College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

FALL 2023 NEWSLETTER

ELECTRICAL AND COMPUTER ENGINEERING

GROWING SEASON

UW–Madison ECE tops 50 faculty members

Greetings from Madison!

We are celebrating recent significant growth in our faculty, graduate student programs, and research advances in ECE at Wisconsin.

This year, our department welcomes 10 new tenure-track faculty—the successful outcome of multiple highly competitive searches over the past year. This accomplishment reflects well on the strengths of ECE at Wisconsin and our strong reputation for outstanding mentoring of junior faculty. With their arrival, we surpass 50 tenure-track/tenured faculty for the first time in our department's history. The significance of this growth is not just in the numbers. Our newest faculty broaden and strengthen our expertise in power electronics, optimization and control for power systems, machine learning and computer vision, computing systems and architecture, robotics and control of autonomous systems, electromagnetic sensing, and wireless communications and networks. Gender diversity among our faculty is also a point of pride: Women comprise 28% of our tenure-track/tenured faculty as of August 2023.

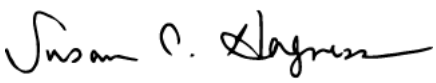
UW-Madison currently ranks eighth in the nation in total R&D expenditures. Our department's research leadership certainly contributes to this top-tier ranking. In fact, ECE research expenditures have grown by 28% over the past two years, totaling nearly $20 million last year. Our faculty are engaging in interdisciplinary research collaborations in exciting new directions. For example:

- Assistant Professor Jennifer Choy just received a $2M grant from the NSF Quantum Sensing Challenges for Transformational Advances in Quantum Systems program, in collaboration with Associate Professor Mikhail Kats and others, to develop quantum atomic sensors that could be used in portable devices like accelerometers and atomic clocks that could be used in outer space.
- Assistant Professors Chirag Gupta and Shubhra Pasayat, together with Associate Professor Daniel Ludois, just received a $1.5M NSF ASCENT grant to use wide bandgap semiconductor materials to develop an ultra-efficient high-voltage transistor to be used in bidirectional power flow. This innovation could have direct implications for electric cars, the power grid, and data centers.

Our current faculty have earned 11 NSF CAREER or DOE Early Career Research Program awards over the last five years, spanning eight core research areas of ECE. One of our most recent CAREER recipients, Assistant Professor Ramya Korlakai Vinayak, is currently investigating data diversity and how to build machine learning models that help algorithms better serve diverse populations. Given the commensurate opportunities for stellar research mentoring at both the graduate and undergraduate level, it is a great time to be an ECE student at Wisconsin!

As I begin my second term as the chair of ECE at UW-Madison, I'm excited to build on the tremendous progress we've made over the past five years. Thank you for staying connected to our department through our newsletter. I always enjoy hearing from our alums and friends of the department, so feel free to reach out to me anytime.

On, Wisconsin!



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ECE at Wisconsin: Committed to ethics and diversity in engineering

UW-Madison ECE welcomes our first year PhD students to campus. Submitted photo.

Demand for graduate degrees from ECE at UW-Madison is growing among men and women. The department's PhD student cohort has increased in size by 10% over the past two years. The total number of PhD students (new and continuing) in ECE this fall is approximately 200, with 27% identifying as women. Our above-national-average gender diversity is up nine percentage points over the past five years; we are simultaneously proud of this success and working hard to sustain this positive trajectory through organizations like Women in ECE at Wisconsin. Adding in our MS students in our research and accelerated degree programs brings the overall graduate program enrollment to more than 375 students this fall.

Our PhD students, under strong faculty mentorship, are helping to advance ECE's research leadership in next-generation electronics including wide-bandgap semiconductors and quantum technologies; sustainable energy systems including power electronics and electrification of vehicles; computer systems and architecture; privacy and security of communications and networks; machine learning, signal processing, optimization, and control of autonomous systems; applied electromagnetics and acoustics; and optics and photonics.

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On the cover: New faculty joining UW-Madison ECE in 2023 and early 2024. Front from left to right: Lei Zhou, Jinia Roy, Akhilesh Jaiswal; back from left to right: Manish Singh, Tsung-Wei (TW) Huang, Feng Ye. Not shown: Guillaume Bellagarda, Grigoris Chrysos, Jeremy Coulson, and Haihan Sun. Photo: Joel Hallberg.

Choy leads team awarded Quantum Sensing Challenge Grant

The National Science Foundation recently selected a project led by Assistant Professor Jennifer Choy for a four-year, $2 million Quantum Sensing Challenge for Transformational Advances in Quantum Systems grant. Choy will lead an interdisciplinary team of UW-Madison researchers, including co-principal investigator Mikhail Kats, the Jack St. Clair Kilby and Antoine-Bascom Associate Professor, as well as UW-Madison colleagues in physics and computer science and an ECE colleague at the University of California, Santa Barbara.

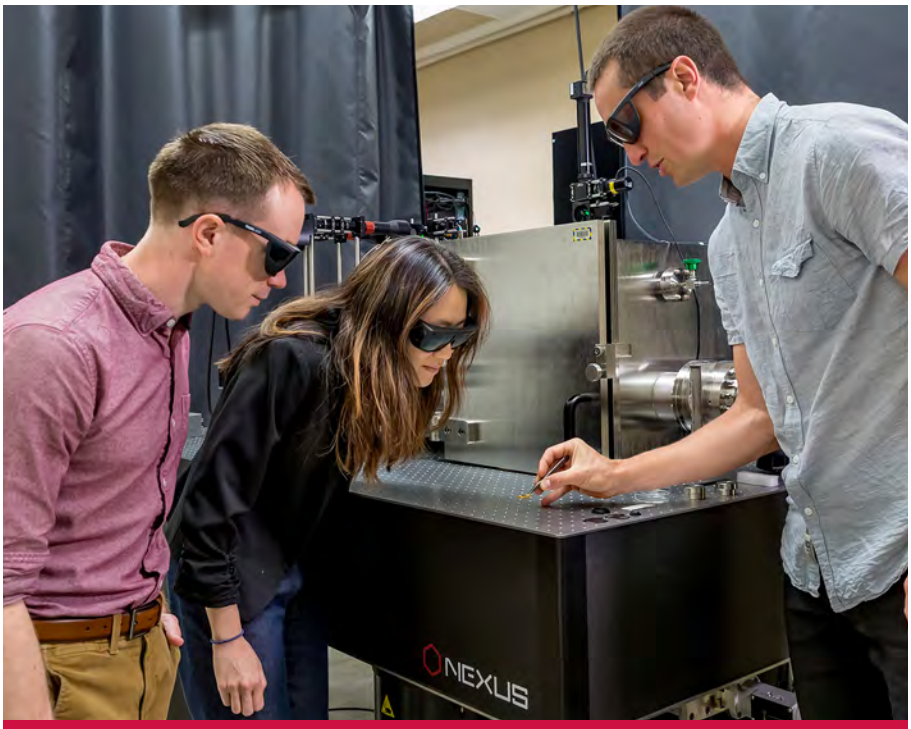
When atoms are cooled to almost absolute zero, they take on certain quantum properties. These cold atoms have been shown to be extremely accurate elements in quantum sensors.

Unfortunately, using these cold-atom systems outside of the lab has proven difficult due to their size, complexity and sensitivity to things like ambient temperature and electromagnetic fields. In their project, Choy and her team plan to overcome these challenges and develop compact and robust cold atom sensors.

To miniaturize these systems and make them more rugged, the team plans to develop and integrate a set of photonic chip-scale hardware and algorithms, comprising a "quantum sensor toolkit," that includes lasers and optics, optimized quantum algorithms for sensor fusion and calibration, and optimal leveraging of quantum entanglement.

These sensors could be used in portable devices like accelerometers and atomic clocks that can take measurements in harsh conditions, like outer space or the poles, and that could guide vehicles where GPS is not available.

"We have assembled a multi-disciplinary team to tackle practical issues, such as size constraints and undesired sensor noise from the environment, that are associated with implementing cold-atom sensors in the field," says Choy. "We are excited to start working together to co-develop and integrate photonic hardware and sensor algorithms that can miniaturize and ruggedize cold-atom inertial sensors and clocks."



Electrical and Computer Engineering Assistant Professors Eric Tervo (left) and Jennifer Choy (center), and Mechanical Engineering Assistant Professor Dakotah Thompson (right) are bringing expertise in quantum mechanics, thermal emissions and measurement techniques to the new Wisconsin Center for Semiconductor Thermal Photonics. Photo: Joel Hallberg.

New research center aims to expand the role of semiconductors

When most people think of semiconductors, they think of computer chips. But the new Wisconsin Center for Semiconductor Thermal Photonics will take semiconductors beyond computing by combining research in photonics, thermal science and quantum science to understand how semiconductors could be used to control the flow of heat. That understanding will be beneficial as researchers seek to develop new types of power generation, energy conversion, refrigeration, advanced sensing and other next-generation applications.

The center is led by Mikhail Kats, the Jack St. Clair Kilby and Antoine-Bascom associate professor; Professor Zongfu Yu, and Assistant Professors Jennifer Choy and Eric Tervo, along with two additional co-principal investigators.

The center, which recently received two years of highly competitive seed funding from UW-Madison's Research Forward initiative, has three initial thrusts: exploring ways to impart directionality to thermal radiation and create devices that work at specific wavelengths; developing new types of spectroscopy and quantum thermometry to better study heat; and developing thermal photonic devices, including semiconductor devices that can convert thermal radiation into electricity, or on the flip side, create new types of refrigeration.

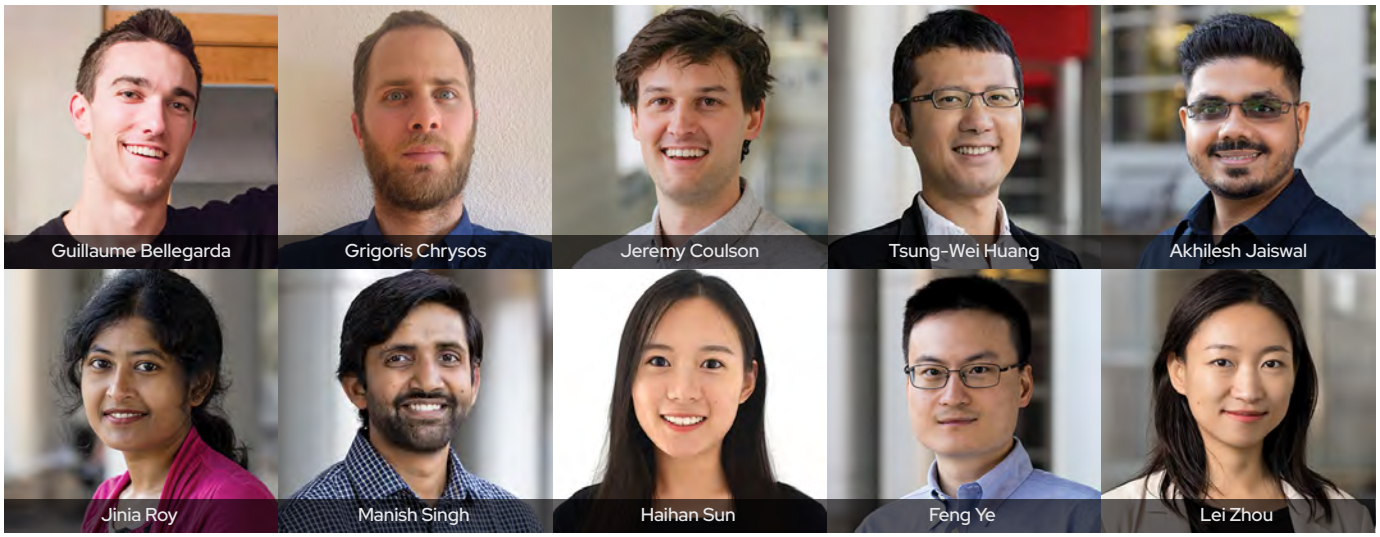
The six investigators are collaborating on a paper that lays out a five-year roadmap for semiconductor thermal photonics, which they say will help establish UW-Madison as a leader in the emerging space.

"The definition of semiconductors as a discipline is going to expand quite dramatically," says Kats. "And that's the point. Ours is a semiconductor center that isn't explicitly about microelectronics or computing. It is about expanding the role of these materials and the fabrication techniques and science involved to encompass a much bigger place in society."

FOCUS ON NEW FACULTY

Over summer and fall 2023, seven assistant professors joined the ECE faculty. Coming from academic institutions around the world and from industry here in the United States, they contribute new capabilities to our department as well as strengthen our current expertise.

In addition to the seven new faculty profiled below, ECE is also happy to welcome three additional faculty this year. Assistant Professor Lei Zhou, who holds a joint appointment with the Department of Mechanical Engineering, is an expert in mechatronics and control systems for manufacturing equipment and robotic systems. Jeremy Coulson, the Mark and Jenny Brandemuehl Assistant Professor of Electrical and Computer Engineering, who arrived in January 2023 to begin building his research lab in robotics and control, started his tenure-track appointment this summer. Finally, in January 2024, Guillaume Bellegarda, an expert in dynamic robotic systems that draw inspiration from machine learning and neuroscience, will also join the department as an assistant professor.



Grigoris Chrysos

MACHINE LEARNING

Machine learning is creeping into all sorts of applications in our everyday lives, from search engines to financial transactions. That's why Chrysos is working on reliable machine learning, or ways to improve the privacy, safety and robustness of artificial intelligence.

"As we get ready to launch some of these technologies more widely, we need to take great care and study their properties closely in the years to come," he says.

Chrysos earned his PhD from Imperial College London, where he pursued research on neural networks, a method of artificial intelligence in which computers process data in a way similar to the human brain. There he began investigating other potential AI models. "In the end, with a bit of luck and a bit of curiosity, we ended up with something called polynomial networks," he says. Polynomial neural networks have applications in deep generative models at the intersection of machine learning and computer vision.

During his PhD studies, he also gained industry experience as a research intern at Nvidia AI, Preferred Networks and Meta Reality Labs. As a postdoctoral scholar at EPFL in Lausanne, Switzerland, over the last three years, Chrysos continued work on polynomial networks, extending the theory behind the model.

At UW-Madison, he hopes to continue that work, and will also focus on reliable machine learning. That means developing theory and tools to make sure AI doesn't go off the rails.

"We need to make sure all the models we launch are fail-safe," Chrysos says. "If we want to launch them to make our life easy, we need to ensure that they make life easy for everybody."

Tsung-Wei Huang

COMPUTER SYSTEMS AND ARCHITECTURE

Modern scientific computing applications, such as simulations, modeling and artificial intelligence, use a mix of processing units—like a combination of CPUs and GPUs—to enable capabilities previously out of reach. This is called heterogeneous computing, and it's very difficult to create programs that can fully use this mix of processors.

Huang works on software systems that simplify the building of these high-performance scientific computing applications. "Nobody wants to use software that runs very slowly. But if you want to make software run fast, it is very, very tricky," he says. "So writing software that efficiently utilizes these kinds of parallel and heterogeneous computing resources is critical."

Huang received his PhD in electrical and computer engineering from the University of Illinois at Urbana-Champaign in 2017 and then spent four years as an assistant professor at the University of Utah prior to joining the faculty at UW-Madison. He received an NSF CAREER Award in 2022, a Humboldt Research Fellowship in 2022, and the ACM SIGDA Outstanding New Faculty Award in 2023.

He has already developed a tool called Taskflow, a general purpose parallel and heterogenous task programming system successfully deployed by thousands of researchers and companies.

He plans to continue this research at UW-Madison and to use the university's many resources to develop even more powerful tools that will seamlessly use heterogenous resources. "People can just focus on building their application on top of our software, while the mapping of the software to the hardware is completely handled by our system," he says.

Akhilesh Jaiswal

COMPUTER SYSTEMS AND ARCHITECTURE

Many cell phones and computer applications rely on cloud computing; ask a digital assistant a question and that query is routed to computers hundreds or thousands of miles away. But with the next generation of smart devices, including smart clothing, sensors and medical equipment, connecting to the cloud won't be fast or efficient enough—and following the traditional processing pathway used by most computers, with separate memory and processing circuits, will be too bulky and slow as well.

That's why Jaiswal is working on developing new paradigms in computing to enable extreme edge computing, in which the processing happens closer to the end user, or "edge," through novel processing techniques.

Jaiswal earned his PhD from Purdue University in 2019, then spent a year as a senior technology development engineer at the major semiconductor firm GlobalFoundries in Malta, New York. From there, he moved to the University of Southern California, where he held a joint position as a computer scientist with the Information Science Institute and as a research assistant professor in the ECE department within the Viterbi School of Engineering.

His projects include in-pixel processing (in which a camera is able use its millions of pixels to actually do the computing and sensing instead of relying on the cloud or a chip) as well as computing-in-memory using static random-access memory and neuromorphic computing, which mimics some of the efficient ways the brain works. He received the 2022 IEEE Brain Community Best Paper Award, already holds 26 patents, and is leading a three-year $2.4M grant from NSF to create new chip designs inspired by human brain performance.

Jinia Roy

ENERGY SYSTEMS

Power converters are critical to a world increasingly reliant on electricity, transforming power so it can be used in various machines and across the grid. Roy, the Thomas A. Lipo assistant professor, has broad expertise in power conversion after serving in academic, government and industry research roles. She plans to work on ways to make these devices smaller, more efficient, more durable and more powerful.

Roy received her PhD from Arizona State University in 2017 before heading to the National Renewable Energy Lab (NREL) in Golden, Colorado, for a stint as a postdoctoral researcher and research engineer within NREL's Power Systems Engineering Center. In 2019 she received the IEEE PELS Prize PhD thesis talk award. In 2020, she joined GE Global Research Center in Niskayuna, New York, as a power electronics research engineer.

Over that time, she has worked on a wide variety of power conversion projects, including developing new photovoltaic inverters with wide bandgap devices, including gallium nitride and silicon carbide. At GE, among many projects, she focused on pulsed-power converters for MRI machines, improving image quality, reducing costs and shrinking the size of the machines. She has also worked on projects exploring ways to optimize power conversion from wind and solar to improve green hydrogen production from these sources.

At UW-Madison, she plans to continue with her wide portfolio of research interests. She would like to expand to power conversion in electric vehicles and explore other pulsed power technologies, including lasers, radar, water treatment and ozone generation.

Manish K. Singh

ENERGY SYSTEMS

Power grids across the world are in transition. As renewable energy makes up a larger and larger share of energy output, grids need to carefully integrate these resources, with fluctuating voltage and frequency, into the power system. Singh is updating optimization and control algorithms and theory to help grid operators manage the power systems as they handle this transition.

"Renewables are changing how the power system behaves," he says. "This increases the dimension and complexity of tasks in grid management. But the computational capabilities and the enabling mathematical frameworks are not yet there. We are figuring all these things out."

After working for three years at the Power Grid Corporation of India Limited, which runs the national grid, and gaining a broad view of how grids operate, Singh completed his PhD at Virginia Tech. He interned at the National Renewable Energy Laboratory in Golden, Colorado, and spent the last two years working as a postdoctoral researcher at the University of Minnesota, investigating modeling and control for future grids and developing machine learning and data-based methods to enable the upcoming transitions.

At UW-Madison, he plans to continue his research on learning, optimization, and control for energy networks and says he's equally excited to be in the classroom. "The kind of research I'm doing is not necessarily something that is relevant only at an advanced PhD level," he says. "My work often affects how we fundamentally understand power systems. So that brings my research and teaching together."

Haihan Sun

APPLIED ELECTROMAGNETICS AND ACOUSTICS

Versions of ground-penetrating radar have been around for nearly a century but, despite advances, the data provided by the technology is still pretty crude. Using cutting-edge hardware and new software powered by artificial intelligence, Haihan Sun is developing ground-penetrating radar systems that can offer incredible amounts of detail.

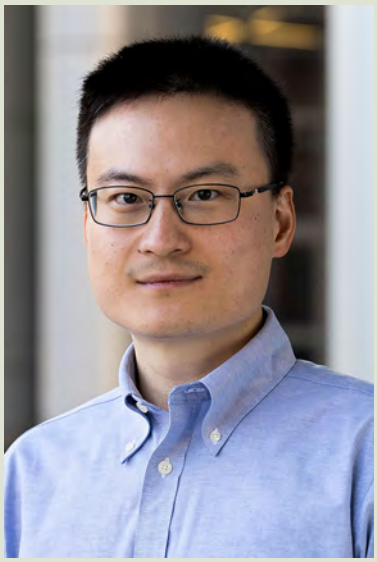
Sun received her PhD at the University of Technology, Sydney, Australia, where she studied base station antenna elements and multi-band antenna arrays on cell phone towers.

In 2019, she began work as a research fellow at the Nanyang Technological University in Singapore, where she turned that antenna work toward the ground. When electromagnetic waves hit an object in the ground and bounce back, the recorded signal contains lots of potential data. However, accessing and interpreting that data is difficult. Sun is using new antenna designs and hardware as well as AI-powered software to declutter that data and pull out rich information, including the size, shape, diameter and electrical properties of subsurface objects. In 2021 she received the Mojgan Daneshmand Grant from the IEEE Antennas and Propagation Society.

"My ultimate goal in this research direction is to develop an intelligent system that can automatically and flexibly acquire and process the signals from the subsurface environment, extract key information, and achieve high-resolution imaging of the subsurface system," she says. "I think this kind of intelligent system could shape the way we perceive and interact with the hidden world around us."

Feng Ye

COMMUNICATIONS, NETWORKS, PRIVACY, AND SECURITY



As the world becomes even more connected, the behind-the-scenes juggling among different types of networks gets more complex. Ye is working on various projects to seamlessly connect communications technologies and optimize the allocation of network resources. His research interests include wireless communications, network traffic analytics, information and network security, and Internet of Things technologies.

"Nobody really cares that much how these networks operate. They just need them to be there," he says. "But there are a lot of things going on behind the scenes. We're making the networks smarter and making the quality of experience better. In the future, we need to know if the network is ready for applications like autonomous vehicles or remote surgery."

Ye earned his PhD at the University of Nebraska-Lincoln. In 2016, he joined the electrical and computer engineering department at the University of Dayton, where he was the PI or co-PI on $1M in research grants from NSF, FAA, and DOE and was promoted to associate professor in 2022.

By measuring and studying network performance, Ye is able to develop software tools that can allocate and optimize the available network resources, so critical applications receive the bandwidth they need.

His current research includes an NSF-funded project using data analytics and communications-focused AI to improve communications between networks and reduce latency. He is also using his expertise in algorithms to work on a variety of other projects, including secure communications for distributed energy resources, new methods for advanced manufacturing and tools that will help test the safety of new types of solid-state batteries. He serves as an associate editor for two IEEE journals and has been recognized as a distinguished member of INFOCOM technical program committees in 2019 and 2022.

PhD student Shimaa Ahmed has helped to show that speaker identification systems, already used by many financial institutions, may not be as secure as previously thought. Photo: Todd Brown.

Down the tubes: Common PVC pipes can defeat voice identification systems

Automatic speaker identification, or using a person's voice as a passcode, is gaining popularity as a digital security system and is already used by some banks. But a team led by PhD student Shimaa Ahmed and Associate Professor Kassem Fawaz has found the systems are not quite as foolproof when it comes to a novel analog attack. By speaking through customized PVC pipes, the type found at most hardware stores, they were able to trick the machine learning algorithms behind automatic speaker identification systems.

"There are a lot of commercial companies selling this technology and a lot of banks using it. It's also used for personal assistants. The systems are advertised now as secure as a fingerprint, but that's not very accurate," says Ahmed. "The attack we developed is very cheap; just get a tube from the hardware store and change your voice."

Ahmed investigated whether it was possible to alter the resonance, or specific frequency vibrations, of a voice to defeat the security system. Because her work began in the middle of the COVID-19 quarantine, she began by using paper towel tubes to test out the idea. Later, after returning to the lab, the group hired Yash Wani, then an undergraduate and now a PhD student, to help modify the PVC pipes in the College of Engineering's makerspace. Using various diameters of pipe purchased at a local hardware store, Ahmed, Yani and their team altered the length and diameter of the pipe until they could produce the same resonance as a target voice.

Eventually, the team developed an algorithm capable of determining the dimensions needed to transform the resonance of almost any voice to another. In fact, the researchers found that mimicking the resonance using the tube attack worked in spoofing 60% of voices in a test set of 91 speakers, while unaltered human impersonators were able to fool the systems only 6% of the time.

Fawaz says the project has a larger purpose than just pointing out a security flaw. "Generally, all machine learning applications that are analyzing speech signals make an assumption that the voice is coming from a speaker, through the air to a microphone. But you shouldn't make assumptions that the voice is what you expect it to be," he says. "There are all sorts of potential transformations in the physical world to that speech signal. If that breaks the assumptions underlying the system, then the system will misbehave."

Computing tool solves decades-old physics problem

Zongfu Yu

Using cutting-edge computational electromagnetics techniques developed at UW-Madison, Professor Zongfu Yu successfully simulated a longstanding problem in physics called Anderson localization. The research provides a roadmap to solving similar intractable physics problems.

In 1958, physicist Phillip Anderson first proposed the Nobel Prize-winning theory, which suggests that if a wave encounters multiple obstacles in a disordered material, it will scatter and bounce back and forth between the objects, becoming trapped. Despite decades of experiments and simulations, researchers could not confirm the phenomenon, mainly because the computational firepower needed to fully simulate it is prohibitively expensive.

To solve the problem, Yu and a multi-institutional team were able to use a tool called Tidy3D developed by Flexcompute, a company co-founded by Yu. The tool uses an algorithm for modeling electromagnetic waves coupled with advanced computing chips available in the cloud. The team was able to speed up its calculations by orders of magnitude and run its simulation thousands of times, giving a much better picture of what's going on. "Our progress was enabled by this new computational power we developed here at UW-Madison that allows people to study huge problems in a high-throughput fashion," says Yu.

Yu says this type of computing resource could also be applied to many other electromagnetic physics problems, like optimizing the complex optical signals used in data centers and developing nanostructured nanolenses for things like chip-based lidar, a remote sensing technology.

Through machine learning maps, cosmic history comes into focus

Kangwook Lee

For millennia, humans have used optical telescopes, radio telescopes and space telescopes to get a better view of the heavens.

Today, however, one of the most powerful tools for understanding the cosmos is the computer chip: Cosmologists rely on processing power to analyze astronomical data and create detailed simulations of cosmic evolution, galaxy formation and other far-out phenomena.

"It is extremely expensive to run these simulations and basically takes forever," says Assistant Professor Kangwook Lee. That's why he is collaborating with colleagues in physics, Moritz Münchmeyer and Gary Shiu, to use emerging machine learning techniques to speed up the process.

Münchmeyer had the idea to improve the process by running large-scale, low-resolution simulations, then use a machine-learning technique called normalizing flow to upgrade them. The results, however, weren't as promising as he'd hoped.

That's why he reached out to Lee, who specializes in a type of machine learning called diffusion—a model capable of generating data similar to a data set on which it is trained. The researchers trained the diffusion model on dark matter simulations of various resolutions. By applying the model to low-resolution datasets, the team could quickly upgrade the data into high-resolution images.

Working across one small patch of sky at a time, then using an algorithm to stitch the data together, they made high-resolution images of some of the cosmic web of galaxies and galaxy clusters that form the universe.

And those machine-learning-enhanced images were accurate: The researchers' images proved extremely similar to those produced by running full, high-resolution simulations of the dark matter and gas distributions.

Creating these high-resolution simulations isn't just about making a map of the universe, says Lee. There's a much loftier goal: addressing the "inverse problem" in cosmology. To understand the origins of galaxies, matter and the Big Bang, researchers must work backward from what they can currently see—so they benefit from a more accurate window into today's universe.

"We can observe the universe today, but we cannot observe the same part of the universe at different times," he says. "But from the arrangement of matter and gas today, we are getting better and better at estimating what the universe looked like in the past, as far back as the time of the big bang. That's what this project is about."

Submitted photo.

ECE PhD alum honored as an exceptional entrepreneur

In spring 2023, Chancellor Jennifer L. Mnookin celebrated Winslow Sargeant (PhDECE '95) as one of four outstanding innovators honored with a 2023 Chancellor's Entrepreneurial Achievement Award.

The awards recognize people with ties to UW-Madison who further the Wisconsin Idea through outstanding accomplishments in entrepreneurship.

Sargeant has built an exceptional career with global reach, bridging entrepreneurship, technology, venture investing, small business advocacy, education and service. Sargeant is on the board of trustees for the Wisconsin Alumni Research Foundation, the Morgridge Institute for Research, and Northeastern University. He's also on the advisory council of Madison's Center for Black Excellence and Culture. He is a Kauffman Fellow and visiting scholar with George Washington University.

As senior advisor for globalization and head of capital markets for Genaesis, Sargeant syndicates opportunities with unaffiliated third-party capital partners. As board chair of the International Council for Small Business, he educates government and nonprofit leaders on sustainable ecosystems for small businesses. He provides leadership to startups as CEO of Purple Team Technologies, an early-stage supply chain informatics company, and as board chair for several other companies. He was previously a managing director for Madison-based Venture Investors, before serving as Senate-confirmed chief counsel for advocacy with the U.S. Small Business Administration.

He has also generously given back to ECE through his endowment of the Winslow Sargeant Distinguished Graduate Fellowship, recently awarded to Abena Otchere-Boateng, a PhD student in ECE.

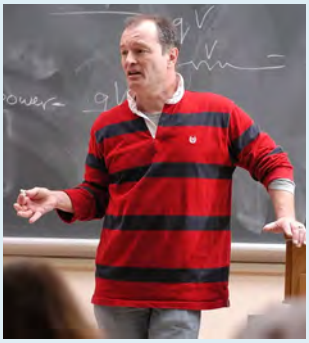
John Booske retires

Booske completed his PhD in nuclear engineering at the University of Michigan in 1985 and worked as a research scientist at the University of Maryland, College Park, before joining UW-Madison in 1990. He retired in June 2023 after 33 years of distinguished service as a member of the ECE faculty.

Booske's research focuses on electromagnetic fields and waves and includes vacuum electronics, microfabrication of millimeter-wave and THz regime sources and components, high-power microwaves, advanced cathodes, physics of the interaction of THz radiation and materials, microwave-generated plasma discharges, electromagnetic metamaterials and biological applications of electric and electromagnetic fields.

He is a fellow of the IEEE, American Physical Society, Institute of Physics, and AAAS. Over his career, he has received numerous awards and honors for his research, including most recently the IEEE Plasma Science and Applications Award, IEEE John R. Pierce Award for Excellence in Vacuum Electronics, and the IEEE Transactions on Plasma Science best paper award.

Booske has also been recognized as a pioneering teaching innovator. During the past 15 years, he helped implement new teaching pedagogies, including blended learning, flipped classrooms and remote learning, while also developing new learning labs and educational spaces. He was honored with a UW-Madison Chancellor's Distinguished Teaching Award, the IEEE EAB Major Educational Innovation Award, and the ECE Department Heads Association (ECEDHA) Innovative Program Award, as well as many college and departmental teaching awards over his career.



Remembering Professor Nick Hitchon

William Nicholas "Nick" Hitchon, a respected researcher and dedicated educator in ECE, passed away July 23, 2023.

Hitchon joined the faculty of UW-Madison in 1982, focusing on a diverse portfolio of "kinetic" theoretical models and computational modeling tools for low-temperature plasmas used in semiconductor fabrication and lighting, the electrical behavior of semiconductor devices, and microscopic phenomena in magnetic computer storage devices and gas dynamics. Over his career, he published more than 100 journal articles and three books. Between 1999 and 2002, he served as the ECE department chair.

During his career, he earned a reputation for outstanding teaching and mentorship. He advised more than 20 graduate students and taught 25 different ECE courses, including many he developed. He was an ardent advocate for the welfare and success of all students, and his dedication in the classroom led engineering undergraduates to name him an outstanding instructor five times.

Hitchon grew up as part of a farming family in Littondale, England. He is widely recognized outside of academia for his participation in the *Up* documentary series, which followed the lives of 14 7-year-olds in Great Britain, revisiting them every seven years over the course of many decades. He last appeared in *63 Up*, released in 2020.

Hitchon received his bachelor's (1978), master's (1979) and PhD in engineering science (1981) from Oxford University.

Alumna was there for the beginning of computer engineering

Electrical engineering alumna Joan (Donohoo) Cotter (BSEE '59) was on campus for a pivotal event, though at the time she couldn't understand its importance. She was a student in the first computer engineering class offered by ECE.

Cotter was the first woman in her family to attend college and was just one of 10 women in the College of Engineering her freshman year in 1955. She was also the only woman out of 300 students in electrical engineering.

When she was a junior, she signed up for a new class on computers, then an emerging technology, taught by electrical engineering professor Charles Davidson, now considered a pioneer of early computing.

While Cotter found the class interesting, she says it introduced concepts that we all now take for granted. "In that class, we never even saw a computer," says Cotter. "In those days there weren't even monitors, just banks of lights."

The students learned about binary, the primary language of computers, and vacuum tubes, which were used for logic circuits. Cotter says she wasn't particularly interested in vacuum tubes because she knew transistors would soon replace them, but otherwise enjoyed the material.

Nevertheless, she developed an interest in computing. After graduating with a degree in electrical engineering as well as options in engineering physics, nuclear engineering and professional engineering, Cotter relocated to St. Paul to work as an engineer at UNIVAC (now Unisys). The company produced one of the earliest commercial computers, and Cotter worked on a magnetic drum data storage device. She also did simulation programming, which made it possible to test the capability of a new computer being designed on an existing computer.

When her first child was born a few years later, Cotter resigned. She soon became interested in education, eventually founding a Montessori school and earning a PhD in mathematics education from the University of Minnesota. She developed a company and curriculum called RightStart Math for elementary and middle schoolers, which she currently runs with her daughter.

Faculty News

UW-Madison recognitions

Charles Ringrose Assistant Professor Bhuvana Krishnaswamy is the recipient of an Early Career Innovator Award, which recognizes early-career faculty members for engaging in technology transfer and commercialization activities from the Office of the Vice Chancellor for Research and Graduate Education.

Keith and Jane Morgan Nosbusch Professor Robert Nowak is the recipient of a Wisconsin Alumni Research Foundation named professorship, the Grace Wahba Professor of Data Science.

Jean van Bladel Associate Professor Daniel Ludois is the recipient of an H. I. Romnes Faculty Fellowship.

Jack St. Clair Kilby Associate Professor Mikhail Kats has been named the Antoine-Bascom Associate Professor.

Assistant Professor Pedro Morgado was selected for a WARF Accelerator Big Data Challenge Grant, which funds new technologies focused on processing and handling large amounts of data.

The College of Engineering selected Lynn H. Matthias Professor Hongrui Jiang for its 2023 Byron Bird Award for excellence in a research publication.

National/international honors

Assistant Professor Chu Ma received the Women in Acoustics Young Investigator Travel Award to attend the Acoustical Society of America meeting in Chicago in May 2023. She also chaired the special session, "Interaction of EM waves with acoustic waves."

A paper, "Effect of nonuniform emission on miram curves," authored by Nosbusch Professor Emeritus John Booske, won the 2023 *IEEE Transactions on Plasma Science* best paper award.

Assistant Professor Tsung-Wei Huang received the ACM SIGDA Outstanding New Faculty Award at the 2023 Design Automation Conference.

Assistant Professor Ying Wang received a 2023 Department of Energy Early Career Award.

Assistant Professors Shubhra Pasayat and Ying Wang were integral to the $18M renewal of the NSF Materials Research Science and Engineering Center at UW-Madison. Pasayat is serving on the center's executive committee and Wang is serving on the IRG2 team investigating magnetic states in strained crystalline membranes.

Student News

Graduate students Jennifer Bui and Brandon Cortez were selected for National Science Foundation Graduate Research Fellowships. The prestigious award provides three years of financial support for graduate studies. They are mentored by Assistant Professor Dominic Gross and Professor Nader Behdad, respectively.

Di Wu, a 2023 PhD graduate working with Assistant Professor Joshua San Miguel, was selected as one of 35 rising stars at the intersection of machine learning and systems research by MLCommons. He was invited to a rising stars workshop at Google in August 2023. He recently joined the University of Central Florida as a tenure-track assistant professor.

PhD student Chih-Chun Chang, working with Assistant Professor Tsung-Wei Huang, received a 2023 Innovation Award from the IEEE High Performance Extreme Computing (HPEC) Graph Challenge.

PhD student Carissa Roper, working in the lab of Professor Susan Hagness, was selected for a 2023 IEEE Antennas and Propagation Society Fellowship.

Audrey Evans, a 2023 PhD graduate mentored by Professor Susan Hagness, received a Mojgan Daneshmand grant from the IEEE International Symposium on Antennas and Propagation. She recently joined Los Alamos National Laboratory as a research scientist.

PhD student Noah Rhodes, working with Associate Professor Line Roald, won the first prize for best student paper at the 2023 IEEE PowerTech conference in Belgrade, Serbia. The paper reported their research on co-optimization of power line de-energization and restoration under high wildfire ignition risk.

Startup corner

Submitted photo.

Professor Dan van der Weide recently exhibited the latest product from his startup company AntenneX at the IEEE International Microwave Symposium in June 2023. The tabletop millimeter wave antenna analyzer allows companies to measure device performance without sending them to outside labs. From left to right, David Andersson (of Keysight), Anouk Hubrechsen, Dan van der Weide, and Roel Bude of AntenneX and alumnus Lucas Hansen (BSEE '05) of Keysight.

Graphic: Type One Energy

Type One Energy, a fusion energy startup based in Middleton, Wisconsin, and co-founded by Jim and Anne Sorden Professor Emeritus David Anderson, received $29 million in its first round of seed funding from investors in spring 2023. The company is using advanced manufacturing methods, modern computational physics and high-field superconducting magnets to develop its fusion stellarator for future commercial use. Investors include Breakthrough Energy Ventures, chaired by Bill Gates, which invests in technologies with the potential to significantly eliminate greenhouse gas emissions.

New certificate in engineering data analytics

ECE and the Department of Industrial and Systems Engineering launched a new undergraduate certificate in engineering data analytics in fall 2023. To earn the certificate, students take 15 credits in four areas, including foundations of data analytics, applications of data analytics, data science, and machine learning, before taking a required capstone course, *Ethics of Data for Engineers*, developed by ECE Assistant Professor Kangwook Lee.

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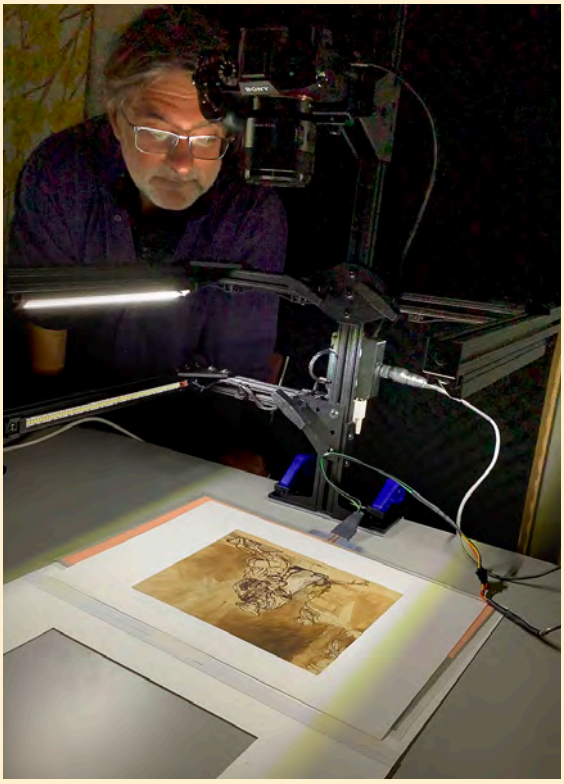

Submitted photo.

The fine art of electrical engineering

Most people who travel to Europe on vacation only get to see the works of old masters from behind thick ropes. But on a visit to the Teylers Museum in the city of Haarlem in the Netherlands in May 2023, Professor William Sethares was able to get very close to several drawings by Rembrandt.

That's because Sethares is part of a project using watermarks and mold marks to date the works of several artists. Rembrandt, for one, was guilty of rarely dating his work. By dating the paper on which a drawing is made, however, researchers can make an educated guess about when an artwork was created.

In the past, paper was made by hand on molds, each with unique idiosyncrasies and makers' watermarks. These molds also tended to wear out on a fairly regular basis, meaning they were often replaced. Looking very closely at the "mold marks" and watermarks on the paper can help researchers group together artworks from the same batch, which could provide information about a date.

To do so, Sethares created a device he and his collaborators call a watermark imaging system (WimSy). The artwork is placed on a lightbox, then photographed in multiple ways, gathering surface images, raking light images, and transmitted light images of the paper. Using software developed by graduate student Elisa Ou, the system can isolate the paper and any watermarks or mold marks created by the papermaker. These can then be used to match pieces of paper made on the same mold, which could help determine a date.

In this photo, Sethares is using WimSy to photograph a drawing made in preparation for Rembrandt's painting *Return of the Prodigal Son*, which has not been definitively dated.

Besides Rembrandt, Sethares has also used WimSy, currently being tested in European museums, on some of Leonardo Da Vinci's very jumbled notebooks.