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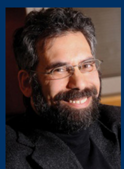
APAM NEWS

School of Engineering & Applied Science, Columbia University
Department of Applied Physics & Applied Mathematics
with Materials Science & Engineering



Dear APAM Community,

Welcome to the Spring 2026 newsletter from the Department of Applied Physics and Applied Mathematics (with Materials Science and Engineering). This issue finds our community at an exciting juncture where foundational scientific discoveries are rapidly translating into tangible, world-changing technologies. The stories within these pages reflect the remarkable breadth of our work, spanning from the quantum realm to the heart of a star to the complex materials and algorithms that will define our future. It is a testament to the power of our interdisciplinary approach, which brings together physicists, mathematicians, and engineers to solve the most challenging problems.

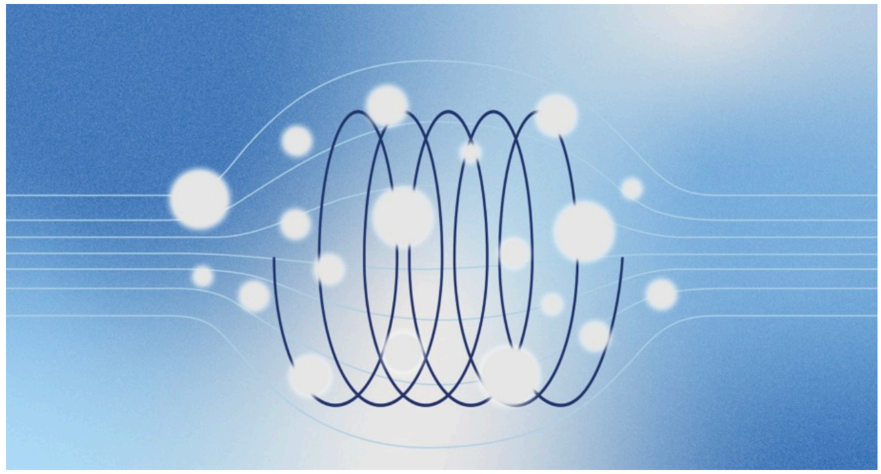
This spring, we are especially proud to highlight the significant momentum in fusion energy research. You'll read about our new Columbia Fusion Research Center, its growing partnerships with industry leaders and international bodies like the IAEA, and our new academic minor designed to train the next generation of fusion industry leaders. We also showcase groundbreaking advances in quantum computing, where our researchers are creating record-breaking neutral-atom arrays, as well as fundamental breakthroughs in materials science, from a new battery electrolyte for safer energy storage to a new understanding of how to control heat flow in crystals. At the heart of this progress are our people, and we are delighted to celebrate numerous faculty, student, and alumni awards, while also taking a moment to honor the indelible legacy of Professor Katayun Barmak.

These highlights offer just a glimpse into the vibrant intellectual life of our department. They are connected by a shared drive to not only push the boundaries of knowledge but also to educate and empower the people who will use that knowledge to build a better world. I invite you to explore these stories and join us in celebrating the achievements of our remarkable community.

Best,

Marc Spiegelman
APAM Department Chair

Cover Image: Columbia Engineering is focusing on fusion energy in the latest issue of *The Lever*.
See page 11 for more details.



2026 APAM Undergraduate Award Winners

Sumer Moudgill, Fulbright Winner

Sumer Moudgill, an Applied Physics major, and double minor in Materials Science and East Asian Studies, will conduct research in India next year as a Fulbright grantee. His work as an undergrad focused on analyzing data from large international gravitational-wave observatories. Drawing on this experience, his work will contribute to the development of INDIGO, a gravitational-wave detector currently under construction in India, where his Fulbright project will focus on understanding and seeking to reduce sources of measurement noise to improve the instrument's sensitivity.

Taifeng (Thomas) Wang, Applied Physics Faculty Award Winner

Taifeng (Thomas) Wang was honored for his exceptional accomplishments in applied physics. A transfer student from Grinnell College, he distinguished himself through a rigorous academic program in Quantum Mechanics and Plasma Physics, outstanding academic performance, and significant research contributions. Working within the plasma physics group, he collaborated with Drs. Hansen, Logan, and Nelson, all of whom praised his technical ability, collegiality, and meaningful impact. Thomas was recognized for his strengths in mathematics, physics intuition, and artificial intelligence, which have supported his research success. He will continue his academic journey at Columbia, where he is expected to interface more deeply with plasma theories and their applications to fusion plasma behaviors.

Szymon Snoeck, Applied Mathematics Faculty Award Winner

Szymon Snoeck was recognized for his outstanding achievements in applied math, with a strong focus on algorithms and machine learning for high-dimensional data. In his research with Prof. Nakul Verma, he studied the limitations of popular data visualization algorithms, resulting in two publications at the 2026 International Conference on Algorithmic Learning Theory and the 2026 International Conference on Learning Representations. He continues to pursue his geometric focus, working on nearest neighbor search with Prof. Alexandr Andoni. Next year, he will start his PhD in computer science at the Courant Institute of Mathematical Sciences at NYU. Driven by a passion for geometry, Szymon continues to explore the intersection of theory and application in modern data science.

Zoe Ning Zachko, Rhodes Prize for Materials Science Winner

Zoe Ning Zachko was awarded the Rhodes Prize for her exceptional proficiency in materials science. At Columbia, she also pursued minors in applied mathematics and French. Driven by an interest in sustainable technologies, Zoe has engaged in research spanning lithium-ion batteries and catalytic materials. In the Billinge Group, she worked with Dr. Tina Na Narong on machine learning approaches to transition metal oxides, contributing to a publication in npj *Materials*. She currently conducts research at Brookhaven National Lab's Center for Functional Nanomaterials, developing machine learning methods to accelerate experimental workflows. Beyond research, Zoe is committed to mentorship and STEM outreach, organizing programs for New York City public school students. She will begin her PhD studies at Northwestern University in Fall 2026.

Graduate Research Fellowship & Award Winners

APAM students were named recipients of the prestigious NSF Graduate Research Fellowship Program which recognizes outstanding graduate students pursuing research-based master's and doctoral degrees in STEM fields. Honorees include **Karina Dovgodko SEAS'25** and **Szymon Gustav Snoeck SEAS'26** in Applied Math; **Ari Willner SEAS'24** and **Andrew Yang SEAS'25** in Applied Physics; and **Kaylynn Chen SEAS'24** in Materials Science.

Abdullah Hyder, a PhD candidate in plasma physics, was awarded the DOE Office of Science Graduate Student Research fellowship. Building on his work with Prof. Elizabeth Paul, he will collaborate with Dr. Jeff Larson, an expert in derivative-free optimization, at Argonne National Laboratory (ANL). He will work to optimize the shear Alfvén continua of stellarators, targeting the reduction of key gaps to suppress Alfvénic instabilities.

Dayoung Gloria Lee, a PhD candidate in Oleg Gang's group, was named an MRS Silver Winner and received the Arthur Nowick Graduate Student Award for her research, "Three-Dimensional Mesoscale Patterning within Nanoscale Lattice Organizations," which she presented at the 2026 MRS Spring Meeting.

2026 Medical Physics Graduates

We are thrilled to celebrate the 2026 Medical Physics Masters of Science and Certificate Program degree recipients as they take the next remarkable steps in their careers. This year's MS graduates - **Dwayne Bryant, Jing Wang Ou Yang, Bon Tack Koo, Nassim Tavakoli,** and **Zahid Ahmad Safi** - along with Certificate graduates **Qing Chao** and **Thomas Khazanov** - have earned not just their credentials, but placements at some of the most respected institutions in the country.

Several of our graduates have secured positions in highly competitive CAMPEP-accredited clinical residency programs in therapeutic medical physics. These 2-year programs train the next generation of board-certified medical physicists to work at the forefront of radiation oncology and cancer care:

- **The Radiation Oncology Medical Physics Residency at Augusta University's Georgia Cancer Center in Augusta, GA** - one of the Southeast's leading academic cancer centers, committed to exceptional clinical care and innovative research in cancer biology and medical physics.
- **The Medical Physics Residency Program at Thomas Jefferson University Hospital - Asplundh Cancer Pavilion in Willow Grove, PA** - part of one of the nation's most storied programs, which received CAMPEP accreditation in 2008 among the first cohort of programs in the country.
- **The Therapeutic Medical Physics Residency Program at UPMC Hillman Cancer Center in Pittsburgh, PA** - an NCI-designated Comprehensive Cancer Center and one of the largest integrated cancer care networks in the U.S., offering residents the opportunity to train at the cutting edge of the field, with optional international rotations at UPMC's cancer center in Rome, Italy.

Another graduate will pursue advanced research at the Gerstner Sloan Kettering Graduate School of Biomedical Sciences at Memorial Sloan Kettering Cancer Center, one of the world's preeminent cancer research institutions, deepening their expertise and contributing to the innovations that will define the future of medical physics.

Medical physicists play an irreplaceable role in the fight against cancer. They are the scientists and clinicians who ensure that radiation reaches tumors precisely, that patients are protected, and that the latest technologies are applied safely and effectively. The work our graduates will do - in clinics, research labs, and cancer centers across the country - will directly improve and save lives.

Above (left-right): Dwayne Bryant, Zahid Ahmad Safi, Jing Wang Ou Yang, Svitlana Samoilina, & Bon Tack Koo

MSE Alum, Tom Caulfield, Graduate Class Day Speaker

Originally published by Columbia Engineering

Thomas Caulfield BS'82, MS'84, EngScD'86, executive chairman of GlobalFoundries (GFS), one of the world's largest semiconductor manufacturing companies, was the 2026 Class Day Speaker for Columbia Engineering Graduate Class Day.

Caulfield has had an extensive career spanning over 30 years of engineering, executive management, and global operational leadership with leading technology companies. In 2018, he was named CEO of GFS and led the company's initial public offering in October 2021, which was not only the largest semiconductor IPO in history at that time, but also the largest IPO across all of Nasdaq that year. He joined GFS in May 2014 as senior vice president and general manager of the company's Fab 8 semiconductor wafer manufacturing facility in Malta, NY.

"I'm honored to address the Class of 2026 at this transformative time for technology and business in the world," said Caulfield. "My time at Columbia Engineering shaped not only my technical foundation, but also my approach to critical thinking and structured problem solving. The combination of rigorous academic training and hands-on, real-world experience prepared me both professionally and personally, and I continue to draw on those lessons every day."

Prior to joining GFS, Caulfield served as president and chief operations officer (COO) at Soraa, the premium LED lighting manufacturer, and served as president and COO of Ausra, a leading provider of large-scale concentrated solar power solutions for electrical power generation and industrial steam production. He also held roles at Novellus Systems, Inc. as executive vice president of Sales, Marketing, and Customer Service, and held a variety of leadership roles at IBM, ultimately serving as vice president of 300mm semiconductor operations for IBM's Microelectronics division, leading its wafer fabrication and R&D operations in East Fishkill, NY.

He currently serves as a member of the board of directors for Sandisk Corporation (following its spinoff from Western Digital, where he also served as a board member) and recently joined the board of USA Rare Earth. He was a Trustee for Union College from 2018 to 2025 and currently serves on the Columbia Engineering Board of Visitors and the Strategic Research Advisory Council for the University of Arizona. In May 2025, he was awarded the prestigious Thomas Egleston Medal by the Columbia Engineering Alumni Association for his distinguished leadership and groundbreaking contributions to engineering innovation in the semiconductor industry. Caulfield also gave a guest lecture to Columbia Engineering students in 2024 as part of the Tech CEO Lecture series.

"Tom has done so much to support, inspire, and encourage our students over the years," said Shih-Fu Chang, Dean of Columbia Engineering. "We are so happy to have him back to campus to once again share his wisdom and insights with our graduate students as they begin this next chapter."

He earned a bachelor of science in physics from St. Lawrence University and a bachelor's, master's, and doctorate in materials science and engineering from Columbia Engineering. He was also a postdoctoral fellow at Columbia's Engineering Center for Strategic Materials.

Columbia Fusion Research Center Graduates

The Columbia Fusion Research Center is proud to celebrate another outstanding graduating cohort of bachelor's and master's students. Many of the students began working in the laboratory as early as their sophomore year, building extensive hands-on experience through long-term involvement in fusion research projects. Most also completed at least one summer of full-time work at the center, contributing to ongoing experimental, engineering, and technical efforts while developing skills that will support them well beyond graduation.

This year's graduates represent a wide range of academic disciplines, including physics, applied physics, mechanical engineering, and electrical engineering. Following graduation, cohort members will pursue careers and further study across an equally diverse range of fields, including graduate programs, fusion and fission startups, the aerospace industry, mechanical engineering firms, and the Juilliard School. We look forward to seeing their continued accomplishments and wish them the very best in their future careers.
Photo: Dinner with graduating students & lab mentors

Congratulations APAM Graduates

October 2025 MS: Zhaocheng Dong (MA), Plamen Hristov (MA), Chunying Huangdai (MA), Chirag Khurana (AP), Matan Pagi (MA)

October 2025 MPhil: David Arnold (AP), Hari Choudhury (AP), Priyansh Lunia (AP), Matthew Pharr (AP), Matthew Tobin (AP), Haley Wilson (AP)

October 2025 PhD: Isabelle Bunge (AM), Jonah Chaban (AM), Paulina Czarnecki (AM), Yin Zhou (AM), Yinan Dong (MSE), Matthew Patrick (MSE)

February 2026 BS: Nicholas D'Souza (AM), Maria Garmonina (AM), Makoto Powers (AM)

February 2026 MS: Peter Antonaros (AM), Afra Ashraf (AM), Carol-Lena Breiter (AM), Evan Bursch (AP), Jinguang Chai (AM), Kai Chang (AM), Aneesh Chatterjee (AM), Guzehong Chen (AM), Ruoyu Chen (AM), Xiaoyu Chen (AM), Yuang Chen (AM), Zachary Daniel (AP), Lirui Deng (AP), Yuxuan Fan (AM), Eliot Felske (AP), Jingge Feng (AM), Harshul Gupta (AM), Mohammed Haque (AP), Jinzhi Hu (AM), Yiou Huang (AP), Aditya Mandar Jabade (AM), Sumesh Jagtani (AM), Bon Tack Koo (MP), John Labbate (AP), Brandon Lee (AP), Xueru Lei (AM), Yanxuan Li (AM), Shu Han Liao (AM), Qiaoyang Lin (AM), Limeng Liu (AM), Xianchi Liu (AM), Ahmed Lone (AM), Haaris Mian (AM), Chaoqun Niu (AM), Ye Hwi Oh (AP), Jing Wang Ou Yang (MP), Tao Peng (AM), Lang Qin (AM), Jacob Rottenberg (AM), Marjan Rumadaul (MSE), Maria Fernanda Sampaio Ferreira (AM), Tamas Sarvary (AP), Shreyas Seethalla (AP), Peihua Su (AM), Zhixing Tang (MSE), Nassim Tavakoli (MP), Kylie Thompson (AP), Xuhan Tong (AM), Kavish Trivedi (AP), Michelle Vadillo Cardenas (MSE), Avigdor Veksler (AP), Jingkai Wang (AM), Kecheng Wang (MSE), Meiyang Wang (MSE), Zhuonan Wang (AM), You-Ting Wu (AM), Songyin Xiao (AM), Kewen Xie (AM), Bofan Xing (MSE), Zichong Xu (AM), Haobo Yang (AM), Jiayi Yang (AM), Zichen Yang (MSE), Tushnim Yuvaraj (AM), Jiaheng Zhang (AM), Wanjing Zhang (AM), Yanbo Zhang (AP), Yutan Zhang (AM), Yujie Zhou (AM), Adam Zortea (AP)

February 2026 MPhil: Anson Braun (AP), Daniel Burgess (AP), Hoi Chun Chiu (AP), Nigel DaSilva (AP), Graydon Flatt (AP), Remy Kassem (AM), Aryeh Krischer (AP), Daozhe Lin (AM), Matthew Notis (AP), Yinxi Pan (AM), Matthew Sisson (AM), Jacob Solomon (AP), Jackson Turner (AM), Oliver Wang (AP), Jiahao Wu (AP), Ruining Zhang (MSE)

February 2026 PhD: Richard Oliver (AP), Yuan Xu (AP)

May 2026 BS: Alejandro Antorcha (AP), Matthew Baisley (AP), Martín Castellanos-Cubides (AP), Romola Cavet (AM), Huiyao Chen (AM), Wayne Chen (AP), Ian Chen-Adamczyk (AM), Israa Draz (MatSci), Bethany Duncan (AM), Mingyuan Gao (AM), Aidan Gregerson (AP), Haohui Guo (AP), John Halloran (MatSci), Gustavo Hernandez Furio (AM), Rae Seong Jeong (AP), Zhenyuan Jiang (AM), Lucas Jones (AM), Emily Lu (MatSci), Pranav Manoj (AM), Derek Martinez (AM), Sander Miller (AP), Sumer Moudgill (AP), Jose Osa (MatSci), Aditya Phatak (AM), Aaroosh Ramadorai (AP), Paul Randall (AP), Shuo Sha (AM), Szymon Snoeck (AM), Christian Tarrasch (AP), Naomi Toft (AM), Viktor Ulanov (AP), Andrea Vergara (AM), Taifeng Wang (AP), Ziyi Wang (AM), Jenny Ye (AM), Zoe Zachko (MatSci), Elena Zhao (AM)

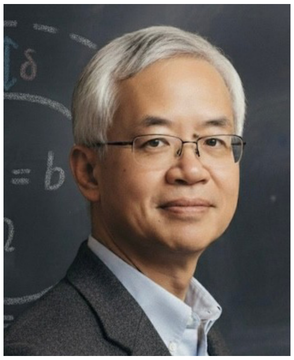
May 2026 MS: Alexandra Aalami (AM), Cristy Almeida (AM), Ian Anthoine (AM), Charles Baranowski (MSE), Manuel Bellod (AM), Dwayne Bryant (MP), Zhangjing Cheng (AM), Lang Faith (AM), Thatcher Geary (AM), Abhishek Kumar (AM), Chentao Li (AM), Yansong Li (AM), Nathaniel Melisso (MSE), Jeremy Mysliwiec (AM), Minwoong Oh (AP), Samantha Oliver (MSE), Talia Rabban (AM), Malavika Rajeev (MSE), Zahid Ahmad Safi (MP), Michael Taft (AM), Anna Vance (AM), Kunlun Wu (MSE), Yuchen Xiao (MSE), Shuwen Yang (MSE)

May 2026 MPhil: Zhenghao Yang (MSE)

May 2026 PhD: Hari Choudhury (AP), Sidarth Raghunathan (AP), Hongjin Wang (MSE)

AP: Applied Physics | AM: Applied Mathematics | Mat Sci: Materials Science | MSE: Materials Science & Engineering | MP: Medical Physics

Alumni news continued on pages 17-18



Du Elected to the American Academy of Arts & Science

Originally published by Columbia Engineering

Qiang Du, the Fu Foundation Professor of Applied Mathematics, has been elected to the American Academy of Arts & Sciences. Du leads the Computational Mathematics and Multiscale Modeling (CM3) group at Columbia. CM3 conducts research at the interface of mathematical, computational and data sciences through partnerships with experts from different fields. Du has developed mathematical models and computational algorithms for various complex and multiscale systems.

He has received much recognition for his work, including the Feng Kang prize in scientific computing (2005), the Eberly College of Science Medal (2007), SIAM (Society of Industrial & Applied Mathematics) Outstanding Paper prize (2016), ACM Gordon Bell Prize finalist (2016), SIAM Review SIGEST Award (2020), USACM (US Association of Computational Mechanics) Thomas J.R. Hughes Medal (2021), ICBS Frontiers of Science Award (2024). He is a Fellow of SIAM, AMS (American Mathematical Society) Fellow, and AAAS (American Association for the Advancement of Science).

He graduated in 1983 from the University of Science and Technology of China with a degree in mathematics and in 1984 was selected by a special AMS-SIAM committee to pursue graduate studies in the U.S. He later earned a PhD in mathematics (1988) from Carnegie Mellon University. Prior to joining Columbia in 2014, he was the Verne M. Willaman Professor of Mathematics and Professor of Materials Science and Engineering at Penn State University. At Columbia, Du has served as the chair of the Applied Mathematics PhD program (2014-2020). As a faculty affiliate of the Data Science Institute, he was also a co-chair of the Center for Foundation of Data Science (2018-2019), the Center of Computing Systems for Data-Driven Science (2020-2024) and the Center of AI for Science and Engineering (2025-).

Ren Named 2026 SIAM Fellow

Professor **Kui Ren** has been named a 2026 Fellow of the Society for Industrial and Applied Mathematics (SIAM). Prof. Ren was recognized for contributions to computational and mathematical analysis of inverse problems and their applications in imaging sciences."

Ren is among 25 newly selected fellows who will be formally recognized at a reception during the SIAM Annual Meeting, scheduled to take place in Cleveland, Ohio, in July 2026. SIAM Fellows are acknowledged for their significant impact on advancing applied mathematics, computational science, and data science.

His research involves several aspects of applied and computational mathematics. His recent work includes theoretical and numerical analysis of inverse problems related to partial differential equations with applications in biomedical imaging; mathematical modeling and computation of the propagation of high-frequency acoustic/electromagnetic waves in random media; numerical and mathematical studies of random graphs and networks; as well as numerical algorithms for kinetic modeling of electrostatics and charge transport in semiconductor devices.

Ren received his BS from Nanjing University in China and his PhD in Applied Mathematics from the APAM Department at Columbia University. He moved to the University of Chicago as a L.E. Dickson Instructor in 2007 and, in 2008, joined the faculty at the University of Texas at Austin in the Department of Mathematics and the Oden Institute for Computational Engineering and Sciences where he became a tenured professor. Ren returned to Columbia Engineering in 2018 and joined the Applied Mathematics faculty in the APAM Department. He is also now a member of the Columbia Data Science Institute, the Initiative for Computational Science and Engineering, and the Artificial Intelligence@Columbia.

Wiggins Takes on New Leadership and Research Roles in AI

Chris Wiggins was appointed Adviser to the Dean for AI Strategy at Columbia College, where he will work closely with Dean Sorrett to advance AI strategy and policy initiatives across the College. The appointment reflects Columbia's growing commitment to shaping the responsible development and use of artificial intelligence in education and research.

Wiggins has also been named a Visiting Professor at the University of Edinburgh for 2026–2029. He will collaborate with Professor Donald MacKenzie (FBA FRSE FAcSS) and colleagues on research exploring the intersection of AI and economics.

CNN has also appointed Wiggins as its new head of machine learning and AI science, a newly created role. Wiggins, who spent more than a decade leading AI and data initiatives as Chief Data Scientist at The New York Times, will strengthen the network's digital new work in machine learning and its AI transformation strategy. Together, these appointments underscore Wiggins's leadership in interdisciplinary AI research and align with APAM's expanding emphasis on collaboration across fields, as well as Columbia's broader AI initiatives.

Wiggins is an associate professor in the APAM Department and a founding member of the university's Data Science Institute, with additional affiliations in systems biology and statistics. He is also co-founder of hackNY, a nonprofit supporting student innovation and startup internships in New York City. A Fellow of the American Physical Society and recipient of Columbia's Avanessians Diversity Award, Wiggins is the co-author of the books "How Data Happened: A History from the Age of Reason to the Age of Algorithms" and "Data Science in Context: Foundations, Challenges, Opportunities," the latter earning the 2024 Prose Award in Computing and Information Sciences.

Neutral-Atom Arrays Are A Rapidly Emerging Quantum Computing Platform. These Columbia Researchers Know How to Make the Biggest Arrays Yet

They combined optical tweezers with metasurfaces to trap over 1000 atoms —with the potential to capture hundreds of thousands more.

By Ellen Neff, Originally published by Columbia Quantum Initiative

For quantum computers to outperform their classical counterparts, they need more quantum bits, or qubits. State-of-the-art quantum computers have around 1,000 qubits. Columbia physicists Sebastian Will and **Nanfang Yu** have their sights set much higher.

"We are laying critical groundwork to enable quantum computers with more than 100,000 qubits," Will said. In a new paper published in *Nature*, Will and Yu combine two powerful technologies—optical tweezers and metasurfaces—to dramatically scale the size of neutral-atom arrays.

Neutral-atom arrays are a rapidly emerging platform to create quantum computers. In a foundational study led by graduate students Aaron Holman and Yuan Xu from the Will and Yu labs, respectively, the team successfully trapped 1,000 strontium atoms and demonstrated that their approach can scale to well above 100,000.

These atoms could one day serve as qubits in a quantum computer, a task for which atoms are well-suited. Atoms offer a powerful way to engineer the quantum properties that quantum computers need, like superposition and entanglement. Each atom is also identical, so there's no need to spend time characterizing and synchronizing them—a daunting task for fabricated forms of qubits, especially as the number grows.

"Atoms are nature's own qubits; perfectly identical and massively abundant. The bottleneck has always been finding a way to control them at scale," said Holman.

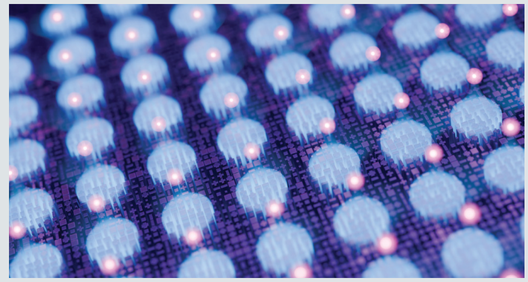
For about a decade, researchers have been trapping atoms with what are known as optical tweezer arrays. In essence, a single "optical tweezer" is a tightly focused laser beam that holds an individual atom at its focal point. Tweezer arrays are made up of many individual tweezers, typically generated via spatial light modulators (SLMs) or acousto-optic deflectors (AODs). Using these techniques, a team at Caltech recently achieved arrays with 6,100 trapped atoms and demonstrated that they can successfully function as qubits. "Their report is an amazing achievement," said Will. "With our metasurface tweezer array approach, we hope to scale neutral-atom arrays even further, perhaps even beyond 100,000 atoms."

This scaling comes from a fundamentally new approach to generating optical tweezer arrays: metasurfaces. Metasurfaces are flat optical devices comprising a two-dimensional array of nanometer-sized "pixels." When a single beam of light passes through a metasurface, it is shaped by the pixels into a unique pattern. In the current work, the pixels are much smaller than the wavelength of the light they are manipulating: less than 200 nm, compared to the 520-nm light used for the tweezers. That means they can directly generate a tweezer array; SLM and AOD approaches require additional equipment that is bulky, expensive, and limits the ultimate size of the array.

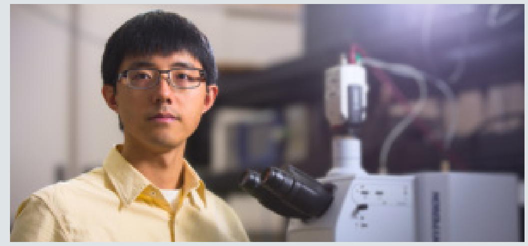
"The metasurfaces used in this work can be considered a superposition of tens of thousands of flat lenses over the same plane and differing in their focal spot location," said Yu, "so that upon the incidence of a laser beam, one metasurface can simultaneously produce tens of thousands of focal spots."

The metasurfaces, made from silicon nitride and titanium dioxide, can also tolerate extremely powerful lasers with optical intensities of more than 2000 W/mm2—that's about a million times more intense than sunlight as it reaches Earth. "The high-power handling capability of metasurfaces coupled with the scalability of cleanroom nanofabrication of ever larger and more precise devices makes our platform uniquely capable of realizing massively scalable optical tweezer arrays," said Xu.

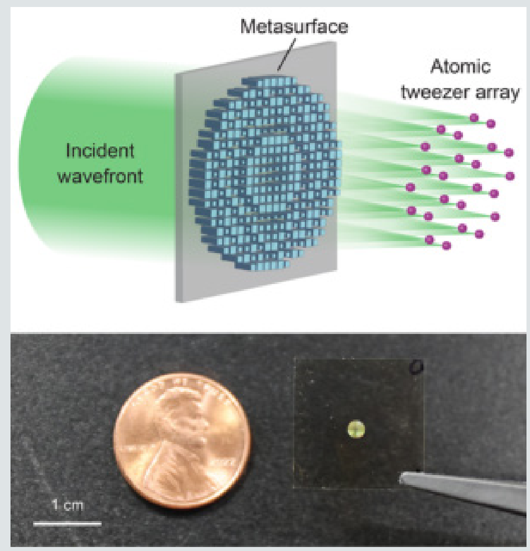
(Continued on the following page)



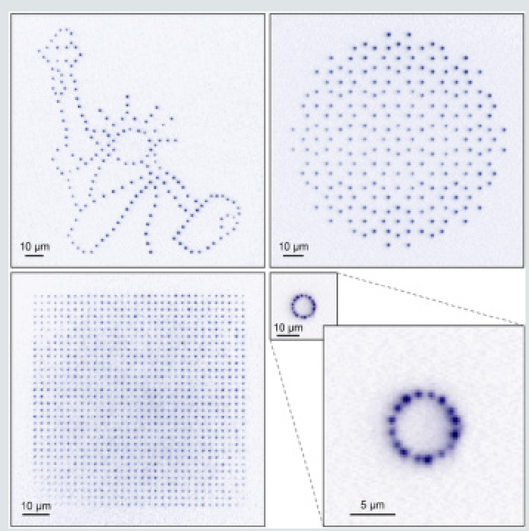
(Above) Image from the Will Lab, Columbia University



(Above) Nanfang Yu, Professor of Applied Physics



(Above) Top: Schematic of how a metasurface shapes a single beam of light into multiple tightly focused beams in a single step. These beams form a series of optical tweezers to trap individual atoms into arrays with arbitrary geometry. Bottom: A metasurface compared to a penny.

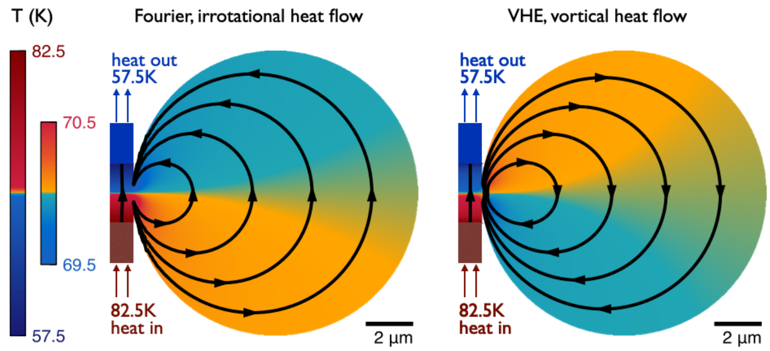


(Left) Atomic tweezer arrays, generated by metasurfaces. The team successfully trapped atoms into several patterns, including the Statue of Liberty, a quasicrystal pattern, a grid of 1024 atoms, and a circle with just under 1.5 microns between each atom. Credits: Will and Yu labs

How Layered Crystals Make Heat Swirl

A new study shows that layered crystals such as graphite and hBN can support fluid-like heat vortices and resonant temperature waves, opening new possibilities for controlling thermal signals.

By Ellen Neff, Originally published by Columbia Quantum Initiative



In 1822, French physicist Joseph Fourier formulated his law of heat conduction, an equation that elegantly describes how heat flows down a temperature gradient. But there are exceptions to the rule: materials in which heat, under the right conditions, can flow backward.

Writing in *Physical Review Letters*, Columbia University applied physicist **Michele Simoncelli** and his collaborators, Bogdan Rajkov from Cambridge University and Jan Dragašević from the University of Copenhagen, demonstrate how this counterintuitive phenomenon can be induced, controlled, and amplified. In certain layered materials, including graphite and hexagonal boron nitride (hBN), heat can move much like a fluid: ebbing, swirling, and rippling in waves. This departs from the diffusive behavior predicted by Fourier's law and opens new avenues for managing and engineering thermal signals in a range of technologies.

"The physics of heat transport in layered materials shares fundamental analogies with classical fluids flowing in porous media; it can even form waves that can be modulated using resonance," said Simoncelli, assistant professor of applied physics and applied mathematics at Columbia Engineering. "That suggests that heat could behave as a controllable signal, rather than a nuisance."

Michele Simoncelli

The team employed quantum-mechanical simulations to solve viscous heat equations and predict non-diffusive heat flow in graphite and hBN, materials widely used in electronics and phononics for their high thermal conductivity. According to Fourier's law, heat should evenly diffuse. But the team's equations describe vortices, a smoking gun for viscous flow, as well as wave-like oscillations, which occur when heat moves against a temperature gradient.

The viscous heat flow in these materials originates from phonons, quantum-mechanical excitations associated with atomic vibrations in crystals, which can interact in ways that carry heat into coherent motion. The resulting viscosity is quite close to that of everyday liquids. "We found that the effective heat viscosity of graphite is similar to that of water, while boron nitride is more similar to toluene, commonly used in paints," said Simoncelli.

This has two important implications for controlling heat flow in these materials. By adjusting their geometry through features such as circular wells, narrow channels, and tailored boundary shapes, researchers can intentionally create heat-flux gradients and vortices, much as fluids do when they encounter an obstacle. And by heating the materials with short pulses, they can excite temperature waves that can be amplified through resonance.

Experimentalists are already familiar with such approaches to induce different phenomena in layered materials, but have long considered heat a nuisance to be avoided. With their new understanding of heat flow, Simoncelli and his collaborators suggest that heat could become a controllable signal.

Read More: Jan Dragašević, Bogdan Rajkov, and Michele Simoncelli. Viscous heat backflow and temperature resonances in extreme thermal conductors. *Physical Review Letters* (2026). DOI: 10.1103/nbbn-56hr

Neutral-Atom Arrays Are A Rapidly Emerging Quantum Computing Platform, (continued from page 5)

For the paper, the team demonstrated the versatility of the metasurface optical tweezer platform by trapping atoms into a number of highly uniform 2D arrays. The patterns include a square lattice with 1024 sites; quasicrystal and Statue of Liberty patterns with hundreds of sites; and a circle made up of atoms spaced just under 1.5 microns apart.

The team also created a 3.5-mm diameter metasurface containing more than 100 million pixels that generates a 600 x 600 array: that's 360,000 optical tweezers in total, which is two orders of magnitude beyond the capabilities of current technologies.

Will and Yu see a realistic path to scalability for neutral-atom arrays, which may not only benefit quantum computers but also other neutral-atom quantum technologies, like quantum simulators, which help scientists model complex quantum many-body phenomena, and precise optical atomic clocks that could be deployed outside of laboratories.

What's next? The team is ready to take on more atoms. To do so, they just need a bigger laser. "To trap a hundred thousand atoms, we'll need a much more powerful laser than we currently have," said Will. "But, it's in a realistic range."

Read More: Aaron Holman, Yuan Xu, et al. Trapping of Single Atoms in Metasurface Optical Tweezer Arrays. *Nature* (2025). DOI: 10.1038/s41586-025-09961-5

Delivering a Quantum Future at Columbia Engineering

By Ellen Neff, Originally published by Columbia Engineering

It's the 100th anniversary of quantum mechanics. Here's how Columbia's scientists and engineers are working together to shape the next century.

Across Columbia, theoretical scientists, experimental physicists, chemists, and engineers cross corridors and courtyards with quantum in mind. It's a uniquely collaborative environment, a refrain echoed by faculty, postdocs, and graduate students across departments and disciplines.

"Columbia is a remarkable place. The scale and intensity of the collaborations here are like nowhere else," said Dmitri Basov, Higgins Professor of Physics at Columbia University and co-lead of the Columbia Quantum Initiative. "It's a delightful experience, and a privilege to be part of this team."

Together, they explore the frontiers of quantum mechanics, a now-century-old theory, in a combined quest to better understand the world — and deliver new quantum technologies. Those will include computers more powerful than any today, networks that can instantaneously transmit perfectly secure information, and sensors to detect quantum-scale changes in bodies, batteries, and more. Getting there means building new foundations that exploit the quantum nature of materials, light, and how they interact.

It's an area that Columbia excels in, one hundred years in the making.

In 1925, Max Born coined "quantum mechanics" to explain, under one theory, the growing number of observations that were physics. Its basic tenets: quantum objects are simultaneously particles, with masses, charges, and discrete amounts of energy called quanta, and waves, with given frequencies and wavelengths. These quantum objects, which include electrons and photons of light, can combine in unique and often counterintuitive ways.

Though scientists in Europe initially developed the theory, Columbia has had a part in quantum history since its earliest days. In 1909, Max Planck brought the concept of energy quanta — the idea that would eventually lend the field its name — to North America in a series of lectures at Columbia. In the coming decades, as theory gave way to applications, Columbians made several Nobel Prize-worthy quantum discoveries that led to now commonplace technologies, including:

- *I.I. Rabi's observations of magnetic resonance, which led to today's magnetic resonance imaging (MRI).*
- *Charles Townes' amplified electromagnetic waves; the result, lasers, are just about everywhere.*
- *Louis Brus's connection between a particle's size and the color of light it emits; these quantum dots have found applications in LED displays, solar panels, and biological sensors.*

Today, Columbia's researchers are creating entirely new materials with unique quantum properties, controlling individual photons of light and entangling them together, and developing theories to guide quantum research into its second century. So, what's to come? APAM faculty share where they think the (quantum) world is heading:

Alexander Gaeta

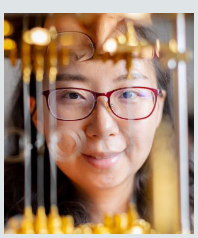
Alexander Gaeta, *David M. Rickey Professor of Applied Physics and Materials Science, Professor of Electrical Engineering, and co-lead of the Columbia Quantum Initiative*

"One hundred years is a pretty long time. Perhaps we will have a quantum computer with a wide variety of applications — ones we aren't even thinking about now. Quantum sensors may also become ubiquitous, all linked through a network and with capabilities we haven't even dreamed of yet. I think a lot of it will hinge on these technologies that we're working on here." Gaeta studies how laser light interacts with matter. "We've been studying quantum systems for several decades already, but it's been remarkable to see how quickly the field has grown recently. I'm particularly excited about using present-day quantum devices to simulate complex quantum materials and resolve long-standing, fundamental questions about how many electrons interact to create complex emergent behavior. There's a lot of synergy here that could help us discover materials that revolutionize how we store energy, perform classical computing, and more in this century."

Aravind Devarakonda

Aravind Devarakonda, *Assistant Professor of Applied Physics and Applied Mathematics*

Devarakonda combines physics, chemistry, and materials science to create and study quantum materials. "In the next 100 years, the way we vote, earn, spend, negotiate, medicate, dress, compute, communicate, sense, and think will rely on harnessing the counter-intuitive laws of quantum mechanics. Just as the steam engine and electricity have transformed civilization, there will be no aspect of everyday life untouched by the fact that nature is quantum mechanical."



Sherry Zhang

Sherry Zhang, *Assistant Professor of Applied Physics and Applied Mathematics*

The next 100 years will likely be the most exciting time for quantum technology, where we build the promises from decades ago into a reality. Quantum sensing, simulation, and computing will be transitioning from the initial demonstration to the utility level or even beyond. Quantum science may have stopped being 'quantum' in the end—it will just be technology, like semiconductors or AI today.

Zhang Group Receives Samsung Global Research Outreach Award

We are thrilled to announce that Professor Xueyue (Sherry) Zhang's lab has received a Samsung Global Research Outreach (GRO) award for their project on Waveguide-Coupled Dual-Transition Superconducting Qubits for Low-Overhead Fault-Tolerant Quantum Computing. Learn more about their research at https://zhang.apam.columbia.edu

A New Electrolyte Points to Stronger, Safer Batteries

The new material brings researchers closer to achieving the long-held goal of anode-free lithium batteries with long cycle life and enhanced thermal stability.

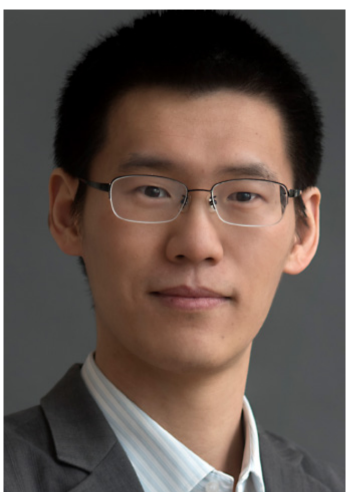
Originally published by Columbia Engineering

Researchers at Columbia Engineering have developed a new gel electrolyte that both improves the lifetime and safety of anode-free lithium batteries, an emerging battery architecture that could dramatically boost energy density while simplifying manufacturing. Although such design promises higher energy density and lower cost, the approach has long been plagued by short battery life and safety concerns caused by unstable lithium plating and parasitic reactions at the electrode-electrolyte interface.

The Columbia team, led by **Yuan Yang**, associate professor of applied physics and applied mathematics at Columbia Engineering, addressed these challenges by rethinking how polymer electrolytes interact with lithium ions at the nanoscale..

A "Salt-Phobic" polymer network that reshapes ion solvation

The researchers designed a gel polymer electrolyte that contains a parasitic salt-phobic polymer network. This structure overcomes previous challenges by selectively repelling lithium salts while attracting solvent molecules. This unique chemical contrast spontaneously divides the electrolyte into nanoscale domains with different local compositions, which favors the formation of an efficient protective layer on the lithium surface.



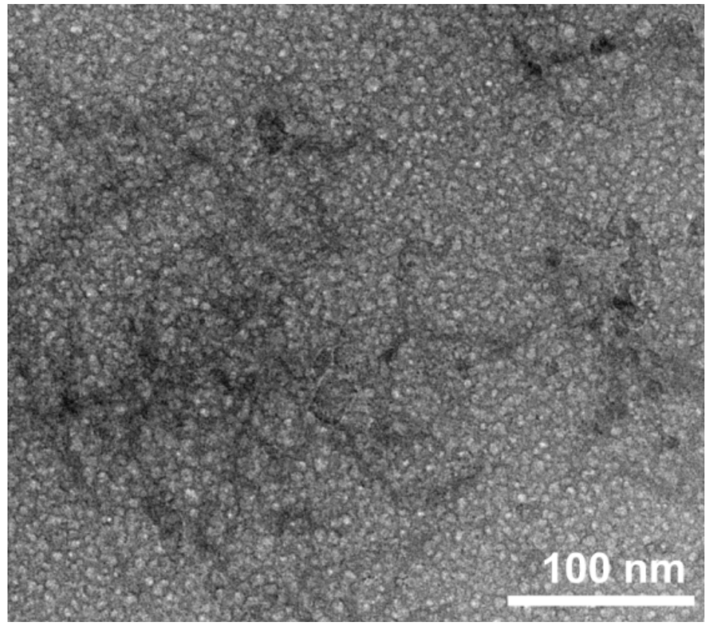
Yuan Yang

"In these confined regions, lithium ions are forced to coordinate more strongly with anions rather than solvent molecules," said Yang. "That anion-rich solvation environment fundamentally changes how the solid electrolyte interphase forms."

Where previous attempts to solve this problem have used large quantities of fluorinated electrolytes, the new approach incorporates the electrolytes directly into the polymer backbone. This enabled the researchers to develop smaller, less expensive, and more efficient batteries.

Stabilizing lithium–electrolyte interface

Advanced spectroscopy, cryogenic electron microscopy, and molecular simulations revealed that this salt-phobic network promotes the formation of a thin, inorganic-rich interphase. This interphase enables smoother, denser lithium deposition and suppresses parasitic reactions that typically consume active lithium in anode-free cells. As a result, anode-free pouch cells using the new gel electrolyte retained over 80% of their capacity after hundreds of cycles under demanding conditions, including high areal capacity, lean electrolyte content, and low external pressure—parameters that closely resemble those required for practical electric vehicle batteries.



Cryo-TEM image of the gel electrolyte featuring a parasitic salt-phobic network, highlighting the aggregation of fluoroacrylate molecules and their incorporation into the gel matrix after gelation. Credit: Yang Lab

Enhanced safety under extreme conditions

Beyond extending battery life, the gel electrolyte also improves thermal stability. In abuse tests, multilayer anode-free pouch cells equipped with the new electrolyte withstood aggressive drilling without thermal runaway, while comparable cells using conventional liquid electrolytes ignited or exploded. "These results show that polymer chemistry can be a powerful and underexplored lever for controlling solvation structure and interfacial stability," said the study's first author **Shengyu Cong**, a postdoctoral research scientist with Yang. Yang said. "By embedding safety and durability directly into the electrolyte architecture, we can push anode-free batteries closer to real-world deployment."

Toward practical high-energy batteries

The work highlights a new design principle for gel electrolytes, using polymer backbone chemistry to engineer nanoscale solvation environments rather than relying on extreme electrolyte formulations. The researchers believe this strategy could be extended beyond lithium to other alkali-metal batteries, opening new pathways for safer, high-energy-density storage technologies.

About the Study

Journal: *Joule*

Title: "Gel electrolyte featuring parasitic salt-phobic network enables anode-free lithium batteries with long cycle life and enhanced thermal stability"

DOI: 10.1016/j.joule.2025.102296

Authors: Shengyu Cong, Zhenghao Yang, Xuhao Wan, Han Chen, Shiyi Yuan, Zhihao Yang, Yuchen Yang, Tong Wang, Sheng Zhang, Maya Narayanan Nair, Yuzheng Guo, Yuanyuan Ma, Yang Li, Hyunsik Woo, Seung Woo Lee, Yongseok Kim, Yuan Yang

Columbia Makes the Case for Quantum on Capitol Hill

Universities will be critical to keeping America at the forefront of this rapidly advancing field

By Ellen Neff, Originally published by Columbia News

(Above) Faculty from Columbia and Stony Brook University speak to congressional staffers about quantum research (Below) (Above) Columbia and Stony Brook faculty and staff in front of the U.S. Capitol Building

On March 10, a panel of researchers from Columbia University and Stony Brook University gave Congressional staffers a crash course in emerging quantum technologies—and the importance of federal support for the American universities driving the field forward.

"Today's conversation is about quantum science and artificial intelligence. But more importantly, it's about ensuring America's capacity to lead in this next era of quantum and AI-driven innovation," Jeannette Wing, executive vice president of research at Columbia, noted in her opening remarks. "AI is a technology already transforming every sector and our daily lives. Quantum information science is no longer a distant or abstract field. Both quantum and AI are rapidly becoming foundational technologies that will shape the global economy, our national security, and our scientific leadership."

The discussion was hosted by Senator Kirsten Gillibrand's office and convened as Congress begins consideration of the National Quantum Initiative (NQI) Reauthorization Bill, introduced in the Senate in January to build on the NQI's work to advance basic research while establishing an ecosystem to develop practical quantum applications.

The panelists discussed two rapidly advancing technologies: quantum computers, which are poised to perform complex calculations beyond the capacities of even today's supercomputers; and quantum networks, which, akin to the classical internet, will someday link those devices and others into a quantum internet.

Early versions of quantum computers and quantum networks both exist today, but research is still needed to bring them to their full potential. "There are impressive commercial demonstrations of quantum technologies, but they are nascent," said **Alexander Gaeta**, David M. Rickey Professor of Applied Physics and Materials Science and professor of electrical engineering at Columbia. In many cases, "universities are still at the state of the art."

Companies are building ever-bigger, more powerful quantum computing hardware that is beginning to perform meaningful calculations, noted Henry Yuen, Srivani Professor of Computer Science at Columbia, but there is still a long road ahead. Not only are more qubits—the quantum equivalent of classical computer bits—needed, but researchers are still grappling with finding ways to correct errors that accumulate in them.

Quantum networks are also expanding worldwide and already provide secure quantum key distribution. The longest in North America spans more than 170 miles across Long Island into New York City and connects research labs at Stony Brook, Columbia, and Yale universities, as well as Brookhaven National Lab. Called SCY-QNet, it, in principle, demonstrates a technology platform for connecting quantum computers.

Quantum information, encoded in light traveling along these networks, cannot be intercepted; the information is teleported from one node to another using a quantum phenomenon called entanglement—Einstein's "spooky action at a distance." "It's secured by physics, not computational complexity," said Eden Figueroa, professor of physics at Stony Brook and lead investigator of the National Science Foundation–funded SCY-Qnet project.

The technologies for creating and teleporting entangled photons are now mature and ready to scale, noted Sebastian Will, professor of physics at Columbia, but the necessary interfaces that enable those photons to interact with qubits in quantum computers are still under development. The United States has an opportunity to push that frontier and pioneer the technologies needed to link quantum devices in a quantum way, he stressed.

Light is also an important link between the quantum world and that of artificial intelligence. "There has been a tsunami of AI, with companies buying compute in gigawatts, not buildings or servers," said Keren Bergman, Charles Batchelor Professor of Electrical Engineering at Columbia. "Energy is the unit of currency." Shifting the field toward moving photons around chips, rather than electrons, could greatly reduce energy consumption in AI data centers while improving their performance. "The next phase of AI systems will build on the same systems as quantum," she said. "Quantum will be an accelerator."

Engineering chip-based photonic devices, qubit interfaces, and quantum error-corrected quantum devices will require substantial federal investment, the panelists stressed. As will developing the workforce needed as quantum technologies continue to move from research labs to commercial industries. "We need to be developing and recruiting talent across the entire academic continuum," said Angela Kelly, professor of physics and STEM education at Stony Brook. That includes, she said, students at the K-12 level, which inspires initial interests in science; undergraduates at both 2- and 4-year universities to fill diverse entry points; and graduate students advancing research in rapidly moving fields.

Even as applications emerge, it remains hard to predict just how transformative they may be. Not unlike the internet, as it was forming with heavy federal research and infrastructure investment from the 1960s into the 1990s. "We're probably just scratching the surface in terms of what is possible," said Yuen.

Inverse Design Enables Complex 3D Nanoparticle Architectures

Researchers, including Columbia Engineering faculty **Oleg Gang**, **Nanfang Yu**, and **Sanat Kumar**, have developed a powerful inverse-design strategy that enables the programmable assembly of nanoparticles into complex three-dimensional (3D) architectures with unprecedented precision. Using DNA-based "voxels" equipped with directional and addressable bonding sites, the team identified symmetry-guided building blocks, termed mesovoxels, that direct the formation of target and hierarchically organized crystal structures while minimizing design complexity.

The approach allows for translating structural blueprints into self-assembled nanoscale materials and reveals how the amount of encoded interaction information influences assembly fidelity. Leveraging this strategy, the researchers created a diverse range of hierarchically ordered 3D nanoparticle organizations, including structures containing low-dimensional features, helical motifs, a nanoscale analogue of a face-centered perovskite crystal, and a distributed Bragg reflector that integrates plasmonic and photonic length scales. This work provides a general route for engineering arbitrarily complex 3D nanomaterials by design, opening new opportunities for advanced optical, photonic, and functional materials with tailored properties.

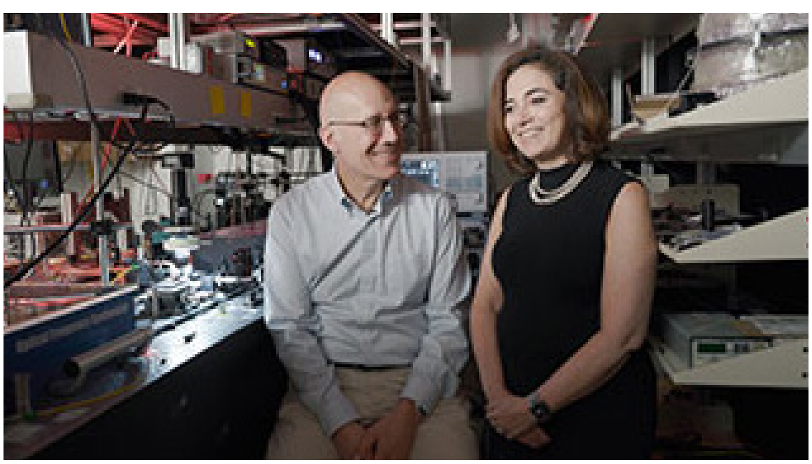
Kahn, J.S., Minevich, B., Michelson, A. et al. Encoding hierarchical 3D architecture through inverse design of programmable bonds. *Nat. Mater.* 24, 1273–1282 (2025). https://doi.org/10.1038/s41563-025-02263-1

Columbia Engineering Researchers Help Drive Xscape Photonics' AI Networking Breakthrough

Xscape Photonics, a semiconductor startup building advanced photonic solutions for AI data center networks, announced $37 million in new funding, bringing its total Series A investment to $81 million. The round was led by Addition, with continued participation from investors including NVIDIA and IAG Capital Partners. Alongside the financing, the company introduced FalconX, a pluggable External Laser Small Form-factor Pluggable device capable of emitting up to eight wavelengths of light to enable faster, higher-capacity, and more energy-efficient optical data transmission across AI infrastructure.

FalconX is designed to address a key bottleneck in modern AI systems: limited "escape bandwidth" between accelerators in large-scale compute clusters. By using Xscape's proprietary CombX laser technology, the device generates multiple wavelengths on a single silicon photonics chip, enabling multi-terabit-per-second data movement with built-in redundancy to improve reliability. The company argues this is increasingly critical as AI clusters scale rapidly and demand far greater interconnect performance than traditional copper-based systems can support.

Xscape Photonics was founded in 2022 by CEO Vivek Raghunathan alongside a team of leading photonics researchers from Columbia Engineering. Among the founding scientific contributors are **Alexander Gaeta** and **Michal Lipson**, whose work in silicon photonics has helped shape the company's technical direction. Looking ahead, Xscape is advancing its ChromX platform, which aims to scale from today's eight-wavelength systems to 16, 32, and ultimately more than 128 colors to power next-generation AI data center fabrics.



(Above) Founding scientific contributors, Alexander Gaeta, the David M. Rickey Professor of Applied Physics and Materials Science and Professor of Electrical Engineering and Michael Lipson, the Eugene Higgins Professor of Electrical Engineering and Professor of Applied Physics, Dept of Electrical Engineering

Qihao Ye Joins Applied Math Faculty

Qihao Ye will join the Applied Mathematics faculty as a limited-term assistant professor in July 2026.

Ye received his BS in Mathematics and Applied Mathematics from the Southern University of Science and Technology in 2020 and his PhD in Mathematics from the University of California San Diego in 2026, under the supervision of Xiaochuan Tian.

His research lies at the intersection of numerical analysis, scientific computing, and machine learning, with a focus on developing mathematically grounded computational methods for PDEs, nonlocal models, stochastic dynamics, and data-driven inference. He is also increasingly interested in using advanced modern tools to accelerate mathematical research, especially through systems that support reliable, self-corrective, and verifiable reasoning. Looking ahead, he aims to broaden his research portfolio across applied mathematics, data science, and computational science, while building computational frameworks that connect analysis, algorithms, data, and decision-making.

Youngren Wins CEAA Distinguished Faculty Teaching Award

Drew Youngren, Lecturer in the Discipline of Applied Mathematics in the APAM Department, has received a 2026 Columbia Engineering Alumni Association (CEAA) Distinguished Faculty Teaching Award. This award is presented annually to Columbia Engineering faculty members who demonstrate exceptional dedication to teaching and outstanding mentorship for undergraduate students.

Youngren earned his BS at Columbia/SEAS, MAs from Stony Brook University and NYU, and his PhD from Northwestern. His interests include PDEs, particularly microlocal analysis, and the role of computation in the learning of mathematics.

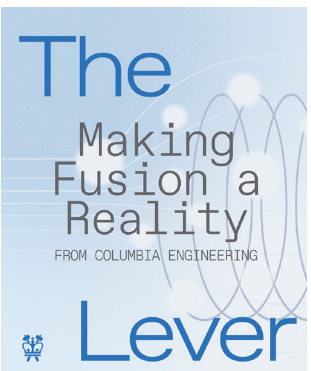
IAEA and Columbia Fusion Research Center Sign Practical Arrangement to Advance Fusion Education and Research

The International Atomic Energy Agency (IAEA) and the Columbia Fusion Research Center have signed a new practical arrangement aimed at strengthening international collaboration in fusion research, education, and training.

The arrangement was signed by Dr. Najat Mokhtar, Head of the IAEA Department of Nuclear Sciences and Applications, and Prof. Carlos Paz-Soldan, Director of the Columbia Fusion Research Center. It establishes a framework for cooperation that brings together the IAEA's global mandate and Columbia's academic and research expertise in plasma physics and fusion energy.

Under the agreement, the two institutions will collaborate on curriculum development in fusion energy, the promotion of open-source software, and the organization of joint events. The partnership foresees cooperation in plasma physics research related to magnetic confinement fusion and plasma astrophysics, including through future Coordinated Research Projects and technical meetings for knowledge exchange.

Through this practical arrangement, the IAEA and the Columbia Fusion Research Center reaffirm their shared commitment to advancing fusion research and developing the next generation of scientists and engineers in this critical field. **(Above) Dr Najat Mokhtar, and Prof. Carlos Paz-Soldan**



Exploring the Future of Fusion

From decades of research to growing industry investments, the latest issue of The Lever examines fusion's path toward reality.

By Grant Currin, Originally published by Columbia Engineering

Fusion power plants would transform the energy landscape. Safer than the nuclear plants in operation today, a fusion power plant would harness the physics of stars to transform hydrogen into energy without direct carbon emissions or unmanageable waste streams. They would run regardless of weather conditions or disruptions to the global oil supply.

Fusion energy has been just over the horizon for a very long time — but the situation may be changing.

Solutions to many of the most daunting technological challenges are in sight (or already resolved) thanks to progress in fields like AI and materials science, and private investors have begun pouring billions of dollars into dozens of startups racing to put the first fusion power plant on the grid.

The Future of Fusion: It's a particularly exciting moment for Columbia, where generations of researchers have been exploring the science behind fusion and chipping away at technical hurdles since the Plasma Physics Laboratory was established in 1961.

That legacy continues today. In the past year, Columbia Engineering launched a minor in fusion energy and announced the Columbia Fusion Research Center, which nurtures existing partnerships with the fusion industry and provides a framework for collaboration with new partners.

Columbia Engineering is focusing on fusion in the latest issue of The Lever, the School's collection of limited-series newsletters on major problems and solutions. APAM Professors Carlos Paz-Soldan and Elizabeth Paul are featured in a 5-part series, "Making Fusion a Reality." Learn more and subscribe to The Lever at https://www.engineering.columbia.edu/lever

Carlos Paz-Soldan, Associate Professor of Applied Physics & Director of the Columbia Fusion Research Center

The Future of Fusion: Professor Carlos Paz-Soldan explains how fusion energy could transform both geopolitics and climate strategy by replacing scarce fossil fuels with abundant resources like seawater and lithium. Paired with renewables, it offers a reliable source of carbon-free baseload power that can keep energy systems running regardless of weather conditions.

https://www.youtube.com/watch?v=-8ZjGFL9L20

Elizabeth Paul, Assistant Professor of Applied Physics

(Almost) Everything is Plasma: Fusion plasmas are hotter than the Sun, and Professor Elizabeth Paul is using AI to design magnetic systems that keep this extreme state of matter under control inside future fusion power plants. Since plasma makes up stars, lightning, and even the space between galaxies, understanding how it behaves could unlock a new era of clean energy powered by the universe's most abundant form of matter.

https://www.youtube.com/watch?v=ccWJonol47M

Inside Columbia's Partnership with Commonwealth Fusion Systems

The new Columbia Fusion Research Center is partnering with industry leaders to make fusion power a reality.

By Grant Currin, Originally published by Columbia Engineering

Humanity is coming close to harnessing the source of energy that powers stars and supernovas. Once the last technical problems are solved, fusion power plants that emulate the physics of the Sun could provide cheap electricity without carbon emissions, the safety risks of nuclear fission, or the intermittent supply of wind turbines and solar panels.

Decades of publicly funded research set the stage for the vibrant ecosystem of companies now competing to develop the first power plant that runs on nuclear fusion. In the last five years, private investors have put more than $10 billion into these efforts. Nearly one-third of that capital backs one company, Commonwealth Fusion Systems (CFS), as it closes in on passing this vital milestone.

Columbia Engineers — including a dedicated community of undergraduate researchers — are making meaningful contributions to CFS's effort. "Columbia has been an awesome partner since shortly after we started the company," says CFS co-founder Brandon Sorbom, who serves as chief science officer. Last year, the University cemented its focus on fusion by establishing the Columbia Fusion Research Center, which has already developed partnerships with roughly a dozen companies in the fusion space. CFS joined as a founding sponsor.

The Center's founding director, **Carlos Paz-Soldan**, says these partnerships ensure that Columbia's research and education stay relevant in this fast-moving sector. "We're not just pursuing academic milestones, we're working closely with companies to accelerate their progress and guide our academic work," says Paz-Soldan, who is an associate professor of applied physics and applied mathematics at Columbia Engineering. "That alignment is rare, and it reflects something distinctive about Columbia Engineering — a willingness to engage directly with industry to solve urgent global challenges."

Columbia Engineering Magazine recently had a conversation about industry-academic partnerships with Brandon Sorbom, Carlos Paz-Soldan, and Michael Segal, CFS's senior director of open innovation.

What is CFS focused on right now?

Sorbom: We're in a sprint to build a commercially viable fusion device before anyone else does.

How do partnerships with academic institutions help you do that?

Sorbom: Industry is very focused, which is a strength and a weakness. We're moving fast, so once I get enough data to solve a problem, it's onto the next thing. The academics we work with have the latitude to go deeper into the details and understand things at a more fundamental level. The company may not need that information to meet our goals for the next couple of years, but it's incredibly valuable in the long run. They can be working in parallel while we're building the hardware that gets headline results.

Segal: CFS recognized early on that our success depends on finding capabilities and assets wherever they are. We prioritize speed in our strategy, so if we think we can accomplish something faster with a partner, we'll do it. Academic partners are especially adept at smaller projects on faster timelines, and they've proven flexible when it comes to making adjustments to meet our goals. University partnerships are a growth category for us.

(left) Carlos Paz-Soldan, Director of Columbia Fusion Research Center. Credit: David Dini; (center) Brandon Sorbom. Courtesy of CFS; (right) Michael Segal. Courtesy of CFS

How did Columbia's partnership with CFS get started?

Segal: We started collaborating with Carlos when he was at General Atomics. When he moved to Columbia, the relationship followed him and started to grow. We began with what you might call a seed project in 2021, and that went really well. We've expanded from there.

Paz-Soldan: That first project was focused on understanding plasma positioning and how precise the construction of the machine needs to be. What happens if magnets are off by just a few millimeters? Is the plasma still stable? We developed new computational tools to find those answers. Through that effort, we started developing specific capabilities that match what CFS was looking for. We also identified several loose ends and open questions that merited further investigation.

What's distinctive about working with Columbia?

Sorbom: When you walk through the lab space, you can tell that people are itching to get results. Sometimes they're cobbling stuff together because they want to get something up and running. I call it scrappy — they're actually getting stuff done. It reminds me a lot of MIT, where CFS got its start. Segal: In a lot of fusion departments, you find plasma physicists who run models or test basic science on a small device. As we scale to commercial deployment, CFS needs much broader expertise in areas like mechanical engineering, materials, controls, and chemistry. We're a founding member of the Columbia Fusion Research Center, and we're keen to see the center grow and bring in other faculty from other disciplines and departments across the University.

Paz-Soldan: Launching the center has enabled faculty members from other departments with other competencies to come out of the woodwork. We're working closely to figure out how to get them resources to execute on ideas that contribute to our goal of fusion energy.

How is the partnership helping train the next generation of fusion engineers?

Paz-Soldan: At Columbia, we've built a program where undergraduates are hands-on with high-temperature superconducting magnets. With hardware donated by CFS, our students are winding magnets, cooling them with cryogenics, and testing them. It's producing graduates who are ready to step into the fusion workforce. Some of our students have already gone to work for CFS.

Segal: From our perspective, that pipeline is essential. We want to deploy thousands of power plants. That takes an enormous workforce of scientists, engineers, and technicians.

We don't want the workforce to be a bottleneck, so we're working with Columbia and other partners to make sure the talent is there.

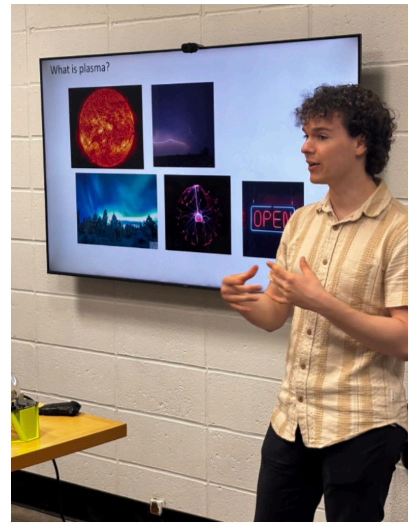
Photo by Julia Gorton

Sobel on Weather, Risk, and Resilience

Adam Sobel, Professor of Applied Physics and Applied Mathematics and of Earth and Environmental Sciences, delivered talks at the SIFMA ILS Conference, the University of Miami (recording available at **https://www.youtube.com/watch?v=I79Y_wDkSPQ**), and a Cornell University summit focused on data science, climate risk, and humanitarian resilience. His work explores the intersection of extreme weather, climate science, and society.

In addition to his podcast, Deep Convection, Sobel recently started Substack (**https://deepconvection.substack.com**) where he writes about science, politics, weather, and culture, including a recent series on his uncle, experimental artist Sumner Crane.

Fusion Energy Week 2026



As part of the nationwide celebration of Fusion Energy Week 2026, the **Columbia Fusion Research Center (CFRC)** opened its doors to members of the New York City community and surrounding areas for a series of student-led educational tours and hands-on demonstrations focused on fusion energy and plasma physics.

Held during Fusion Energy Week, the tours welcomed approximately 40 visitors to learn more about the science and engineering behind fusion energy research and its potential role in the future global energy landscape. The tours were organized and led by students and researchers from the CFRC, offering attendees an opportunity to engage directly with the next generation of fusion scientists and engineers.

Each session included introductory presentations on plasma physics and fusion energy fundamentals, followed by hands-on demonstrations and guided laboratory tours. Visitors were able to participate in one-on-one question-and-answer conversations with student researchers, creating an accessible environment for discussion about fusion science, research pathways, and the broader societal implications of clean energy technologies.

These events at the CFRC contributed to a broader national effort to increase public knowledge of fusion energy and build support for continued investment in fusion research. Columbia research scientist **Dr. Oak Nelson, Professor Carlos Paz-Soldan**, and student members of the CFRC outreach team also contributed to the national organization and coordination of Fusion Energy Week activities alongside collaborators across the U.S. fusion community.

Public engagement and education are central components of the CFRC's mission. Through outreach programming that includes laboratory tours, educational demonstrations, and community partnerships, the center works to make fusion science more accessible to all students, educators, and the public with a specific focus on underrepresented communities. Additional outreach initiatives can be found on the CFRC Outreach page.
Fusion Energy Week reflects growing momentum across the fusion field to connect cutting-edge scientific research with public dialogue and community participation. By welcoming visitors into the laboratory and fostering direct interaction with researchers, the CFRC's events highlighted both the scientific promise of fusion energy and the importance of public engagement in shaping its future.

Applied Physics Junior/Senior Seminar Visits Brookhaven National Laboratory

On December 5, 2025, junior and senior Applied Physics majors enrolled in APPH 4903 (the AP junior/senior seminar) traveled to Brookhaven National Laboratory (BNL) for an afternoon tour of the lab's facilities. This year's seminar, co-taught by Professors **Elizabeth Paul and Aravind Devarakonda**, emphasizes applications of artificial intelligence and machine learning in applied physics, and the visit was organized to give students a firsthand look at how a major DOE national laboratory is incorporating AI/ML across its research programs. The group of roughly 35 students, accompanied by APAM faculty including Department Chair **Marc Spiegelman**, traveled to Upton, NY by chartered bus and were hosted by Kristyn Noren of BNL's Protocol Office. Tour stops included a demonstration of autonomous experiments at the National Synchrotron Light Source II (NSLS-II), a visit to the Brookhaven–Stony Brook quantum network node, and a tour of the Center for Functional Nanomaterials (CFN).

The trip continues a tradition established by last year's seminar, which visited IBM's Yorktown Heights research facility during a quantum-computing-themed iteration of the course taught by Prof. Mike Mauel. Visits like these complement classroom discussions by exposing students to the breadth of career paths and research environments available beyond Columbia — from national laboratories to industrial research centers — and to the increasingly central role that data-driven methods are playing across the applied physical sciences. Many thanks to Sharon Sputz of the Office of Research Initiatives and Development for facilitating the initial connection with BNL, and to Noel Blackburn and Kristyn Noren at Brookhaven for their hospitality in hosting the group.

In Memoriam: Prof. Katayun Barmak

The APAM Department and Columbia Engineering mourn the passing of **Prof. Katayun (Katy) Barmak**, the Philips Electronics Professor of Applied Physics and Applied Mathematics.

Professor Barmak's research explored the fundamental nature of materials to understand their structure and physics at nano-, micro-, and macro-scales, and how they impact material properties and, ultimately, the performance of engineered systems. Professor Barmak was instrumental in establishing and leading the cutting-edge transmission electron microscopy facility within the Columbia Nano Initiative where she conducted her studies. Her particular interests included materials synthesis, structure, and phase transformations, especially for electronic and magnetic thin films and nanomaterials.

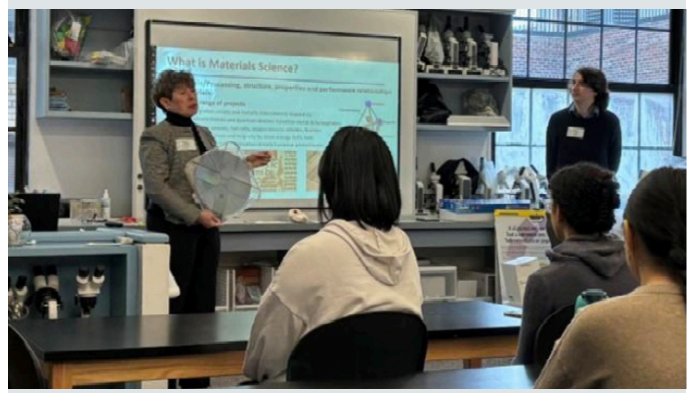
With a BA and MA from the University of Cambridge, and PhD in materials science from MIT, Professor Barmak joined Columbia Engineering in 2011 as the Philips Electronics Professor of Applied Physics, Applied Mathematics, and Materials Science and Engineering, and served as the Director of the Materials Science and Engineering Program from 2013 to 2019. Prior to joining Columbia, she was a professor in the Department of Materials Science and Engineering at Carnegie Mellon University from 1999 to 2011 and held faculty positions at Lehigh University from 1992 to 1998, where she also co-directed the Thin Film Laboratory. Earlier in her career, Professor Barmak spent three years at the IBM T.J. Watson Research Center and the IBM East Fishkill Development Laboratory, and served as a visiting scientist there from 1998 to 2004.

During her time at Columbia, Professor Barmak received widespread recognition for her outstanding research and leadership. With over 200 publications and 5 patents, honors include selection as a 2026 Fellow of the Materials Research Society (MRS), 2023 Fellow of ASM International, and a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) in 2019. She was also an exemplary teacher and mentor and was awarded the 2017 School of Engineering and Applied Science (SEAS) Edward and Carol Kim Award for Faculty Involvement, to honor Columbia faculty who are excellent teachers and show a personal commitment to students.

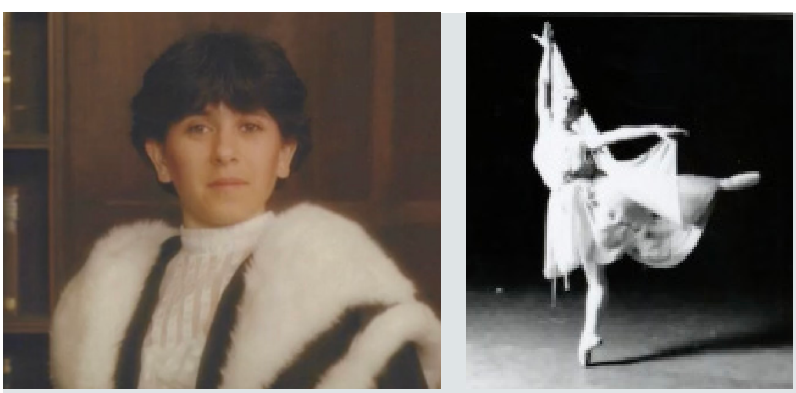
The Department of Applied Physics and Applied Mathematics at Columbia Engineering greatly benefited from Professor Barmak's dedication, vision, and leadership. Her creativity, commitment, and guidance made a lasting impact on colleagues, students, and the broader academic community. Her devotion to advancing knowledge, mentoring young scientists, and fostering collaboration will continue to inspire everyone fortunate enough to have worked with her. We are all better for having known her, and she will be dearly missed.

Barmak was named a 2023 Fellow of the ASM International Society

Barmak received the 2017 SEAS Kim Award for Faculty Involvement



Committed to outreach efforts, Barmak visited The Spence School to give a talk during their Research Scientist program



Barmak earned her BA and MA from the University of Cambridge, and PhD in materials science from MIT. She was also a professional ballet dancer.

Barmak was instrumental in establishing and leading the transmission electron microscopy facility within the Columbia Nano Initiative

Memorial Service for Prof. Katayun Barmak

A memorial service celebrating Prof. Katayun (Katy) Barmak, the Philips Electronics Professor of Applied Physics and Applied Mathematics at Columbia Engineering, was held on Thursday, May 7, in St. Paul's Chapel on Columbia's main campus. Colleagues, students, alumni, friends, family members, and members of the broader Columbia community gathered to honor Prof. Barmak's extraordinary contributions to science, education, mentorship, and academic life at Columbia. Following the service, guests gathered for a reception in the APAM Department in 200 Mudd, where conversations and shared memories continued in celebration of Prof. Barmak's life and enduring legacy.

Professor Marc Spiegelman, APAM Department Chair

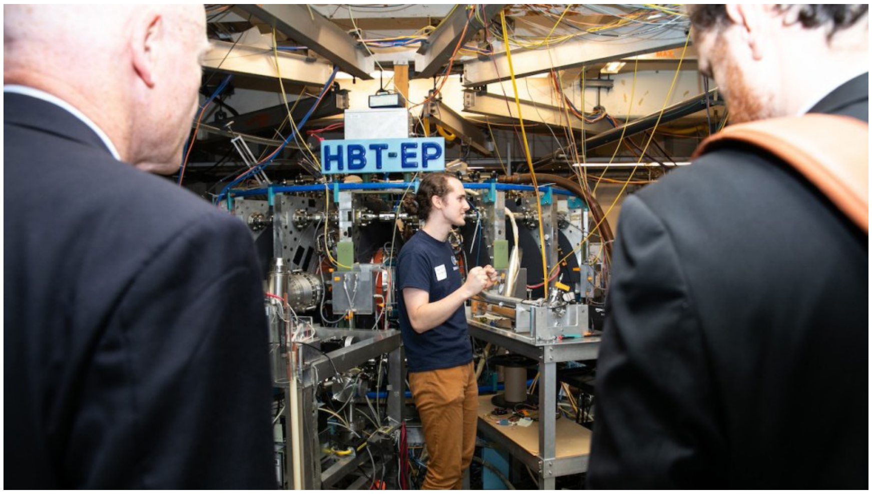
Dean Shih-Fu Chang, Columbia Engineering Dean

Babak Barmak, Professor Katy Barmak's brother

Professor I.C. Noyan, Former APAM Department Chair

Lauren Grae, Professor Barmak's former student

Dr. Matthew Patrick, Professor Barmak's former student



New Minor Prepares Students for Fusion Industry

Columbia Engineering has announced the launch of its new minor in fusion energy, an innovative program designed to provide Engineering students an opportunity to engage with fusion while completing their main degree. This new program prepares students to work in the fusion industry or other high-tech sectors or to pursue graduate studies in fusion or plasma physics.

“Advancing progress in fusion will require expertise across disciplines,” said Dean of Columbia Engineering Shih-Fu Chang. “With this minor, we are preparing students with a solid foundation they can build on to join in this exciting effort.”

The six-course curriculum, which builds upon foundational math and engineering, includes required courses in nuclear and plasma physics and elective courses in those fields, as well as fluid dynamics, circuits and control, mathematical and computational modeling, fluid and finite element modeling, and materials science. In a testament to the interdisciplinary nature of the contemporary fusion energy landscape, these courses are drawn from a wide range of engineering disciplines.

“Our goal for this new minor is to invite students from a wide range of engineering backgrounds to join the global effort to make fusion energy a reality,” said **Carlos Paz-Soldan**, associate professor of applied physics and applied mathematics and founding director of the Columbia Fusion Research Center. “These courses will prepare graduates to contribute meaningfully to the companies and research organizations that are developing this vital new source of energy.”

In developing the course, faculty members drew on the expertise of Columbia Engineering undergraduates who participate in fusion research. Their insights helped the faculty determine which courses in the School’s catalog best prepare students to solve the problems they encounter in the lab and when working with industry partners.

“Our undergraduate researchers brought a sophisticated sense of which courses from their respective departments taught skills that were most relevant to the fusion research they’re actively pursuing,” said **Sophia Guizzo**, who assisted in developing the program. Guizzo BS’24 is pursuing her PhD in applied physics at Columbia Engineering.

“With so many private companies hiring employees straight out of undergraduate programs, we sought to design a program that covers skills that are particularly desirable in today’s fusion industry.”

Columbia Students Host Panel on U.S. Energy Policy and the Nuclear Renaissance

by Matthew Tyler Tobin

In February 2026, the **Columbia Science and Tech Policy Group** and the **Plasma Students Association** jointly sponsored a panel discussion on U.S. energy policy and the evolving “nuclear renaissance” (see photo below). The event featured Dr. Ashley Finan, Prof. Sheila Foster, and Prof. John Rhodes, who discussed recent trends in energy policy and the future direction of the sector in the United States.

The discussion highlighted the growing importance of energy in U.S. environmental, technological, and foreign policy at the national, state, and local levels. It also addressed ongoing scientific and engineering developments in both fission and fusion energy, including new approaches to reactor design and continued interest in fusion as a potential future energy source.

Panelists considered how these developments may influence the broader trajectory of U.S. energy policy in the years ahead.

We’d love to hear from you, APAM Students & Alumni, and feature you in our next newsletter!

Please send your news to apam@columbia.edu

Dr. Sai Kanth Dacha Named to 2026 Class of Optica Ambassadors

Dr. Sai Kanth Dacha has been selected as a member of the 2026 class of Optica Ambassadors, a competitive program that annually recognizes 10 early-career academic researchers and industry professionals. The Ambassadors develop and lead initiatives focused on career development and mentorship for Optica's global community of students and early-career members.

Dacha is a postdoctoral research scientist in **Alexander Gaeta**'s research group at Columbia University, where his work centers on nonlinear and quantum optical phenomena and thermal effects in silicon-based photonics platforms. He earned his Ph.D. in Physics from the University of Maryland, College Park, in 2022, with dissertation research on spatiotemporal nonlinear optical effects in multimode fibers. During his doctoral studies, he also worked as a research intern and co-op at Nokia Bell Labs, contributing to research on the fundamental limits of deep-space optical communication systems.

Beyond his research, Dacha is deeply engaged in science communication and science and technology policy. His interest in policy was sparked by a course taught by alumni of President Obama's President's Council of Advisors on Science and Technology (PCAST). Since then, he has participated in policy workshops and case competitions and has served on multiple Congressional delegations for Optica, advocating for increased federal support for fundamental research and workforce development. Reflecting on his new role, Dacha said, "As an Optica Ambassador, I am keen on drawing from my experiences and helping a new generation of students and early career researchers become better communicators of their science to technical as well as non-technical audiences."

(Below) Dr. Sai Kanth Dacha participated in the Optica Congressional delegation in Spring 2023

Alum Joseph Lee Receives Presidential Teaching Award

Joseph Lee (BS '21, Applied Physics) received a 2026 Columbia University Presidential Award for Outstanding Teaching. He is currently a fifth-year Ph.D. candidate in Physics at Columbia University, working in the group of Ana Asenjo-Garcia on quantum optics and open quantum systems. He previously earned his Bachelor of Science in Applied Physics from Columbia Engineering, where he received the 2021 Applied Physics Faculty Award from the APAM Department. He is a recipient of both the Townes Fellowship and the NSF Graduate Research Fellowship. Joseph is also a dedicated educator and has been recognized with the Allan Blaer Outreach and Inclusion Award and the Allan Sachs Teaching Award for his contributions to the physics community at Columbia.

Alumni Updates

Professor Adam Sobel shared updates about his former applied mathematics/atmospheric science students. **Melanie Bieli** (PhD '19) works as a Weather Analyst at Jane Street; **Zane Martin** (PhD '20) is a Climate Scientist at USAA; **Isalbelle Bunge** (PhD '25) is a postdoctoral fellow in Earth, Environmental, and Planetary Sciences at Rice University; **Patrick Orenstein** (PhD '24) works in Science-Policy Integration at ZeroEx - a climate startup in Germany; and **Sean Cohen** (PhD '24) is a postdoc at Columbia's Lamont-Doherty Earth Observatory. Cohen, along with Professors Robert Pincus and Lorenzo Polvani recently published a paper in *Nature Geoscience* titled "Stratospheric cooling and amplification of radiative forcing with rising carbon dioxide."

Richard Robinson (PhD 2024, Applied Physics) returned to Columbia to speak at the Materials Science & Engineering Colloquium. He is currently an associate professor at Cornell University in their Materials Science Department. Robinson's work has been recognized with awards including the *Journal of the American Chemical Society* Young Investigator selection, the NSF CAREER award, the Fulbright scholar fellowship, the 3M Faculty Award, and the R&D 100 Award. His papers have been highlighted in journals like *Physics Today*, *Scientific American Israel*, and the *Journal of Materials Chemistry A*, where he was chosen for the inaugural "Emerging Investigators" issue, and he was a featured speaker for PBS NOVA's Secret life of Scientist series.

Feng Zhang (PhD 2003, Materials Science) and his family visited with Prof. Siu-Wai Chan (pictured below), his former advisor and collaborator. After receiving his PhD from Columbia, he built a 22-year career in the hard disk drive industry, holding various technical and leadership roles in materials characterisation, process integration, and yield engineering. He currently serves as Senior Director of Operational Excellence at TDK Headway Technology, where his responsibilities include wafer fab systems, automation, operation planning and analytics. Feng met his wife in NYC while they were both graduate students and now live in the San Francisco Bay Area with their two high school children.

Read more alumni updates online at:
www.apam.columbia.edu/alumni-reports

Exploring Passions at Columbia Turned into a Career in AI Innovation at IBM

Nicholas Fuller PhD'02 traces his path from Columbia Engineering to AI innovation.

Originally published by Columbia Engineering

Nicholas C. M. Fuller was drawn to New York City for its culture and proximity to family, and chose Columbia for its rigorous academics. Now as vice president of AI & Automation at IBM, Fuller leads the global innovation agenda for agentic AI and next-generation automation, supporting IBM's multibillion-dollar automation software business and influencing emerging industry standards across IT operations, Industry 4.0, software engineering and business processes. He holds more than 75 patents, has authored more than 80 publications with over 3,700 citations, and his work has been featured by Forbes, The Deep View, TechRadar, IEEE Spectrum and international media. His work has had impact across AI, automation, edge computing, and semiconductor R&D. We caught up with Fuller about his experience studying at Columbia Engineering and what advice he has for those looking to study and work in AI.

Why did you choose to attend Columbia?

When I visited the applied physics department that had accepted me, I got a very warm reception. I met graduate students, postdoctoral researchers and professors; and there were many prospective advisors with whom I could have worked. The existing collaborations with various institutions (Lucent Technologies, IBM, etc.) also helped to nudge me in the direction of Columbia. I was deciding between Columbia and a couple others, but Columbia emerged at the top.

Did you have a favorite professor, project or class?

When I started my graduate studies at Columbia, the technology world was deeply immersed in tackling the challenges posed by aggressive semiconductor device scaling (deep sub-micron) for traditional computing. In the applied physics program, I simply loved how each of the various faculty members delivered and shaped their content in a manner heavily focused on and aligned with this prevailing (and other major) technology trend(s) of that time. So, the combination of the rigor and passion that I had for the domains that I was pursuing, and last but not least, the application of it all to what was happening practically in the world was really remarkable. I enjoyed it tremendously.

How did studying at Columbia assist in your career path?

I would say two things from Columbia helped in that regard — one was the opportunity that I had through my advisor, **Professor Irving P. Herman**, now retired. Part of his work focused on utilizing laser technology to unravel the mechanism(s) of semiconductor device processing for various critical materials in low temperature plasma environments; I found this work quite novel, intellectually stimulating and of course very relevant for the semiconductor and microelectronics industries. Secondly, he (Professor Herman) had a collaboration with Vincent Donnelly, formerly of Bell Labs, Lucent Technologies, and core to their partnership was the exploration of a range of similar and other techniques to diagnose low temperature processing plasmas. For these two reasons, I got major insight into what I wanted to pursue for my PhD dissertation and overall career.

What were your peers like at Columbia?

The camaraderie that existed there certainly helped all of us, particularly during difficult times such as the 9/11 attacks. I forged strong bonds with fellow students with whom I matriculated, discussing our thesis topics and other matters, socializing and growing as young burgeoning scientists and engineers. Today we have a WhatsApp chat group and we use that to frequently check in on each other and we occasionally get together as well, though more so in the past for each other's weddings and other events. Additionally, the environment created in the applied physics department certainly helped to facilitate that support network that we all needed to become successful.

How did the curriculum at Columbia prepare you to work in AI?

I evolved my career from a semiconductor researcher who built next-generation microprocessors for IBM for 10 years into someone who is now driving AI innovation for our automation software business. That dynamism, that change, comes, in part, from me being constantly knowledge-seeking and passionate about new trends in science and technology, and in part from the technical rigor of the graduate degrees I pursued at Columbia. Secondarily, my advisor's research lab on campus was in close proximity to students doing work in natural language processing, multimedia and other multidisciplinary areas. This co-location in the same building (CEPSR - Center for Engineering and Physical Science Research) made it easy to have discussions on other topics.

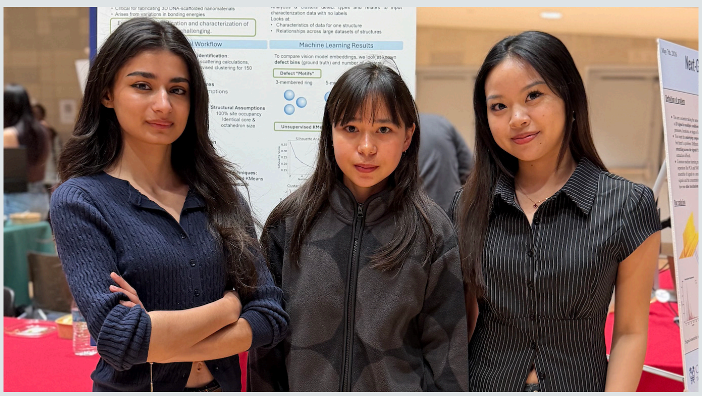
Do you have any advice for future students studying AI at Columbia?

Number one, maintain your passion. Do something for the right reason. Listen to that voice inside of you that makes you want to wake up and do something for 10 plus hours a day. When you find the thing that you can do passionately, it's not a job, it is a calling. Columbia is a great place to be. In my humble opinion, it is one of the best academic institutions to pursue your graduate studies.

In terms of AI specifically, the emergence of language language models (LLMs) a few years back has rapidly ushered in this new AI era where the rate and pace of innovation spanning LLMs, agentic AI and physical AI is simply unprecedented. It can seem daunting, however, I believe with the continued shrinking of our global village and the more keen awareness of our technical and non-technical challenges that the latter brings, there is probably no better time, than in this AI age, to be a graduate student. I believe the opportunities are boundless as we seek technical breakthroughs for societal benefit in many domains ranging from hyperautomation, the future of software engineering, energy-efficient accelerators, AI-driven algorithmic design, the intersection of AI and quantum computing and more. As our School motto says: in lumine tuo videbimus lumen (in thy light shall we see light).

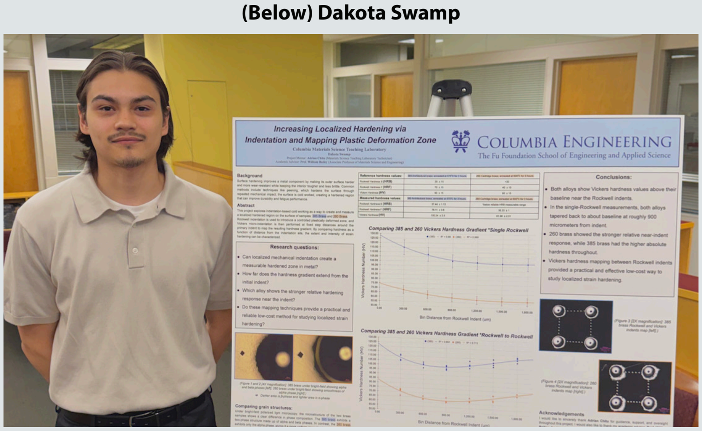
2026 Senior Design Expo

Materials Science undergraduates participated in the annual Senior Design Expo, presenting interdisciplinary projects that drew on materials science, applied physics, applied mathematics, and related fields to address some of today's most pressing scientific and engineering challenges. **Dakota Swampt** investigated localized surface hardening techniques in metallic materials, using Rockwell and Vickers micro-indentation to map hardness gradients produced through controlled cold working, with direct implications for improving wear resistance in engineering components. **Israa Draz** took on the economics of climate technology, presenting a comprehensive techno-economic analysis of three solid sorbent materials for direct air carbon capture. Her findings identified Zeolite 13X as the standout candidate, achieving a levelized cost of $47.53 per ton of CO_2 — well below the DOE's 2030 target of $100 per ton — and outlined a roadmap for scaling the technology toward gigaton-level carbon removal by mid-century. **John Halloran** developed diffpy.stretched-nmf, an open-source Python package that extends non-negative matrix factorization to account for thermal expansion in materials characterization data. The tool outperforms standard NMF on real experimental datasets and was built following best practices for collaborative scientific computing. **Emily Lu** explored the use of chitosan-based hydrogels as a platform for localized cancer drug delivery. Her study demonstrated that a Chitosan/DF-PEG hydrogel could enable the gradual, sustained release of the anticancer drug 5-fluorouracil in T-cell leukemia cell cultures — offering a promising alternative to conventional therapies that often suffer from systemic toxicity and poor localization. **Jose Osa** developed a physics-based framework for understanding laser-induced nucleation and microstructural evolution in ultra-thin films of nickel, aluminum, and copper. By connecting thin-film behavior under rapid thermal cycling to broader aerospace manufacturing phenomena — including additive manufacturing and laser shock peening — his work bridges materials science fundamentals with real-world aerospace engineering applications. **Zoe Zachko** used interpretable machine learning to map structural defects in DNA-scaffolded gold nanoparticle nanoclusters to their X-ray scattering signatures. By applying KMeans clustering to scattering intensities and pair-distribution functions, she developed an analysis pipeline that can help researchers identify defect types in experimental samples where manual extraction from scattering data is impractical. Together, these projects reflect the breadth of APAM's Materials Science program and the ability of its students to connect rigorous scientific thinking to meaningful, real-world impact. Congratulations to the Class of 2026 and to the faculty mentors whose guidance made this work possible!



(Above) Israa Draz, Zoe Zachko, & Emily Lu
(Below) Dakota Swamp

(Above) Mat SciClass of 2026 (first row) Israa Draz, Prof. Siu-Wai Chan, Emily Lu, Zoe Zachko (back row) Dakota Swamp, Jose Osa; (Below) Jose Osa



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