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APAM NEWS

THE DEPARTMENT OF APPLIED PHYSICS & APPLIED MATHEMATICS

THE FU FOUNDATION SCHOOL OF ENGINEERING & APPLIED SCIENCE, COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

Photo (left-right): Prof. I.C. Noyan, Kathleen Kennedy (B.S. '16 Materials Science), Prof. Simon Billinge, and Prof. Katayun Barmak

Dear Alumni and Friends of APAM,

Another school year is over. Our graduates and their proud families are gone; convocation signs have been removed from the school and the Department; and we, faculty and staff, have started the task of getting ready for the coming school year.

Looking back we see that 2015-2016 has been a good year for us. Our faculty and students have been achieving good results in all programs; we are showcasing some highlights in this issue of *APAM News*, but there are many more which could have been included.

Our goal remains that of maintaining sustainable growth while working on problems of scientific and societal importance, and transferring such knowledge to our students. Making educated choices based on long-range, multi-step planning is becoming more vital in today's competitive global economy.

I wish all of you a healthy and productive summer term.

Best,

I. Cevdet Noyan
Chair, APAM

In This Issue

Dr. Hande Öztürk, Dr. Jane Faggen, Prof. Latha Venkataraman, Prof. I.C. Noyan, & Dr. Brian Capozzi

Capozzi & Öztürk Share 2016 Simon Prize

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, we have two winners: **Dr. Brian Capozzi** and **Dr. Hande Öztürk.**

Dr. Capozzi earned his B.S. in Physics from Adelphi University in 2010. As an undergraduate, he worked in a lab where he investigated photon entanglement and the principle of complementarity. After graduation, he joined APAM where he earned an M.S. in Applied Physics in 2011.

Dr. Capozzi joined Prof. Latha Venkataraman's lab for his doctoral studies where he completed his dissertation entitled "Environmental Control of Charge Transport through Single Molecule Junctions." His graduate research focused on understanding how electrons flow through single molecules, particularly examining how local environmental factors could be used to tune current flow. In doing so, he developed techniques to create single-molecule analogues of transistors and diodes. These same techniques have also provided a comprehensive experimental method to study the electronic properties of single-molecule circuits. Over the course of his research, he had the pleasure of collaborating with many students and faculty from Columbia's Chemistry department and the Molecular Foundry at Lawrence Berkeley National Lab.

While in the Venkataraman lab, Dr. Capozzi's work resulted in eight publications, including four first-author papers, in top interdisciplinary journals including *Nature Nanotechnology, Nature Chemistry, Nano Letters*, and the *Journal of the American Chemical Society*. One publication demonstrated the best performing single-molecule diodes to date. The paper was featured as a News and Views, and also received attention from several pop-science publications including *Gizmodo*. He is currently exploring a new facet of life, as a data scientist at Macy's, but he certainly does miss physics.

Dr. Öztürk, a native of Turkey, graduated from Bogaziçi University in 2007 with a double major degree in Physics and Mechanical Engineering. Following graduation, she moved to the United States and received her MSc degree in Mechanical Engineering from Boston University in 2009. After one year of postmasters research work at Boston University, she moved to New York in 2010 and started her doctoral studies in the APAM Department under the supervision of Prof. I.C. Noyan. She successfully defended her doctoral dissertation entitled "Computational Analysis of Diffraction in Ideal Nanocrystalline Particles" in August 2015.

Dr. Öztürk's dissertation work focuses on the quantification of the statistical uncertainty that accompanies a typical diffraction signature from a collection of crystalline particles. Dr. Öztürk said, "Following a computational approach, we generated synthetic diffraction data from crystalline powder ensembles by first principal direct modeling and showed that the classical statistical formulations failed to estimate the true sampling uncertainty for particle systems in the nanometer size regime. In an era when every branch of science is switching their focus to exploiting the extraordinary properties of nanomaterials, our results will definitely be of great value in developing more accurate characterization algorithms and will serve to speed up the science of nanomaterials."

Dr. Öztürk is currently a postdoctoral research associate at the Brookhaven National Laboratory and is working with the team at the newly built Hard X-ray Nanoprobe Beamlight at the National Synchrotron Light Source II.

Following her appointment at the Brookhaven National Laboratory, Dr. Öztürk plans to continue on the academic track. She said, "I believe working as a professor at a university provides one with the satisfaction and joy of teaching and mentoring young minds, generating new knowledge and contributing to solving the world's problems. I also believe I have a personal responsibility for setting an example for female students, particularly those who are hesitant to pursue degrees in the STEM fields."

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.

APAM Members Win SIAM Outstanding Paper Prize

The paper, "Analysis and Comparison of Different Approximations to Nonlocal Diffusion and Linear Peridynamic Equations," published in the *SIAM Journal on Numerical Analysis*, by Applied Math graduate student, **Xiaochuan Tian**, and her thesis advisor, Prof. **Qiang Du,** was chosen as one of three papers to receive a 2016 SIAM Outstanding Paper Prize.

This major prize from SIAM is awarded each year to recognize papers that exhibit originality—for example, papers that bring a fresh look at an existing field or that open up new areas of applied mathematics.

Tian's winning paper, which was also her very first publication, provided analysis and comparisons of different algorithms for the numerical solution of nonlocal models such as the peridynamic theory of continuum mechanics. According to Prof. Du, she used elegant analysis and illuminating examples to demonstrate the importance of designing robust algorithms in numerical simulations. She has published several subsequent papers and is expected to graduate in a year.

2015-2016 Graduates

October 2015

B.S. - George Tsai (AM)

M.S. - Warren Fong (MP), Bridget Gormalley (AP), Nadezhda Khapochkina (MSE), Benjamin Shank (AM)

M.Phil. - Maxwell Terban (MSE)

Ph.D. - Brian Capozzi (AP), Michael Jenkinson (AM), Yi Li (MSE), Hande Ozturk (MSE), Chenyang Shi (MSE), Mikhail Treger (MSE), Xiaohao Yang (MSE)

February 2016

B.S. - Christopher Florencio Aleman (MSE)

M.S. - Maxwell Belanger (MP), Ting-Ting Chang (MP), Xianda Chen (MSE), Xingyi Chen (MSE), Arely Clavel (MP), Owen Evans (AM), Xinyuan Gao (MSE), Fernando Goncalves Neto (MSE), Lingfei Guo (MSE), Ziqi Han (MSE), Yuanye Huang (MSE), Chenyuan Hui (MSE), Houwang Li (AM), Yuan Li (MSE), Haoran Liang (MSE), Xun Liao (MSE), Qiyuan Lin (MSE), Lin Liu (MSE), Yuxuan Liu (MSE), Weixi Lu (MSE), Jian Luan (MSE), Kevin Ludwig (MP), Yeying Ma (MSE), Devin Olek (MP), Christopher Peltzer (AM), Fu Qiao (MSE), Yihong Qin (MSE), Vineetha Ram (MP), Xincheng Song (MSE), Sarah Spence (MP), Maria del Mar Torreblanca (AM), Aditya Varshnei (MSE), Haozhen Wang (MSE), Min Wang (MSE), Shenghe Wang (MSE), Chen Xu (MSE), Xin Xu (MSE), Peng Yue (MSE), Shirong Zhang (MP), Baihui Zhang (MSE), Wuyi Zhang (MSE), Yunlong Zhao (MSE), Chengjunyi Zheng (MSE), Qi Zhou (MSE)

M.Phil. - Kenneth Hammond (AP), Chanul Kim (AP), Mordechai Kornbluth (AP), Daniel Shaevitz (AM), Ryan Sweeney (AP)

Ph.D. - Olgun Adak (AP), Sean Harnett (AM), Christopher Stoafer (AP)

May 2016

B.S. - Ramya Ahuja (MSE), Anton Baleato Lizancos (AP), Sean Ballinger (AP), Chloe Blanchard (AM), Maya Chandrasekaran (AM), Joshua Cohen (AP), Richard Creswell (AP), Richard Greene (AM), Marco Groenendaal (AM), Dorcas Huang (AM), Adam Jaffe (MSE), Kathleen Kennedy (MSE), Dillon Kraus (MSE), Yih-Jen Ku (AM), Varun Kumar (AM), Michelle Lee (AM), Shim Young Lee (AM), David Lin (AM), Andrew Liou (AM), Rachel Mester (AM), Ridge Montes (AM), Seth Olsen (AP), Caroline Park (AM), Jihyuon Park (AM), Marc Pelessone (AM), Daniel Puttmann (MSE), Neel Rakholia (AM), Siddharth Ramakrishnan (AM), Harris Shabbir (AM), Robert Shorb (AM), Lucas Vargas Zappetello (AP), Lanruo Wang (AM), Jason Williams (AP), Yuxuan Xia (MSE), Anji Zhao (AM)

M.S. - George Donald (AP), Mark Gluzman (AM), Russell Hanner (AM), Derek Huang (MSE), Rachael Keller (AM), Gaurav Mehta (MSE), Tiffany Morris (AM), Anais Sandra Nguemto (AM), Gabriel Reder (AM), Brian Roche (AM), Manveer Sidhu (MSE), Sai Sunku (AP), Bigeng Wang (AP), Tian-le Wang (AP), Brian Weinstein (AM), Zeyu Ye (MSE)

M.Phil. - Amy Notis (MSE) & Wenkai Pan (AP)

Ph.D. - James Lee-Thorp (AM), Jin Wang (MSE), Ying Wang (MSE)

Certificate: Pippa Storey (MP)

(Photo: Prof. Michael Weinstein & Dr. James Lee-Thorp)

Undergraduate Awards

Photo (left-right): Adam Jaffe, Prof. Michael Mauel, & Dorcas Huang

Applied Physics Faculty Award

Richard Creswell (B.S. '16, Applied Physics with an Applied Math minor) maintained an excellent GPA, earning no less than thirteen A+ grades in technical coursework. He was also an integral member of the team that showed that graphene provides extremely effective passivation when encapsulating quantum dots. One faculty member writes: "He was exceptional. What I remember most, is his final exam review assignment. I tell students to review and write up their notes for the whole semester as part of their review process. Richard submitted notes for the entire semester typeset in LaTeX. He basically typed up course lecture notes for me! He went way above and beyond what anyone else did. That's Richard - his performance makes him stand apart from his peers." He will continue his graduate studies with us in Applied Mathematics.

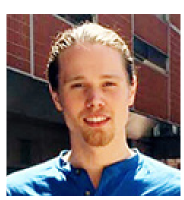
Applied Mathematics Faculty Award

Dorcas Huang: (B.S. '16 Applied Mathematics, concentration in Quantitative Biology) maintained a high GPA and an intense course load. Faculty said she was an active and consistently high-achieving student. Her applied math seminar presentation was on "Recommendation using Matrix Methods and Latent Factors" and, apart from her stellar performance in her classes, she was known to ask great questions and help other students with their work. In a recent internship, she examined healthcare spending in different medical sectors in relation to geographic and demographic information. Next year, she will continue working in technology consulting using software like Tableau and QlikView to find solutions for clients from industries such as pharmaceuticals and life sciences, insurance, and consumer goods.

Francis B. Rhodes Prize for Materials Science

Adam Jaffe (B.S. '16 Materials Science) is an exceptional student with a high GPA. Faculty said, "He is a star student in materials science, who has blown us away with his grasp of concepts and performance in class." His senior project was an attempt to create a completely impermeable structure based on graphene oxide, which allows the permeation of water but is otherwise impermeable to other liquids, vapors, and gases. He is a C. Prescott Davis Scholar and an inductee to the Tau Beta Pi Engineering Honors Society. Adam said that, what he enjoyed most about his time at Columbia, was the opportunity to live and study with brilliant people from around the world. After graduation, he will work in the New York Office of Arup, and engineering consulting firm founded by the Anglo-Danish Engineer Ove Arup.

Raspberry Simpson (B.S. '14 Applied Physics) and **Lucas Zeppetello** (B.S. '16 Applied Physics), won graduate research fellowships from the National Science Foundation. Fellows will receive an annual stipend for three years, along with an allowance for tuition, fees, and opportunities for professional development.



Olsen Named SEAS Salutatorian

by Melanie Farmer, originally published by *Columbia Engineering*

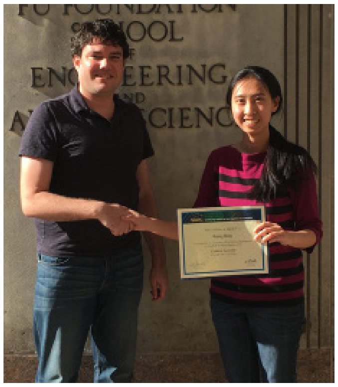
Seth Olsen (B.S. '16 Applied Physics), was the SEAS Salutatorian.

Plans after graduation: Attend Princeton as a Ph.D. candidate in physics, emphasis in theoretical high-energy physics

Why physics: I love the feeling of childlike wonder that I get every time I discover an exciting new answer that deepens my understanding of physics.

SEAS taught you: A chance to take physics courses and to gain research experience in both experimental and theoretical physics

Your definition of engineering: Using your own creativity along with the body of science and technology that came before you to design and implement a useful device. When I hear the word "engineering," I can't help but think specifically of inventors like [Nikola] Tesla whose work really blew people's minds.



Zhang Receives SIAM Recognition Certificate

In recognition of her efforts as president of Columbia's student chapter of SIAM, **Huiying Zhang** (Applied Mathematics '17) received a SIAM student chapter certificate of recognition this academic year. Huiying has played a key part in resurrecting the group this past year: she organized a talk from Dr. Ken Golden from the University of Utah, only the third mathematician to be named to the Explorer's Club, and a number of other SIAM student chapter activities. **Photo: Prof. Kyle Mandli & Huiying Zhang**

SIAM Students Participate in SWE's Engineering Exploration Experience

SIAM students, **Chloe Blanchard** (Applied Mathematics '16), Ivy Chen, and Lu Qiao, helped to design and run one of the workshops the Columbia Society of Women Engineers (SWE) Engineering Exploration Experience.

Many of these workshops include lab visits, lectures by notable SEAS faculty and alumni, and hands-on demonstrations. For an applied mathematics demonstration, the group decided on the hands-on approach and worked on presenting two Jupyter notebooks - one studying the tracks and intensities of hurricanes in the Atlantic and the other on ways to study match-fixing in tennis. The first was based on publicly available data for the last fifty years of storms and asked the participants to formulate and ask questions of the data. The second was based on a BuzzFeed tutorial studying predictability of tennis matches and, as a consequence, the likelihood that someone may have cheated.

Cowan Receives APS Award

Tyler Cowan, Applied Physics '17, received an "Outstanding Undergraduate Poster Award" for his presentation on "Characterization of Mode Activity during Disruptions for Shaped and Unshaped Plasmas," at the 57th Annual Meeting of the APS Division of Plasma Physics meeting in Savannah, GA.

Last summer, Tyler conducted research as part of the HBT-EP Team investigating the structure and dynamics of plasma discharge disruptions. This is among the critical instabilities that must be prevented in the next generation of large energy producing tokamak experiments. In Tyler's work, he performed the first step in modeling the currents that occur due to plasma-wall contact. His analysis of the magnetic field showed that disruptions occur in two distinct phases. The first phase is characterized by progressive increases in the current quench rate and various non-symmetric oscillations. During the second phase, the plasma moves radially inward, contacts the inner edge of the vessel, and then decreases in minor radius. Remarkably, when the hot plasma is shaped, only the latter phase is observed. In both cases, kink oscillations persist through the entirety of the disruption, with a frequency that increases over time. These findings are guiding our future measurements of halo currents during the disruption, as well as an x-ray analysis of the plasma's interior.

In addition, three other undergraduates presented their plasma research at the APS Plasma Meeting. **Sean Ballinger**, Applied Physics Senior, presented his work, entitled "Imaging of X-point turbulence in Alcator C-Mod." **Alex Battey**, Applied Physics Junior, presented his work, "Multiple-Probe Excitation and Control of Low-Frequency Fluctuations in a Laboratory Magnetosphere"; and **James Page**, Applied Physics Junior, presented his research entitled, "Plasma Emission Profile Recreation using Soft X-Ray Tomography."

Undergrad Presentations on Sustainable Energy

Applied Physics juniors and seniors participated in a seminar entitled "Innovation and science to advance our energy and climate goals." Students learned the physics of climate and energy from leading experts at Columbia, and followed the world-wide events leading up to the 2015 Paris Climate Conference.

In addition to studying the physics of planetary climate and the scale of world-wide energy technology, students formed five "Innovation Teams" to bring their own ideas to the seminar. Each student prepared presentations, based on individual interests, about an innovation contributing to sustainable energy including a technical summary of work and research to be done and arguments showing why their ideas showed promise. Each presentation was lead by members of this year's senior class. They explained the innovation with minimal jargon and explained how it addresses sustainable energy issues. This year's team presentations were:

"Revolutionize Battery Technology using Supercapacitors built with graphene & carbon nanotubes" by Seth Olsen, Jonathan Fletcher, Alex Battey, Kevin Murphy, & Chen Zhang

"The Smart Grid: A look at how technology & data can revolutionize the energy industry" by Omar Mahmood, Drew Feldman, Edwin Vargas, William Wei, Tyler Cowan, & Derek Tropff

"A Platform for Public Education on Basic Climate Change Science" by Joshua Cohen, Lucas Zeppetello, & Jason Williams

"Liquid Fluoride Thorium Reactors: Back to the Future" by Sean Ballinger, Ben Israeli, Michael Wang, & Farrah Simpson

"Agricultural Methane Capture & Use" by Anton Baleato Lizancos, Richard Creswell, James Page, & Lauren Riddiford

Alumni News

Gabriel Ganot (Ph.D. '12, Materials Science and Engineering) and his wife welcomed their first child, Simon, into the world on February 4, 2016. Gabe is currently a consultant at Exponent Engineering and Scientific Consulting.

Timothy Merlis (B.S. '06, Applied Mathematics) visited this spring to present talks at the SEAS Colloquium in Climate Science (hosted by APAM) and at the Ocean & Climate Physics Seminar (hosted by the Lamont–Doherty Earth Observatory). He is an Assistant Professor in Atmospheric and Oceanic Sciences at McGill University, a Canada Research Chair (Tier 2) in Atmospheric and Climate Dynamics, and a member of the McGill Space Institute.

Shantikumar Nair (M.S.'78, Ph.D. '83 Materials Science and Earth and Environmental Engineering) writes, "I am now the Dean of Research at Amrita University, the highest-ranked private university in India by *Times Higher Education*. I moved to Amrita University in 2006, before which I was an associate professor at University of Massachusetts at Amherst, MA. I am also the director of the Centre for Nanosciences and Molecular Medicine at the Amrita Institute of Medical Sciences. Recently I was invited to give a talk at the UNAI-START (United Nations Academic Impact–Science and Technology Accelerating Rapid Transformation) conference, on the role of nanotechnology in developing new solutions for energy, water, and health care—problems reaching crisis proportion in our world and requiring urgent action across all levels. I was also recently awarded the prestigious Professor C. N. R. Rao Award for outstanding contributions in the field of nanotechnology." **(Spring 2016 Engineering Newsletter)**

Aaron Svoboda (M.S. '07 Medical Physics) launched the 2016 Medical Physics Seminar with his up-to-date and timely talk, "I wish they taught me THAT back in medical physics school!" on Thursday, 2/18, followed on Friday by a social at Mel's Burgers. There, Aaron and other seasoned alumni, who are now practicing professionals in area hospitals, joined current medical physics students to share refreshments and insider wisdom.

The SEAS Alumni Reunion Weekend took place from June 2-5. For details, see:

http://engineering.columbia.edu/reunion

Faculty Updates

Adam Sobel's article, "Why are hurricanes forming in January?" was published by *The Conversation* and his article, "All at Sea - What Mumbai needs to learn from Superstorm Sandy," was published in T*he Times of India* (Delhi). Sobel participated in a discussion about El Niño on Talk Radio News Service (TRNS), appeared in AXA's December webcast on climate change, and was featured on an episode of Yale Climate Connections, titled "Climate Change and Extreme Weather."

Michael Tippett was featured in the Earth Institute news article, "Extreme Tornado Outbreaks Have Become More Common, Says Study: Climate Could Be Implicated, But Answers Are So Far Unclear."

Latha Venkataraman, along with Colin Nuckolls from the Chemistry Department, won a grant from Columbia's Research Initiatives in Science and Engineering (RISE) for their proposal: *Imaging a Single Molecule Circuit*.

Chris Wiggins was chosen to represent Columbia on the Business-Higher Education Forum's (BHEF) Data Science & Analytics (DSA) Working Group (WG) - "the nation's oldest membership organization of Fortune 500 CEOs, prominent college and university presidents, and other leaders dedicated to advancing innovative education and workforce solutions and improving U.S. competitiveness." http://www.bhef.com/

Adjunct Faculty Updates

A review paper "Neoclassical plasma viscosity and transport processes in non-axisymmetric tori" by K.C. Shaing, K. Ida, and S.A. Sabbagh (APAM alumn, APAM Senior Research Scientist, and APAM Adjunct Professor) was published in *Nuclear Fusion* 55 (2015) 125001 (http://stacks.iop.org/0029-5515/55/125001). The paper reviews extensive work on neoclassical transport processes, especially neoclassical toroidal viscosity (NTV), published in ~10 papers by Shaing, et al. through the period 2000 -2010. Foundational NTV experimental work on stellarators and tokamaks is also contained in the review.

George Tselioudis, APAM Adjunct Professor and climate scientist at NASA's Goddard Institute for Space Studies, was featured in the press release "Expanding Tropics Pushing High Altitude Clouds Towards Poles, NASA Study Finds". Tselioudis worked on this project with Prof. Lorenzo Polvani and applied math graduate student, Bernard Lipat.

Wang, Sobel, & Tippett Win NSF & NOAA Grants for Extended Tropical Weather Prediction

Dr. Shuguang Wang, APAM Associate Research Scientist, along with Professors **Adam Sobel** and **Michael Tippett**, won an NSF (National Science Foundation) grant, titled "The Madden Julian Oscillation and the Maritime Continent", and an NOAA (National Oceanic and Atmospheric Administration) Climate Program Office's Modeling, Analysis, Prediction, and Projection (MAPP) Program grant, titled "Madden Julian Oscillation: the Maritime Continent barrier and seamless verification". The team will use the two research grants to explore different aspects of tropical weather prediction between a week and a season.

The general goal of these projects is to improve both scientific understanding and the ability to predict the weather disturbances associated with the Madden-Julian Oscillation - a weather disturbance in the tropics which evolves over periods of one or two months. The focus is on how the disturbances move from west to east across the Maritime Continent, which is the region along the equator around and including Indonesia. The projects will seek to understand how the presence of the Indonesian islands, as well as the mountains on those islands, influence the motion of the weather disturbances: what causes the disturbances either to move across the islands or not do so, and how that motion can be forecast better.

Photo (top to bottom): Adam Sobel, Shuguang Wang, and Michael Tippett

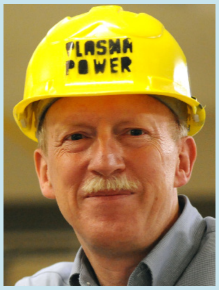
2016 Severe Convection & Climate Workshop

Severe thunderstorms, tornadoes, hail, and damaging winds have substantial societal and economic impacts, especially in the United States where they are frequent. From March 9-10, a group of over 110 participants from North America, Europe, and China gathered at the 2016 Severe Convection and Climate Workshop in Davis Auditorium to discuss how climate influences the risk of severe thunderstorms, now and in the future.

Michael Tippett and the Columbia Initiative on Extreme Weather and Climate organized the workshop with support from the Earth Institute, the National Science Foundation, Munich Re, and Willis Re. The workshop brought together attendees from academia, government, and the private sector. Topics included the influence of El Niño and climate change on tornado frequency, estimation of hail swaths from satellite images, as well as prospects for seasonal prediction of severe weather activity.

In addition to the latest climate science, a unique feature of the workshop was an afternoon-long session devoted to the reinsurance industry. Severe convective storms are a leading natural hazard in terms of insured losses, especially recently. However, the so-called catastrophe models used to estimate potential losses from severe convective storm are less mature than those for other perils such as hurricanes. Overall, the workshop provided an excellent showcase of the current science on climate and severe thunderstorms in a context that was conducive to industry engagement and collaboration.

Photo: C.K. Chu, Fu Foundation Professor Emeritus of Applied Mathematics, was recognized by the Asian Columbia Alumni Association at their 20th Anniversary Gala on April 30, 2016 in Low Library.



Mauel Named New Editor-in-Chief of *Physics of Plasmas*

by Holly Evarts, originally published by *Columbia Engineering*

Applied Physics Professor **Michael Mauel** has been appointed the new editor-in-chief of *Physics of Plasmas*, the foremost scientific journal on plasma physics published monthly by the American Institute of Physics.

"This is a great honor for me," Mauel says. "*Physics of Plasmas* is dedicated to the publication of original experimental and theoretical contributions in plasma physics and I am excited to be leading the next chapter of this journal as our field evolves and grows. We are looking forward to continuing to feature the highest quality research in plasma physics from around the world and to expand our coverage of space & astrophysical plasmas and the interactions between ionized and non-ionized matter."

Mauel joined the School's Department of Applied Physics and Applied Mathematics (APAM) in 1985, after earning his ScD. from MIT. He served as APAM's chair from 2000 to 2006. Focusing on high-beta tokamak research, he collaborated with the Tokamak Fusion Test Reactor (TFTR) research team at Princeton University to explore the influence of plasma current profile on fusion transport and stability, and he was a visiting scientist at DIII-D National Fusion Facility in 1994 where he developed techniques to create internal transport barriers. At Columbia, he built experimental research programs in microwave plasma processing in collaboration with IBM and in laboratory space physics with the support of NSF, NASA, and the Air Force Office of Scientific Research.

Affiliated with many professional organizations, Mauel is a fellow of the American Physical Society (APS) and served as the chair of the APS Division of Plasma Physics. He has been an active member of the Plasma Science Committee, National Research Council, most recently serving as its chair from 2012 to 2014. In 2000, he received the Rose Prize for Excellence in Fusion Engineering from the Fusion Power Association and was recipient of the Jefferson Science Fellowship for the 2006-07 academic year. In 1989, Mauel received a Certificate of Appreciation from the U.S. Department of Energy for high-beta tokamak research, and, in 2007, he received a Certificate of Appreciation from the U.S. Department of State for his work supporting the Office of International Energy Policy.

Mauel has published more than 150 refereed journal articles and, since 2003, has served on the editorial boards of several journals, including associate editor of *Physics of Plasmas*.

Gaeta: Learning How to Engineer Light

by Amy Biemiller, originally published by *Columbia Engineering*

Physicists have long been fascinated by the behavior and properties of light. That drive to understand light and harness its frequencies led to inventions including X-ray and strobe technology and the laser, all of which have expanded the boundaries of science, medicine, industry, and defense.

Researchers like **Alexander Gaeta**, David M. Rickey Professor of Applied Physics and of Materials Science, study nonlinear optics, or how light interacts with matter. By doing so, they uncover new ways to use light, from getting a closer look at ultrafast processes in physics, biology and chemistry, to enhancing communication and navigation, medical testing, and security.

For Gaeta, a pioneer in nonlinear optics, and his team of researchers, the key to furthering that technology is fully understanding how light of one color (i.e., light frequency) can interact with a material to create new colors.

"Some of our work involves the interaction of light with matter at extremely short durations—billionth of millionth of seconds—and at extreme light intensities," says Gaeta. "It can be pretty spectacular."

In other research in his lab, Gaeta focuses on creating new frequencies of light using silicon rings created by Professor Michal Lipson's group.

"We shine laser light into tiny little silicon rings. Depending on how the rings are designed, we can send in one frequency of light and get thousands of new frequencies," he explains. New frequencies of light could positively impact the speed of data transfer and communication processes. But it's how these new frequencies align that really has Gaeta interested.

"While the creation of new frequencies is exciting, we also have learned that in these micro-rings, these frequencies are generated such that the separation between them is extraordinarily and exactly identical—similar to what a comb would look like."

Optical frequency combs can be used as very exact rulers to measure the frequencies of other light sources with extremely high exactitude, making it an important spectroscopic tool able to measure, identify and manipulate molecules and atoms. Optical frequency combs also make it possible to build optical atomic clocks to keep track of the passage of time with extraordinary precision. They also help researchers watch chemical reactions in real time.

But optical frequency combs have not yet had widespread commercial use—Gaeta's personal holy grail for his work.

"Frequency combs are used in research all the time, but this is a field of investigation that I know has great potential for commercial applications," he says. "We can put this all on a silicon chip, which makes it compact and energy efficient. Future potential uses could include advanced communication and navigation systems, remote chemical detection, and medical testing."

Prior to joining Columbia Engineering, Gaeta was the Samuel B. Eckert Professor of Engineering at Cornell University, where he also served as the Chair of the School of Applied and Engineering Physics from 2011 to 2014 and the Director of the Center for Nanoscale Systems from 2007-2012. He is a fellow of the America Physical Society and the Optical Society of America and is the founding editor-in-chief of *Optica*.

Q&A: Katayun Barmak

by Melanie Farmer, originally published by *Columbia Engineering*

Katayun Barmak is aiming to define structure-property relationships of metals in engineered high-tech systems like data storage, integrated circuits, and advanced permanent magnets. As an experimental materials scientist, Barmak spends the majority of her time in the lab, peering into electron microscopes to study the very minute, nanometric-scale structure of materials, with the hope of finding the link between their structure— for example, the three-dimensional arrangement of the nanocrystals—and their properties, whether it's electrical conductivity or magnetic hardness.

"I'm very interested in basic studies that explore the relations between how you make a material, what its structure is, and then, how it behaves. Is it a good or poor conductor of electricity, and so on," explains Barmak, the Philips Electronics Professor in the APAM Department. "I find it very exciting because I like to work on that edge of science where I can see the application. I want to know that the science will be used; I'm interested in the underlying science of the material that goes into building even just a small part of an engineered system."

Before joining Columbia Engineering in 2011, Barmak was on the faculty at Carnegie Mellon University, where she rose to full professor in just three years. She was one of the first materials scientists ever to successfully map the crystallographic orientation of polycrystalline structures on the nanoscale for statistically significant populations. An exciting research feat at the time—four years ago—when high throughput crystal orientation mapping methods at the nanoscale were not available. But now the technique is readily available, making it possible, for example, to see how metallic elements like copper can be tailored to be even better nanoscale electrical conductors.

Q: How did you get your start in metallurgy?
A: I went to Cambridge as an undergraduate and started in natural sciences to give me some flexibility in the choice of classes. I had to pick a last class. I had only been in England for two years. To me, English was still a second language, although I spoke it very well, so I was trying to avoid any classes where essay assignments were involved. Ironically, all I do now is write, and I was trying to avoid writing. There was only one class without essays and it was Crystals. We started to do a lot of visible light microscopy of crystals, and the images were beautiful. What you can see in the microscope, those images, just grabbed me. I spent a lot of my time collecting images, analyzing images, extracting information from images. And, I love art. I love the visual arts, the performing arts, and painting. For me, the images were beautiful, appealing in their own right; but also what kept my interest was the information content extracted from those images. The images led to the science.

Q: The performing arts were actually a big part of your life at one point.
A: I wanted to be a ballet dancer. I started at age 8. In the end, I did ballet on and off for 25 years. I danced in graduate school and afterwards. I danced with chamber ballet companies. In a dance class, your mind is completely engaged in trying to learn the steps, keep to the music, keep to the time. It's physically and mentally so fully engrossing that you come out of class exhausted but also refreshed. I miss it terribly. It was the best thing. So initially I wanted to become a ballet dancer. Now, I look back on the insanity of that. I grew up in Iran, but at the time of rapid growth and modernization. The country had a ballet company that I could join. And we had dancers and teachers from all over the world. It was just this phenomenal pocket of time where we thought we were dancing on the world stage . . . but then my parents thought this was absolutely not the career for me. [Laughs] And in retrospect, it was a very lucky thing I didn't do it.

Q: You're currently doing a lot of research on the nanoscale. What is the materials science field like now?
A: It's an exciting time. It's exciting because now our instrumentation and our computing power are beginning to match our desires.

Katy Barmak, the Philips Electronics Professor in Applied Mathematics & Applied Physics and the Chair of the Materials Sciences & Engineering Program Committee, stands in the newly constructed Electron Microscopy (EM) Laboratory located on the first floor of Havemeyer Hall.

Photo: J. Schifman

The computing power that wraps around every instrument is making things so much better and enabling new science. In materials, for me, it's a very exciting time because we do not yet have the full predictive theories in materials that will allow us to design a material for an engineered system in a computer, then go and make it and have it behave the way we wanted. But we're getting there. Some of what [Associate Professor] Chris Marianetti and others do—computing materials from the principles of quantum mechanics—and some of the materials and properties predicted we're now able to measure and verify. We're beginning to get glimpses of what we can do.

Q: What is the end goal?
A: To find new or better materials—there's always newer and better defined by some figure of merit. Hopefully, the new is better. [Laughs]

Q: This academic year, faculty, students, and researchers across Columbia will have access to the School's new Electron Microscopy (EM) Lab in Havemeyer. This is significant.
A: It has been exciting (and, at times, exasperating) constructing this new central facility for not only our faculty and students, but for other Columbia members and alumni. I am looking forward to the creativity we're going to get out of its use, the world-class science that will come out of it from researchers using the instrument and who are doing exciting work here. I think we'll be blown away!

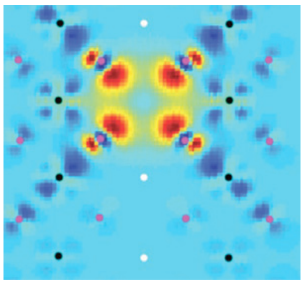
13th Joint Magnetism & Magnetic Materials & Intermag Conference

Prof. Barmak was the program co-chair, together with Dr. Atsufumi Hirohata of the University of York, UK, for the 13th Joint Magnetism and Magnetic Materials and Intermag Conference. The General Chair for the Conference was Dr. Bruce Gurney.

The Joint Conference, which convenes every three years, is the combination of two annual premiere international conferences on magnetism: the International Magnetics Conference (Intermag) and the Magnetism and Magnetic Materials Conference (MMM). The Conference included all aspects of fundamental and applied magnetism, with sessions reviewing the latest advances in magnetic materials, emerging applications, new phenomena, spin electronics, energy and power applications, biomagnetism, and much more.

The Conference, sponsored jointly by AIP Publishing and the Magentics Society of the IEEE, in cooperation with the American Physical Society, was held in San Diego, CA, from January 11-15, 2016. With over 1800 attendees from 50 countries and 1850 oral and poster presentations, it was one of the largest Joint Conferences in its history. This was also a special year for the Conference, as it celebrated the 60th anniversary of the Magnetism and Magnetic Materials Conference (MMM). A note of historical interest is that Barmak's great uncle by marriage, Professor Joseph Libsch of Lehigh University, was one of the program co-chairs of the 1st MMM Conference.

(Above) Chris Marianetti
(Below) Research image from Prof. Marianetti



Marianetti: Theory Unlocks the Secrets at the Nanoscale

by Amy Biemiller, originally published by *Columbia Engineering*

The first-principles theory of materials science continues a great tradition that emerged in the aftermath of the quantum revolution nearly 90 years ago. In 1929, Nobel Laureate Paul Dirac keenly noted, in essence, that the mathematical laws of physics necessary to describe all of materials science were completely known, but the solution of these equations was impossibly difficult.

Applying physics and mathematics to solve difficult equations is what brought electronics to our landscape. Much of today's commonly used technology was developed based on preliminary understanding of how electrons move through various materials under different conditions. That theoretical science combined with heroic experimental efforts made it possible, by the mid-20th century, to harness the behavior of electrons in materials to create the modern computer.

In the realm of nanotechnology, theorists like **Chris Marianetti**, associate professor of materials science and applied physics and applied mathematics, are particularly important in helping understand how the subatomic world works in complex scenarios. To better understand and explain what happens on the nanoscale, theorists use quantum mechanics, the mathematical description of the motion and interaction of subatomic particles. The core equation in quantum mechanics is the Schrödinger equation.

"In terms of materials science and chemistry, the Schrödinger equation holds all the information that we need, but the secrets are locked away inside. We work to apply sophisticated mathematical formalisms, which are amenable to reasonable approximations, and work to develop new approaches when our existing methodologies break down," explains Marianetti.

It is these computational approaches that allow researchers to model outcomes of experiments with atomic particles—a job that would be prohibitive if one solely relied on experimental trial and error. These mathematical descriptions help researchers understand how to control the structure of matter and evaluate hundreds of possible material combinations to find the most promising.

"We can now predict many aspects of materials properties for systems spanning the entire periodic table," says Marianetti.

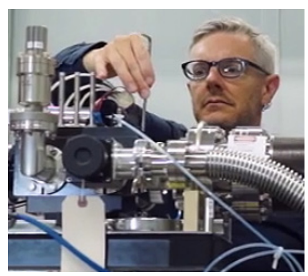
One such material is graphene—a single layer of bonded carbon atoms one million times thinner than paper, which could replace silicon. Marianetti and his group used quantum mechanics to demonstrate that straining this material should induce a novel phase transition, which would cause graphene to mechanically break. Strain is a way to engineer the properties of graphene, so understanding its limits is very practical.

"This phase transition has not yet been observed, so it is still a bit of a mystery. Several colleagues not connected to our original work have proposed hypotheses on the absence of this transition, and five years out we are still searching for what we believe is the dominant reason. We believe we are close to unraveling this mystery, and ultimately experiment will prove us right or wrong; that is part of what makes this game so fun. I like to say that physics is an art, with a sense of right and wrong."

Marianetti's research has also enhanced understanding about the solid-state properties of plutonium, the radioactive element which is used in radioisotope thermoelectric generators, fuels in some types of nuclear reactors, and was used in creating many existing weapons in the world's nuclear stockpile. He was the first to predict the temperature dependence of the magnetic properties of the material, which is relevant to safe storage of weapons and ensuring the Nuclear Test Ban Treaty far into the future. Research underway in his lab also focuses on understanding the behavior of nonconventional material and nanostructures of multifunction oxides, metals, and semiconductors to accelerate innovations in analog, logic, and memory devices.

Theory, as exploratory engineering, bookends the science of nanotechnology. Theorists help other scientists and engineers predict new possible combinations of atoms and molecules and, once combinations have been made, test those new materials to explain what is happening on the nanoscale. Theory magnifies experimental capability, and researchers like Marianetti are learning to create functional materials and devices via assembly and manipulation at the nanoscale.

"Theoretical and computational developments help us understand how materials behave under all sorts of conditions," he says. "This understanding will enable us to design new materials at the atomic scale and work with experimentalists to realize novel phenomena and functionality."



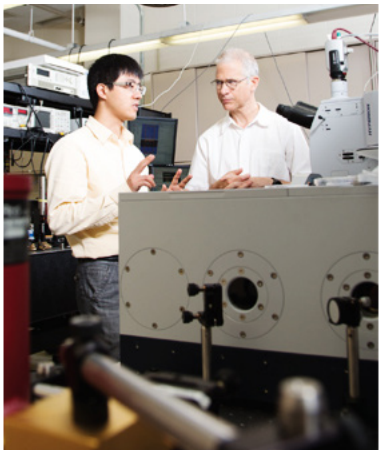
Billinge: Materials of Tomorrow

originally published by *Columbia Engineering*

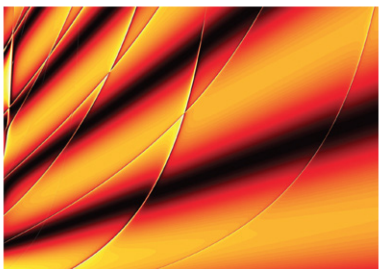
Simon J. L. Billinge, professor of materials science and applied physics, recently received a major grant from the National Science Foundation to help advance his innovative approach to cut the cost of designing custom materials for high-performance devices such as photovoltaics and batteries. The three-year, $983,000 grant, part of a high-profile initiative to fast-track the discovery of new materials, supports research at Columbia University and the National Synchrotron Light Source II at Brookhaven National Lab in Long Island where samples are bombarded with high-energy X-ray beams to probe their nanostructure.

Experiments, with implications for pharmaceutical materials, batteries, catalysts, and novel high-temperature superconductors, explore how the precise atomic structural arrangement of substances affects their behavior. The effort depends on building large databases compiling measured and calculated quantities describing the material structure and properties that will be made available to the larger materials research community. The interdisciplinary project brings together a variety of SEAS faculty, including applied mathematician **Qiang Du** and computer scientist Daniel Hsu, with expertise in information theory, machine learning, and image recognition.

The goal is to use data analytic techniques, similar to those that power Google and Netflix apps, in combination with latest generation experimental techniques, to accelerate the discovery of novel high-performance materials. Initial targets will be cadmium selenide nanomaterials for photovoltaics and flat-panel displays, and lead telluride, useful as a material for waste heat recovery. Billinge, a member of Columbia's Data Science Institute, is also investigating how to measure the active ingredients in complex cutting-edge drugs to help make standardized pills that are easily absorbed into the bloodstream.



Above (left-right): Nanfang Yu & Michael Weinstein in Yu's optics lab (photo by J. Schifman), Below: Reflection spectra of bonding and anti-bonding perturbation resonances in a symmetry broken periodic silicon nanostructure with varying height. (Image by Adam Overvig)



Weinstein & Yu: Smooth Surfing of Optical Waves

by Amy Biemiller, originally published by *Columbia Engineering*

Solitary ocean waves ridden by surfers eventually break, but there are optical waves that travel along interfaces and are able to glide smoothly around and through rough environments without distortion.

This unusual class of optical waves is the focus of an ongoing collaboration between **Michael Weinstein**, professor of applied mathematics, and **Nanfang Yu**, assistant professor of applied physics.

Weinstein, who has a joint appointment as a professor of mathematics in the Department of Mathematics, and **James Lee-Thorp**, his student, recently obtained mathematical results on the existence and properties of "topologically protected edge states" in structures whose material spatial variations have special symmetries. According to Weinstein, "An edge state manifests itself as a surface wave propagating along a structured surface between two distinct media. What is remarkable is that these guided waves do not spread out or decay in amplitude, even in the presence of strong perturbations."

Yu pointed out that "this robustness is a highly desirable feature for information transfer in 'optical integrated circuits,' and it is very compelling for us as device physicists to investigate physical realizations of these robust edge states."

Telecommunication relies on reliable transfer of light from one location to another. On a chip, this is impeded by factors such as inaccuracy of device geometry due to fabrication errors, varying operation conditions of the chip, and defects introduced to the chip while it is in use. Yu and Weinstein remark that the optical edge states they are studying promise to have fewer issues of this sort, and therefore offer an improved platform and can serve as a fundamental building block with which to create robust on-chip photonic devices.

"This is an exciting collaboration between mathematical theory and experiment," said Weinstein. "Mathematicians and physicists naturally come at questions from different angles, so one is always learning and also being challenged to communicate one's own perspective."

Added Yu, "Weinstein's group predicted the existence of a robust guided optical wave in a nonobvious structure, which physicists and engineers in the photonics community would be very unlikely to invent or study otherwise."

"Nanfang Yu and his student **Adam Overvig** are outstanding device physicists and experimentalists in photonics. They have the expertise to design and realize novel device functionalities by choosing the right materials systems, and a device architecture that is feasible for nanofabrication," said Weinstein. Together, the two research groups have a very broad toolset to demonstrate and explore modes of robust energy transport, and to develop mathematical and experimental approaches that can be used well beyond the current problems.

Weinstein and Yu's research on optical "topologically protected" edge states is closely related to "topological insulators," a field of intense fundamental and applied scientific activity. Their collaborative effort is supported by the National Science Foundation, the Air Force Office of Scientific Research, and the Simons Foundation.

Yu Wins Young Investigator Award from the U.S. Office of Naval Research

by Jesse Adams, originally published by *Columbia Engineering*

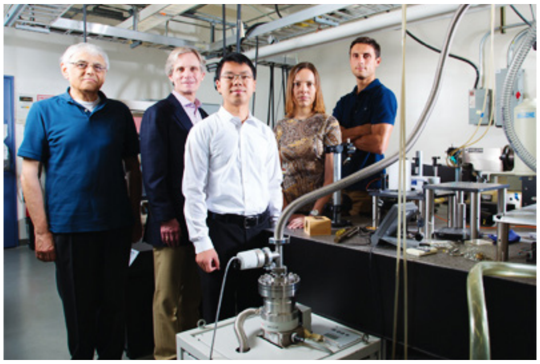
Nanfang Yu has won a 2016 Young Investigator Award from the U.S. Office of Naval Research for exceptionally creative research with far-reaching implications for technological needs of the Navy and the Department of Defense.

Yu is one of just 47 early-career tenure-track academic scientists selected this year for the prestigious honor, one of the oldest and most selective research advancement programs in the country. For his proposal, "Phase-Change Correlated Perovskites as a New Platform for Photonics," he is slated to receive approximately $510,000 over a three year period for equipment, graduate student stipends and scholarships, and other expenses to sustain his research.

Earlier this year, Yu received a major grant from the U.S. Air Force's Office of Scientific Research as part of the Defense University Research Instrumentation Program (DURIP), which helps researchers procure state-of-the-art equipment for developing next-generation defense capabilities and will support his work with infrared cameras and other light sources.

Yu's research interests include mid-infrared and far-infrared optics and optoelectronic devices and active plasmonics and metamaterials with gain media. He studies the interaction between light and structured active materials at the nanometer scale and builds novel devices including lasers, detectors, and active components for controlling light. His recent work includes investigations into what humans can learn from unique Saharan silver ants capable of surviving extreme heat and research into unusual optical waves that resist distortion.

Prof. Yu also leads a team, which was one of five recipients, who won a grant from the PowerBridgeNY program to pursue clean energy related research and commercialization. PowerBridgeNY is a New York State funded program that facilitates collaborations between prominent institutions in the downstate, leveraging clean energy innovations emerging from institutional research labs to create more and stronger energy businesses in New York State.



(Right to left) The Artificial Graphene team - Diego Scarabelli, Yuliya Kuznetsova, Sheng Wang, Shalom Wind, and Aron Pinczuk. (Photos by J. Schifman)

Pinczuk & Wind: Artificial Graphene - Better than the Real Thing?

by Holly Evarts, originally published by *Columbia Engineering*

Working at the cutting edge of physics at the nanoscale, **Aron Pinczuk** and **Shalom Wind** are developing new ways to access quantum mechanical phenomena by manipulating matter at nanoscale dimensions. One of the areas they are especially interested in is artificial graphene, a material that is now attracting more and more attention because researchers believe it will have more versatile properties than the real thing.

"This is a rapidly expanding area of research," says Wind, adjunct professor and senior research scientist in the APAM Department. "We are uncovering new phenomena that couldn't be accessed before. As we explore novel device concepts by engineering the artificial graphene in different ways, we can unlock the potential to expand frontiers in quantum mechanics, with potential applications in advanced optoelectronics and data processing."

Graphene has highly unusual electronic properties: its electrons can travel great distances before they are scattered, making the material an outstanding conductor. In addition, the way atoms are arranged in graphene causes them to behave as if they are relativistic particles that have zero mass and can move close to the speed of light, fueling hopes for hyperfast electronics and more.

"These properties are very exciting because they can lead to the observation of exotic quantum mechanical states," says Pinczuk, professor of applied physics and physics, who uses optical methods to examine nanostructures. "But accessing these states in natural graphene is challenging, because handling single atomic layers entails extremely complex operations."

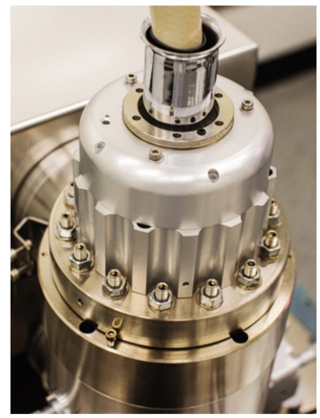
While researchers have been trying to create artificial graphene in semiconductors, until now they have been unable to reach the small dimensions required to create an interconnected electronic lattice. The Columbia Engineering team's latest breakthrough has been to recreate, for the first time, the electronic structure of graphene in an engineered semiconductor. Using the tools of conventional chip technology, they made quantum dots—instead of carbon atoms—in a gallium arsenide-based semiconductor and organized them in a honeycomb lattice, mimicking the graphene crystal structure. Once the quantum dots were placed close enough to each other that they could share electrons, they displayed the electronic signature of graphene.

This artificial graphene has several advantages over natural graphene; for instance, researchers can design variations into the honeycomb lattice to modulate electronic behavior. And because the spacing between the quantum dots is much larger than the interatomic spacing in natural graphene, researchers will be able to observe even more surprising quantum phenomena with the application of a magnetic field.

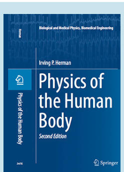
"It will be easier to make observations with the artificial graphene we've developed," Pinczuk notes. "Potential applications include new types of electronic switches, novel photodetectors and transistors with superior properties, and even perhaps new ways of storing information based on novel quantum mechanical states. And we've created a new materials base to explore intriguing quantum physics."

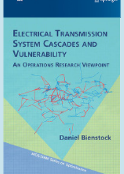
He and Wind are now working on the next generation of artificial graphene devices, which will have more closely spaced lattices, making it easier to observe electronic states. They will use the devices for experiments at high magnetic fields as well as transport experiments, where they measure current through the artificial graphene lattice.

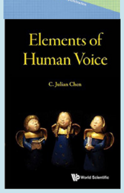
"This is an exciting time for those of us working in nanoscience," Wind adds. "As our ability to structure matter at increasingly small dimensions continues to improve, we'll be able to observe newer and more exotic phenomena and create materials, like artificial graphene, that we've only been able to dream about."



(Above) The Nanobeam nB4 electron beam lithography system, shown here, uses a finely focused beam of electrons to "write" nanoscale patterns that define the artificial graphene lattice. The nB4 is one of the critical tools within the Columbia Nano Initiative that enable leading-edge nanoscience research.





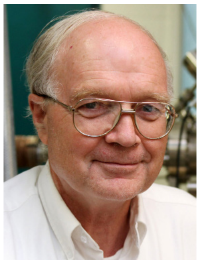


Faculty Books

Springer recently published the 2nd edition of **Prof. Irving Herman's book, *Physics of the Human Body***. The 1st edition, published in 2007, evolved from an undergraduate course Prof. Herman developed at Columbia with the same name. The 2nd edition includes expanded and cross-referenced treatments of motion, sports, multi-segment modeling, pregnancy, diseases and disorders, and aging. It includes improved treatments of muscles and the throwing, hitting, and motion of balls and additional problems and solutions. In addition to being a text, this book can be of more general interest to physicists, biomedical engineers, physicians, physical therapists, evolutionary biologists, and others who want to learn about the overlapping worlds of physics and medicine/human biology.

Prof. Daniel Bienstock's new book, *Electrical Transmission System Cascades and Vulnerability: An Operations Research Viewpoint*, was jointly published by the Mathematical Optimization Society and the Society for Industrial and Applied Mathematics as part of their series on Optimization. Bienstock is a Professor in the Department of Industrial Engineering and Operations Research and has a joint appointment with the APAM Department.

World Scientific Publishing Co. recently published **Adjunct Professor C. Julian Chen's book, *Elements of Human Voice***. This is a monograph about human voice, expounding from a novel view of voice production. The novel view was established through carefully analyzing large amount of human voice data, especially simultaneously acquired voice signals and electroglottograph signals; and a thorough investigation of various theories of voice production since enlightenment era. The contents encompass the physics and physiology of voice production, parametrical representations of voice signals, and various technology applications. Mathematical tools pertinent to quantitative descriptions of human voice are explained.



Osgood Named Fellow of National Academy of Inventors

originally published by *Columbia Engineering*

In recognition of his numerous contributions to integrated optical devices and design, Richard M. Osgood, Eugene Higgins Professor Emeritus of Electrical Engineering and professor emeritus of applied physics, has been named a 2015 Fellow of the National Academy of Inventors (NAI).

Among the most prestigious distinctions accorded to academic inventors, the recognition honors leaders "who have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and welfare of society." Just 582 innovators nationwide are NAI Fellows, nominated by their peers for remarkable contributions to technological progress. Collectively, the NAI fellows hold more than 20,000 issued U.S. patents.

"It is a great honor to be recognized by the National Academy of Inventors for my research and its resultant inventions during my nearly 50 years as a working scientist," said Osgood. "Columbia has had many great pure scientists, such as Charles Townes and Arthur Schawlow, who have also left a great impact from the intellectual property of their basic-science findings; I and others at Columbia who are in the NAI are honored to be part of this important tradition."

Osgood is an internationally renowned researcher whose specialties include new classes of lasers as well as understanding the dynamics of their material medium, the physics and applications of laser surface interactions, solar cells, linear and nonlinear Si integrated optics and physics, the electronic structure of low dimensional materials and nanostructures, and computational electromagnetics. He has published nearly 500 research papers, written a book, edited several anthologies, and received 23 patents. He and his lab group have been involved in numerous startups focused on optical materials and materials processing, including the photonic design system RSoft that was later purchased by Synopsys.

A member of the Columbia Engineering faculty since 1981, Osgood cofounded the Columbia Microelectronics Sciences Laboratories (MSL), co-directed the Columbia Radiation Laboratory (CRL), and headed up the Columbia University Center for Integrated Science and Engineering (CISE), now the Columbia Nano Initiative. He took a two-year leave of absence beginning in 2000 to serve as associate laboratory director for energy sciences at Brookhaven National Laboratory, where he oversaw the National Synchrotron Light Source II, the Center for Functional Nanomaterials, and wide-ranging research in chemistry and materials science including condensed matter physics.

Osgood is also a fellow of the American Physical Society (APS), the Institute of Electrical and Electronic Engineers (IEEE), and the Optical Society of America (OSA). Among his many honors, he has received the R.W. Wood Award from the OSA, the APS-OSA Traveling Lectureship, and a Guggenheim Fellowship. Earlier this year, he received the 2015 IEEE Photonics Society Quantum Electronics Award for "seminal contributions to novel laser systems, laser-surface photochemistry, and integrated linear and nonlinear Si waveguides."

In Memoriam: Edward Christman, 1943-2016

During his many years at Columbia, Professor Edward A. Christman was affiliated with the graduate Program in Medical Physics, which was established in the School of Public Health (SPH) in 1989 and transferred to the School of Engineering and Applied Science in 1993. Initially through the SPH, and later as Adjunct Professor in the Department of Applied Physics and Applied Mathematics, from 1997 until he retired in 2012, Prof. Christman taught *Health Physics*, a lecture course, the *Health Physics Practicum*, and the *Medical Health Physics Tutorial*. The tutorial, which he designed in 2010, provides a professional overview of the field and includes lectures, seminars, tours, and hands-on experience.

Prof. Christman graduated from Rutgers University in Environmental Sciences (M.S. 1974, Ph.D. 1977). Subsequently, as an Associate Graduate Faculty Member (1979-1999), he taught at Rutgers and for a time served as Director of their Radiation and Environmental Sciences Department. His research interests included radiological health physics, radiation safety, radiation dosimetry, microdosimetry, and occupational health and safety. His published research was performed at Rutgers, Princeton, Columbia, and Berkeley.

Board certified and licensed in the State of New York, Prof. Christman also served from 1991-1999 as Director of the Columbia Environmental Health and Safety Office at the Health Sciences campus where he was responsible for all environmental and occupational health and safety programs for the campus.

From 1999-2012 Prof. Christman was an independent consultant in radiation and occupational and environmental health and safety, specializing in high technology research and development environments. He was a resource contact for the Philippine Nuclear Research Institute (PNRI) on matters related to health physics and radiation protection.

Prof. Christman was a member of the American Association of Physics in Medicine (AAPM), the Society for Risk Analysis, and the Health Physics Society. He was elected President of the New Jersey chapter of the Health Physics Society in 1987.

At his retirement, Prof. Christman was honored by the Columbia medical physics faculty for his years of selfless service. His colleagues, as well as his students, remember him as a kind and generous man and a talented and dedicated teacher. We will miss him.

He is survived by his sister Elizabeth, brothers Doug and Glenn, and his wife Florence Cua.

A Year in Review: Photos from the APAM Commencement Reception, Simon Prize Reception, Senior Dinner and awards ceremony, Senior Design Expo, and other student activities from 2015-2016.

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