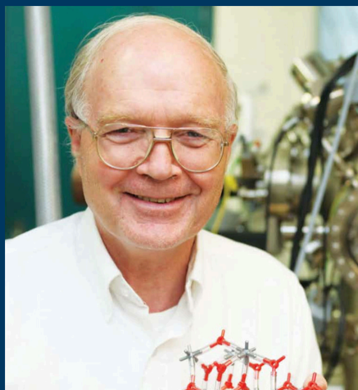
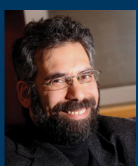
Columbia Engineering
The Fu Foundation School of Engineering and Applied Science

Fall 2023, Vol. 18 Issue 1

APAM NEWS

Applied Physics & Applied Mathematics Department
with Materials Science & Engineering
Columbia University in the City of New York





Dear APAM Community,

Greetings and best wishes for the New Year. The Fall semester in APAM was marked by significant activity, and through this newsletter, we aim to share the remarkable accomplishments of our students, alumni, faculty, and scientists. Additionally, we extend a heartfelt welcome to new members joining our department and bid farewell to those who have been longstanding friends and colleagues.

Across all three APAM programs—Applied Physics, Materials Science, and Applied Mathematics—faculty and students have been immersed in diverse scientific challenges. In this update, we present highlights including a wide range of activities in our burgeoning Plasma Physics program, advanced photonic devices for high-bandwith communication, and new applications of machine learning and AI in a range of scientific fields. We are also proud to announce numerous awards, honors, and leadership roles that showcase the dynamic and interdisciplinary strengths of the faculty and department. Moreover, we are thrilled to introduce several new faculty members to APAM, promising groundbreaking developments in novel quantum materials and applied mathematics.

While we embrace the fresh opportunities brought by new faculty, we also take a moment to pay tribute to cherished colleagues who have passed or recently retired. We mourn the loss and celebrate the life of Richard M. Osgood, Jr., the Higgins Professor *Emeritus* of Electrical Engineering and Professor *Emeritus* of Applied Physics at Columbia University, a trailblazer in laser and solid state physics and a valued member of the department.

Wishing everyone a year filled with continued achievements, growth, and discovery.

Best,

Marc Spiegelman, APAM Chair

Cover images: Prof. Richard M. Osgood (1943-2023), the Applied Physics Student Team who won a DOE Grant, and Prof. Gerald Navratil

(Left to right) Eray Baykal MechE '25, Hope Hersom MechE '25, Eliot James Felske APAM '24, Sebastian Gomez APAM '24, Sophia Guizzo APAM '24, Jacobo Guzowski Lang APAM '25

Student Team wins DOE Grant to Advance Fusion Energy Research

Columbia Engineering undergraduates lead a team to quantify the interaction of cryogenic ice pellets with energetic particle beams to better understand their behavior in fusion plasmas.

The U.S. Department of Energy has awarded a grant to an undergraduate student team led by the lab of **Carlos Paz-Soldan**, associate professor of applied physics and applied mathematics at Columbia Engineering, together with Oak Ridge National Laboratory, to establish the "Pellets at Columbia" project. The experiment is designed to advance critical supporting technologies for future fusion pilot plants that will provide clean, safe, and cheap power to the grid.

The idea is that these plants will use the same fusion reaction that fuels the sun. But such fusion reactions require extremely high temperatures–in excess of 100 million degrees Celsius–where the fuel is in a plasma (a very high energy gas) state and must be confined using magnetic fields. In case of an unexpected event, researchers must quickly shut down the high-temperature plasma by injecting small, cryogenically frozen cylinders called "pellets" that are made of a variety of hydrogen isotopes and other gasses such as neon or argon.

The injection of solid pellet material into the fusion plasma enables researchers to deposit ions deep inside the device. This deposition occurs through a process called ablation, in which layers of atoms are vaporized from the outer surface of the pellet and then ionized due to the high temperatures. The research team plans to directly measure the ablation of various pellet types to validate and improve current computational ablation models.

The researchers are a group of undergraduates from applied physics, applied mathematics, and mechanical engineering. They have conceptualized, designed, and begun to assemble the project in Paz-Soldan's lab. They plan to run a series of experiments designed to learn more about the interactions of pellets with highly energetic plasma particles.

"I'm thrilled the students have put this project together from the ground up," said Paz-Soldan. "The students are responsible for all subsystems of the experiment: the control system for making pellets, the measurement tools, the cryogenics, everything. They will be putting together the setup this year and we look forward to our first pellet measurements in the spring."

The experiment is under construction in the Plasma Physics Laboratory at Columbia University, with some components provided by Oak Ridge National Laboratory. The system consists of vacuum chambers, cryogenics to freeze the gas, and high-voltage equipment for the particle beams. The students expect to have it up and running near the end of the academic year. Throughout this time, Oak Ridge will be providing equipment and the necessary expertise for operation and optimization of the test stand.

"My classmates and I are extremely grateful for the opportunity to work on a brand new experiment," said **Sebastian Gomez**, a senior applied physics student. "We're glad that we can put our diverse skill set to the test and contribute to the broader fusion energy community."

Alumni Updates (Originaly published by Columbia Engineering Magazine)

Madeline Feltus BS'77, MS'80, PhD'90 writes: "Nuclear engineering is an exciting career. After working in the industry for 14 years, then teaching nuclear design and fuel management at Penn State for eight years, I now enjoy working in the office of nuclear energy at the Department of Energy on innovative fuel designs and TRISO fuel development. No retirement planned in the near future since I am still having fun and learning so much!"

Nicholas Fuller PhD'02 writes: "Greetings to all Columbians and, in particular, the graduate Class of 2002! In July 2021, I was appointed Vice President, Distributed Cloud IBM, Research. In this role, I am responsible for providing data/AI and Kubernetes–based platform innovations to accelerate enterprise transformation in edge computing and distributed cloud management domains. A year into this role, our work in this space has been featured in Forbes magazine (https://www.forbes.com/sites/moorinsights/2022/08/08/ibm-research-rolls-out-a-comprehensive-ai-and-ml-edge-research-strategy-anchored-by-enterprise-partnerships-and-use-cases/?sh=3f726c3d13ed). Many thanks to the IBM research, product, development, and consulting team members who are leading this effort! Best wishes."

Katharina Gallmeier '22 writes: "I joined the Institute for Defense Analyses (IDA) as a data science fellow in the information, technology, and systems division of IDA's systems and analyses center. IDA is a nonprofit corporation that operates three federally funded research and development centers in the public interest. IDA answers the most challenging US security and science policy questions with objective analysis leveraging extraordinary scientific, technical, and analytic expertise."

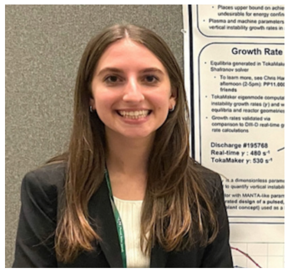
(Continued on page 4)

Columbia Students and Scientists Shine at Annual Meeting of Plasma Physics

by Michael Mauel

Columbia students, scientists, and faculty attended the 65th Annual Meeting of the APS Division of Plasma Physics, the world's largest meeting devoted to the latest results in plasma physics and fusion science. Columbians authored or co-authored over 125 presentations, co-hosted a town-hall meeting, and participated in mini-conference discussing the stellarator path to fusion energy involving public and private efforts.

Dr. Andrew Oak Nelson



Sophia Guizzo (Applied Phyiscs '25)

William Boyes, Doctoral student

Major highlights of the meeting were reports of the latest results from the DIII-D National Research Facility describing the physics and beneficial fusion-performance of so-called "negative triangularity" shaping for magnetic fusion. Applied Physics undergraduate, **Sophia Guizzo** (Class 2025) received accolades for her presentation "Modeling the vertical stability of negative triangularity reactors," which received a best undergraduate poster award. Doctoral student, **William Boyes**, was invited to present his doctoral work "Scenario Development and MHD Stability of Negative Triangularity Plasmas in DIII-D," and **Dr. Andrew Oak Nelson** presented his invited lecture titled "Robust avoidance of edge localized modes alongside pedestal formation in negative triangularity plasmas."

In addition to these presentations, Columbia University participation included six undergraduates, fourteen research scientists and post-doctoral scientists, and six presentations from Applied Physics faculty. Undergraduate research projects were presented by **Ashton Binks, Eliot Felske, Sebastian Gomez,** and **Lucia Rondini**. Additional graduate student presentations were given by **David Arnold, Anson Braun, Daniel Burgess, Amelia Chambliss, Rian Chandra, Hari Choudhury, Nigel DaSilva, Todd Elder, Mohammed Haque, Abdullah Hyder, Boting Li, Priyansh Lunia, Matthew Notis, Matthew Pharr, Jacob Rabinowitz, Juan Riquezes, Melanie Russo, Matthew Tobin, Yumou Wei, Haley Wilson,** and **Jamie Xia**. First-year graduate students **Jacob Halpern** and **Alexandra Lachmann** and undergraduate **Arian Timm** (University of Minnesota) presented their research conducted as part of the Plasma and Fusion Undergraduate Research Opportunities (PFURO) program supported by the U.S. Department of Energy.

Presentations from Columbia research scientists and post-doctoral scientists were given by **Antoine Baillod, Alexander Battey, Guillermo Bustos-Ramirez, Christopher Hansen, Jeremy Hanson, Alexey Knyazev, Nils Leuthold, Jeffrey Levesque, Nikolas Logan, Steven Sabbagh, Ian Stewart, Veronika Zamkovska, Garima Joshi** (Astronomy), and **Luca Comisso** (Astronomy). Finally, five faculty specialists in plasma physics also presented research results and overview: **Allen Boozer, Michael Mauel, Gerald Navratil, Elizabeth Paul,** and **Carlos Paz-Soldan**.

We'd love to hear from you, APAM Alumni!

Send your news to **apam@columbia.edu** and read more alumni updates online at: **www.apam.columbia.edu/alumni-reports**

Alumnus Establishes New Scholarship for Undergraduates in Tech, Entrepreneurship

by Katie Luna, Originally published by Columbia Engineering

Bahram Jalali aims to encourage the next generation of innovators.

A lifelong, devoted academic, **Bahram Jalali ('86, '87, '89**) has always understood the importance and impact of higher education.

Fueled by his own experiences as a lifelong student, a professor, and an entrepreneur, Jalali was inspired to establish a new scholarship at Columbia Engineering: the Jalali Ruminate Scholarship. This scholarship is intended to fund financial aid efforts to support undergraduate students studying industrial engineering and operations research (IEOR), computer science, and applied physics and applied mathematics.

The first scholar, Manasa (Hari) Bhimaraju, named during the 2022-2023 academic year, is a junior studying IEOR and computer science. Bhimaraju's academic interests include technology, consulting, entrepreneurship, health tech, and sustainability.

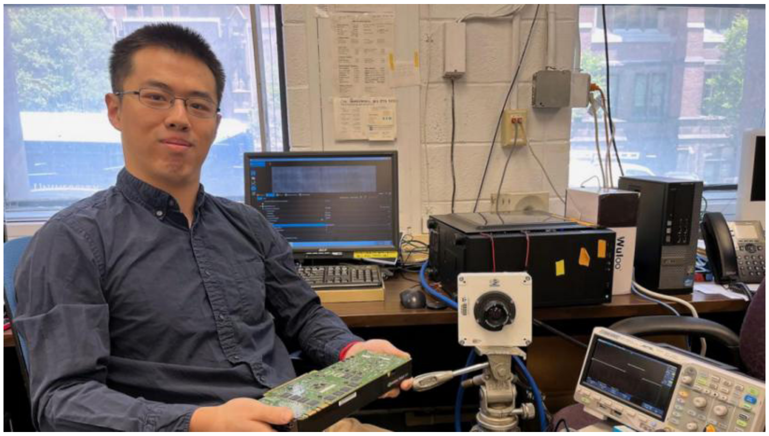
Endowed financial aid like the Jalali Ruminate Scholarship ensures that talented students like Bhimaraju can attend Columbia regardless of financial considerations, allowing students from many backgrounds to come to Columbia and engage with the rigorous curriculum, innovation ecosystem, and leadership development opportunities without fiscal pressure.

Jalali finds inspiration for his scientific and entrepreneurial endeavors in a quote attributed to Mark Twain: "Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did do. So throw off the bowlines. Sail away from the safe harbor. Catch the trade winds in your sails. Explore. Dream. Discover." In this same spirit of exploration, Jalali expressed his strong desire to support future engineers to explore, dream, and discover new fields, interests, and innovations through the Jalali Ruminate Scholarship.

Jalali's road to Columbia Engineering and beyond

Jalali began his academic studies at Florida State University, where he earned a B.S. in physics in 1984. He went on to receive his M.S. in applied physics from Columbia Engineering in 1986, followed by his MPhil in applied physics in 1987 and his PhD in applied physics and nuclear engineering in 1989. Following graduation, he joined the physics research division at Bell Laboratories from 1988 to 1992. In 1993, Jalali went on to join the faculty at UCLA, and became a trailblazing researcher in the fields of silicon photonics and scientific instruments. During this time, his laboratory pioneered two qualitatively new approaches to imaging: the Time Stretch camera and the radio frequency fluorescent camera. These novel imaging technologies generated new applications in cell biology and diagnostics and the discovery of ultrafast laser phenomena.

A renowned researcher and entrepreneur, Jalali holds 32 U.S. patents and 11 foreign patents, and his novel innovations have led to the foundation of three successful startups. He is a member of the National Academy of Engineering and the National Academy of Inventors.



Building Fusion Control with Machine Learning

Applied Physics doctoral student **Yumou "William" Wei** published his latest research on controlling a fusion plasma using machine learning. The paper was invited as part of the Special Issue on the 26th Workshop on MHD Stability Control, [Y. Wei, et al 2023 *Plasma Phys. Control. Fusion* 65 074002; **https://iopscience.iop.org/article/10.1088/1361-6587/acd581],** and was co-authored by **Drs. Jeff Levesque and Chris Hansen** and by **Profs. Mike Mauel and Gerald Navratil.**

William used dual high-speed video cameras to detect light fluctuations from the plasma as instabilities caused the hot plasma to graze the cold wall surrounding the plasma. Then using a state-of-the-art graphical processing unit (called a "GPU"), he implemented a new algorithm to track the amplitude and phase of the instabilities trained by artificial intelligence, or "deep learning." For the first time, William showed how a neural network could successfully predict key parameters using solely optical measurements from one or more cameras. The new algorithm outperformed other, more conventional, algorithms, and William explored the impact of different input data streams on the accuracy of the model's predictions.

This work was carried our on the High Beta Tokamak - Extended Pulse (HBT-EP) device. Additional design and optimization is underway for deploying neural network models on field-programmable gate arrays (FPGA) which will further speed-up the rate of mode identification and satisfy the requirements for real-time mode feedback control on HBT-EP and other fusion energy devices.

This work was supported by U.S. Department of Energy, Office of Science, Office of Fusion Energy Science, Grant No. DE- FG02-86ER53222.

Above (left-right): Dr. Francesca Turco and Dr. Nikolas Logan reported their latest results at the 29th IAEA Fusion Energy Conference (FEC) hosted by the United Kingdom Atomic Energy Authority (UKAEA)

Columbia Scientists Report Research at IAEA Fusion Energy Conference

By Michael Mauel

APAM scientists and alumni were invited to report latest results at the 29th IAEA Fusion Energy Conference (FEC) hosted by the United Kingdom Atomic Energy Authority (UKAEA) in London.

Every two years, the IAEA FEC brings together scientists and engineers from around the world to share fusion research results and highlight worldwide advances in fusion theory, experiments, technology, engineering, materials, advanced concepts, safety, socio-economics and preparation to industrial deployment.

Highlights from this year's meeting included plenary lectures by Columbia University scientists **Dr. Francesca Turco** and **Dr. Nikolas Logan** and reports from a growing private sector with launching public-private partnerships to address remaining challenges to the technological feasibility of fusion power for clean sustainable energy.

Dr. Franceca Turco's presentation "First Tungsten radiation studies and non-linear oscillations in DIII-D's ITER Baseline Demonstration Discharges" reported new experiments at the DIII-D National Tokamak Facility and the first studies of the impact of metallic impurity radiation and transport in planned burning plasma experiments in the ITER device and concluding good understanding of fusion performance with changing levels of metallic impurity.

Dr. Nikolas Logan's presentation "Improved pedestal performance utilizing resonant magnetic perturbations and edge localized electron cyclotron current drive" also reported experiments on the DIII-D tokamak identifying two new ways to operate the tokamak with improved confinement in the presence of resonant magnetic perturbations (RMPs). When the plasma rotates opposite to the direction of plasma current, particles "pump-inward" due to a reduction of turbulent transport. When the plasma rotates in the other direction, Logan and colleagues showed how microwaves can be used to drive local regions of plasma current and gain access to a high temperature edge with super high confinement properties.

This year's conference embraced public-private partnerships for fusion energy development with a special session called "Pathways to fusion." Columbia University alumnus **Dr. Brian Grierson** (PhD 2009), Director of General Atomics fusion pilot plant project, summarized the design and technology maturation of General Atomics steady-state advanced tokamak fusion pilot plant. Presentations were also made by **Dr. Ben Levitt** (PhD 2004), VP of Research and Development at Zap Energy, "Path to Commercial Fusion Energy Based on Sheared-Flow-Stabilized Z Pinches" and by **Dr. David Gates** (PhD 1993), CTO Thea Energy, "Stellarator Fusion Power Plant Enabled by Arrays of Planar Coils."

Several other Columbians were invited to participate and present research summaries. **Prof. Carlos Paz-Soldan** presented "Equilibrium, Stability, and Disruption Calculations Supporting the Design and Assembly of the SPARC Tokamak," **Prof. Mike Mauel** represented the work of the HBT-EP Tokamak and graduate student **Yumou Wei** and presented "Innovations In Detection and Control of Helical Instabilities in Wall-Stablized Tokamak Plasma," **Dr. Steve Sabbagh** presented "High Accuracy, Multi-Device Physics-Based Tokamak Disruption Prediction and Forecasting With First Real-Time Demonstration," **Dr. Jeremy Hanson**, reported "Variable-Spectrum Mode Control of High Poloidal Beta Discharges," and **Dr. Andrew "Oak" Nelson** presented "Robust L-Mode Edge Behavior in High Performance Negative Triangularity Plasmas: From Experiments to Reactors."

APAM Plasma Physicists Present Research at Theory & Simulation of Disruption Workshop

by Lucia Rondini

From July 19-21, fifteen Columbia University students, scientists and faculty attended and presented research at the 2023 Theory and Simulation of Disruptions Workshop at Princeton Plasma Physics Laboratory. The workshop takes place semi-annually with the goal of addressing disruptions, large-scale instabilities within fusion devices that can result in a loss of plasma control and cause damage to plasma-facing components. This year, Columbia professor **Carlos Paz-Soldan** (Professor of Applied Physics) served on the organizing committee and chaired a session on wall currents, tearing modes and mitigation.

Several students, scientists and faculty also presented invited talks:

Allen Boozer (Professor of Applied Physics) presented an invited lecture titled "The asymmetry between magnetic surface breakup and reformation," detailing theoretical aspects of the crossing and "breaking" of magnetic field lines into mutually-repulsive geometries as a result of large-scale instabilities. Magnetic surface breakup and reformation can transfer a plasma's magnetic energy to its component particles, enhancing harmful disruptions.

Steven Sabbagh (Applied Physics Adjunct Professor & Senior Research Scientist) presented an invited lecture titled "First real-time application of disruption event characterization and forecasting and associated research," providing an overview of the Disruption Event Characterization and Forecasting (DECAF) toolkit, which uses physics-based models to predict tokamak disruption events using a compendium of past data with up to 100% prediction accuracy for a given year's worth of shots on some tokamak fusion devices.

Veronika Zamkovska (Applied Physics Research Scientist) also presented an invited lecture involving DECAF, titled "Cross-device DECAF investigation of abnormal evolution of plasma vertical position and current indicating disruptions and internal reconnection events." Zamkovska's lecture focused on the ways in which a specific set of plasma characteristics (vertical position within the tokamak, and current) can be used as warning signs of a possible disruption or magnetic reconnection event.

William Boyes (Applied Physics doctoral student) presented an invited lecture, "MHD stability and scenario development of negative triangularity plasmas in DIII-D," on the properties of negative triangularity (inverted-D shaped) plasmas, whose viability as a possible reactor solution has grown in recent years as their stability and confinement benefits have become better understood.

Chris Hansen (Applied Physics Research Scientist) presented an invited lecture titled "Design of passive and structural conductors for tokamaks using thin-wall eddy current modeling," detailing computer models of disruption-induced eddy currents in components of tokamak devices meant to serve structural purposes. Such models can in turn be used to improve the design of these components.

The following students also presented posters at the workshop's poster session:

David Arnold (Applied Physics doctoral student): NIMROD validation studies on the HBT-EP tokamak

Anson Braun (Applied Physics doctoral student): Runaway electron mitigation coil design and predictions for the HBT-EP tokamak

Hari Pal Choudhury (Applied Physics doctoral student): The effects of electron cyclotron heating on quiescent relativistic electron plasmas in DIII-D

Juan Riquezes (Applied Physics doctoral student): Cross-machine comparison of born-rotating mode locking forecaster developed for real-time implementation

Lucia Rondini (Physics undergraduate student): Verifying improved particle trapping in negative triangularity plasmas

Matthew Tobin (Applied Physics doctoral student): Operational space assessment of vertical controllability and predictive capability of a vertical stability metric for disruption avoidance in tokamak plasmas

Alumni Updates

(Continued from page 2)

Joseph Ganser MS'11 is working as a data scientist/data engineer.

Barin Moghimi MS'14 writes: "I have been accepted to Georgia Tech for aerospace engineering. I am studying in the fields of intelligent control and robotics. I interned this past summer at Massachusetts Institute of Technology Lincoln Labs with Space Systems Test and Analysis Group."

Anthony Ruda '13 edited the monograph Destructive Emotions: Jain Perspectives (forthcoming via Motilal Banarsidass Publishing House)

Jose Alberto Sainz MS'97 is working at a hedge fund in London as a prop trader.

Aaron Wininger '94 writes: "I have recently been appointed chair of the American Intellectual Property Law Association's Committee for IP Practice in China. As chair of the Committee, I keep our members updated about new Chinese intellectual property laws, guidelines, guiding cases, and government-issued opinions. I also coordinate the Association's response to the Chinese government's request for comments on draft amendments to intellectual property laws and guidelines."

Prof. Adam Sobel writes, "Some of my most recent PhDs are both doing interesting climate science jobs in the private sector. **Melanie Bieli** is a Natural Catastrophe Specialist at Swiss Re (Armonk, NY office) and **Zane Martin** is a Climate Scientist at PwC. **John Dwyer** works at Gro Intelligence (an interesting startup doing climate as well as agriculture data), along with two former LDEO researchers, **Rick Russotto** and **Chiara Lepore.**"

Prof. Siu-Wai Chan connected with alumni on a recent trip to Boston. Prof. Chan writes "Suraj Cheem (BS' 12 Materials Science) is now an assistant professor (tenure track) at MIT and Michael Wong, my former high school intern, is now also working at MIT."

Suraj Cheem, Siu-Wai Chan, & Michael Wong

(Alumni updates continuted on page 13)

Gerald Navratil

Navratil Wins 2023 FPA Distinguished Career Award

Gerald A. Navratil, the Thomas Alva Edison Professor of Applied Physics, is a recipient of the Fusion Power Associates (FPA) 2023 Distinguished Career Award.

The FPA Board of Directors selected Navratil in recognition of his "nearly half-century of research and leadership contributions to plasma science and fusion energy, as well as to the education of a new generation of scientists." His award letter goes on to state that the Board also noted his important "role in the establishment of the University Fusion Association" and his "lengthy service on the Fusion Power Associates Board of Directors, including two terms as Board Chair."

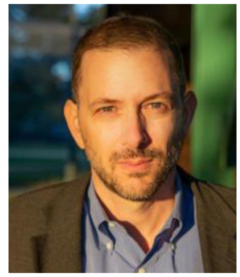
Navratil is internationally known for his work in the field of fusion energy and plasma physics and his research focuses on MHD equilibrium and stability of magnetically confined plasmas. He directs the U.S. Department of Energy funded HBT-EP tokamak experiment in the Columbia Plasma Physics Laboratory and as well as an off-campus collaboration at the DIII-D National Fusion Facility in San Diego.

Navratil received his Bachelors degree in physics from the California Institute of Technology in 1973 and his PhD in plasma physics from the University of Wisconsin-Madison in 1976. In 1977, he joined the faculty of Columbia University and in 1978 became a founding member of the APAM Department, serving as department chair from 1988-1994 and from 1997-2000. He also served as Interim Dean of the School of Engineering and Applied Science at Columbia University from 2007-2009.

Navratil was President of the University Fusion Association in 1991 and 2005-2006, and co-chair of the 2002 Fusion Energy Sciences Summer Study held at Snowmass. He was appointed to the Board of Directors of Fusion Power Associates in 1999 and served as Chairman of the Board of Directors 2007-2009 and 2018-2020.

Navratil was named an Alfred P. Sloan Research Fellow in Physics in 1984, a Fellow of the American Physical Society in 1989, received the Fusion Power Associates Leadership Award in 2006, and received the American Physical Society's John Dawson Award for Excellence in Plasma Physics Research in 2007. He has served as host of many national advisory committees, including the U.S. ITER Project Technical Advisory Committee and the DOE Fusion Energy Sciences Advisory Committee, among others. He also served as the Associate Editor for Physics of Fluids from 1987-1990 and Physics of Plasmas from 1994-2002.

The award was presented at the Fusion Power Associates 44th Annual Meeting and Symposium, Pilot Plants for Fusion Power, in Washington, DC.



Adam Sobel

Sobel Named 2023 AGU Fellow

Adam Sobel, Professor of Applied Physics and Applied Mathematics and of Earth and Environmental Sciences, was named a 2023 fellow of the American Geophysical Union "for outstanding contributions to understanding of tropical meteorology and climate."

The AGU Fellows program "recognizes AGU members who have made exceptional contributions to Earth and space science through a breakthrough, discovery, or innovation in their field. Fellows act as external experts, capable of advising government agencies and other organizations outside the sciences upon request." (AGU.org)

Sobel studies the dynamics of climate and weather, especially in the tropics. In recent years he has become particularly focused on understanding the risks to society from extreme weather events and climate change. Sobel is author or co-author of over 200 peer-reviewed scientific articles; a book, Storm Surge, focused on Hurricane Sandy; and op-eds and articles in the mainstream media. He hosts a podcast, Deep Convection, featuring wide-ranging conversations with other scientists.

Two APAM affiliates were also recognized this year by the AGU. **Suzana Camargo**, who works with Adam at the Lamont-Doherty Earth Observatory (LDEO), was also named an AGU fellow "for outstanding contributions that have advanced our understanding of tropical cyclones and their relation to climate variability and change." Suzana co-advises APAM graduate student, Patrick Orenstein, along with Adam Sobel and Greg Elsaesser (NASA/GISS). **Michela Biasutti,** also from LDEO, was awarded the AGU Charney Lecture, which was awarded to Adam in 2022. She co-advises two APAM graduate students, Isabelle Bunge and Sean Cohen, along with Adam.

"Congratulations to Adam, Suzana, and Michela" said Marc Spiegelman, APAM Department Chair. "All of us in APAM are thrilled by this well-deserved honor for their outstanding contributions to climate and atmospheric science. We are grateful for all they do for the program and department."

Elizabeth Paul

Paul Wins DOE Early Career Research Award

The U.S. Department of Energy (DOE) has chosen **Elizabeth Paul**, assistant professor of applied physics and applied mathematics, as an early career scientist for its 2023 Early Career Research Program. She is among 93 young scientists recognized this year as a next-generation leader in STEM for her proposal "Modeling fast-ion mode interactions toward a stellarator infusion power plant."

Controlled fusion has the potential to be a long-term and sustainable energy source. With the emergence of the stellarator as a leading alternative to the tokamak for fusion power plants (FPPs), researchers have been focused on developing methods to control energetic particle (EP) instabilities in a stellarator FPP. Confining EPs for a length of time is of critical importance to maintain the fusion burn and prevent deterioration of the FPP's walls.

Paul's project is focused on advancing 3D modeling capabilities to better understand mode-particle interactions and control them through 3D shaping. Through theoretical and advanced computational techniques, she hopes to develop models for new stellarator FPP design concepts with enhanced EP confinement.

Paul received her AB in astrophysical sciences with concentrations in applied and computational mathematics and applications of computing from Princeton University in 2015 and her PhD in physics from the University of Maryland, College Park, in 2020. She was previously a Presidential Postdoctoral Research Fellow at Princeton University from 2020 to 2022.

Liliana Borcea

New Applied Mathematics Faculty Member: Liliana Borcea

Liliana Borcea will join the Applied Mathematics faculty in July 2024.

Prof. Borcea's research interests are in applied mathematics, with particular interests in wave propagation in random media with applications to wave-based imaging and free space optical communications; inverse problems for hyperbolic, elliptic, and parabolic partial differential equations; and data-driven reduced order modeling and applications to inverse problems.

Prof. Borcea earned her undergraduate degree in Applied Physics from the University of Bucharest in Romania and her PhD in Scientific Computing and Computational Mathematics (SCCM) from Stanford University. Following a one-year postdoctoral fellowship in the Department of Applied Mathematics at Caltech, she joined the faculty in the Department of Computational and Applied Mathematics at Rice University in 1996 and was named the Noah Harding Professor in 2007. She then joined the Mathematics faculty at the University of Michigan, Ann Arbor, where she has been the Peter Field Collegiate Professor of Mathematics since 2013.

Prof. Borcea was recognized as the AWM-SIAM Sonia Kovalevsky Lecturer for 2017, selected "for her distinguished scientific contributions to the mathematical and numerical analysis of wave propagation in random media, array imaging in complex environments, and inverse problems in high-contrast electrical impedance tomography, as well as model reduction techniques for parabolic and hyperbolic partial differential equations." She is a member of the 2018 class of SIAM Fellows and was elected to the American Academy of Arts and Sciences in 2023.

Aravind Devarakonda

New Applied Physics Faculty Member: Aravind Devarakonda

Aravind Devarakonda has joined the Applied Physics faculty as an Assistant Professor.

Dr. Devarakonda and his group use tools and techniques from solid-state chemistry, nanoscience, and low-temperature physics to study the quantum mechanical behavior of matter. His group is particularly interested in creating materials hosting unusual ground states emerging from the interplay of electron-electron interactions and topology. Ultimately the Devarakonda lab aims to detect, manipulate, and harness these ground states towards future applications in quantum information science and beyond.

Dr. Devarakonda obtained his B.S. in Applied Sciences and Engineering from Rutgers University in 2014 and his Ph.D in Physics from MIT in 2021 under the supervision of Joe Checkelsky. Subsequently he joined Columbia University as a Postdoctoral Research Scientist and Simons Junior Fellow working with Prof. Cory Dean in the Department of Physics.

Xuenan Li

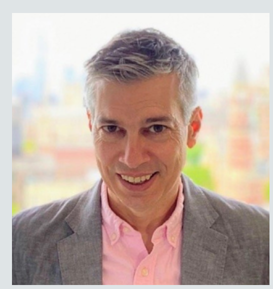
New Applied Mathematics Faculty Member: Xuenan Li

Xuenan Li has joined the Applied Mathematics faculty as a term Assistant Professor in Applied Mathematics.

Dr. Li's research interests focus on Calculus of Variations, Partial Differential Equations, Elasticity Theory, and Mechanical metamaterials, particularly in their static and dynamic behavior.

Dr. Li received her B.Sc. in Mathematics and Data Science from the University of Michigan in 2018. She then joined New York University's Courant Institute of Mathematical Sciences and earned her Ph.D. in mathematics in 2023 under the supervision of Robert V. Kohn. Dr. Li is the recipient of the Sandra Bleistein Prize from New York University, and also received travel awards to attend the SIAM Annual Meeting (AN22) and 10th International Congress on Industrial and Applied Mathematics (ICIAM 2023). At the Courant Institute, she was a member of the Association for Women in Mathematics and the DEI Reading Group.

Wiggins on AI and Data Science



Chris Wiggins, associate professor of applied mathematics at Columbia Engineering and the Chief Data Scientist at *The New York Times*, was recently named as one of "AI 100 2023: The top people in artificial intelligence" and "The top 7 media people in AI" by *Business Insider*, as well as one of "The Top 10 Data Science Influencers in the UK 2023" by *Only Data Jobs*.

Wiggins was recently featured at various events and contributed to panel discussions focusing on AI and Data Science. He spoke to the board of trustees of the Aspen Institute about the history and ethics of data and AI. He also recently appeared on *Next Question with Katie Couric* in the episode "Katie Plus One Presents AI For Dummies with Vivian Schiller, Vilas Dhar, and Chris Wiggins" **https://shorturl.at/einOZ**

Wiggins was featured on a panel at the *100% Human at Work Festival of Ideas* in New York which focused on the ways that generative AI will impact how we work. Read more in "Generative AI and the inclusive workforce" by Virigin.com **https://shorturl.at/AGKUX**

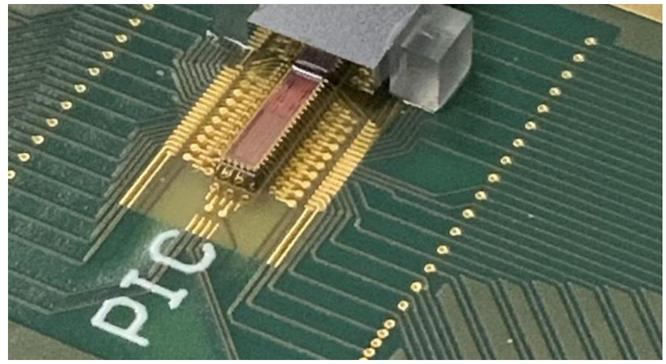
Wiggins and co-author Matthew L. Jones discussed their book, "How Data Happened: A History from the Age of Reason to the Age of Algorithms" aboard the Intrepid aircraft carrier as part of an event hosted by Own, introducing their company rebrand and an addition to their SaaS data platform. Read more about the discussion in *Information Week*'s article, "Guinness, an Aircraft Carrier, and the History of Data." **https://shorturl.at/ahFVW**

Transferring Data with Many Colors of Light Simultaneously

The new photonic chip enables exponentially faster and more energy-efficient artificial intelligence

Originally published by Columbia Engineering

The data centers and high-performance computers that run artificial intelligence programs, such as large language models, aren't limited by the sheer computational power of their individual nodes. It's another problem — the amount of data they can transfer among the nodes — that underlies the "bandwidth bottleneck" that currently limits the performance and scaling of these systems.



Photonic transmitter chip mounted on a printed circuit board with electrical and fiber optic connections. Credit: Lightwave Research Laboratory/Columbia Engineering

The nodes in these systems can be separated by more than one kilometer. Since metal wires dissipate electrical signals as heat when transferring data at high speeds, these systems transfer data via fiber-optic cables. Unfortunately, a lot of energy is wasted in the process of converting electrical data into optical data (and back again) as signals are sent from one node to another.

In a study published in *Nature Photonics*, researchers at Columbia Engineering demonstrate an energy-efficient method for transferring larger quantities of data over the fiber-optic cables that connect the nodes. This new technology improves on previous attempts to transmit multiple signals simultaneously over the same fiber-optic cables. Instead of using a different laser to generate each wavelength of light, the new chips require only a single laser to generate hundreds of distinct wavelengths of light that can simultaneously transfer independent streams of data.

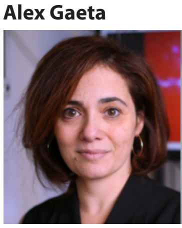
A simpler, more energy-efficient method for data transfer: The millimeter-scale system employs a technique called wavelength-division multiplexing (WDM) and devices called Kerr frequency combs that take a single color of light at the input and create many new colors of light at the output. The critical Kerr frequency combs developed by **Michal Lipson**, Higgins Professor of Electrical Engineering and Professor of Applied Physics, and **Alexander Gaeta**, David M. Rickey Professor of Applied Physics and Materials Science and Professor of Electrical Engineering, allowed the researchers to send clear signals through separate and precise wavelengths of light, with space in between them.

"We recognized that these devices make ideal sources for optical communications, where one can encode independent information channels on each color of light and propagate them over a single optical fiber," says senior author Keren Bergman, Charles Batchelor Professor of Electrical Engineering at Columbia Engineering, where she also serves as the faculty director of the Columbia Nano Initiative. This breakthrough could allow systems to transfer exponentially more data without using proportionately more energy.

The team miniaturized all of the optical components onto chips roughly a few millimeters on each edge for generating light, encoded them with electrical data, and then converted the optical data back into an electrical signal at the target node. They devised a novel photonic circuit architecture that allows each channel to be individually encoded with data while having minimal interference with neighboring channels. That means the signals sent in each color of light don't become muddled and difficult for the receiver to interpret and convert back into electronic data.

"In this way, our approach is much more compact and energy-efficient than comparable approaches," says the study's lead author Anthony Rizzo, who conducted this work while a PhD student in the Bergman lab and is now a research scientist at the U.S. Air Force Research Laboratory Information Directorate. "It is also cheaper and easier to scale since the silicon nitride comb generation chips can be fabricated in standard CMOS foundries used to fabricate microelectronics chips rather than in expensive dedicated III-V foundries."

(Above) Photonic integrated chip capable of encoding data on 32 independent frequency channels on a U.S. dime for scale. Credit: Lightwave Research Laboratory / Columbia Engineering (Below) Michal Lipson & Alex Gaeta




The compact nature of these chips enables them to directly interface with computer electronics chips, greatly reducing the total energy consumption since the electrical data signals only have to propagate over millimeters of distance rather than tens of centimeters.

Bergman noted, "What this work shows is a viable path towards both dramatically reducing the system energy consumption while simultaneously increasing the computing power by orders of magnitude, allowing artificial intelligence applications to continue to grow at an exponential rate with minimal environmental impact."

Exciting results pave the way to real-world deployment: In experiments, the researchers managed to transmit 16 gigabits per second per wavelength for 32 distinct wavelengths of light for a total single-fiber bandwidth of 512 Gb/s with less than one bit in error out of one trillion transmitted bits of data. These are incredibly high levels of speed and efficiency. The silicon chip transmitting the data measured just 4 mm x 1 mm, while the chip that received the optical signal and converted it into an electrical signal measured just 3 mm x 1 mm—both smaller than a human fingernail.

"While we used 32 wavelength channels in the proof-of-principle demonstration, our architecture can be scaled to accommodate over 100 channels, which is well within the reach of standard Kerr comb designs," Rizzo adds. These chips can be fabricated using the same facilities used to make the microelectronics chips found in a standard consumer laptop or cellphone, providing a straightforward path to volume scaling and real-world deployment. The next step in this research is to integrate the photonics with chip-scale driving and control electronics to further miniaturize the system.

Rizzo, A., Novick, A., Gopal, V. et al. Massively scalable Kerr comb-driven silicon photonic link. *Nat. Photon*. 17, 781–790 (2023). https://doi.org/10.1038/s41566-023-01244-7

Professors Michal Lipson and Alex Gaeta were also named Clarivate Highly Cited Researchers in Physics for 2023! Learn more at: https://clarivate.com/highly-cited-researchers/

Yuan Yang

A Scalable, Safer, & Potentially Cheaper Way to Isolate Valuable Isotopes

A team of researchers, led by Yuan Yang, have developed a new method for purifying materials that are crucial for energy, medicine, and scientific research.

by Grant Currin, Originally published by Columbia Engineering

New research published in *Science Advances*, led by **Yuan Yang**, associate professor of materials science at Columbia Engineering, and collaborators at Lamont-Doherty Earth Observatory, demonstrates a novel technique for isolating isotopes.

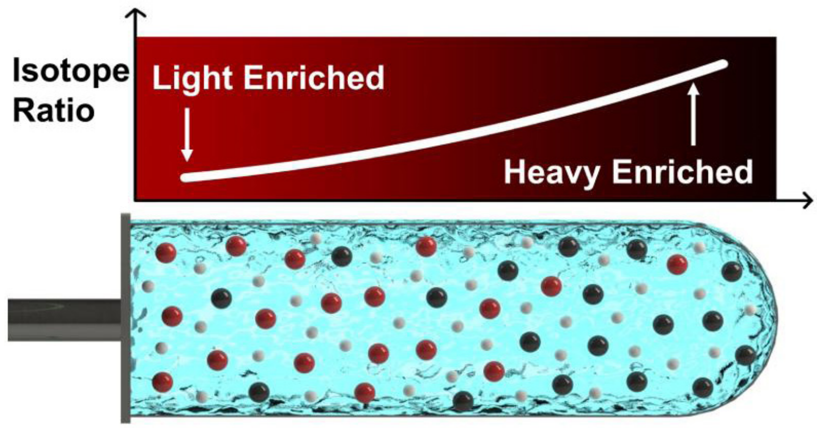
High Stakes: Oxygen is a critical component in the positron emission tomography (PET) scans oncologists use to search for tumors. But not just any oxygen will work. While most oxygen atoms have eight neutrons, about 1 in 500 atoms has ten. Those extra neutrons are necessary for the PET imaging scans to work.

The Challenge: It's extremely expensive to isolate the slightly heavier oxygen atoms. A cubic meter of regular water (H2O) costs less than $2 from your tap. When the lighter oxygen atoms (and hydrogen) are removed, the heavier oxygen atoms that remain are worth closer to $30,000.

The Breakthrough: Researchers at Columbia figured out how to isolate heavier or lighter atoms — called isotopes — by dissolving the target element and salts in water before spinning that solution in a centrifuge. It's more effective, cheaper, and easier to scale than the current state-of-the-art techniques, which also use toxic chemicals that aren't necessary for the new method.
Broader Applications

Pure isotopes are extremely useful — and extremely valuable. Every year, tens of millions of people across the world receive medical tests that require a hard-to-extract isotope called 100-Molybdenum. Calcium isotope Ca-48 is so rare and sought-after that a single gram currently costs $250,000. And if nuclear fusion becomes a viable source of energy, it will take thousands of tons of a lithium isotope to satisfy the world's energy demands.

Looking Ahead: Since collaborating with Columbia Technology Ventures to patent the new technology, the researchers have been in touch with several companies about building prototypes and developing a plant to begin isolating isotopes. They've used computational modeling to discover several innovative methods that further increase the method's efficiency.



Heavier isotopes become more concentrated at the outer edge of the centrifuge, while lighter isotopes become more concentrated at the inner edge. The electrostatic force acts to attract the target ions and counterions to one another, resulting in charge neutrality. This schematic is to show the design of a swing bucket centrifuge used to produce experimental data in this work. Credit: Columbia Engineering

Dive Deeper: The Yang lab addresses a range of problems in the fields of sustainable technologies and clean materials. While a large emphasis is on developing next-generation lithium-based batteries using modern electrochemical engineering and nanoscience, other recent directions have included developing methods to separate important isotopes which have broad applications in the fields of nuclear fusion and radiomedicine.

Joseph F. Wild, Heng Chen, Keyue Liang, Jiayu Liu, Stephen E. Cox, Alex N. Halliday, and Yuan Yang,
Liquid solution centrifugation for safe, scalable, and efficient isotope separation. *Sci. Adv*.9, eadg8993(2023), DOI:10.1126/sciadv.adg8993

Simon Billinge

Billinge Presented Flack Lecturer for the Swiss Society for Crystallography

Simon Billinge was named the Flack Lecturer for the 2023 Howard Flack Lecture Series of the Swiss Society for Crystallography SGK/SSCr from November 6-10, 2023. He spent a week in Switzerland and presented 6 lectures in 5 days.

The 2023 Howard Flack Lecture Series focused on local order and pair distribution function analysis with Professor Simon Billinge as the invited Flack Lecturer. As a materials scientist, Prof. Billinge uses and advances crystallographic techniques to study local-structure property relationships across many different materials used for energy, catalysis, environmental remediation, and pharmaceuticals.

Billinge's research focuses on the study of local-structure property relationships of disordered crystals and nanocrystals using advanced X-ray and neutron diffraction techniques. In particular, he is a leader in the development of the atomic pair distribution function (PDF) method applied to complex materials. These methods are applied to the study of nanoscale structure and its role in the properties of diverse materials of interest, for example, in energy, catalysis, environmental remediation and pharmaceuticals. The approach is to use advanced X-ray, neutron and electron scattering methods, utilizing some of the world's most powerful sources, and applying advanced computation and analysis, including artificial intelligence, machine learning, and graph theoretic methods. A major activity is the study of the nanostructure inverse problem (NIP) where the goal is to obtain the 3D arrangement of atoms from structures with nanoscale atomic structures from scattering data, and the synthesis inverse problem, where the goal is to find an unknown synthesis recipe given a desired material product. These are non-trivial ill-posed inverse problems that require novel applied math and computational approaches to solve.

Katayun Barmak

Automated Grain Boundary Detection for BrightField Transmission Electron Microscopy Images via U-Net

Researchers led by principle investigator **Prof. Katayun Barmak** and graduate student **Matthew Patrick**, have developed the first generalizable and automated approach to identifying grain boundaries in bright-field transmission electron microscope (BF-TEM) images using a machine learning model based on a U-Net architecture and a tailored post-processing scheme [MJ Patrick et al., *Microsc. Microanal. ozad*115 (2023)].

The majority of technologically important materials are polycrystalline, comprised of a myriad of small crystals of different orientations, called grains, which are divided by grain boundaries. The size and shape of the grains, as well as the properties of the network of their boundaries, have important impacts on the properties of the material, from mechanical strength and failure to the electronic properties of the material.

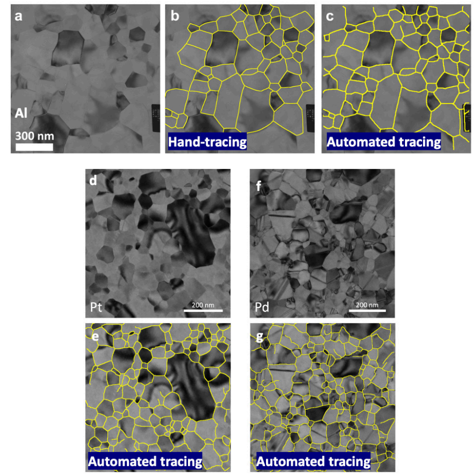


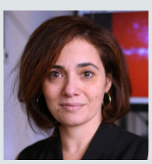
Figure 1: Bright field TEM images of (a) Al with its (b) hand tracing and (c) post-processed automated tracing overlaid (c). (d-g) BF-TEM images of Pt and Pd, respectively, with their post-processed automated tracings overlaid.

Polycrystalline metallic thin films are particularly important in modern electronics, but characterizing the use of TEM imaging is required to resolve the details of their fine grained structures at the length scale of 10-100 nm. Unfortunately, image formation in BF-TEM micrographs is governed by complex electron scattering and thus the images have many artifacts and complicated contrast between grains. Since studies have begun on these materials, the only viable technique to collect reliable and reproducible data from these images has been tedious hand labelling of grain boundaries by expert tracers, usually begrudging graduate and undergraduate students. This approach severely limits the throughput of experiments and dashes any dreams of analyzing many large datasets like those collected during in situ heating experiments, necessary for the next generation of microstructural studies of nanocrystalline thin films.

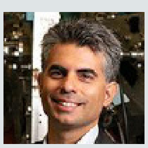
The researchers trained the machine learning model, based on a U-Net convolutional neural network, using ground truth data constructed from aluminum images and tracings generated by hand in the early 2000s. The results of the model applied to unseen images from the same era were shown to match their hand tracings through a variety of statistical metrics. Furthermore, the model was also applied to generate new results on a recently prepared aluminum film and has shown great promise in platinum and palladium thin films, even when images are captured during in situ heating experiments, as visualized in Figure 1. This is the first time an automated segmentation approach for this kind of image has been able to be used on images dissimilar to those for which was initially designed!

Full understanding of the evolution of thin film microstructures requires a lot of data, and this advance opens the door to high throughput analysis of thin film microstructures at a scale never before possible, bringing the rapid, quantitative study of the dynamics of grain growth within reach.

Faculty Updates

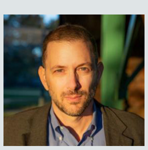


Michal Lipson (the Higgins Professor of Electrical Engineering and Professor of Applied Physics and Optica President), wrote "Science: The Universal Language," for Optica's *Optics and Photonics News*. Lipson writes, "The global importance of our science makes it the responsibility of everyone in our community, whatever their home country, to reach across borders." **rb.gy/uolmed**



Carlos Paz-Soldan, associate professor of applied physics, was featured in the article, "Companies say they're closing in on nuclear fusion as an energy source. Will it work?" by wfdd.org (December 4, 2023) **https://bit.ly/46PcsrE**

Paz-Soldan was also recently featured in the *MIT News* article, "New study shows how universities are critical to emerging fusion industry." (November 30, 2023) **https://shorturl.at/tEIPZ**

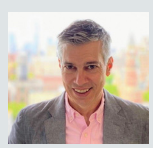


Read **Adam Sobel**'s latest op-ed, "Why we're seeing so many deadly floods," in *CNN* (September 21, 2023) **https://rb.gy/sa94e0**

Sobel was featured in the *Wall Street Journal* article, "Idalia's Damage Tied to How Fast It Intensifies," (August 30, 2023) **https://shorturl.at/wDMX2**

On August 18th, Sobel made an appearance on *Fox 5 News* and discussed discussed extreme weather, Hurricane Hillary, and warming oceans.

Michael Tippett was featured in the article, "NOAA ENSO August 2023 Update: Greater Than 95% Chance of El Niño This Winter – But What Does That Mean?" by *SnowBrains* (August 10, 2023) **https://bit.ly/46LXqmA**



Chris Wiggins was featured in the *Fortune* article, "What is data science? Everything you need to know" (November 29, 2023). **https://shorturl.at/eqGKP**

He was featured in the article, What journalists should know about AI-generated disinformation," published in the *International Journalists' Network* (October 25, 2023) **rb.gy/37qdvg**

Wiggins was also featured in "Ones and Zeros: The rise and rise and rise of data" in *The Nation* (October 16, 2023) **https://shorturl.at/BDM19**

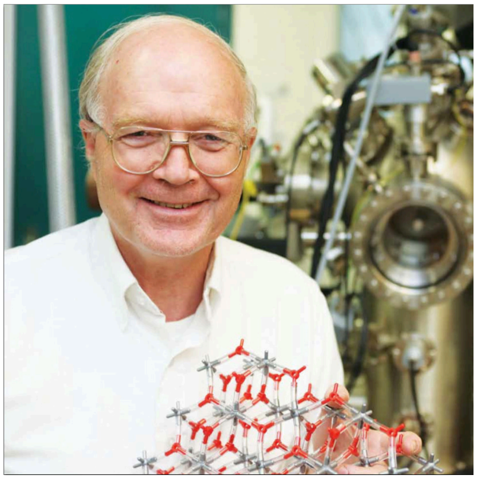
Wiggins book, 'How Data Happened: A History from the Age of Reason to the Age of Algorithms,' was recently featured in the article, "Airplane Books for Autumn Travel" by *425 Business* **(October 10, 2023)**

Recent Faculty Publications

Sobel, Adam et. al, **Near-term tropical cyclone risk and coupled Earth system model biases**, *Proc Natl Acad Sci* doi: 10.1073/pnas.2209631120.

Lee, S. H., M. K. Tippett, and L. M. Polvani: **A New Year-Round Weather Regime Classification for North America**. *Journal of Climate*, https://doi.org/10.1175/JCLI-D-23-0214.1

Sobel's podcast is now in its 4th season! Deep Convection, a podcast co-created by Adam Sobel and APAM alumna Melanie Bieli, features real conversations between climate scientists. https://deep-convection.org/



Richard M. Osgood, Jr. (1943-2023)

In Memoriam: Richard M. Osgood, Jr. (1943-2023)

The Columbia Engineering and Applied Science community mourns the loss and celebrates the life of **Richard Magee Osgood, Jr.**, the Higgins Professor *Emeritus* of Electrical Engineering and Professor *Emeritus* of Applied Physics at Columbia University.

Richard "Rick" Osgood, a pioneer in the field of lasers and a beloved member of the electrical engineering and applied physics faculties at Columbia for over 4 decades, passed away on October 20, 2023. He will be remembered very warmly by those who had the pleasure of working alongside him and by the 67 doctoral students that he trained.

Born on December 28, 1943, in Kansas City, Missouri, Osgood was a graduate of the United States Military Academy at West Point, earned his master's degree in Physics from the Ohio State University, and received his Ph.D. in physics from MIT, with Ali Javan as his doctoral advisor. After receiving his doctorate, Osgood did research at MIT Lincoln Laboratories.

Osgood joined the faculty at Columbia University in 1981 as an Associate Professor in the Department of Electrical Engineering and was promoted to full Professor in both the Departments of Electrical Engineering and of Applied Physics and Applied Mathematics (then Applied Physics and Nuclear Engineering) in 1982. He was named the Higgins Professor of Electrical Engineering and Professor of Applied Physics in 1988 and continued his career at Columbia until his retirement in 2014. He created and directed the Microelectronics Sciences Laboratories (MSL), a research center that pioneered new microelectronic capabilities and materials and was co-director of the Columbia Radiation Laboratory. As MSL Director, he designed and led the first shared Clean Room fabrication facility at Columbia, which was essential to the research of generations of faculty and students.

Osgood's research, in collaboration with colleagues and students, created new surface chemistry and interactions, and nonlinear optical materials and processing. In addition to service at the university, Osgood contributed to pure and applied science at the national level, participating in multiple studies during the summers for the Defense Advanced Projects Agency (DARPA). Later in his career at Columbia University, Osgood led efforts to create and apply silicon photonics, in non-linear optical materials and in the new field of plasmonics, which experienced exponential growth in the 2000s and led him to publish many highly cited papers.

"This department and the Columbia engineering community as a whole owe Rick a great debt for his work in making them what they are today," said Electrical Engineering Department Chair John Kymissis. "He led by example, both as an educator in the classroom and as a pioneer in his field of study."

Irving Herman, long-time colleague and a professor in the Department of Applied Physics and Applied Mathematics, noted, "Rick was a great friend, colleague, and mentor to many at Columbia. He will be remembered for a very long time because he helped make Columbia a top institution in physical sciences and engineering through his ground-breaking research and the impact of his leadership."

In 1991, Osgood, along with Daniel J. Ehrlich and Thomas F. Deutsch, received OSA's R. W. Wood Prize "for the invention of laser photochemical deposition and the application of laser induced photochemical reactions to materials processing." In 1995, his lab group created a photonic design system, RSoft, which led to a successful startup company. In 2000, he became the Associate Director of Energy Sciences at Brookhaven National Laboratory (BNL) for two years while on leave from Columbia; BNL is one of a handful of American National Laboratories with advanced synchrotron facilities leading worldwide research. On January 5, 2009, Osgood was honored by colleagues at Columbia and internationally with a symposium honoring his then 40 years of contributions to pure and applied science. He was a fellow of the Optical Society, the American Physical Society, and the IEEE.

(left-right) Osgood with his 60th PhD student, Zhisheng Li; 2009 Symposium honoring Osgood's 40 years of contributions; Osgood with Morton Friedman

An obituary by the Osgood family can be found at: **rb.gy/uuj0im** and the Osgood family also welcomes you to share comments and memories of Rick on the "memory wall." A recording of Professor Osgood's memorial is available at: **rb.gy/gdmo9b**

Materials Science Demonstration & Presentation at the Spence School

As part of a recent outreach effort, **Prof. Katayun Barmak** and graduate student **Matthew Patrick** visited The Spence School, a local all-girls high school, to give a talk during their Research Scientist program.

This program gives these budding scientists a chance to conduct their own research and provides them the opportunity to connect with active researchers to learn about cutting edge work across a wide variety of disciplines. The visitors began by introducing the fundamentals of their field, Materials Science and Engineering, through the lens of ever developing microelectronics technology, showcasing example devices from some of the earliest magnetic storage media, to once-revolutionary "floppy" disks, to modern thin-film hard-drives. Hands on demonstrations brought defects, deformation mechanisms, and solid-solid phase transformations to life, through the dramatically different mechanical properties of paper clips and shape memory wires. Barmak and Patrick concluded with a presentation of their latest research results on automated grain boundary detection, a long-standing problem finally solved using a modern machine learning approach, demonstrating to these young women that while research is often a decades-long process, with enough patience and persistence, old problems can be solved with new tools if only you continue to try. Finally, the class participated in a Q&A, where Professor Barmak shared some advice about building a fruitful and fulfilling career as a researcher and as a scientist.

Prof. Katayun Barmak & Matthew Patrick visited The Spence School to present a talk on the fundamentals of Materials Science & Engineering

Video: Data & Society

Check out a new video by Columbia Engineering Magazine: **Prof. Chris Wiggins** & Columbia School of Social Work **Prof. Courtney Cogburn** explore the promise and pitfalls of using data to understand the world — & to change it. **https://topics.engineering.columbia.edu/lets-talk-data/**

Logan Joins Plasma Physics Laboratory

Nikolas Logan

APAM warmly welcomes **Dr. Nikolas C. Logan**, a new Associate Research Scientist working with **Prof. Carlos Paz-Soldan** in the Plasma Physics Laboratory at Columbia Engineering. Dr. Logan's work centers on magnetohydrodynamic (MHD) stability and "3D" optimizations of toroidal reactors for the design of simultaneously high performance and stable fusion plasmas.

Dr. Logan earned his PhD at Princeton University in Astrophysical Sciences - Plasma Physics in 2015. Following his PhD, he continued working as a researcher in Princeton's ITER and Tokamaks Division until 2020. He then joined the Lawrence Livermore National Laboratory's Fusion Energy Sciences Division as the Leader of the 3D & Stability Physics topical group at the DIII-D tokamak. He has been an invited speaker at the Annual Meeting of the APS Division of Plasma Physics in 2015, 2018, and 2022; the 2020 AAPPS-DPP 4th Asia Pacific Conference on Plasma Physics; the 2020 US-Japan Workshop on MHD Stability Control; and the 2019 KSTAR Conference.

As a fusion energy sciences researcher who works on many national-scale experimental user facilities across the world, Dr. Logan is always looking to perform impactful research that will facilitate the advent of a magnetic-confinement fusion reactor.

Dr. Logan's personal research is defined by a through-line of optimizing the various consequences of breaking a tokamak's axisymmetry (tokamaks are torus-shaped devices with nominal symmetry in the toroidal direction). His early work at Princeton included developing a new model of neoclassical toroidal viscosity (NTV) induced by non-axisymmetric perturbations, using predictive MHD modeling to optimize magnetic perturbation diagnostics, installing said diagnostics on the DIII-D tokamak, and leading experiments to validate the model predictions with these diagnostics. Since then, his research has expanded to encompass a wide range of experimental efforts studying resonant magnetic perturbation, stability and transport in major tokamak facilities such as EAST (China), KSTAR (Korea) and DIII-D (USA).

Dr. Logan also continues to develop and maintain the Generalized Perturbed Equilibrium Code (GPEC) MHD model used by 30+ researchers at 8+ laboratories as well as the OMFIT profile fitting tool used to analyze diagnostic data at 17+ fusion centers across the world. He continues to balance model development and experimental work to maximize his impact in the field of fusion energy sciences.

In addition to his work with Prof. Paz-Soldan, Dr. Logan also plans to collaborate with Prof. Elizabeth Paul, Dr. Jeremy Hanson, and Dr. Chris Hansen, as well as graduate students in the Plasma Physics Lab. Dr. Logan stated, "I believe that together we will create a world-leading program in 3D plasma physics that will be sought after for involvement in all major tokamak programs - both public and private. I am further excited by the prospect of training future leaders in this field and giving them the opportunity to become immediately involved in such an effective science team."

Alumni Updates

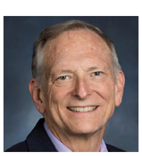
Siu-Wai Chan writes: "In the number of years that I have spent teaching materials science & engineering at Columbia Engineering, I have belonged to different departments, including the Department of Mining, Minerals & Metallurgy (now Earth & Environmental Science), where I have a joint appointment, the Department of Chemical Engineering, and finally the APAM Department. Last summer, I met up with 5 former students and a Massachusetts Institute of Technology classmate in Sunnyvale, California."

Mike Farmer '82 writes: "I am now at Kettering University as Department Head of Computer Science. It's a unique co-op school where the students alternate work and academic terms. My wife and I are entering our 20th year of marriage, and I am so happy. I'm still finding time on the boat in the summer and time for my winter passions of skiing and snowboarding. I am also playing bass in a learning band with some other adults and having a blast performing at some local bars."

Kallee Gallant '22 writes: "After graduation in May, I drove a moving truck from New York City to the Bay Area and have been living here since the beginning of July! I love my job and feel very fortunate for my brilliant coworkers and that I was able to start part-time during senior spring. I'm planning on applying to graduate programs for entrance in Fall 2023 and will be taking a machine learning class at Stanford in the meantime. Very excited for my first year out of college!"

Carl Gurtman BS'64, MS'65 writes: "When I was at Columbia, I was in the Department of Nuclear Engineering and later worked as a health physics assistant, which in many ways was a foretaste for my career. Upon graduating, I worked as a nuclear engineer at the Portsmouth Naval Shipyard, eventually heading, in turn, many divisions. One interesting assignment was as head of the radiological emergency planning division. I retired after 37 years as the assistant nuclear engineering and planning manager. After retiring, I was a so-called consultant in Tennessee and New Mexico. No actual consulting: These are at will, no benefit, highly paid positions. I still ride my bike, but engage in fewer and fewer activities as I get older. My wife Linda and I enjoy our three adult children and our four grandsons."

Theodore Moustakas PhD'74 writes: "I carried out my PhD studies at Columbia University from 1969 to 1974 in solid state science and engineering, what was then an interdepartmental program between materials science, electrical engineering, and physics. After completing the required coursework in these three departments as a Campbell Fellow, I was offered an IBM scholarship to carry out my thesis work at IBM Research Laboratories in Yorktown Heights. I was fortunate to have the opportunity to work in this laboratory, one of the premier laboratories worldwide for the study of semiconductors. My only regret is that by not living close to the University, I lost communication with the rest of my classmates. I was going to the University once a month to discuss my progress with my academic advisor, professor Art Nowick. Upon graduation, I carried out three years of postdoctoral work in the applied physics and engineering division at Harvard University and 10 years at Exxon Research Laboratories in Clinton, New Jersey. My work in these institutions was related to fundamental studies of amorphous silicon and its application to solar cells. In 1987, I was appointed professor in the electrical and computer engineering department at Boston University with a joint appointment in physics. Here, I focused my research on wide bandgap semiconductors (diamond-thin films and nitride semiconductors). Intellectual property that resulted from my work nitride semiconductors and their applications to optoelectronic devices (blue and ultraviolet LEDs and lasers) was licensed by Boston University to more than 40 companies (Cree, Nichia, Philips, OSRAM, Apple, Amazon, Microsoft, Hewlett-Packard, Dell, Motorola, Samsung, LG, Sony, Panasonic, Sharp, NEC, Blackberry, Nokia etc). In the course of this work, I mentored more than 30 PhD students and as many MS students, as well as a number of postdoctoral scholars. I retired from Boston University in 2015. In my personal life, I married Elena Palumbo, another Columbia alumna, and we have two children and four grandchildren."



Bill Quirk '67 writes: "I have finally retired. I worked as a computational physicist from 1970 until 2005. I was a member of the Hayward City Council from 2004-2012 and was an assembly member of the California Legislature from 2012-2022. I now live in a retirement community, Acacia Creek, in Union City, California. I have been married to Laurel Burkinshaw Quirk for 52 years. Laurel is a Barnard and Columbia Library School graduate. I have two married children and three grandchildren, aged one, two, and five.

Alumni Letter: Sicen Du

Greetings from Beijing!

I hope this message finds every member of the Columbia APAM family in high spirits. It's astonishing how swiftly time has flown since my days on campus, and I'm keen to share some exciting updates from my journey post-Columbia.

After completing my Master's degree in Materials Science and Engineering at Columbia University, the rigorous education at Columbia kindled my passion for materials physics and computational materials. However, as time progressed, I found myself increasingly drawn to the transformative potential of data science and artificial intelligence. Today, I stand at the forefront of the AI arena.

I'm elated to announce that I've joined MiningLamp Technology in Beijing as an NLP Algorithm Engineer, with a primary focus on Large Language Models (LLMs). Here, I am harnessing my expertise in LLMs to drive innovations in the realm of natural language processing. This role has afforded me the privilege of collaborating with some of the brightest minds, delving into the capabilities and applications of advanced language models.

While I've ventured into new challenges and perspectives, my time at Columbia laid a robust foundation for my present trajectory. I'm deeply grateful to Professor Yuan Yang for his invaluable mentorship during my time at the university. Additionally, I'd like to extend special thanks to Professor Katayun Barmak for her unwavering support and guidance. I also owe immense gratitude to Professor James Im and Professor William Bailey for their insights and contributions to my academic journey at Columbia.

As I continue to delve deeper into AI, I remain enthusiastic about collaborating and exchanging insights with peers. Should any APAM member or student harbor interests in Large Language Models, NLP, or any facet of AI, I'd be delighted to connect. I genuinely believe that through collaboration and knowledge sharing, we can shape the future of these fields.

Wishing all current APAM students and faculty continued success, I look forward to the possibility of our paths intersecting again in the near future. Columbia and the APAM community will always occupy a special place in my heart.

Warm regards,

Sicen Du
MS '17, Materials Science & Engineering

In Memoriam:

Bennett Miller (PhD '65, Applied Physics) recently passed away. He graduated from Columbia College in 1959 and, during his undergraduate years, he was class president, Phi Beta Kappa, and a member of the wrestling team. He continued his graduate studies at Columbia University and was Professor Robert Gross' first Plasma Physics PhD student, graduating in 1965.

(Student & Department News, continued)

Inaugural Plasma Physics Summer Student Poster Symposium

The Columbia Engineering Plasma Physics program in the Department of Applied Physics and Applied Mathematics (APAM) held an inaugural summer student poster symposium on August 11, 2023.

This summer, 14 summer undergraduate and masters students carried out projects in the Plasma Physics group. These students presented their work in a poster symposium format at the end of the summer, which was well attended by the plasma and broader APAM community. The students discussed their research with peers and gained valuable experience in preparing and giving presentations.

Anonymous judges visited the posters and spoke with the students. A best poster prize was awarded to Somin Lee and Xueyi Bu for their poster entitled "Improving performance of energetic particle integration".

The event was such a success that we are already planning the second annual symposium next year!

Students presenting posters included:

Mohammed Haque: "Strain optimization of CSX prototype coil design"

Vikram Ailiani: "Analyzing CAKE performance across multiple 0D and 1D profile features"

Kalen Richardson: "Columbia Stellarator Experiment"

Sebastian Gomez: "Automated Production of Cryogenic Pellets in the PAC Experiment"

Arian Timm: "Summer Tale's From the Tokamak"

John Labbate: "Analyzing mode stability to identify stable operating regions for the novel SMART tokamak"

Alastor Sherbatov: *"Development of Toroidal Field Supports for CUTE"*

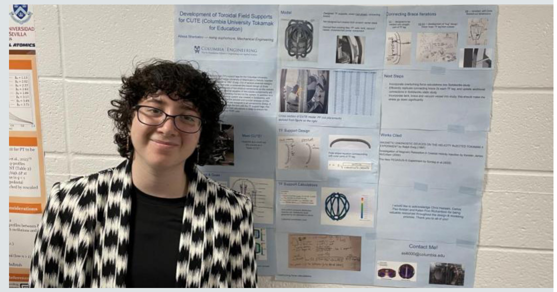
Jacobo Lang: "Pellets @ Columbia Summer 2023"

Sander Miller: "Python Script for Translation of Mesh Files from VALEN to ThinCurr"

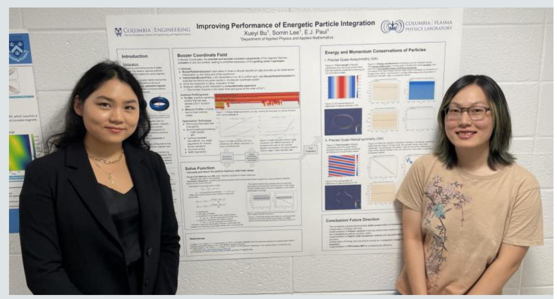
Siwanta Thapa: "Coil optimization using Boozer surface approach"

Somin Lee and Xueyi Bu: "Improving performance of energetic particle integration"

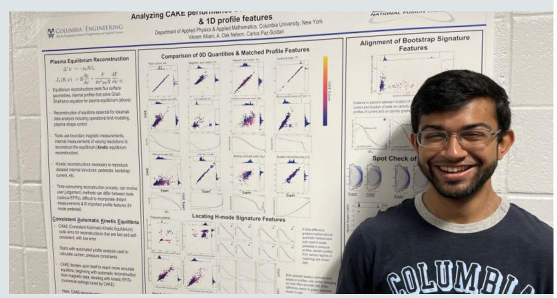
Anonymous judges visited posters & spoke with students



Alastor Sherbatov: "Development of Toroidal Field Supports for CUTE"



The "best poster prize" was awarded to Somin Lee and Xueyi Bu (above) for their poster entitled "Improving performance of energetic particle integration".



Vikram Ailiani: "Analyzing CAKE performance across multiple 0D and 1D profile features"

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Contact Us

We'd love to hear from you and stay connected! Follow us on social media and please send your news and updates to **apam@columbia.edu**

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