng—the James W. (1963) and Patricia T. Poitras Professor in BCS, investigator at the McGovern Institute, and an institute member at the Broad Institute, also recently used a CRISPR-Cas9 system to develop a primate model for autism that may lead to better treatment options for people with neurodevelopmental disorders.

Zhang and Aviv Regev, professor of biology and a core institute member at the Broad Institute, have developed a new technique called DNA microscopy that reveals spatial and molecular information that is not easily accessible through other microscopy methods. DNA microscopy uses DNA itself as a tool to tag molecules of cellular, genetic material without using specialized equipment. Using interactions among the tags, researchers can calculate the locations of different molecules, allowing researchers to understand how different and distinct cell types may interact with each other.

MIT researchers have developed a way to dramatically enhance the sensitivity of nuclear magnetic resonance spectroscopy, a technique used to study the structure and composition of many kinds of molecules, including complex proteins linked to Alzheimer's and other diseases. This new approach, developed by Robert Griffin, the Arthur Amos Noyes Professor of Chemistry, relies on short pulses of microwave power and could allow scientists to analyze in mere minutes structures that would previously have taken years to decipher.

Timothy Jamison, Robert R. Taylor Professor of Chemistry, and Klavs Jensen, Warren K. Lewis Professor of Chemical Engineering, developed a new automated chemical synthesis system that could cut the amount of time required to optimize a new chemical reaction from weeks or months down to a single day. They have patented the technology with the hope that it will be widely used in both academic and industrial chemistry labs.

Jeremiah Johnson, associate professor of Chemistry, and his colleagues have designed a polymer material that can change its structure in response to light, changing from a rigid substance to a softer one that can heal itself when damaged. The material consists of polymers attached to a light-sensitive molecule that can be used to alter the bonds formed within the material. Eventually, such material could be used to coat objects such as cars or satellites.

Professor Alan Edelman officially released the Julia 1.0 programming language, which combines the best features of Ruby, MatLab, C, Python, R, and other programming languages. Julia 1.0 is used by more than 700 universities and research institutions and by companies such as Aviva, BlackRock, Capital One, and Netflix. Julia is the language used by Lincoln Laboratory and the Federal Aviation Administration to develop the Next-Generation Airborne Collision Avoidance System. Julia is also used by the MIT Operations Research Center to optimize school bus routing for Boston Public Schools and by the MIT Robot Locomotion Group for robot navigation and movement.

Climate Change

Catherine Drennan, professor of biology and chemistry and a Howard Hughes Medical Institute investigator, continued her research program into carbon capture chemistry. Drennan and her colleagues have discovered a unique aspect of the structure of the so-called C-cluster—the collection of metal and sulfur atoms that forms the heart of the enzyme carbon monoxide dehydrogenase. This enzyme is of great interest to researchers who want to find new ways to remove greenhouse gases from the atmosphere and turn them into useful carbon-containing compounds. Learning more about how these clusters work, how they are assembled, and how they are affected by oxygen could help scientists copy their action for industrial use.

Climate change is causing significant changes to phytoplankton in the world's oceans, and a new MIT study found that over the coming decades these changes will affect the ocean's color, intensifying both its blue regions and its green ones. Satellites should detect these changes in hue, providing early warning of wide-scale changes to marine ecosystems. Along with colleagues, Stephanie Dutkiewicz, principal research scientist in EAPS and the Center for Global Change Science, ran the model through the end of the 21st century and found that by the year 2100 more than 50% of the world's oceans will shift in color because of climate change.

Through global monitoring networks such as the Advanced Global Atmospheric Gases Experiment (AGAGE) and the National Oceanic and Atmospheric Administration Global Monitoring Division, scientists have been taking measurements of ozone-depleting chlorofluorocarbons (CFCs) in the atmosphere for more than 40 years. Last year, the monitoring systems detected that CFC-11 had increased despite a global phase-out under the Montreal Protocol. Ronald Prinn, leader of the AGAGE network, TEPCO

Professor of Atmospheric Science, director of the Center for Global Science Change, and co-director of MIT's Joint Program on the Science and Policy of Global Change, determined that China was responsible for 40% to 60% of the global increase in CFC-11 emissions between 2014 and 2017.

Awards and Honors

Faculty Awards and Honors

Every year, academic and professional organizations honor numerous School of Science faculty members for their innovative research and service to the community. Individual reports from the School's departments, labs, and centers will document these awards more completely, but several notable awards deserve mention.

At this year's Breakthrough Prize ceremony, Angelika Amon, professor in the Department of Biology and member of the Koch Institute for Integrative Cancer Research, was one of five to receive the 2019 prize in life sciences for her work on understanding living systems and extending human life. For her research on cell growth and division, especially with respect to cancer and aging, Amon also received the 2019 Vilcek Foundation Prize in Biomedical Sciences, awarded to immigrants who have made lasting contributions to American society

Lisa Barsotti, principal research scientist at the Kavli Institute for Astrophysics and Space Research, was one of several faculty members awarded a New Horizons prize in 2019. She received a New Horizons Prize in Physics for her work on LIGO. For her leadership with LIGO and for collaborating with its counterpart, the Virgo interferometer in Europe, Barsotti was also named an American Philosophical Society Fellow.

Associate professor of physics and Kavli Institute member Matthew Evans received a New Horizons Prize in Physics for his work on LIGO. Assistant professor of physics Daniel Harlow won a 2019 New Horizons prize in Physics for his research on quantum information, quantum field theory, and gravity. In the Department of Mathematics, Professor Chenyang Xu received the New Horizons Prize in Mathematics for his work on the minimal model program and applications to the moduli of algebraic varieties.

Pfizer-Laubach Career Development Professor Alexander Shalek in the Department of Chemistry became a 2018 Pew-Stewart Scholar for Cancer Research for his work on creating and implementing new technologies to better understand how cells perform functions on a system level. In 2019, Howard S. (1953) and Linda B. Stern Career Development Professor Stefani Spranger was also named a Pew-Stewart Scholar for her work on immunotherapy response in patients based on their tumor's immune microenvironment. Assistant professor of biology Eliezer Calo became a Pew Scholar in Biomedical Sciences for his work on childhood disorders through the study of defects in ribosome assembly in tissues.

Kerry Emanuel, Cecil and Ida Green Professor of Atmospheric Science in EAPS and the Center for Global Change Science, was elected to the American Philosophical Society for his work on tropical meteorology and climate.

Maria Zuber, vice president for research and the E. A. Griswold Professor of Geophysics in EAPS, was awarded the 2019 Gerard P. Kuiper Prize by the American Astronomical Society's Division for Planetary Sciences for her contributions to advancements in geophysics, planetary gravity mapping and laser altimetry, particularly with respect to Mars and the moon.

Mark Harnett, Middleton Career Development Assistant Professor of Neuroscience in BCS and investigator at the McGovern Institute, won a 2019 McKnight Scholar Award for his research on dendrites and neuronal function. He was also named a Vallee Foundation Scholar in 2018.

Yufei Zhao, Class of 1956 Career Development Assistant Professor in the Department of Mathematics, was named the second recipient of the School of Science's Future of Science Award.

Professor Guoping Feng became an American Association for the Advancement of Science Fellow for his research into brain synapses.

Professor of physics and special advisor to the president Ernest Moniz was awarded the inaugural award for Excellence in Public Policy and Public Affairs in honor of his independence and effectiveness in public service, especially regarding his appointment on President Obama's cabinet, where he advised on nuclear defense, the Iran nuclear deal, and climate change.

Susan Hockfield, president emerita and professor of neuroscience in BCS, received the 2019 Geoffrey Beene Foundation Builders of Science Award. The award was given in recognition of her leadership and determination in building an outstanding scientific research organization, for her work as president of MIT, and for promoting the convergence of life sciences with engineering and the physical sciences, as well as being at the forefront of scientific research.

This year, the Max Planck Society Fellows elected Michael Halassa, an assistant professor in BCS, for his research on neural circuits related to cognitive functions that may play a role in autism and attention deficit disorder.

Several faculty members were selected for Bose Fellowships. Professor Leonid Levitov of the Department of Physics was selected for his investigations into condensed matter theory. In the Department of Chemistry, Novartis Professor Laura Kiessling and Professor Elizabeth Nolan were selected for their work on infectious disease, bacterial infection, and antibiotic resistance.

Institute Professor Sallie "Penny" Chisholm, a member of the Department of Biology with an additional appointment in the Department of Civil and Environmental Engineering, was chosen for the 2019 Crafoord Prize in Biosciences in honor of her discovery of *Prochlorococcus*, a cyanobacterium that is the most abundant photosynthesizing organism on Earth. She gave a lecture at the awards ceremony, which was attended by the King and Queen of Sweden.

Josh Tenenbaum was named Innovator of the Year by *R&D Magazine* in 2018 for his accomplishments in cognitive science and artificial intelligence as well as for his collaborative nature.

School of Science Rewards and Recognition

The School of Science Rewards and Recognition program continues to acknowledge the dedication and hard work of the people who fill our departments, labs, and centers and whose efforts are the source of our prestige. The School continues its Spot Awards, which rewards employees "on the spot" for going beyond the requirements of their normal duties.

Since the Infinite Mile Award program was established in 2001, the School of Science has presented the award to more than 150 of its members in the last 10 years based on the nominations of grateful colleagues. This year's winners were Christine Brooks (Chemistry), Annie Cardinaux (Simons Center for the Social Brain), Kimberli DeMayo (Mathematics), Arek Hamalian (Picower Institute), Jonathan Harmon (Mathematics), Tanya Khovanova (Mathematics), Kelley Mahoney (Kavli Institute), Walter Massefski (Chemistry), Raleigh McElvery (Biology), and Kate White (BCS).

The Infinite Kilometer Award, which is designated for postdoctoral researchers and research scientists, was added in 2012 to recognize their contributions both to our scientific endeavors as well as to the MIT community as mentors and advisors to students and colleagues. This year's winners were Robert Grand (Biology), Slawomir Gras (Kavli Institute), Matthew Golder (Chemistry), Yeong Shin Yim (Picower Institute), and Yong Zhao (Laboratory for Nuclear Science).

Personnel

Appointments and Promotions

The following faculty members were promoted to full professor: Laurent Demanet (Mathematics), Elizabeth Nolan (Chemistry), Paul O'Gorman (EAPS), Taylor Perron (EAPS), and Feng Zhang (BCS).

The following faculty members were granted tenure: William Detmold (Physics), Semyon Dyatlov (Mathematics), Mary Gehring (Biology), David McGee (EAPS), Ankur Moitra (Mathematics), Matthew Shoulders (Chemistry), Tracy Slatyer (Physics), and Michael Williams (Physics).

The following faculty members were promoted to associate professor without tenure: Joseph Checkelsky (Physics), Ibrahim Cisse (Physics), Gregory Fournier (EAPS), Alexander Shalek (Chemistry), Jing-Ke Weng (Biology), and Omer Yilmaz (Biology).

The following faculty members joined the School as associate or full professors: Zhiwei Yun and Chenyang Xu joined the Department of Mathematics as full professors. Nike Sun joined the Department of Mathematics as an associate professor with tenure. Ila Fiete joined BCS as an associate professor with tenure.

The following faculty members joined the School faculty as assistant professors: Tristan Collins (Mathematics), Julien de Wit (EAPS), Peter Hintz (Mathematics), Ankur Jain (Biology, and member of the Whitehead Institute for Biomedical Research), Long Ju (Physics), Kiyoshi Masui (Physics), Phiala Shanahan (Physics), and Alison Wendlandt (Chemistry).

The following faculty members retired from the School of Science: Martha Constantine-Paton (BCS), Alexander Klibanov (Chemistry), and Terry Orr-Weaver (Biology).

There were a number of changes in positions within the School. Professor Jacqueline Hewitt stepped down as director of the Kavli Institute for Astrophysics and Space Research and Robert Simcoe, the Francis Friedman Professor of Physics, was named director. Rick Danheiser, the A C Cope Professor of Chemistry, is replacing Professor Susan Silbey as chair of the faculty. Timothy Jamison is stepping down from head of the Department of Chemistry and moving to the newly created position of associate provost.

Faculty Lunch Programs

Tenure-track faculty lunch meetings are intended to help junior faculty members meet their peers in different departments and to provide a forum for discussion of important issues. This year's meetings included faculty presentations in the fall by Mary Gehring, an associate professor of biology, who presented a talk, "Control of Epigenetic Dynamics in Plants," and Joseph Checkelsky, an associate professor in physics, who presented a lecture on quantum electronic materials. In the spring, Matthew Shoulders, the Whitehead Career Development Associate Professor in Chemistry, gave a talk, "Viruses, Proteostasis, and Evolution," and Nikta Fakhri, the Thomas D. and Virginia W. Cabot Career Development Assistant Professor of Physics, presented a lecture on the thermodynamics of biological active matter.

The dean hosts a faculty lunch every semester. This year, Taylor Perron, a professor of Earth, Atmospheric, and Planetary Sciences, gave a presentation, "Rivers, Landscapes, and Methane Rain." In the spring, Jeremiah Johnson, an associate professor in chemistry, presented a discussion, "Chemical Tools for Investigating the Topology of Polymer Networks."

School of Science Learn@Lunch Series

To provide administrative staff the support they need to do their jobs effectively, the School of Science holds a monthly lunch series for staff members on a variety of subjects. This year, presentations included an overview of MIT's compensation initiative and a discussion on onboarding, career development, and the school's peer-to-peer mentoring program by Heather Williams. In May, Maryann Kirkbride, executive administrator of the Mind Hand Heart initiative, made a presentation on several Institute-wide programs, including Random Acts of Kindness Week and the departmental support project that is focused on increasing the diversity and inclusion of the academic units.

School of Science Peer Mentoring

The peer-to-peer mentoring program pairs new School of Science staff with mentors who will help them navigate job responsibilities, MIT policies and procedures, and Institute organization and culture. The program provides opportunities for both mentors and new employees to expand their skill sets, increase their confidence, and make connections with School of Science community members outside their home department, lab, or center. After a recent conversation with School of Science staff members, this program is being expanded and guidelines and resources have been added for those interested in participating as mentors, mentees, or reference experts.

Michael Sipser
Dean
Donner Professor of Mathematics