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APAM NEWS

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

Dear APAM Family:

What an eventful and successful year for APAM!

From our most recent student award winners (Norman Nan Shi, Jyotirmoy Mandal, Daniel Edelberg, Betty Hu, and Evan Spotte-Smith) to our most recent faculty award winners and honorees (Alex Gaeta, Michal Lipson, Cev Noyan, and Latha Venkataraman)!

From our remarkable research in the materials science of quantum dots and batteries, to that in weather modeling and in plasma physics — and to all of the stellar research by our undergraduate and graduate students!

This term we were honored by the visit of DOE Under Secretary Paul Dabbar to our plasma physics program.

We happily remember our cherished retired colleagues John and Marlene Arbo, and take a moment to bid a fond farewell to our friends and colleagues Paul Duby and Ed Nickoloff, who helped make APAM the great place it is.

I wish all of you a fun-filled (and productive) summer, and look forward to you joining us (at least in spirit) in September for a new and exciting academic year!

Best,

Irving P. Herman
Chair, APAM

Photo (left-right): APAM Chair Irving Herman, Senior Advisor to DOE Under Secretary Lane Genatowski, DOE Under Secretary Paul Dabbar, Prof. Mike Mauel, SEAS Dean Mary Boyce, Dr. Steve Sabbagh, Prof. Gerald Navratil, Dr. Jeff Levesque, and Columbia Executive Vice President for Research Michael Purdy. See p. 9 for details.

Dr. Norman Nan Shi Wins 2019 Robert Simon Memorial Prize

Dr. Norman Nan Shi

The Robert Simon Memorial Prize is awarded annually by the APAM Department to the graduate student who has completed the most outstanding dissertation. This year's prize was awarded to **Dr. Norman Nan Shi**.

Dr. Shi received his Ph.D. from Columbia University in May 2018, where he was advised by **Prof. Nanfang Yu**. His dissertation, entitled "Biological and Bioinspired Photonic Materials for Passive Radiative Cooling and Waveguiding," focused on studying and understanding optical and thermal properties of insects living in harsh thermal environments, and then developing biomimetic nanophotonic devices that utilized these unique properties towards applications in sustainable energy and image transport. Dr. Shi was first author on articles related to these researches in *Science* (2015) and *Light: Science & Applications* (2018).

Dr. Shi received his B.S. in Materials Science and Engineering, with a minor in Energy and Resources from the University of California, Berkeley in 2009. Prior to pursuing a graduate degree at Columbia University, Dr. Shi worked as a characterization engineer in the field of renewable energy (2009-2011). While at Columbia University, Dr. Shi was the recipient of the NSF IGERT fellowship (2012-2013) and the DOE office of Science Graduate Research fellowship (2015-2016).

Following his Ph.D., Dr. Shi served as a post-doctoral research scientist at the Palo Alto Research Center, where he contributed to the development of photonic based instruments and devices in the field of cell sorting and energy distribution. Currently, Dr. Shi is an optical engineer at Western Digital, contributing to the development of the next generation nanophotonic system used in heat assisted magnetic recording (HAMR).

History of the Prize: *Robert Simon (1919-2001) spent a lifetime making valuable contributions to the field of computer science. He received a B.A. degree cum laude in Classics from CUNY in '41 and an M.A. in Mathematics from Columbia in '49. He was a Lieutenant in the U.S. Armed Forces serving in England, France, and Italy. He worked for 15 years at Sperry's Univac Division and also worked at the Fairchild Engine Division as Director of the Engineering Computer Group. He directed the establishment of several company computer centers at sites throughout the U.S. and was a partner with American Science Associates, a venture capital firm. He was a founder and Vice President of Intech Capital Corporation and served on its board and a founder and member of the board of Leasing Technologies International, Inc. until his retirement. The Prize was established by Dr. Jane Faggen with additional support from friends and relatives of Mr. Simon.*

Jyotirmoy Mandal

Jyotirmoy Mandal Named a Schmidt Science Fellow

by Holly Evarts, originally published by *Columbia Engineering*

Jyotirmoy Mandal, Ph.D. candidate, has been selected as a Schmidt Science Fellow, an innovative post-doctoral program focused on developing the "next generation of interdisciplinary science leaders to tackle the world's most significant problems and maximize scientific opportunities for society."

He is one of 20 young researchers from 15 countries chosen for this program, now in its second year that was founded by Eric and Wendy Schmidt in partnership with the Rhodes Trust. Each fellow is awarded a stipend of $100,000 and receives personalized mentoring from experienced and internationally accomplished scientists.

For his doctoral studies, Mandal, who works with Yuan Yang, assistant professor of materials science and engineering, and in collaboration with Nanfang Yu, associate professor of applied physics, has focused on spectrally selective designs. One of his works, on a paintable polymer coating that can passively cool buildings, was published in *Science*, while another, on a selective solar absorber design for harvesting solar heat was published in *Advanced Materials*. Having grown up in Bangladesh, Mandal has sought to create these designs using common materials and simple techniques, and is working towards their implementation in developing countries.

As a postdoctoral scholar, Mandal plans to study the fundamentals of optical design, and combine the knowledge he gains with his current expertise to create low-cost optical components for next-generation cameras and imaging systems.

"I am thankful for this exciting opportunity to embark on this new field and broaden my scientific knowledge," says Mandal, who received his BA degree in physics and mathematics, with a minor in materials science and engineering, in 2014. "The Schmidt Science Fellowship is an extraordinary honor, which will support my desire to simultaneously understand the fundamentals of optics and pursue the design of novel and inexpensive technologies that address critical needs in resource-poor communities. This has been possible because of the guidance and support from my advisor, colleagues at Columbia and Vanderbilt Universities, friends, and my family, and I am deeply grateful to all of them."

Through an initial commitment of at least $25 million for the first three years, the Schmidt Science Fellowship program is part of a broader $100 million effort by Eric and Wendy Schmidt to promote scientific leadership and interdisciplinary research over the next decade and beyond. In addition to their $100,000 award stipends, fellows, once they have received their Ph.D.s, are placed in world-leading research environments that offer a disciplinary pivot from their current work so that they are exposed to new ideas and techniques from a different scientific discipline.

2018-2019 Degree Recipients

B.S. October 2018
Devin Etcitty (AM), Helen Leddy (AM), Alexander Vera (AP)

M.S. October 2018
Alexander Battey (PP), Michael Berkson (MSE), Juan Riquezes (PP), Justin Ugbo (AM), Rulan Xiao (AM)

M.Phil. October 2018
Melanie Bieli (ATMOS), Owen Evans (ATMOS), Jiayang Hu (MSE), Chia-Hao Liu (SS), Yunzhe Tao (AM), Jeffrey Taylor (SS)

Ph.D. October 2018
Bernard Lipat (AM), Hongjian Qi (SS), Dennis Wang (SS)

B.S. February 2019
Umar Mohd Abdul Karim (AM), Charles Wang (AM)

M.S. February 2019
Ilyes Benslimane (MP), Andrew Black (AP), Ziyu Cai (MSE), Israel Chavarria (MP), Yuga Tejaswi Chitrapu (MSE), Michael Cohen (MP), Tiago Correia (AM), Philip Dinenis (AM), Wen Ding (AM), Shimon Dukhovny (AM), Zeenia Dumasia (MSE), Tingting Fan (MSE), Ho Kwan Fung (AM), Xun Gao (MSE), Weichang Ge (MSE), Xinpei Geng (MSE), Tianyao Gong (MSE), Kangan Hu (MSE), Baili Huang (MSE), James Huang (MSE), Jiaqi Huang (MSE), Kuang Huang (AM), Xiaoyan Huang (SS), Zeyu Hui (MSE), Tianwei Jin (MSE), Jonathan Karp (SS), Alessandro Lauro (AM), Benjamin Lavon (AM), Alex Li (MSE), Kathy Li (AM), Zhaochen Li (MSE), Shizhuo Liu (MSE), Sirun Liu (MSE), Siyang Liu (MSE), Yu Cheng Liu (MP), Chenxing Luo (MSE), Yanran Ma (MSE), William Martin (MP), Richard Oliver (SS), Kavya Prasad (MP), Navaneeth Ravindranath (AM), Alex Saperstein (PP), Bonan Shen (MSE), Changmin Shi (MSE), Qingquan Song (MSE), Chuyu Sun (MSE), Sugal Sutter (AP), Olga Talarico (MP), Laiyuan Tan (MSE), Yu Tang (MSE), Songsheng Tao (SS), Tianqi Wan (MSE), Hongjin Wang (MSE), Shih-Chieh Wang (MP), Yini Wang (MSE), Jingyi Weng (MSE), Yehua Xie (MSE), Emma Xu (MSE), Lee Xu (MP), Yusheng Yang (MSE), Ziyang Yu (MSE), Meng Yuan (MSE), Haochen Zhang (MSE), Jiachen Zhu (MSE), Longping Zhu (MSE), Jingyi Zhuang (MSE)

M.Phil. February 2019
Peter Bullen (SS), Shaowen Chen (SS), Adam Overvig (SS), Sajan Shrestha (SS), Oded Stein (AM), Sai Sunku (SS), Wentao Xu (AM)

Ph.D. February 2019
Yi Lin (SS), Anirban Sinha (AM), Yunzhe Tao (AM)

B.S. May 2019
Max Aalto (AM), Sawal Acharya (AM), George Austin (AM), Sasaank Bandi (MSE), Phil Beylison (AM), Xin Chen (AP), Shengyao Du (AP), Daniel Edelberg (AM), Mehrzad Farnoosh (MSE), Abhiram Gaddam (AM), Roy Garcia (AP), Christopher Gaw (AM), Bianca Cristina Gotuaco (AM), Betty Hu (AP), Shuyi Huo (AM),
Yutong Jiang (AM), Christian Joseph (MSE), Jin Woo Jung (AM), Shikun Ke (AM), Rebecca Latto (AP), Ayeong Lee (AM), Yiwei Lian (AM), Yuxuan Liu (AM), Diana Masch (AM), Benjamin McCaffrey (MSE), Abraham Oh (MSE), Maria Ines Padilla (AM), Kaitlynn Pugliese (AM), Lu Qiao (AM), Michael Qu (AM), Ashley Rodriguez (AM), Susmitha Sayana (AM), Yifan Shen (AM), Leying Shi (AM), Aren Small (MSE), Evan Spotte-Smith (MSE), Donald Swen (MSE), Lindsey Tensen (AM), Calvin Tong (AM), Chengcheng Xin (AP), Haoran Zhang (AM)

M.S. May 2019
Jonathan Ang (AP), Rachel Berglas (AM), Preston Bradham (AM), Jeffrey Ludwig (AM), Guang Peng (MP), Saumya Puthenveettil (AM), Sean Thatcher (AP), Allen Wu (MSE), Ken Zhao (AM)

M.Phil May 2019
John Brooks (PP), Cheng-Chia Tsai (SS), Christopher Wright (MSE), Jared Ginsberg (SS)

Ph.D. May 2019
Peter Bullen (SS), Roshan Sharma (ATMOS), Jeffrey Taylor (SS), Haowei Zhai (MSE), Jiao Li (AM)

AM - Applied Mathematics, AP - Applied Physics, MP - Medical Physics, MSE - Materials Science & Engineering, PP - Plasma Physics, SS - Solid State Physics

Undergraduate Award Winners

Three seniors were presented with awards at the APAM Senior Dinner on Thursday, May 2. Each winner was selected by the faculty in recognition of their excellent academic achievements.

Daniel Edelberg - *Applied Mathematics Faculty Award*

Daniel is from Princeton, NJ, and has also lived in Paris, New York, and Boston. He is an applied math major who is interested in the applications of mathematics and computer science to healthcare decision-making. For the past four years, Daniel has worked with Dr. Calum McCrae at the Brigham and Women's Hospital/ Harvard Medical School (Boston, MA) and the Google-American Heart Association-AstraZeneca One Brave Idea project. He presented his research on the use of machine learning for stroke risk assessment at the 7th Annual SEAS Research Symposium in 2018. During his time at Columbia, Daniel has been an EMT for CUEMS, a coach with Youth for Debate, and a CU Well Peer Leader. He has also served as a Teaching Assistant for a number of Applied Mathematics and Computer Science courses. This fall, Daniel will embark on a Ph.D. in Applied Mathematics at Yale University, with a focus on advances in machine learning.

Betty Hu - *Applied Physics Faculty Award*

Betty is originally from Ann Arbor, Michigan. She came to Columbia to study some sort of engineering but switched to Applied Physics after realizing her favorite part of the engineering curriculum was just the physics. She was fortunate to spend the summer after her freshman year working at Cornell in Prof. Kyle Shen's laboratory researching unconventional superconductors. After her sophomore year, she worked at Stanford/ SLAC National Laboratory, where she discovered a love for all things cosmological and computational when she worked with the BICEP/ Keck collaboration to research signal demodulation algorithms to be used in experiments studying the cosmic microwave background. Starting her junior year, she began working with Prof. Zoltan Haiman in the Astronomy Department, looking for novel ways to detect supermassive black hole binaries. On campus, she has been a resident adviser for three years, worked as a teaching assistant for numerous classes in the Math Department and APAM, and taught sex education in public schools around the city through Peer Health Exchange. After graduation, Betty will attend Harvard to pursue a Ph.D. in physics.

Evan Spotte-Smith - *Frances B.F. Rhodes Prize for Materials Science*

Evan was born and raised in Columbia, MD. He declared his major in the Materials Science program because he believed that the classes would be easy and fun. While he was wrong about the difficulty of the program, he has thoroughly enjoyed and excelled in his classes, maintaining a GPA above 3.9. Beyond his coursework, Evan has been actively engaged in research for much of his undergraduate program. At Columbia, Evan served as the Lead Undergraduate Researcher in the Herman Group for three years, working on experiments related to nanoparticle self-assembly on campus and at Brookhaven National Laboratory. During the last year, Evan has also worked on a new project, using computational techniques to identify materials for thermal energy storage with the Hacking Materials group at Lawrence Berkeley National Laboratory. Evan's interests have taken him outside of Columbia's campus, working with communities close to home and far away. For over two years, he taught and mentored students as part of an after-school program at the Brooklyn Latin School. Meanwhile, his interest in sustainable development brought him to Columbia University Engineers Without Borders, where he served in a variety of roles to develop agricultural processing and rural electrification projects in the Teso Sub-Region of Uganda. He will soon return to Uganda for the third time, as a Travel Mentor and Trip Lead. After he returns to the U.S., Evan will begin his doctoral studies at the University of California, Berkeley, where he will work under Prof. Kristin Persson.

Evan Spotte-Smith was also the APAM Department nominee for the SEAS Wendell Prize for character, scholarship, and service.

Latha Venkataraman, the Vice Provost for Faculty Affairs & the Lawrence Gussman Professor of Applied Physics Chair

Venkataraman Appointed Vice Provost of Faculty Affairs & the Lawrence Gussman Professor of Applied Physics

Latha Venkataraman, Professor of Applied Physics and Chemistry, was appointed as Vice Provost for Faculty Affairs in January 2019. Effective July 1, 2019, she will also be named the Lawrence Gussman Professor of Applied Physics Chair.

Provost John H. Coatsworth stated online, "I am pleased to welcome the newest member of the Office of the Provost, Latha Venkataraman, who I have appointed as Vice Provost for Faculty Affairs. Latha, a Professor of Applied Physics and of Chemistry, previously served on the University-wide Tenure Review Advisory Committee. As Vice Provost, she develops the University's policies governing the appointment of its academic officers, manages Columbia's tenure review system, and authorizes leaves on behalf of the President. She serves as a resource for deans, chairs, the University Senate and other offices, and individual faculty on academic appointments and regulations."

Vice Provost Venkataraman joined Columbia in 2003. Her research focuses on developing and using novel instruments to make and study electronic circuits at the nanometer scale where the functional element is a single-molecule, a collection of a few atoms. Over the past few years, her research group has developed methods to not only measure the current that flows across a single molecule, but also the force required to break such a circuit and the amount of electricity one can generate using heat in these devices. Her research is highly interdisciplinary and she has received prominent awards including the National Science Foundation Career Award, Packard Fellowship for Science and Engineering, and the Alfred P. Sloan Fellowship in Chemistry.

Research from Prof. Venkataraman's group was recently published in the article, "Non-chemisorbed gold–sulfur binding prevails in self-assembled monolayers," in *Nature Chemistry*. Improved mechanistic understanding will help answer the question of how predominantly chemisorbed sulfur-gold SAMs can be reliably formed under ambient conditions, if at all. This will help focus efforts to identify new linker groups, and/or preparation methods, that facilitate the construction of more stable SAMs with increased electronic transparency and stability. The effect of surface pre-treatments on the molecule-substrate bonding of gold-thiol SAMs is likely also a rich area of further study/reinterpretation. https://doi.org/10.1038/s41557-019-0216-y

Gaeta Receives 2019 OSA Charles Hard Townes Award

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Alexander Gaeta, the Rickey Professor of Applied Physics & Materials Science

The Optical Society (OSA) named Alexander Gaeta the 2019 Charles Hard Townes Award recipient. Gaeta was recognized for his seminal contributions to chip-based nonlinear photonics, nonlinear optics in photonic crystal fibers and nonlinear propagation of ultrashort laser pulses.

"Technologies emerging from basic research in quantum and nonlinear photonics can be traced in many instances to the achievements of Alexander Gaeta," said 2019 OSA President Ursula Gibson. "For more than two decades, his discoveries and inventions have been a driving force in the quantum revolution unfolding from advances in optics and photonics."

Gaeta received a Ph.D. in optics in 1991 from the University of Rochester and he is currently the David M. Rickey Professor of Applied Physics and Materials Science in the APAM Department at Columbia University. He was on the faculty of the School of Applied and Engineering Physics at Cornell University from 1992-2015 and served as director from 2012-2014. He has published more than 230 papers in quantum and nonlinear optics. He is the founding Editor-in-Chief of *Optica* and is a Fellow of the OSA, APS, and IEEE. He holds 10 patents and co-founded PicoLuz, Inc.

He has made pioneering contributions to the fields of quantum and nonlinear photonics. These include key advances to nonlinear wave propagation that provided critical understanding to self-focusing and filamentation of ultrashort laser pulses, the generation of slow light via stimulated scattering, and nonlinear processes in photonic crystal fibers. Gaeta and his group have also performed seminal research in nonlinear nanophotonics that enabled photonic-chip dispersion engineering, optical frequency combs, generation of quantum states of light, and all-optical signal processing.

Established in 1980, the Townes Award recognizes an individual or group for outstanding experimental or theoretical work, discovery or invention in the field of quantum electronics. The medal honors Charles Hard Townes, whose pioneering contributions to masers and lasers led to the development of the field of quantum electronics. Bell Laboratories, Hewlett-Packard, The Perkin Fund and students and colleagues of Charles Townes endow the award.

Noyan Wins 2019 Hanawalt Award

I. Cevdet Noyan, Professor of Materials Science and Engineering and of Earth and Environmental Engineering and former APAM Chair, won the 2019 Hanawalt Award from the International Centre for Diffraction Data (ICDD). He was selected for this honor for his many relevant contributions to X-ray diffraction methods and for the depth and breadth of knowledge in combining materials science and diffraction characterization. Among the most recent contributions specifically addressed to Powder Diffraction, the Hanawalt Award Selection Committee considered the recent articles published by his group in the *Journal of Applied Crystallography* 48 (2015) 1212-1227 and 50 (2017) 1307-1322, showing a rigorous physical modeling of the scattering processes from nanocrystalline materials. Noyan is the second faculty member in the APAM Department to receive the Hanawalt Award. Prof. Simon Billinge won the award in 2010.

Lipson Elected into National Academy of Sciences & Awarded 2019 Comstock Prize in Physics

by Joanne Hvala, originally published by *Columbia Engineering*

Michal Lipson, the Eugene Higgins Professor of Electrical Engineering & Professor of Applied Physics

Michal Lipson, Eugene Higgins Professor of Electrical Engineering and professor of applied physics, as well as a Columbia Nano Initiative Executive Committee member, has been elected to the National Academy of Science (NAS) in recognition of her "continuing and distinguished achievements in original research." She is one of 100 new members and 25 foreign associates who were announced on April 30, 2019. Earlier this year, Lipson was awarded the Comstock Prize in Physics by the NAS for her pioneering research in silicon photonics. The prize, which is awarded about every 5 years to a North American resident for a recent, innovative discovery in electricity, magnetism, or radiant energy, was presented to Lipson at a ceremony on April 28 in Washington, D.C.

Lipson's pioneering research established the groundwork for silicon photonics, a growing field in which she remains a pioneer and leader. The technology, which uses optical rays to transfer data among computer chips, is now considered to be one of the most promising directions for solving major bottlenecks in microelectronics.

"I am deeply honored to be elected to membership in the National Academy of Sciences and to be among so many distinguished men and women in the Academy," said Lipson.

Lipson investigates the physics and applications of nanoscale photonic structures and is particularly interested in light-confining structures that can slow down, trap, enhance, and manipulate light. Her innovations involved techniques to tailor the electro-optic properties of silicon that led to the first major advances in silicon photonics, including demonstrating the ability to confine light well beyond the traditional diffraction limit using what she termed "slot waveguides." These waveguides are being applied for many applications, including telecommunications, bio-sensing, and on-chip transport of nano-particles.

Lipson's work has played a major role in advancing the field of silicon photonics. Among her many discoveries, she has demonstrated the first silicon photonics GHz modulator for transmitting electronic signals over large distances with low power. Today silicon photonics is being commercialized extensively. It is one of the very few areas in applied physics ever to be adopted by industry fewer than 10 years after its conception. Her research interests are constantly evolving to keep up with important trends, and her Lipson Nanophotonics Group now includes expertise in areas ranging from imaging of the brain to energy recycling.

The co-author of more than 200 scientific publications, which have collectively been cited more than 35,000 times, Lipson is one of the most highly cited researchers in modern physics and holds more than 20 patents.

Lipson joined the Columbia Engineering faculty and the Columbia Nano Initiative in 2015. In addition to the Comstock Prize, she has received other honors, including the 2019 IEEE Photonics Award, the Optical Society's (OSA) R. W. Wood award, MacArthur Fellowship, Blavatnik Award, IBM Faculty Award, and the NSF Early Career Award. In December 2018, she was awarded an honorary doctorate degree by Trinity College at the University of Dublin. Since 2014 she has been named every year by Thomson Reuters as a top 1 percent highly cited researcher in the field of physics. She has held several leadership positions in the scientific community, including serving on the boards of the IEEE Photonics Society and OSA.

Faculty Updates

Prof. Katayun Barmak was a featured speaker at the Women in Engineering Day on April 19, hosted by Columbia Engineering's undergraduate chapter of the Society of Women Engineers (SWE). The event, hosted by Dean Mary Boyce, featured 5 faculty members who spoke about their current research and also offered advice and insights from their career paths.

Prof. Kyle Mandli will host a workshop on "Future Directions for Enabling Coastal Storm Flooding Prediction for High-Resolution Forecasts and Climate Scenarios" at Columbia from October 24-25. Coastal hazards related to strong storms are one of the most frequently recurring and wide spread hazards to coastal communities today and in the future. These flooding hazards include storm surge, wind-waves and extreme precipitation all of which are predicted to grow in danger with climate change impacts. The purpose of this workshop is to gather people from across the academic and government to discuss what future directions computational modeling of these hazards is going and should go to better enable protection of our coastlines under the current and future threat of climate change.

Prof. Gerald Navratil will host the 24th Workshop on MHD Stability Control at Columbia from October 28-30. The workshop theme is "Key MHD Control Issues on the Path Towards a Compact Fusion Pilot Plant." It embraces the focus of the Community Planning Process, building on the National Academy recommendation that, "the United States should start a national program of accompanying research and technology leading to the construction of a compact pilot plant that produces electricity from fusion at the lowest possible."

Prof. Adam Sobel was featured in CBS News article, "Record-breaking jet stream accelerates air travel; flight clocks in at 801 mph," by Jeff Berardelli. "The last couple weeks the atmosphere has been in a much more El Niño-like state because it's teaming up with another natural climate phenomena known as the Madden–Julian Oscillation (MJO)," said Sobel. "The MJO is associated with clusters of thunderstorms and bursts of westerly winds."

Prof. Michael Tippett, was featured in the article, "Is climate change making U.S. tornadoes worse?" by Nsikan Akpan in PBS News Hour online. "There's a lot of interest nowadays in how climate change is going to affect aspects of weather, especially extreme weather — whether it's droughts, heat waves, floods or hurricanes," said Tippett.

How Surface Ligands Influence the Lattice Dynamics of Cadmium Selenide Quantum Dot Nanoparticles

Simon Billinge, a Professor of Materials Science and Engineering and Applied Physics and Applied Mathematics and a Scientist at Brookhaven National Laboratory, along with APAM alumn, Chenyang Shi (Ph.D. '15, Materials Science and Engineering), were recently featured in the following article by Mary Alexandra Agner. It was originally published as highlight on the Advanced Photon Source/ Argonne National Laboratory website.

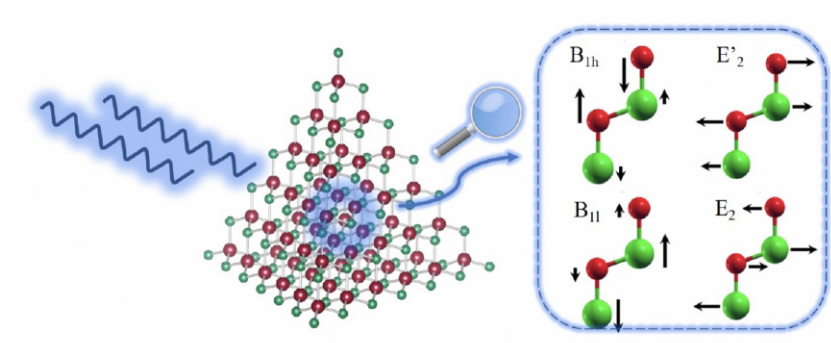
These days, when one has an epiphany, it's a figurative solid-state light bulb that lights up over one's head. Those energy-conscious, white-light spectrum bulbs could benefit from the characteristics of semiconducting quantum dot nanoparticles – an alternative to the currently-used solid phosphors. In order to leverage these nanoparticles' valuable properties, material scientists need a thorough understanding of their lattice structure and energy dynamics and how those characteristics differ between a bulk sample of the crystal and the nano-sized one. Unfortunately, the most widely-used materials characterization methods are tailored to bulk crystals. However, recent research efforts carried out at the U.S. Department of Energy's Advanced Photon Source (APS) and National Synchrotron Light Source II (NSLS-II) have yielded new structural and energetic insights into quantum dot nanoparticles by pairing a new technique for precisely-generating cadmium selenide quantum dots with the x-ray scattering techniques. In addition to demonstrating the advantages of this combination, the researchers concluded that the nanoparticle material could be intentionally manipulated to select for certain desired electronic behaviors.

Quantum dot nanoparticles are of interest in applications ranging from electronics to biology because of their optoelectronic properties. These include their size-tunable band gaps, high efficiency at producing light, and long-term stability. The key challenges in utilizing a specific nanoparticle are two-fold: determining its structure with atomic precision, and detailing the energy dynamics of its lattice. When characterizing the lattice, scientists are most interested in atomic bonding and the behavior of atomic collective excitations (phonons). Phonons are quantum atomic vibrations generated in the lattice and from the phonon density of states, scientists can calculate many thermodynamic properties relevant in optoelectronic applications.

The research team in this study, comprising members from Columbia University, Miami University, Argonne National Laboratory, Brookhaven National Laboratory, and the American Physical Society, began by generating gram quantities of identical cadmium selenide quantum dot nanoparticles. These quantum dots are important and novel because they are atomically precise. This atomical precision allowed the team to determine the dots' structure by applying pair distribution function analysis to powder x-ray scattering diffraction data taken of the nanoparticles at beamline 28-ID-2 at NSLS-II, an Office of Science user facility at Brookhaven National Laboratory.

The combination of atomical precision and a structure solution allowed the team to use density functional theory to derive theoretical values for the phonon density of states, which they then measured using the HERIX spectrometer at Sector 30 of the APS, an Office of Science user facility at Argonne. The team subjected bulk and nanoparticle samples (of three different sizes) to applied high-energy resolution inelastic x-ray scattering with an overall energy resolution of 1.5 milli-electron volt. Figure 1 shows a depiction of this scattering and the vibrational states in the nanoparticle the team was hoping to find. They reduced this scattering data and from it calculated measured values for the phonon density of states for all samples.

When the team compared the phonon density of states – both the theoretical values and the measured ones – for the nanoparticles and the bulk sample, they found that the peaks for the nanoparticles were blue-shifted with respect to the bulk sample. They also found that the peaks which appeared in the bulk sample were significantly broader and less distinct in the nanoparticles' phonon density of states.



Depiction of the x-ray scattering from cadmium selenide quantum dot nanoparticle that, when combined with theory, results in an understanding of the energies of vibrational states (shown on the right)

Because of the small size of the nanoparticles, the team had expected their features in the phonon density of states to be sharper than the bulk sample rather than flattened. Since each sample was atomically precise, they concluded that this flattening occurred because the lengths of the atomic bonds varied across an individual quantum dot sample.

The team was surprised to discover the theoretical calculations predicted a red-shift rather than the blue-shift that was observed. The team found that by adding heavy surface ligands to the calculations, they could replicate the blue-shift observed in their measurements. The team concluded that it should be possible to vary the surface ligand's mass to manipulate the phonon density of states, and thus manipulate the phonon frequencies, which is a result worthy of a very bright lightbulb indeed.

Chenyang Shi[1], Alexander N. Beecher[1], Yan Li[2], Jonathan S. Owen[1], Bogdan M. Leu[3,4], Ayman H. Said[3], Michael Y. Hu[3], & Simon J.L. Billinge[1,5], "Size-Dependent Lattice Dynamics of Atomically Precise Cadmium Selenide Quantum Dots," Phys. Rev. Lett. 122, 026101 (2019).

DOI: 10.1103/PhysRevLett.122.026101

Author affiliations: [1] Columbia University, [2] American Physical Society, [3] Argonne National Laboratory, [4] Miami University, [5] Brookhaven National Laboratory

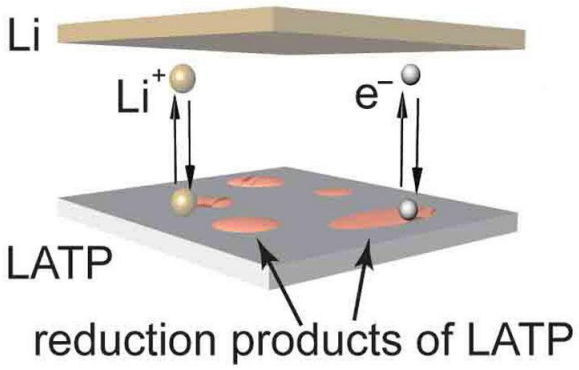
New Technique Produces Longer-lasting Lithium Batteries

by Holly Evarts, originally published by *Columbia Engineering*

Columbia engineers develop a nano-coating of boron nitride to stabilize solid electrolytes in lithium metal batteries, increasing battery life while ensuring battery safety

The grand challenge to improve energy storage and increase battery life, while ensuring safe operation, is becoming evermore critical as we become increasingly reliant on this energy source for everything from portable devices to electric vehicles. A Columbia Engineering team led by **Yuan Yang**, assistant professor of materials science and engineering, announced that they have developed a new method for safely prolonging battery life by inserting a nano-coating of boron nitride (BN) to stabilize solid electrolytes in lithium metal batteries. Their findings are outlined in a new study published by *Joule*.

While conventional lithium ion (Li-ion) batteries are currently widely used in daily life, they have low energy density, resulting in shorter battery life, and, because of the highly flammable liquid electrolyte inside them, they can short out and even catch fire. Energy density could be improved by using lithium metal to replace the graphite anode used in Li-ion batteries: lithium metal's theoretical capacity for the amount of charge it can deliver is almost 10 times higher than that of graphite. But during lithium plating, dendrites often form and, if they penetrate the membrane separator in the middle of the battery, they can create short-circuits, raising concerns about battery safety.



Schematics of the protection mechanism of boron nitride (BN) and characterizations of BN nanofilm. The left visual shows that a Lithium aluminum titanium phosphate (LATP) pellet that touches lithium metal will be immediately reduced. The severe side reaction between lithium and solid electrolyte will fail the battery in several cycles. The right shows that an artificial BN film is chemically and mechanically robust against lithium. It electronically isolates LATP from lithium, but still provides stable ionic pathways when infiltrated by polyethylene oxide (PEO), and thus enables stable cycling. (Image credit: Qian Cheng)

"We decided to focus on solid, ceramic electrolytes. They show great promise in improving both safety and energy density, as compared with conventional, flammable electrolytes in Li-ion batteries," says Yang. "We are particularly interested in rechargeable solid-state lithium batteries because they are promising candidates for next-generation energy storage."

Most solid electrolytes are ceramic, and therefore non-flammable, eliminating safety concerns. In addition, solid ceramic electrolytes have a high mechanical strength that can actually suppress lithium dendrite growth, making lithium metal a coating option for battery anodes. However, most solid electrolytes are unstable against Li—they can be easily corroded by lithium metal and cannot be used in batteries.

"Lithium metal is indispensable for enhancing energy density and so it's critical that we be able to use it as the anode for solid electrolytes," says **Dr. Qian Cheng**, the paper's lead author and a postdoctoral research scientist in the APAM Department who works in Yang's group. "To adapt these unstable solid electrolytes for real-life applications, we needed to develop a chemically and mechanically stable interface to protect these solid electrolytes against the lithium anode. It is essential that the interface not only be highly electronically insulating, but also ionically conducting in order to transport lithium ions. Plus, this interface has to be super-thin to avoid lowering the energy density of batteries."

The study is titled "Stabilizing Solid Electrolyte-Anode Interface in Li-Metal Batteries by Boron Nitride-Based Nanocomposite Coating" https://doi.org/10.1016/j.joule.2019.03.022.

Authors: Qian Cheng[1]; Aijun Li[1,3]; Na Li[2]; Kai Yan[4]; Shuang Li[2]; Amirali Zangiabadi[1]; Tai-De Li[5]; Wenlong Huang[1]; Alex Ceng Li[1]; Tianwei Jin[1]; Qingquan Song[1]; Weiheng Xu[1]; Nan Ni[1]; Haowei Zhai[1]; Martin Dontigny[6]; Karim Zaghib[6]; Xiuyun Chuan[3]; Dong Su[2]; and Yuan Yang[1,8].

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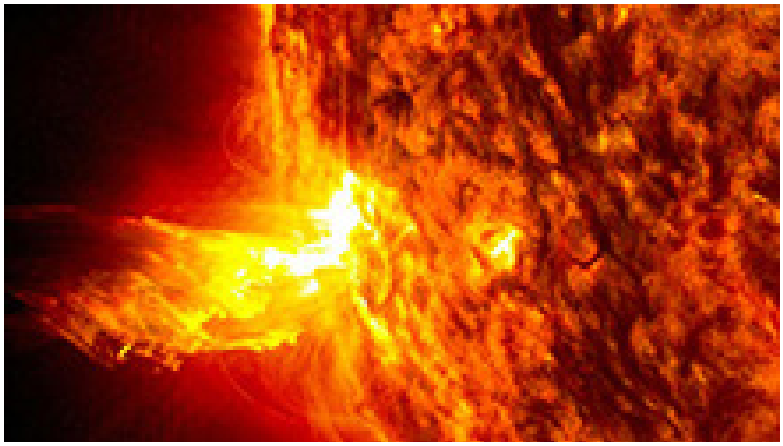
[2] Brookhaven National Laboratory
[3] Key Laboratory of Orogenic Belts & Crustal Evolution, School of Earth & Space Sciences, Peking University, Beijing
[4] Amprius Inc., California
[5] CUNY-Advanced Science Research Center, New York
[6] Centre of Excellence in Transportation Electrification and Energy Storage (CETEES), Hydro-Quebec, Canada

The study was supported by the Air Force Office of Scientific Research (FA9550-18-1-0410) and Research Corporation for Science Advancement (Award #26293), and the NSF MRSEC program through Columbia in the Center for Precision Assembly of Superstratic and Superatomic Solids (DMR-1420634).

To address these challenges, the team worked with colleagues at Brookhaven National Lab and the City University of New York. They deposited 5~10 nm boron nitride (BN) nano-film as a protective layer to isolate the electrical contact between lithium metal and the ionic conductor (the solid electrolyte), along with a trace quantity of polymer or liquid electrolyte to infiltrate the electrode/electrolyte interface. They selected BN as a protective layer because it is chemically and mechanically stable with lithium metal, providing a high degree of electronic insulation. They designed the BN layer to have intrinsic defects, through which lithium ions can pass through, allowing it to serve as an excellent separator. In addition, BN can be readily prepared by chemical vapor deposition to form large-scale (~dm level), atomically thin scale (~nm level), and continuous films.

"While earlier studies used polymeric protection layers as thick as 200 µm, our BN protective film, at only 5~10 nm thick, is record-thin—at the limit of such protection layers—without lowering the energy density of batteries," Cheng says. "It's the perfect material to function as a barrier that prevents the invasion of lithium metal to solid electrolyte. Like a bullet-proof vest, we've developed a lithium-metal-proof 'vest' for unstable solid electrolytes and, with that innovation, achieved long-cycling lifetime lithium metal batteries."

The researchers are now extending their method to a broad range of unstable solid electrolytes and further optimizing the interface. They expect to fabricate solid-state batteries with high performance and long-cycle lifetimes.



This image shows the bright light of a solar flare on the left side of the sun and an eruption of solar material shooting through the sun's atmosphere, called a prominence eruption. Shortly thereafter, this same region of the sun sent a coronal mass ejection out into space.

Debunking the Solar-Cycle/North Atlantic Winter Weather Connection

by Holly Evarts, originally published by *Columbia Engineering*

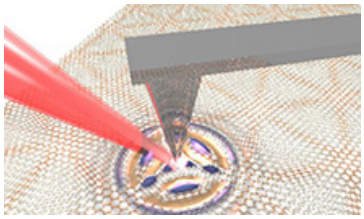
A new *Nature Geoscience* study from Applied Physics and Applied Mathematics (APAM) and Lamont Doherty researchers has upended a commonly accepted theory that variations in the energy emitted by the sun affect weather patterns in the North Atlantic and the likelihood of storms and floods over Europe. The North Atlantic Oscillation (NAO) is considered a key driver of winter weather patterns over the northern hemisphere. A positive NAO is linked with more windstorms, and mild and wet winters in Europe. A negative NAO indicates snowy and cold winters in Europe.

In recent years, published research has claimed the existence of a correlation between the NAO and the 11-year solar cycle, a periodic change in the sun's activity. That claim has held that the connection between the NAO and the solar cycle is strong enough to inform predictions of the NAO as much as a decade in advance, which would in turn, enable scientists to predict winter weather patterns as many as ten years in advance.

APAM research scientist **Gabriel Chiodo** and Ph.D. student **Jessica Oehrlein**, together with **Prof. Lorenzo Polvani** (also a professor of Earth and Environmental Sciences) showed in the new study that there is no robust connection between the solar cycle and the NAO. Their paper essentially debunks what was considered a "demonstrated link" between the 11-year sun cycle and winter weather over the northern hemisphere and found that it is, for the most part, a coincidental alignment. Using sophisticated computer modeling and extended observations, they demonstrated that before 1960 evidence of any correlation simply vanishes.

The implications of these new findings are substantial both for Europe and for science. The older correlation claim, if substantiated, would have meant great advantages to societies in the northern hemisphere, giving enough warning of periods of intense storms and flooding to inform community planning efforts. But this new finding—"Insignificant influence of the 11-year solar cycle on the North Atlantic Oscillation"—will be important for climate research into the future, as it implies that the causes for decadal weather changes over Europe lies elsewhere, not in the solar variations. DOI: 10.1038/s41561-018-0293-3

Impact of the QBO on MJO Convection in Cloud-Resolving Simulations: APAM Ph.D. candidate, **Zane Martin**, and APAM Associate Research Scientist, **Dr. Shuguang Wang**, were first authors on a study published by the *Journal of Atmospheric Sciences* which examines the relationship between the Madden–Julian Oscillation (MJO) and the stratospheric quasi-biennial oscillation (QBO) in a limited-area cloud-resolving model with parameterized large-scale dynamics. The study, titled "The Impact of the QBO on MJO Convection in Cloud-Resolving Simulations," includes contributions from Ji Nie, from Peking University, and **Adam Sobel**, Professor of Applied Physics and Applied Mathematics and of Earth and Environmental Sciences. https://doi.org/10.1175/JAS-D-18-0179.1



First "Quantum Photonic Crystal" in Graphene

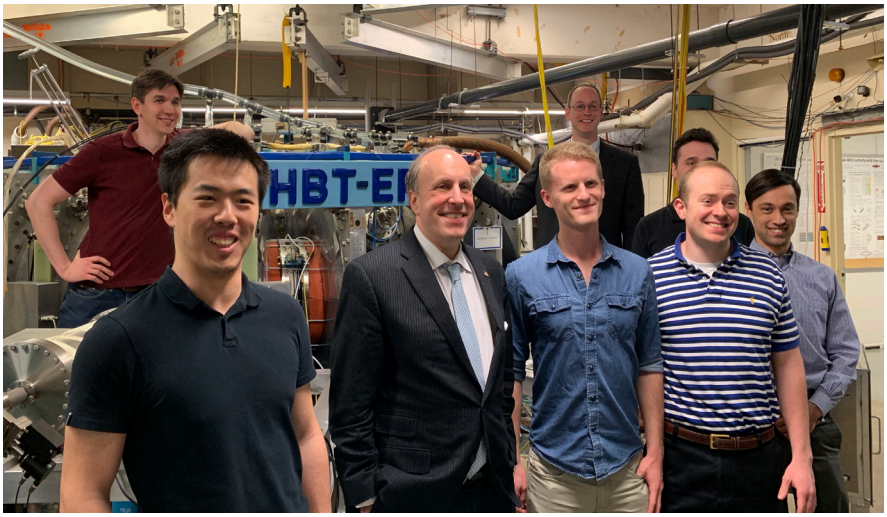
by Holly Evarts, originally published by *Columbia Engineering*

Sai Swaroop Sunku, a Ph.D. student in applied physics, is the lead author of a study, "Photonic crystal for nano-light in moiré graphene superlattices," conducted in the lab of Physics Professor Dmitri Basov. Published in *Science*, the paper examines surface plasmons, or nano-light, which are hybrids of light (photons) and electrons in graphene.

Since the 1980s, scientists have been trying to manipulate plasmons to build smaller and faster interfaces between the transistors in computers and the fiber optic cables that carry data. Plasmons could also be used to transfer data on a chip at low power with little energy loss. Studies done over the past five years, including in the labs of Basov, Mechanical Engineering Professor Jim Hone, and others at Columbia, have shown that plasmons in graphene show great promise for such applications because they are much smaller than actual light waves and can travel long distances. But even though the small size of the graphene plasmons is what scientists want for applications such as data transfer, it has been extremely challenging to make structures small enough to manipulate the nanolight.

Sunku and his team are the first to make a "quantum photonic crystal" in graphene, a structure that can control and direct the nano-light using quantum effects. More importantly, their approach avoids the complications of making tiny structures.

The researchers discovered that they could enhance the plasmonic properties of graphene by introducing and then rotating a second graphene layer so that there is a slight angle between the atomic registry of the layers. Twisting these layers forms a moiré pattern with confined conducting channels that reflect the plasmons in a specific, tunable way. The size of this moiré pattern can be made as small as necessary simply by changing the twist angle between the layers. Thus, by controlling the structure of the pattern, the team was able to create a pathway for a nanophotonic platform that can be used for data transfer on a chip and perhaps even computation. The team is now running more experiments at low temperatures, trying to observe novel effects such as one-dimensional plasmons that are also predicted to occur in this system.



Front Row (left-right) Yumou Wei, Under Secretary Paul Dabbar, Alex Saperstein, Todd Elder, & Rian Chandra. Back row (left-right): John Brooks, Dr. Jeff Levesque, & Ian Stewart

DOE Under Secretary for Science Paul Dabbar Visits Columbia's Plasma Physics Lab

by Michael Mauel

The U.S. Department of Energy's Under Secretary for Science, Paul Dabbar, along with Lane Genatowski, Senior Advisor to the Under Secretary and President Donald Trump's nominee to be Director of the Advanced Research Projects Agency-Energy (APRA-E), and Kristen Ellis, chief of staff to Dabbar, visited the APAM Department on April 9, 2019.

Under Secretary Paul Dabbar's visit included conversations with faculty, research scientists, and students. A highlight of the visit was the tour of Columbia's Plasma Physics Laboratory and the High Beta Tokamak-Extended Pulse (HBT-EP) research facility where students develop and test new technology to control magnetically confined plasma for fusion energy.

Under Secretary Paul Dabbar spoke of the importance of science and innovation to our nation's prosperity, security, and national competitiveness. Fusion energy research is one of seven R&D priorities for the U.S. DOE Office of Science.

The Honorable Paul Dabbar serves as the principal advisor on fundamental energy research, energy technologies, and science for the Department of Energy and is the lead for technology commercialization activities for the Department and its 17 national labs. Paul M. Dabbar, who worked on energy sector mergers and acquisitions for J.P. Morgan for more than 20 years, and graduated with an engineering degree from the U.S. Naval Academy and an MBA from Columbia University.

Plasma Physics Lab Outreach

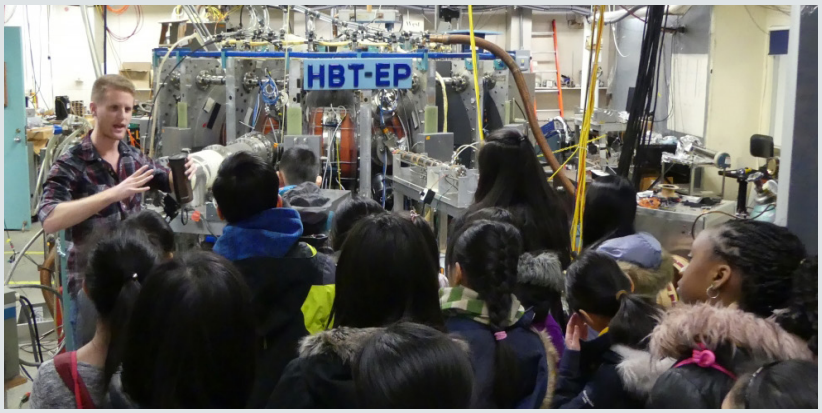
The Plasma Physics Laboratory, led by **Prof. Gerald Navratil** and **Prof. Michael Mauel**, is the site for several high-temperature plasma experiments.

Prof. Navratil and Prof. Mauel oversee the HBT-EP tokamak, which investigates the application of magnetic controls to stabilize plasma instabilities at high pressure. The Plasma Lab is also home to the Collisionless Terrella Experiment (CTX) which studies the long-time, coherent interactions between energetic trapped electrons and a variety of plasma and electromagnetic fluctuations.

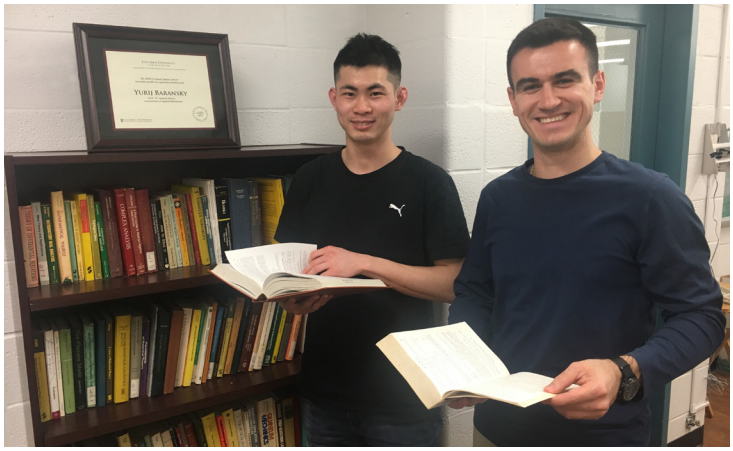
This past semester, the Plasma Lab opened its doors to groups of middle school and high school students in the U.S. and abroad. Prof. Mauel, along with Plasma Lab group members and staff, gave the visitors a lab tour and a brief introduction to fusion energy and plasma physics.

Top photo: APAM Ph.D. candidate, **Alex Saperstein**, spoke to thirty middle school students who visited the Plasma Lab on March 8, 2019 as part of the School of Engineering and Applied Science (SEAS) Outreach Program.

Bottom Photo: APAM Ph.D. candidate, **John Brooks**, led a tour of the HBT-EP tokamak on April 22, 2019 for twenty high school science students visiting from St. Cuthbert's School in Auckland, New Zealand.



Dr. Katherine Marvel, Associate Research Scientist at NASA Goddard Institute for Space Studies and the APAM Department, testified before Congress on May 15th at the "The Economic and Health Consequences of Climate Change" hearing. Her statement is available online at: https://waysandmeans.house.gov/legislation/hearings/economic-and-health-consequences-climate-change



Above: Applied Math graduate students explore the Baransky Library

Book Donation from Yuri Baransky (Ph.D. '87)

Dr. Yuri Baransky (Ph.D. '87, Applied Physics, concentration in Applied Mathematics) donated hundreds of physics and mathematics books from his personal collection to the APAM Department graduate student library. The "Baransky Library" resides inside the Applied Mathematics graduate student office so that students can easily access and share the informative texts while they study. The department warmly thanks Dr. Baransky for his generous contribution which will inspire and instruct generations of APAM students.

APAM Career Events

by Kristen Henlin

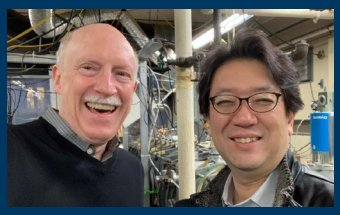
As the Career Placement Officer of the APAM Department, my goal is to support the professional growth of our students outside of the classroom. During the fall semester, undergraduate and graduate students had the opportunity to network with employees from the French bank BNP Paribas, learn about plasma energy from the Naval Nuclear program, and connect with data scientists at Pager Health. APAM graduate students attended a special presentation by Dr. Steve Rabinowitz (Ph.D. '92, Physics), Research Staff Member at the Institute for Defense Analyses, to discuss career opportunities in national security analysis.

In the spring, APAM students met with the CEO of MSQ Ventures, a cross-border venture capital firm focused on partnering U.S. based technology, consumer, and healthcare companies with strategic Chinese corporate and institutional investors. Students also had the opportunity to visit the publishing and financial information firm, Dow Jones HQ to learn about internship and full-time opportunities within their data analytics and software engineering departments. We closed out the year with a very special event for graduate students, led by APAM alum, **Dr. Aron Ahmadia** (Ph.D. '10, Applied Mathematics), to discuss career opportunities in machine learning at Capital One.

Alumni Reports

Ethan Coon (Ph.D. '10, Applied Mathematics) stopped by the department to collaborate with Prof. Marc Spigelman. Dr. Coon is a computational hydrologist in the Climate Change Science Institute at Oak Ridge National Lab. He has a background in applied and computational mathematics, and has done research in applying computational methods for the Earth, especially land surface and subsurface processes. Broadly, he is interested in process-based modeling, integrating models with data, and leverage modeling to understand the processes that govern our changing planet.

Sarah Goler (B.S. '07, Applied Physics) was one of five featured panelists at the Columbia Engineering Alumni Association (CEAA) dinner on April 17, 2019 on "How to get hired from a multi-disciplinary, multifunctional perspective." She earned her Ph.D. in Condensed Matter Physics at Scuola Normale Superiore, Pisa, Italy, in 2014, and currently owns a restaurant and natural wine bar, Tannat Wine & Cheese LLC, with her husband.



Akihisa "Aki" Sekiguchi (Ph.D. '91, Plasma Physics) visited APAM to see Prof. Michael Mauel and the Plasma Lab. Aki is the Deputy Division General Manager of the Corporate Innovation Division at Tokyo Electron Limited (TEL). He is also the Corporate Marketing GM in charge of device technology at TEL. Prior to joining TEL 11 years ago, he worked at IBM Semiconductor Research and Development Center (IBM SRDC) in East Fishkill, New York, for 17 years. At IBM, he worked on process technology development (DRAM, logic) mostly on unit process and module process development (FEOL to BEOL including lithography). During his last three years at IBM, he was the Process Technology Transfer Manager for the "Cell" project (Sony, IBM, Play Station 3) working on all aspects of semiconductor process technology from substrate to final shipped product quality control. He earned B.S. and M. Eng. in Applied & Engineering Physics from Cornell University, M.S. and Ph.D. in Applied Physics from Columbia University, and an MBA in Finance from the Stern School of Business, New York University. His past notable speeches include key notes at SPIE, EUVL Symposium and SEMICON CHINA among others. He is also a member of SEMI Board of Industry Leaders as well as the SEMI CTO Forum representing Tokyo Electron. (Photo: Prof. Michael Mauel & Dr. Aki Sekiguchi)

Francesca Terenzi (Ph.D. '09, Applied Mathematics) stopped by the department last fall to visit with faculty. She is currently a Senior Principal Catastrophe Risk Modeler at Risk Management Solutions, Inc. (RMS) in London where she is involved in the integration of both RMS proprietary models and clients/3rd Party models into RMS(one), cloud based risk management platform.

In Memoriam: Paul F. Duby

We mourn the loss of Prof. Paul F. Duby (1933-2019) who was one of the founding faculty members of the Materials Science & Engineering (MSE) Program. He taught many MSE classes until he retired and was also the adviser of the Columbia Video Network (CVN) MSE Program for over a decade. Prof. James Im said, "He was such a warm hearted and kind person who always melted away the stressful elements around our work environment. I will miss his easy laughter and genuine smile."

The following tribute was written by Joanne Hvala, originally published by *Columbia Engineering*

Paul F. Duby, an *emeritus* professor in the Department of Earth and Environmental Engineering, died at the age of 85. Devoted to his department, the School of Engineering and Applied Science, and Columbia University, Professor Duby is remembered as a scholar, an outstanding researcher, and a superb teacher, whose students have fond memories of his guidance and mentorship. One example of his institutional dedication was his many years of service as a senator in the University Senate, culminating in his chairing the executive committee.

His research was in the areas of extractive metallurgy, electrochemical and hydrometallurgical processes, including the corrosion of metals and wastewater treatment and material recycling. In particular, he focused on electrowinning of rare earth metals from mixtures of molten salts and new electrodes for plating alloys.

Duby received two degrees from the University of Brussels, an Ingenieur Civil Mecanicien at Electricien in 1956 and an Ingenieur Commercial in 1959, before earning his Doctor of Engineering Science degree from Columbia University in 1962. Among the many honors and recognitions he received are the Laureate of the Concours Universitaire, Belgium, and the Medal of the Free University of Brussels.

Several of his former students reflected on Professor Duby's contribution to their lives and careers.

Sam Marcuson, a student of Professor Herbert Kellogg, whom Duby mentored, described Duby as a "courtly professor of the old school," who demanded rigor in his classes and whose interest in his students went beyond the classroom. In 1974, Duby took a station wagon full of students on a field trip to Bethlehem Steel and Pechiney aluminum in Hagerstown, Maryland. Summing up, he said, "Professor Duby cared and this caring made a difference to me and other students."

D. Nagaraj, a chemical metallurgist like Duby, also remembers him as a great teacher. "I took three courses with him. And I vividly remember the classrooms, most of the concepts and diagrams, his handwriting, his soft voice, his smile..... I still have the class notebooks. And I have put all of the learnings from his courses to very good use in my career."

Echoing these sentiments, Professor Brij Moudgil, called Duby "a great teacher, an outstanding researcher, and above all a kind-hearted, gentle human being. He was most caring of students' well-being and was always ready to share his wisdom. He was very approachable to students and professionals alike.

I was fortunate to meet him fairly regularly during my visits to Columbia. He will be sorely missed."

In Memoriam: Edward L. Nickoloff

A long time affiliated faculty member of the Medical Physics Program, **Dr. Edward L. Nickoloff**, from Orangeburg, NY, passed away on March 11, 2019 after a long illness.

Dr. Nickoloff was born in Harrisburg, PA and attended Central Dauphin High School, Carnegie Tech, Lebanon Valley College, the University of New Hampshire, where he received a Master's of Science degree, and the John Hopkins School of Public Health, where he received a Doctor of Science degree with Distinction in 1977.

Dr. Nickoloff was an *Emeritus* Professor of Radiology at the Columbia University College of Physicians and Surgeons and Chief Hospital Physicist at the Columbia University Medical Center for 33 years. He had lectured extensively at scientific conferences across the country; wrote two books on the subject of Radiation Physics - one of which was used extensively in Radiology Residency programs across the USA; published 150 journal articles, 57 peer reviewed journal articles, and 87 abstracts; and held 24 offices in professional organizations.

He is survived by his wife of 35 years, Diane (Zambetti); daughter, Andrea; son, Edward Jr., and daughter-in-law, Katarina. He was an avid reader, Jack of all trades, and outdoorsman.

Originally published in the *The Journal News* on Mar. 13, 2019

John & Marlene Arbo Bring their Affiliation with Columbia to a Close

John Arbo was a cornerstone of the graduate program in Medical Physics (MP) from its inception. For 22 years he served as the MP graduate student academic advisor, taught the *Radiation Instrumental and Measurement Laboratory* courses, and was the coordinator and host of the *Medical Physics Seminar*. In 2008 APAM recognized John for his "Leadership in the Development and Nurturing of the Medical Physics Program" and for his "Service as Instructor of Outstanding Quality and Dedication." In 2010 he was appointed Associate in the Discipline of Applied Physics and Applied Mathematics.

Marlene Arbo's tenure with the department spanned 40 years. Initially an assistant for student and academic affairs, she moved on to become APAM Department Administrator and, in 2007, Medical Physics Program Coordinator.

Both John and Marlene value and fondly remember the rewarding experience of engaging with remarkable students and colleagues on the main and the uptown campuses. To contact the Arbos, email jca10@columbia.edu or mja2@columbia.edu.

2019 Senior Design Expo

The APAM Department's Materials Science seniors participated in the annual Senior Design Expo on May 9, 2019.

(left-right) Sasaank Bandi, Donald Swen, Evan Walter Clark Spotte-Smith, Abraham Oh, Mehrzad Farnoosh, Benjamin McCaffrey, Christian Joseph, Prof. Simon Billinge, and Aren Small

Contributing Authors: Mary Alexandra Agner, John Arbo, Marlene Arbo, Argonne National Laboratory, *Columbia Engineering*, Daniel Edelberg, Holly Evarts, Kristen Henlin, Betty Hu, Irving Herman, Joanne Hvala, *The Journal News*, Michael Mauel, Norman Nan Shi, The Optical Society, Evan Spotte-Smith

Photos/Images: Barbara Alper, Argonne National Laboratory, Eileen Barosso, Simon Billinge, *Columbia Engineering*, Daniel Edelberg, Betty Hu, Jeffrey Levesque, Michael Mauel, Akihisa Sekiguchi, Norman Nan Shi, Evan Spotte-Smith, Timothy Lee Photographers, Yuan Yang, Nanfang Yu

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