Department of

FALL 2022

PHYSICS Newsletter

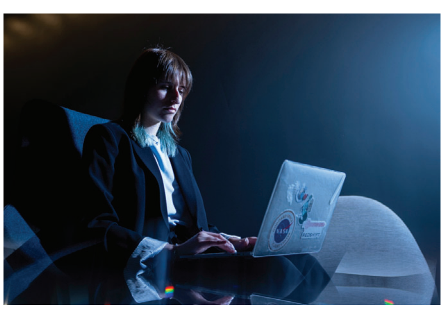
Northeastern co-op fulfills childhood dream by working at NASA

Mya Karinchak visited Kennedy Space Center for the first time when she was in middle school. She entered the center's planetary theater and although it only played a 15-minute video about NASA, Karinchak walked out completely changed.

"By the end of it I had tears in my eyes," Karinchak recalls. "I was just so in awe, and I think I told my mom, 'I really want to end up here somehow.'"

This summer, Karinchak's dream came true. A fourth-year physics student at Northeastern, Karinchak landed a co-op at NASA's Goddard Space Flight Center, working to predict solar winds and explore their impact on Mars.

"I've just always said, 'Oh, maybe I'll end up at NASA,' not knowing if that would ever happen," Karinchak says. "It was a dream of mine, not something I thought I would get into this early in my life, honestly."



Top of page. Photos by Alina Mak
Undergraduate Students at Annual Physics Department Ice Cream Social

Northeastern University
Physics

Karinchak works on the heliophysics–solar physics–team, and her work with a predictive tool called the Wang-Sheeley-Arge model is already leaving a mark on NASA. The WSA model is able to predict solar wind parameters, such as the polarity of the sun's interplanetary magnetic field in its inner heliosphere and the velocity of solar wind. Karinchak's work will help determine the most accurate predictions for these parameters and their impacts on the red planet, which can be significant due to the conditions around Mars, she says.

"Mars lacks an intrinsic global magnetic field, so any time solar wind comes to Mars it's shaping the magnetosphere differently," Karinchak says. "Every time something brushes past the Martian magnetosphere, it is constantly changing around that."

By comparing solar wind polarity and velocity predictions with those observed at Martian spacecraft, NASA can also gain new insights into Mars. That information becomes even more relevant as NASA moves forward with plans to send astronauts to Mars.

"When we have these predictions, it's basically giving more background to what's happening around Mars," Karinchak says. "Solar winds affecting the Martian magnetosphere can lead to things like planetary ion escape, which leads to Martian atmospheric erosion, so that's one application of finding more context around the solar winds and getting more accurate predictions."

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Notes from the Chair

After serving my first 5-year term as Chair of the Physics Department, I was honored to be appointed to another 5-year term. I am proud of our success in continuing to expand our mission and grow as a department despite the difficulty associated with teaching and learning during the pandemic. In my second term I hope to continue to build on our success in my previous term, expanding the department in multiple new research areas while adding excellent tenured, tenure-track, and non-tenure track faculty. Our goal is to develop a top physics department, providing valuable educational experiences for diverse groups of graduate and undergraduate students in a positive and collegial environment.

Department faculty leadership has undergone one change. Alessandra Di Credico has replaced Swastik Kar as Undergraduate Curriculum Chair. After 5 years in that position, Swastik will now focus on development of the Quantum Materials and Sensors Institute on the Burlington campus. Swastik oversaw a dramatic change in our course offerings, helping to bring our curriculum in line with that of other top research universities, while also developing a new astrophysics minor and concentration. Alessandra contributed significantly to these efforts, so she is in an excellent position to continue our progress in curriculum development. I am delighted that the following faculty leaders have continued in their positions: Emanuela Barberis (Executive Officer), Meni Wanunu (Graduate Director), Tim Sage (Undergraduate Advisor), and Bryan Spring (Undergraduate Recruiter).

Since January 2022, we have welcomed 7 new full time faculty members, with three more starting this spring or next fall. This includes faculty members doing research in a diverse range of fields, including astrophysics, high energy theory, network science, quantum materials and sensors, and experimental biophysics. Please see the separate article introducing the new faculty.

This year we are happy to hold in-person department events, including weekly meetings of the Society of Physics Students undergraduate group and the Introduction to Research course for incoming PhD students. Our active seminar series are now being held in person with remote option for attendance. It is great to experience the active intellectual discourse at these events.

-Mark Williams, Chair

‘Star Trek is not that far away' Grant will help develop cutting-edge Quantum Technology on Burlington Campus

A $3.5 million grant from the state of Massachusetts will help advance the field of quantum technology, create jobs and change our lives for the better.

Northeastern University’s Innovation Campus in Burlington, Massachusetts, is set to become the epicenter of cutting-edge quantum technology, thanks in part to a new grant.

Massachusetts Housing and Economic Development Secretary Mike Kennealy announced a $3.5 million grant to establish the Experiential Quantum Advancement Laboratories (EQUAL) at the Innovation Campus.

The grant, part of the Collaborative Research & Development Matching Grant Program and administered by the Innovation Institute at the Massachusetts Technology Collaborative (MassTech), will support the nearly $10 million project.

The award will help strengthen the EQUAL project’s partnerships with the state, nine academic institutions and 23 industry partners. Together, they will advance work on quantum technologies that have wide-reaching applications, while at the same time training students and workers and, in turn, helping to boost the Massachusetts economy.

“This is how we work together to get things done,” Kennealy said during the announcement. “In so many respects, this is the best of who we are, how we work and how we collaborate together.”

EQUAL’s unique focus on industry partnerships means that when the laboratory is completed in Building V, new technologies can be applied at the commercial level right away. The 1,600-square-foot lab sits empty now, but Northeastern Associate Professor and EQUAL Co-Director Swastik Kar was optimistic about what it will become—an “assembly line” from concept to commercialization.

There, students will have the opportunity to get in on the ground floor of big discoveries. This includes students in the Biotech Associates to Masters (A2M) Pathway program in partnership with Middlesex Community College, as well as Northeastern students participating in experiential learning programs. Northeastern also plans to expand degree offerings to include Ph.D. and master’s degree programs in quantum information science and engineering.

Importantly, the lab, which Kar expects to open in spring 2023, will all but eliminate the middleman between research and application.

“There’s a lot of researchers doing hard-core research where they’re sort of siloed away and there’s no clear pathway for translating quantum technology from lab to the market,” he said.

Instead, at EQUAL, “there’s a buildup, from the basic level all the way to the end application. And to do that we need not just the expertise, but also a facility that allows us to go from concept all the way to mature technologies all in one go,” he said.

At the end of the assembly line are the industries that will use this technology, like Park Systems, which manufactures atomic microscopes and is located right on campus, and Qnami, a company based in Switzerland that develops technology using quantum mechanics, as well as other small businesses.

“[Northeastern] is the first customer we have in the U.S., and having that facility whose goal is really to explore, understand, and advance quantum sensing technology, it’s a unique chance for us,” said Mathieu Munsch, co-founder and CEO of Qnami. “It’s the perfect place to start in the U.S.”

EQUAL’s work will have implications for the state of Massachusetts, as well. In addition to building on the connection between Northeastern and the state government, EQUAL is slated to create new jobs and bring in revenue to the state, and help Massachusetts compete in the growing field of quantum technologies.

“Our goal is really to make an investment in emerging technology that can have a foreseeable impact on the economy,” Pat Larkin, deputy director of MassTech, said.

But EQUAL’s reach could go even farther than that. There is no one application for quantum technology, Kar explained; it can be applied almost anywhere.

“What [the work is] enabling us to do is develop new technologies that will impact our day-to-day lives, whether it’s health, security, sustainability and other areas,” Kar said.

And the sky’s the limit for what it can accomplish, according to University Distinguished Professor and EQUAL Co-Director Arun Bansil. “All that stuff in Star Trek is not that far away,” he said.

Kar and Bansil can’t wait to get started, and they’re excited to have the support of the commonwealth. “We are extremely grateful to the Baker-Polito Administration and MassTech for helping establish the EQUAL lab with this generous grant,” Kar said.

Article and Images from: News@Northeastern
https://news.northeastern.edu/2022/09/07/quantum-technology/

NASA, from page 1

Karinchak still has three months left in her co-op, but she already feels like she’s gained a lot from the experience. More than anything, her passion for science has been reaffirmed by working with the talented scientists at NASA.

“The inspiring passion and affinity of people that work at NASA just for science or whatever they’re working on, whatever their specific project is–it’s just something that brings everyone together,” Karinchak says.

Her co-workers at NASA have also helped give her a new perspective on her future. Karinchak is entering the final year of her undergraduate education at Northeastern–and is on track to the mechanical engineering PlusOne graduate program. The future is coming up fast, but Karinchak feels that her experience at NASA has helped her learn that the path to success is far from linear.

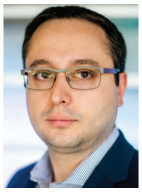
“I feel like it’s always encouraging to hear from PhD scientists at NASA who have done years of research and have relevant experience that ‘I didn’t have a linear path. Explore your interests. There’s always a lot of ways things can go, and you can’t predict that.,’” Karinchak says.

“I don’t want to put too much pressure on my path. I just want to see where things take me. I want to stay true to my passion and then that can lead the way.

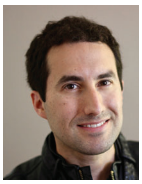
Article and image from: News@Northeastern
https://news.northeastern.edu/2022/09/20/working-at-nasa/

New Faculty Join the Physics Department

In 2022, seven new faculty members joined the department.



Matteo Chinazzi is a Research Associate Professor at Northeastern University (Department of Physics), Roux Institute member, and Core Faculty at the Network Science Institute. He conducts research at the intersection between network science, data science, epidemiology, economics, and artificial intelligence.
(information courtesy of https://roux.northeastern.edu/people/matteo-chinazzi/)



Camille Gómez-Laberge is an Associate Teaching Professor with interests in undergraduate education and in particle physics research. In teaching, Camille applies and develops novel active-learning and peer-instruction techniques in class and merges analytical, experimental, and computational methods to broaden students' perspective of the physics subject matter. In research, Camille is studying new theoretical frameworks for calculating scattering amplitudes, with a special interest on processes having infrared-divergent asymptotic states.

Camille received his PhD from Carleton University and held a Postdoctoral Fellowship and Preceptorship at Harvard University.

Miten Jain is an Assistant Professor of Bioengineering and Physics and leads the Genome Technology Laboratory at Northeastern University. He did his PhD at UC Santa Cruz in the nanopore group. Miten's research interests include: developing experimental and computational methods for genomics; long-read Nanopore sequencing of DNA, RNA, and proteins; and resolving nucleotide and protein modifications. Long-term interests for the group include combining sequence, modification, and structure information from DNA, RNA, and proteins, and developing clinical applications.

Jacqueline McCleary is an observational astrophysicist who uses galaxy clusters as a laboratory in which to explore the nature of dark matter and its interaction with galaxies. Her research makes careful measurements of the positions, colors, and shapes of galaxies in deep images of the night sky, thereby enabling the reconstruction of galaxy clusters' dark matter through an application of general relativity. Jacqueline's data comes from telescopes on mountaintops, floating in the stratosphere, and out in space. She is involved in several exciting projects, including the Local Volume Complete Cluster Survey (LoVoCCS), a stratospheric balloon-borne telescope experiment (SuperBIT), and a JWST collaboration (COSMOS-Web).

Jacqueline first joined the physics department as a Northeastern ADVANCE Future Faculty Fellow before "graduating" to an Assistant Professorship in 2022. She has received a master's degree in astronomy from New Mexico State University, a PhD in physics from Brown University, and was a post-doctoral fellow at NASA's Jet Propulsion Laboratory. Jacqueline loves New England and is thrilled to be someplace as exciting as Northeastern!

Mauricio Santillana, PhD, MSc is the Director of the Machine Intelligence Group for the betterment of Health and the Environment (MIGHTE) at the Network Science Institute at Northeastern University. He is a Professor at both the Physics and Electrical and Computer Engineering Departments at Northeastern University, and an Adjunct Professor at the Department of Epidemiology, T.H. Chan Harvard School of Public Health.

Dr. Santillana's research areas include the modeling of geographic patterns of population growth, modeling fluid flow to inform coastal floods simulations and atmospheric global pollution transport models, and most recently, the design and implementation of disease outbreaks prediction platforms and mathematical solutions to health-care. His research has shown that machine learning techniques can be used to effectively monitor and predict the dynamics of disease outbreaks using novel data sources not designed for these purposes such as: Internet search activity, social media posts, clinician's searches, human mobility, weather, etc.

Qimin Yan's research focuses on computational condensed matter physics and data-driven materials science. Research topics include the design and discovery of low-dimensional quantum materials, physical principle enhanced machine learning, and functional defects for quantum information technologies.

Qimin received his PhD in Materials from UC Santa Barbara in 2012. From 2013 to 2016, he was a Postdoctoral Researcher at Lawrence Berkeley Lab and UC Berkeley. He worked in the Department of Physics at Temple University as an Assistant Professor from 2016 to 2022 and joined Northeastern this summer as an Associate Professor. He received a DOE Early Career Award in 2019 and an NSF CAREER Award in 2022.

Yizhi You's research focuses on a variety of problems in the field of quantum many-body theory. Her primary focus is the study of collective phenomena arising due to quantum mechanical effects in systems of correlated electrons.

New Faculty, continued on page 5

Northeastern Physics Student Awarded Goldwater Scholarship

Physics student B. Parazin is one of three Northeastern students who recently received the Barry Goldwater Scholarship, one of the nation's most prestigious, merit-based awards for undergraduate students who plan to pursue research careers in natural sciences, engineering, and mathematics.

"These awards are a recognition of our ambitious, accomplished students and of our values as a university dedicated to experiential education," says Jonna Iacono, Director of Undergraduate Research and Fellowships at Northeastern. "These students are doing work that matters, and that's why they stood out among the other applicants."

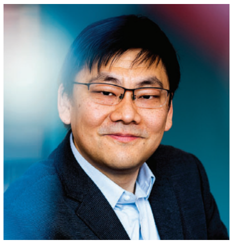
Parazin, who will graduate with a degree in physics next spring, plans to obtain a doctoral degree in geophysics. Parazin's research has covered both earthly topics and far-off concepts in space. Parazin has simulated the climate conditions of the Mississippi River during historic and recent floods and written programs that improve the functions of telescopes that measure gravitational waves.

"I want to highlight the great mentoring I've had as an undergraduate," they say. "I've been fortunate to have some great guidance from some great professors, which allowed me to do some really cool research under their supervision."

Article adapted and image from: News@Northeastern
http://news.northeastern.edu/2022/03/31/northeastern-students-goldwater-scholarships/

For Max Bi, Physics + Biology = A Sloan Research Fellowship

Dapeng (Max) Bi, an Assistant Professor of physics, is the twelfth Northeastern faculty member to earn the prestigious award.



Dapeng (Max) Bi, a physicist, was initially drawn to biology after his PhD. A dozen years later, his work straddling the two disciplines has earned Bi a Sloan Research Fellowship.

Bi is among 118 early-career scientists and scholars across a wide variety of disciplines to receive fellowships this year from the Alfred P. Sloan Foundation. He is the 12th Northeastern faculty member to earn the prestigious award, which has recognized 53 eventual Nobel Prize winners and 17 fellows who have won the Fields Medal in mathematics.

Bi's multidisciplinary research, which offers insight on the treatment of cancer, asthma, and other diseases, is contributing to the evolution of theoretical and computational physics.

"That's a strength of Northeastern's physics department," says Bi, an Assistant Professor of Physics. "We recognize that modern science is defined by the problem and not by the discipline, and tackling these problems requires interdisciplinarity. I think Northeastern is doing very well in that area."

Fellows are awarded $75,000 for research-related expenses. Bi plans to use the award to support doctoral students in his research group, enabling them to attend in-person conferences and workshops after two years of remote participation prompted by the COVID-19 pandemic.

"It's a big boost to my own morale, and hopefully to the morale of my group," Bi says of the Sloan award. "Even though we don't work in a physical laboratory, the pandemic has hit us quite harshly. I hope this shows them that what we are working on is highly impactful."

Bi's interest in the behavior and movement of cells was launched by his PhD study of granular physics.

"I started to work with biological cells, which of course are much more complicated than the nonliving granular materials," he says. "That was when I started to learn more biology, and to apply the tools of physics to biology."

Human cells cluster together to form stable, protective layers, which Bi refers to as a "jammed" state—as though the cells were stuck in a traffic jam.

"But under other conditions—such as cancer, or asthma attacks, or a wound that injures the skin—the cells are no longer stuck together," Bi says. "They begin to move around. It's very much like when a traffic jam starts to move, when the traffic starts to flow. We've been calling that state 'unjammed.'"

What causes cancer cells to metastasize and move to other areas of the body? Bi and his team have created a simple metric that identifies the cells that are more likely to migrate: A ratio between the perimeter of the cell and its area.

"If that ratio—that number—falls below a certain precise value, then it's 'jammed,'" Bi says. "If it's above that value, it's 'unjammed.' We call that value the 'cell shape index'."

The cell shape index has been verified across a wide range of cells—in humans and animals, and even in fruit flies—in tests conducted with Jeff Fredberg and Jin-Ah Park at Harvard School of Public Health. In each case, the size of the cell proved to be indicative of its inclination to move.

Other tests conducted with Ming Guo at MIT have affirmed another of Bi's theories, that the behavior of cells is affected by curved surfaces—such as an airway or a lung.

Bi's curiosity has led him on an "exhilarating journey" that also encompasses materials science and medicine, says Alain Karma, a CAS Distinguished Professor in Physics and Director of the Center for Interdisciplinary Research on Complex Systems (CIRCS).

"In the biological realm, Max's research focuses on understanding how groups of cells work together to accomplish vital tasks," Karma says. "One example is wound healing, which requires

Sloan Fellowship, continued on page 5

His Out of this World Discovery: Signals from Billions of Light Years Away

"This is about the fundamental phyics of our universe," Daching Lin says.

Dacheng Lin, a Northeastern Research Associate Professor of Physics, has identified a new class of high-energy signals that were created billions of light years from Earth.

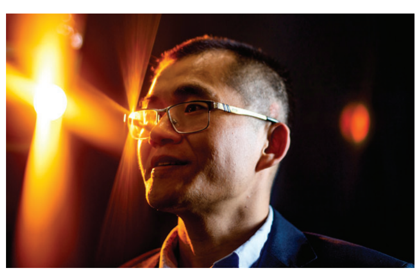
The signals are known as fast X-ray transients (FXTs), a burst of X-rays that lasts for hours. They appear to be generated by a collision of two neutron stars that results in the creation of a magnetar, which is an even heavier neutron star with an extraordinary magnetic field.

Lin's finding, detailed in The Astrophysical Journal, offers new hope for locating the gravitational waves caused by such rare cosmic events.

"This is about the fundamental physics of our universe," Lin says. "Neutron stars are extremely dense—equivalent to the sun compacted and squeezed into a body the size of New York City."

There used to be limited opportunities for discovering magnetars. The violent union of two neutron stars creates gravitational waves—"ripples in spacetime," according to Lin—that are accompanied by jets of radiation that are launched in opposite directions.

A new vein of exploration was created in 2015 when an FXT was detected by NASA's Chandra X-ray Observatory, a space telescope that was launched by the space shuttle in 1999. The FXT had been emitted 6.6 billion light years from Earth by the spinning energy and blinding radiation of a magnetar.



The discovery of the X-rays "makes another strong case that nature's fecundity repeatedly transcends human imagination," Niel Brandt, a principal investigator of the phenomenon, said in an official 2019 announcement.

Lin's analysis of terabytes of data collected by Chandra over the past two decades led to his discovery of three similar FXTs.

"These FXTs have unique features matching those expected for a newly-born magnetar formed in a neutron star-neutron star merger," Lin says. "Our discovery dramatically expanded the sample and firmly established the existence of a new class of signals from neutron star-neutron star mergers.

"The signals are short-lived," Lin adds. "But they are very, very important."

The relationship between FXTs and magnetars offer two promising paths of research. One is to pinpoint the locations of gravitational wave events. The other is especially profound.

"One main mystery of astronomy is: What is inside a neutron star?" Lin says. "People have tried to study its interior, which is very compact and filled with neutrons. This signal, when combined with gravitational waves, provides a new way to study the interior."

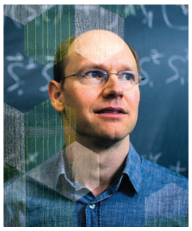
The development of neutron stars and other faraway mysteries has intrigued Lin for as long as he can remember.

"Normal stars are quite boring to me," Lin says with a smile. "But black holes, neutron stars, and supermassive black holes are highly interesting".

Article and image from: News@Northeastern https://news.northeastern.edu/2022/04/13/neutron-star-collision/

Researchers Discover New 'Unexpected' Phenomenon in Quantum Physics Materials

Researchers at Northeastern have discovered a new quantum phenomenon in a specific class of materials, called antiferromagnetic insulators, that could yield new ways of powering “spintronic” and other technological devices of the future.



The discovery illuminates “how heat flows in amagnetic insulator, [and] how [researchers] can detect that heat flow,” says Gregory Fiete, a Physics Professor at Northeastern and co-author of the research. The novel effects, published in Nature Physics this week and demonstrated experimentally, were observed by combining lanthanum ferrite ($LaFeO_3$) with a layer of platinum or tungsten.

“That layered coupling is what is responsible for the phenomenon,” says Arun Bansil, University Distinguished Professor in the Department of Physics at Northeastern, who also took part in the study.

The discovery may have numerous potential applications, such as improving heat sensors, waste-heat recycling, and other thermoelectric technologies, Bansil says. This phenomenon could even lead to development of a new power source for these—and other—budding technologies. Northeastern graduate student Matt Matzelle and Bernardo Barbiellini, a Computational and Theoretical Physicist at the Lappeenranta University of Technology, who is currently visiting Northeastern, participated in the research.

Illustrating the teams’ findings requires considerable magnification (literally) to observe the world of atomic-scale particles—specifically, at the nano-lives of electrons. It also requires an understanding of several properties of electrons—that they possess something called “spin,” have a charge, and can, when moving through a material, generate heat flow.

Electron spin, or angular momentum, describes a fundamental property of electrons defined in one of two potential states: Up or down. There are many different ways these “up or down” spins of the electrons (also thought of as north-south poles) orient themselves in space, which in turn gives rise to different types of magnetisms. It all depends, Bansil says, on the ways atoms are patterned in a given material.

In a magnetic system, typically the spins in that material have aligned themselves in the same direction. That electron arrangement in magnetic (or “ferromagnetic”) crystals is what produces that force that attracts or repels other crystals. Lots of magnetic materials also conduct electricity when electrons are able to flow through them. Those materials are called conductors, since they are able to conduct electricity.

In addition to generating an electric current, the movement of electrons through a material also carries a heat current. When an external electromagnetic field is applied to materials that conduct electricity, a heat current results.

“Heat is just when these electrons are jiggling around faster or slower, so, as a result, they can carry more or less thermal energy,” Bansil says.

Usually the spin current flows in the same direction of the heat current, Bansil says. But, in the specific materials used in this study, “it flows perpendicular to the direction of the heat current.”

“That is what is new here,” Bansil says. It’s this “unexpected” interaction that opens the door to new ways of thinking about power generation.

“What we want to do is create a current of magnetism that generates electrical power, and the way you do that is by generating a voltage,” Fiete says.

To do that, researchers combined the antiferromagnetic insulating material (here $LaFeO_3$) with another heavier element, such as platinum or tungsten, which are conductors. The coupling throws the electrons slightly off-kilter

“This particular material has the spins that are, on closest neighboring atoms, nearly perfectly anti-oriented,” Fiete says, “meaning they’re a little bit canted. They’re not perfectly anti-oriented—they are mostly, but there’s a little bit of a twist. And that little offset is actually very important, because it’s part of what gives rise to the interesting effects that we see in the project.”

That’s what gives this particular class of materials its name: Canted antiferromagnet.

An emerging class of electronic devices, so-called “spintronics,” rely on the manipulation of electron spin with the aim of improving information processing capabilities in future technologies. Another related field, called spin caloritronics, focuses on “how you convert heat flow into the flow of magnetism, or spin flow, and ultimately into a voltage,” Fiete says.

“The quantum physics of materials is of particular interest because it directly connects with a lot of technologies: Technologies in quantum computing, quantum sensing, and quantum communications,” Fiete says. “And the idea that is really gaining traction … right now is: How do we transition research from the university, like the kind my team is involved in, into technologies that will impact the way that we live our lives?”

Article and images from: News@Northeastern
http://news.northeastern.edu/2022/05/19/quantum-physics-discovery-antiferromagnetic-insulators/

Sloan Fellowship, from page 4

cells to regenerate and move to a specific location to repair damaged tissue. Another is morphogenesis, which refers to the orchestrated movement of individual cells and cell sheets during organ development. Max’s research has shed new light on how cells interact with each other and their environment through chemical signals and mechanical forces to collectively achieve those seemingly miraculous tasks.”

Bi’s findings have a variety of applications, says Erin Cram, Associate Dean for Research in Biology at Northeastern.

“Among other things, his work is helping us understand how mechanical cues like tissue stiffness are sensed and interpreted by cells,” says Cram. “Cells behave very differently in different environments, and understanding this is critical for designing therapies for promoting wound healing and, conversely, blocking cells from migrating out of a tumor. As a cell biologist, I am excited to see physicists like Max applying their knowledge, quantitative and modeling skills, and deep insights to biological problems.”

Bi is excited about continuing his research along a variety of lines, including biology-inspired designs for exotic materials that can manipulate sound or light.

“I’m deeply honored to receive this award,” he says. “To be recognized by my peers is very special, and this would not have been possible without the hard work of my group members and the support of my mentors and colleagues at Northeastern and beyond.”

Article and image from: News@Northeastern
https://news.northeastern.edu/2022/02/22/max-bi-sloan-research-fellowship/

New Faculty, from page 3

Areas of research include the study of fracton phases of matter, quantum field theory, and entanglement dynamics. Yizhi received her PhD from UIUC in 2017 and was a research associate at Princeton University before joining Northeastern as an Assistant Professor in Physics.

College of Science unveils new logo

Northeastern Barabási Receives Prestigious Prize from the American Physical Society

The American Physical Society selected Northeastern University Professor Albert-László Barabási to receive the 2023 Julius Edgar Lilienfeld Prize for his innovative work on the statistical physics of networks.

The APS chose Barabási "for pioneering work on the statistical physics of networks that transformed the study of complex systems, and for lasting contributions in communicating the significance of this rapidly developing field to a broad range of audiences," said Frances Hellman, APS president.

"I am very delighted, because this is the first award that I am getting from the American Physical Society, which is my intellectual home," said Barabási, Robert Gray Dodge Professor of Network Science and Distinguished University Professor of Physics.

The APS has 50,000 members globally, and it is a huge honor to be chosen across all fields of physics and out of a large number of great physicists, Barabási said.

Barabási will formally accept the prize at a ceremony during the APS annual leadership meeting in Washington, D.C., on Jan. 26, 2023.

Barabási was trained in statistical physics, a field of physics that studies behaviors of large collections of interacting objects and combines the principles and procedures of statistics with the laws of both classical and quantum mechanics. He received a doctorate degree in that area from Boston University.

He currently heads the Center for Complex Network Research at the Northeastern Network Science Institute, where he investigates the hidden order behind various complex systems using the quantitative tools of network science, a research field that he pioneered. His work led to the discovery of scale-free networks in 1999, helping explain the emergence of many widespread natural, technological and social networks.

"I do consider it to be fully part of physics, to be more precise, of statistical physics," Barabási said. "Network science is a very modern branch of that field which has grown very big."

Now, network science attracts researchers from different disciplines, Barabási said, including computer scientists, sociologists, political scientists and biologists.

Barabási is interested in a wide range of topics, including unveiling the structure of the brain, treating diseases using network medicine, mapping out success in art and studying how science really works. CCNR has studied complex metabolic and genetic networks inside a cell; topology of the World Wide Web, showing that webpages are on average 19 clicks away from each other; and how actors are connected in Hollywood, among many other subjects.

Barabási, who is Hungarian, grew up in the Transylvania region of Romania. Hungarian physicists and other scientists who made a big impact in their fields were a big inspiration for him as a child, he says. As a teenager, Barabási remembers reading about Jeno Wigner, who won a Nobel Prize in physics in 1963, and John von Neumann, a Hungarian-American mathematician, physicist, computer scientist, best known for his work in the early development of computers.

"When you grew up in an environment where you have such a great set of predecessors in your small nation, there is no way that you are not aware of it. And that was certainly a big inspiration for me," Barabási said.

The annual Julius Edgar Lilienfeld Prize was established in 1988 under the terms of a bequest of Beatrice Lilienfeld, wife of the prominent Austro-Hungarian and American physicist and electrical engineer.

The Lilienfeld Prize recognizes outstanding contributions to physics and exceptional skills in lecturing to diverse audiences. It comes with a cash prize of $20,000, an invitation to give a talk at an APS meeting and three lectures at APS, at a research university and at a predominantly undergraduate institution, all expenses covered.

The APS is a nonprofit membership organization that works to advance and diffuse the knowledge of physics and represents physicists in academia, national laboratories, and industry in the U.S. and throughout the world.

Article and image from: News@Northeastern https://news.northeastern.edu/2022/10/12/american-physical-society-honors-barabasi/

Northeastern Professors to be Featured in Greta Thunberg's New Book

Drought, wildfires, intense storms and rising temperatures–thinking about climate change can be overwhelming. It's why international climate activist Greta Thunberg is using her new book, "The Climate Book," which was released on Oct. 27, 2022, to educate people and give them hope for the future, with the help of scientists and scholars, including a couple of Northeastern's finest.

Northeastern Professors Mauricio Santillana and Jennie C. Stephens are two of the more than 100 experts Thunberg has gathered to help share their expertise on how to combat climate change. Santillana is a Professor of Physics and Network Science, while Stephens is a Professor of Sustainability Science and Policy. Although they approach climate change from different fields, they are united in their insistence that climate change is a pressing issue that must be tackled with speed and ambition.

"Most of the authors in this book embrace a transformative lens," Stephens says. "At this point we're not talking about small, incremental changes. We're talking about a bigger transformation of society that's needed."

Santillana, who co-authored his chapter with John Brownstein, Derek MacFadden and Sarah McGough, drew on previous research about the effect climate change has had on antibiotic resistance. His work drew Thunberg's interest because of how it illustrates the subtle impacts of climate change, Santillana says.

Antibiotic resistance has been increasing, making it more difficult to fight bacterial infections with medicine like penicillin, which was long thought to be a "magic bullet," Santillana says. In part, this has to do with the frequent use of antibiotics on humans and on animals that eventually become food, but Santillana says he and a team of researchers discovered that, in the U.S., antibiotic resistance differs based on region.

"The South has seen a larger prevalence of antibiotic resistance and the North not as much," Santillana says. "We hypothesized whether it could be where farms were located, but at the end of the day when we combined weather data from the models that reconstruct weather in the past–the ones that we use for weather forecasting–we realized that there was a very strong correlation between places that were experiencing warming and antibiotic resistance."

Santillana and his team later looked at 20 years' worth of data from Europe and found a similar trend: Antibiotic resistance occurred more quickly in warmer places.

By illustrating these findings in Thunberg's book, Santillana wanted to "go beyond the usual side effects that we know well about global climate change." The impact of climate change on public health is still being unpacked, but what's clear to Santillana is that antibiotic resistance "is one of the symptoms that happens as a consequence of a larger system."

"The lesson here is that there are other ways in which the consequences of climate change will bite us, so it's important to not look the other way and to do something and own our role in this ecosystem and to be more responsible–for the sake of our generation but more so for the sake of future generations," Santillana says.

Despite their different fields of study, both Santillana and Stephens are using "The Climate Book" as an opportunity to educate readers with the conviction that with knowledge comes power.

"What I'm hoping is that we all acknowledge the role we have had and we still have and become more proactive," Santillana says. "Being aware of that empowers us as humans to react and try to curb the way in which we are basically dumping pollution into the atmosphere and other resources like water."

Article excerpt and image from: News@Northeastern http://news.northeastern.edu/2022/10/11/greta-thunberg-the-climate-book/

Department Nota Bene

Honors

Professor Michele Di Pierro received a prestigious $2 million Maximizing Investigators' Research (MIRA) Award from the National Institutes of Health. The aim of the funded research is to gain mechanistic understanding of functional genomic interactions through computational modeling.

Arun Bansil, a University Distinguished Professor of Physics; Albert-László Barabási, Robert Gray Dodge Professor of Network Science and Distinguished Professor of Physics and Alessandro Vespignani, Sternberg Family Distinguished Professor were three of six Northeastern University professors who have been named in the 2021 Highly Cited Researchers list.

A 2022 Advancing Women in Science Scholarship was awarded to Kianna Cabral, a double Physics and Mathematics major from the Cape Verdean Islands. She's involved with Northeastern's STEMpower, the Association for Women in Math student chapter, and the College of Science Student Diversity Advisory Council. Cabral plans to graduate in May 2024.

Professor Latika Menon collaborated on an NIH supplementary grant funding at Harvard medical school to support mental wellness programs for graduate students in systems biology. Under this project over 50 grad students learned the sky breath meditation technique offered through skycampushappiness.org.

Physics Department Awards

The 2022 Physics Department Awards were presented online on April 28 via YouTube.com. Congratulations to this year's winners.

Excellence in Teaching

First Year:	Ilana Albert
	Victor Meszaro
	Yidi Qi
	Alexander Shilcusky
Second Year:	John (JP) Dervan
	Nica Jane Ferrer
	Ryan McCarthy
	Nicole Voce
Advanced TA:	Sudip Timilsina

Journal Club Speaker Award
Seyedehmaedeh (Maede) Seyedolmohadesin
Jiancheng Zeng

Graduate Academic Excellence

First Year	George Wanes
Second Year	Yiwen Tang

Morelli Graduate Research Fellowship
Arpit Raj
Douglas White

Alumni Sponsored Research Fellowship
Zhengxun Liu

Physics Research Internship Award
Vedant Rautela

Undergraduate Research Award for Women in Physics
Ayushi Shirke

Physics Co-Op Research Fellowship
Kianna Cabral

Undergraduate Scholastic Excellence

First Year

Kail Arthur	Varun Gupta
Christian Bernier	Aneel Kahlon
Yash Bhora	Maria Mataac
Eric Concannon	Daniel Nica
Douglas Dwyer	Ethan Saff
Benjamin Ecsedy	Haotian Zhang

Second Year

David Abrahamyan	Caolyn Huey
Aaron Angress	Evan Lentz
Sean Coursey	Heather Morell
Noah Haggerty	Henry Noyes

Third Year

Kyle Ednie	Samuel Koblensky
Nicholas Hurley	Vedant Rautela

Fourth Year
William Kovarik

Congratulations to our 2021/2022 Physics Degree Recipients

Doctor of Philosophy

Prasad Bandarkar (Fall 2021)
Advisor: Professor Paul Whitford
Biomolecular flexibility in confined spaces - A study of tRNA and protein translocation through nanopores

Davoud Hejazi (Summer 2021)
Advisor: Professor Swastik Kar
Dispersion-Free Accurate Color Estimation using Layered Excitonic 2D Materials and Machine Learning

Kaihua Ji (Fall 2021)
Advisor: Professor Alain Karma
Phase-field modeling of microstructural pattern formation during ice emplating and alloy solidification

Ryan Lang (Summer 2021)
Advisor: Professor Bryan Spring
Multiplexed in vivo Imaging and Analysis Methods for Optical Imaging Biopsy of Cancer

Gustavo Salinas de Souza (Spring 2022)
Advisor: Professor Brent Nelson
Axions and Dark Sectors from String Theory

Keegan Stoner (Spring 2022)
Advisor: Professor James Halverson
A correspondence between neural networks and quantum field theory

Benjamin Sung (Spring 2022)
Advisor: Professor James Halverson
Topics at the Interface of Algebraic Geometry and String Theory

Liam Timms (Spring 2022)
Advisor: Professor Srinivas Sridhar
Preclinical Applications and Clinical Translation of the QUTE-CE MRA Technique

Tanvi Wamorkar (Summer 2021)
Advisor: Professor Toyoko Orimoto
Search for exotic decays of the Higgs boson using photons with the Compact Muon Solenoid experiment

Bingran Wang (Spring 2022)
Advisor: Professor Darien Wood
Search for ZZ vector boson scattering in pp collisions at 13 TeV

Andrew Wisecarver (Fall 2021)
Advisor: Professor Emanuela Barberis
Measurement of the strong coupling constant using differential cross sections of the W boson produced in association with jets with the CMS detector at the LHC

Xinyue Xiong (Spring 2022)
Advisor: Professor Alessandro Vespignani
Forecasting the Epidemics with Reaction Diffusion Processes upon Networks

Luhang Yang (Spring 2022)
Advisor: Professor Adrian Feiguin
1D spin and fermionic systems with long-range antiferromagnetism

Master of Science

Daniel Abrams (Fall 2021)
Nolan Flannery (Fall 2021)
Justin Gardner (Fall 2021)
Jasmine Kohli (Summer 2021)
Brian Menezes (Spring 2022)

Bachelor of Science

(Spring 2022 unless otherwise noted)

Kenyon Allan
Jake Barnett-Hill
Jacob Bernhardt**
Joshua Bigman*
Max Caiati-Nardone
Sean Callahan*
Sydney Couval
Riley Crowley
Eve Decamp**
Nikhil Deliwala
Christopher DeLorenzo
John DeMastri
Peter Diaz*
Emily DiPietro
John Donaghue
John Donahue
Thomas Doyle
Cy Elliott
Ethan Fasking
Adrian Fedorko
Noah Fox
Joseph Franjieh
Jonathan Grove
Nicole Heller**
Megan Hott
Polina Kamenskaya
Ryan Lackey
Noah Levinsky**
Gregory Leo
Kearsley Lewis
Gilbert Liang
Zhengxun Liu
Daana Masumi
David Muir
Jack Nedell
Jeremy Paton
Cara Pesciotta
Thomas Pioch
Kathryn Rolfe**
Harshul Sahni**
Malcolm Schaenen
Nabeel Sherazi
Samuel Smucny
Asher Solnit
Jonah Spector
Matthew Todd**
Timour Tricoire
Jack Tuthill
Jazzmin Victorin
Samuel Wu-Ochs
Alec Yeager

*August 2021 degree conferral
**December 2021 degree conferral

Supporting the Department

The Physics Challenge is an opportunity to make a lasting contribution to the future of the Physics Department and the University.

Your support will provide scholarships to students, develop new physics programs, and contribute to new facilities and equipment.

Your support is essential to furthering our mission to provide our students with education and experiences that will help transform their lives.

For more information on how to give, please go to
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or contact:
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Assistant Vice President, Advancement
j.poulos@northeastern.edu

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Do you know of an alumnus who is not receiving our newsletter but would like to be on our mailing list?

Contact Us

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