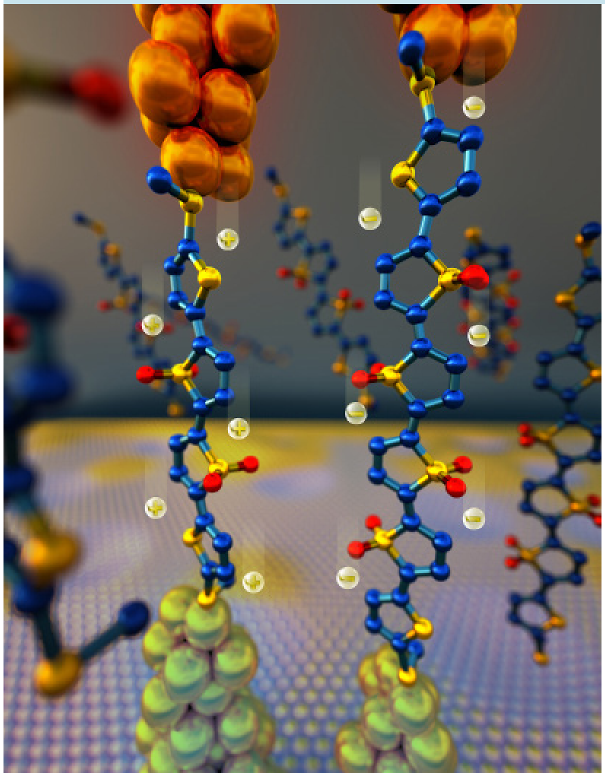
Spring 2015, Vol. 9 Issue 2

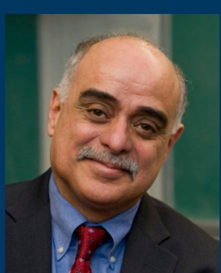
APAM NEWS

THE DEPARTMENT OF APPLIED PHYSICS & APPLIED MATHEMATICS

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



In This Issue



Dear Alumni, friends, students and faculty,

Another spring semester has finished and the Class of 2015 is leaving us for the world. We are happy to have helped them with their growth and wish them the best in the coming years. I am pleased to report that the Department is happy and healthy. You may see in the following pages that we have quite a few successes in all program areas. In addition, this semester we have been able to grow the Materials Science and Engineering Program by completely renovating the Student Laboratory, modifying the undergraduate curriculum, and by recruiting a new colleague. Dr. Yuan Yang, an expert in materials synthesis and high-technology batteries, will be joining us in July as an Assistant Professor of Materials Science (tenure track). He is currently finishing his post-doctoral research at M.I.T.

I wish all of you a wonderful summer.

Best,

I. Cevdet Noyan
Chair, APAM

Cover image: Prof. Latha Venkataraman and colleagues (including APAM students, Brian Capozzi and Haixing Li) were featured in *Nature Chemistry's* editorial, "Molecular electronics under the microscope." See page 9 for details.

2015 Simon Prize Winner: Dr. John Dwyer

The Robert Simon Memorial Prize is awarded annually by the APAM Department to the graduate student who has completed the most outstanding dissertation. **Dr. John Dwyer** (Ph.D. '14 Applied Mathematics) is this year's recipient.

Adam Sobel, Aron Pinczuk, Jane Faggen, John Dwyer, & I.C. Noyan

Dr. Dwyer earned his B.A. in Physics and Mathematics from Columbia University in 2007. While an undergraduate, he was a member of the LIGO scientific collaboration, joining other astrophysicists in the search for gravitational waves. Before returning to Columbia, Dr. Dwyer earned a M.S. in Physics from the University of California, San Diego, where he became interested in climate and atmospheric science.

He conducted his doctoral studies under the supervision of Professor Adam Sobel and Michela Biasutti, Lamont Associate Research Professor. His dissertation was titled: "Projected Changes in the Annual Cycle of Surface Temperature and Precipitation Due to Greenhouse Gas Increases." This dissertation investigates the causes of changes in seasonality in temperature and precipitation that are simulated by climate models in response to greenhouse gases. These seasonality changes manifest as a delayed onset of monsoonal precipitation in the tropics and greater warming in winter than in summer at high latitudes. By using a diagnostic analysis, Dwyer's research is able to identify mechanisms that apply to high latitudes and in the tropics. This work has resulted in several publications in top U.S. climate science journals.

Dr. Dwyer is currently an NSF postdoctoral fellow in the Program in Atmospheres, Oceans, and Climate in the Department of Earth, Atmospheric, and Planetary Science at the Massachusetts Institute of Technology.

"Working with John has been a great experience. In his thesis, he tackled a complex question: how rainfall seasonality changes under greenhouse gas forcing. John had the determination, the creativity, and the smarts to employ many tools to elucidate the dynamical mechanisms behind this phenomenon. His work has won him the respect of senior scientists and young colleagues alike. That, plus his easy way with people, his kindness and trustworthiness convince me that John will soon be a leader in his field. I could not be more proud." - Michela Biasutti

"John is smart, creative, technically skilled, and he works very hard. In the course of his Ph.D. he became remarkably independent, in the way that the very best Ph.D. students do. He figured out on his own how to do things technically; but more importantly, he formulated the basic questions and hypotheses that determine the next steps on his own. The result of this is that in his thesis, he was able to make a number of fundamental advances on the difficult climate dynamics problem that Michela and I set for him when he arrived here. In short, he has become a mature scientist, able to design and execute his own research projects. He is eminently deserving of the Simon Prize, and I'm thrilled that the department has seen fit to award it to him. In his postdoc at MIT and beyond, I expect to see him emerge soon as one of the young leaders in the fields of climate and atmospheric science." - Adam Sobel

***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 in various capacities including marketing, planning, systems engineering, systems programming and information services. He also worked at the Fairchild Engine Division as Director of the Engineering Computer Group. He personally directed the establishment of several company computer centers at sites throughout the U.S. He 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 Simon Prize was established in 2001 by Dr. Jane Faggen with additional support from friends and relatives of Mr. Simon.*

Learn more about our new Ph.D.s at http://apam.columbia.edu/2014-2015-phds

Undergraduate Student Award Winners

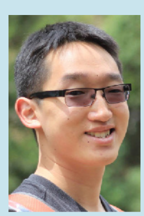
Outstanding seniors were recognized at the APAM Senior Dinner on Friday, May 1, 2015. Winners received a small trophy and a check for $250. The name of each winner was also inscribed on a plaque inside the APAM Department.

Andrew Kaluzny: Applied Mathematics Faculty Award

While Andrew's work at Columbia was outstanding academically, he also applied his knowledge to multiple projects outside of the classroom. For the applied math seminar, he performed an analysis on NYC's restaurant inspection scores, perhaps shining some disturbing light into the corners of your favorite restaurants. He also spent time working with Prof. Kyle Mandli, studying ways to optimize adaptivity in storm surge simulations and, inadvertently, become a guinea pig for the new Columbia computing cluster Yeti. Next fall, he heads to Brown University to study applied mathematics as a Ph.D. student.

Minyong Han: Applied Physics Faculty Award

Minyong Han is an outstanding major in applied physics with remarkable mathematical and physical insight. Right from Freshman year, he has been interested in carrying out research in experimental applied physics, and has participated in multiple research projects with Prof. Philip Kim and Prof. Nanfang Yu. He plans to attend graduate school at Harvard University and will pursue a career in experimental condensed matter physics.



Joseph Eun: Francis B.F. Rhodes Prize

Joseph Eun is an outstanding student in materials science, who quietly masters the material. His senior project addressed laser crystallization of zinc oxide thin films for sensor applications and was presented at the SEAS Senior Design Expo. Joseph is the recipient of the Paul H. Blaustein Scholarship and a member of Columbia's Tau Beta Pi Engineering Honors Society. He will be pursuing his Ph.D. in MSE at Georgia Institute of Technology.

2014-2015 Graduates

October 2014

B.S. - Joseph Feisel (AM), Alexander Jiang (AM)

M.S. - Thomas Clark (AM), David Andersen (AM-CVN), Brian Davis (AM), Pradeep Manikonda (AM-CVN), Alexander Rogers (AM- CVN), Wilkie Choi (PP)

M.Phil. - Kate Eckerle (AM), Chenxi Guo (AM), Wencan Jin (SS), Zhaoyi Li (MSE), Dov Rhodes (PP)

Ph.D. - John Dwyer (ATMOS), William Martin (ATMOS), Arunabh Batra (SS), Erika Penzo (SS)

February 2015

B.S. - Kyoung Won Chah (AM), Anthony Gong (AM), Mark Greenan (AP), Minyong Han (AP), Won Chun Lee (AM)

Certificate - Cuihuan Wang (MP)

M.S. - Mervat Ali Alharbi (MP), Tian Cao (AM), Wei Cao (MSE), Wendi Chang (MSE), Yitao Chen (MSE), Zhengqian Cheng (SS), Dylan DeAngelis (MP), Michel Doumet (AP), Hao Duan (MSE), Mark England (ATMOS), Heather Garcia (MP), Konstantinos Georgiou (MP), Jiayang Hu (MSE), Yanjun Hu (MSE), Kassia Kelly (MP), Jiao Li (AM), Tiffany Lin (MP), Bernard Lipat (ATMOS), Haoming Lu (MSE), Rongtao Ma (MP), Ziying Ran (MSE), Tzlil Rozenblat (MP), Shihan Shen (MSE), Junhua Song (MSE), Kristen Stryker (MP), Jeffrey Taylor (SS), Jing Ti (AP), Deanna Tufano (AM), Shun Wang (MSE), Wentao Xu (AM), Xiaodi Zhong (MSE)

M.Phil. - Christopher Stoafer (PP), Qian Peng (PP), Chaitanya Rastogi (SS), Datong Zhang (SS), Diego Scarabelli (SS), Eric Isaacs (SS), Sheng Wang (SS)

Ph.D. - Iva Vukicevic (AM), Yan Yan (AM)

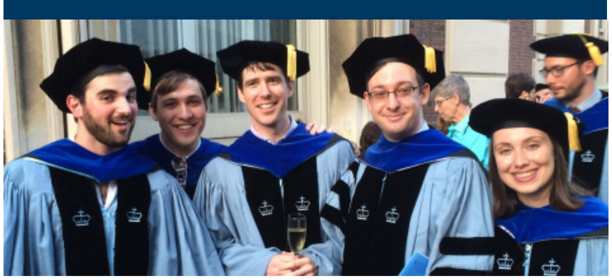
May 2015

B.S. - Leonardo Abbrescia (AM), Thaer AlSheikh Theeb (AP), Isabel Baransky (AP), Ross Basri (AP), Sergio Becerra (AP), Andrew Celsus (AM), Rachel Chung (AM), Sidney Drill (AM), Haris Durrani (AP), Joseph Eun (MSE), Sijie Fan (AM), Adrian Febre (AP), Yiming Ge (AM), Srishti Goel (MSE), Maksim Grinchenko (AP), Jeffrey Handler (AM), Kevin Hwang (AM), Andrew Kaluzny (AM), Sung Kim (AM), Sunhong Kim (AM), Laticia Lee (MSE), Karim Mukaddem (MSE), Dam Linh Nguyen (AM), Smita Patankar (AM), Bradford Reed (AM), Robyn Ridley (MSE), Jasraj Sangha (AM), Cole Stephens (AP), Anna Teng (AM), Ari Turkiewicz (AP), William Van Arsdall (AM), Lingxiang Yu (AM), Mateusz Zukowski (AM)

M.S. - Melissa Abler (PP), Soham Banerjee (MSE), Nicholas Chan (AP), Shaowen Chen (SS), E-Dean Fung (SS), Alexander Glasser (PP), Mark Greenan (AP), Xun Liao (MSE), Yarong Lin (MSE), Yi Lin AP (SS), Jyotirmoy Mandal (SS), Endri Mani (MSE), Baruch Tabanpour (SS), Shuoying Yang (MSE), Fan Ye (MSE)

M.Phil. - Aditi Dandapani (AM), James Lee-Thorp (AM), Patrick Byrne (PP)

Ph.D. - Philip Chuang (MSE), Chenxi Guo (AM), Zhisheng Li (SS), Thomas "Max" Roberts (PP)



Kaluzny Named '15 Salutatorian

Andrew Kaluzny

Andrew Kaluzny was named the SEAS Class of '15 Salutatorian. Interview by Melanie A. Farmer/*Columbia Engineering Magazine*

Name / hometown: Andrew Kaluzny / Seattle, WA

Major / minor: Applied Mathematics / Computer Science

Favorite course: COMS W4995: Cryptography & Financial Processes taught by Michael Rabin

Senior project: I did a project looking at data on NYC health inspections. I was mostly looking for patterns in how restaurants fared from one inspection to the next.

Favorite CORE class: Contemporary Civilization; It was a great introduction to some thinkers and ideas I don't think I would have encountered otherwise.

Favorite place to study: If I'm writing a paper, probably the Science & Engineering Library; for problem sets, I like working in my room where I have a couple of whiteboards set up.

Hobbies: Hiking, LEGO, and baking; I'm currently refining a recipe for chocolate caramel shortbread bars!

Words to live by: Correlation does not imply causation.

Post-graduation plans: An internship with Redfin back in Seattle for the summer, and then I'll be pursuing a Ph.D. in applied math at Brown.

Your definition of engineering: The systematic application of human knowledge to solve problems

What did you gain most from SEAS: A solid understanding of the basics, of first principles — I've acquired a good sense of technical intuition that will serve me well in whatever kinds of problems I may encounter in the future.

Undergraduate Student News

Sean Ballinger, Applied Physics junior and Egleston Scholar, received the "Outstanding Undergraduate Poster Presentation Award" at the 56th Annual Meeting of the APS Division of Plasma Physics in New Orleans. See page 11 for photos and more information about the meeting.

Haris Durrani presented a poster on "Space Debris: Observation, Mitigation, Remediation and Their Legal Factors," at the prestigious National Collegiate Research Conference (NCRC) in January. The 3-day gathering, hosted by Harvard University, showcased some of the most promising and significant work from rising undergraduate leaders in the global research sphere. Durrani, an applied physics senior, was supervised by Professor of Professional Practice (and former NASA astronaut) Mike Massimino (B.S. Industrial Engineering, Columbia University '84).

Graduate Student News

Brian Capozzi, a Ph.D. candidate in Solid State Physics in the Venkataraman group, won an APS Ovshinsky Student Travel Award for the 2015 March APS Meeting in San Antonio, TX. He was one of eleven students chosen out of sixty highly competitive applicants.

Plasma Physics Ph.D. candidate, **Dov Rhodes**, won the "Best Graduate Student Poster" award at the 2015 International Sherwood Fusion Theory Conference held at the Courant Institute of Mathematical Sciences in March. His poster, "Modeling Error-Field Response of the Resistive Wall Mode," featured joint work with APAM faculty, Prof. Andrew Cole, Prof. Michael Mauel, and Prof. Gerald Navratil, and Prof. Richard Fitzpatrick from the University of Texas, Austin.

Chenyang Shi, a Ph.D. candidate in Materials Science and Engineering in the Billinge group, received a Chinese Government Award for Outstanding Students Abroad. The $6000 award was set up by the China Scholarship Council (CSC) to honor overseas Chinese students with outstanding academic accomplishments. Chenyang received the award at a ceremony and reception held at the Chinese Consulate General in New York on April 17, 2015.

Alumni Updates

Alan Chia (B.S. '05 Applied Physics) and Eiffel Zhang were married on September 9, 2014. **(Spring 2015 Engineering Newsletter)**

Matthew Davis (Ph.D. '13 Plasma Physics) has had several cartoons published in *The New Yorker*. Samples of his artwork are available at www.cartoonbank.com.

Plasma Physics alumni, **Andrea Garofalo** (Ph.D. '97), **Brian Grierson** (Ph.D. '09), **Jeffrey Levesque** (Ph.D. '12), and **Steve Sabbagh** (Ph.D. '90), presented new research at the 56th Annual Meeting of the APS Division of Plasma Physics. For more information, see page 11.

Ky Harlin (B.S. '08 Applied Mathematics), the former director of data science at Buzzfeed, is now the first vice president of growth and data science at Conde Nast.

Chris Hegna (Ph.D. '89 Plasma Physics), won the 2014 John Dawson Award for Excellence in Plasma Physics Research. "Hegna is currently a Professor in the Dept. of Engineering Physics at the Univ. of Wisconsin-Madison and serves as the Director of the Center for Plasma Theory and Computation. His primary field is theoretical plasma physics with an emphasis on magnetic confinement. Current research interests include the areas of nonideal and nonlinear MHD instabilities, kinetic theory modifications to fluid-like descriptions of plasmas, plasma dynamics in 3-D magnetic confinement systems and the role of magnetic geometry, symmetry and topology on plasma instabilities, turbulence and transport properties. He has worked at the National Institute for Fusion Studies in Japan and UKAEA Technologies at Culham Laboratories, Abingdon, England. He is an APS fellow (2003) and has served on the Division of Plasma Physics Fellowship Committee, Press Committee and Program Committee. He has also served as the Chair of the Sherwood Fusion Theory Executive Committee, on the USBPO research committee and council, on the Theory Coordinating Committee and on various advisory committees and review panels." **(APS website)**

Medical Physics program alumni are actively engaged in research at the Memorial Sloan Kettering Cancer Center (MSKCC). **Hailiang Huang** (M.S. '14) and **Carl Philipp Gaebler** (M.S. '12) are named authors on an article by Dr. Guang Li, "Novel Spirometry Based on Optical Surface Imaging," published in *The Journal of Medical Physics*.

Saurabh Jain (B.S. '02 Applied Mathematics) writes, "My wife, Seema, and I had our second son, Saarik, last March. My oldest, Aarav, just turned three in November. I am a partner at an investment firm called BHR Capital, based in New York. I am still playing lots of basketball and hope to see the Lions go all the way this year." **(Spring 2015 Engineering Newsletter)**

Papot Jaroenapibal (B.S. '02 Materials Science and B.S. '02 Economics; '02 Rhodes Prize winner) writes, "After graduating from Columbia, I attended a Ph.D. program at the University of Pennsylvania and graduated in 2007. After that, I worked as a postdoc at the same institution until 2009. Currently, I am an Assistant Professor at Khon Kaen University, Thailand. I am also a vice-director for the Industry/University Cooperative Research Center (I/UCRC) in HDD Component, Thailand. My current research topics include: synthesis and characterization of nanomaterials, diamond-like carbon films, electron microscopy and tribological properties of materials."

Oratai Jongprateep (B.S. '00 Materials Science, B.S. '02 Economics, and M.S. '02 Materials Science) is an Assistant Professor in the Materials Engineering Departmant at Kasetsart University in Thailand.

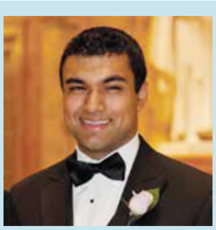
Christine Luu (B.S. '05 Applied Mathematics) finished her federal clerkship for a district judge in Memphis, and just joined the intellectual property department of Kirkland & Ellis, focusing on patent litigation, specifically infringement of medical devices. **(Spring 2015 Engineering Newsletter)**

Alex Papandrew (B.S. '00 Materials Science, '02 Rhodes Prize winner) is a research assistant professor of Chemical and Biomolecular Engineering at the Univ. of Tennessee, Knoxville (UTK). Prior to his appointment at UTK, he was a senior scientist at Superprotonic, Inc., in Pasadena, CA, where he performed pioneering work on the first commercial fuel cells based on solid acid electrolytes. His Ph.D. work was conducted at Caltech with support from a National Defense Science and Engineering Graduate Fellowship. At UTK, he is the institutional PI of a recently awarded ARPA-E grant for the development of nanocomposite fuel cell electrodes in partnership with Oak Ridge National Laboratory. His work is concentrated on advanced materials for energy storage and conversion, including intermediate-temperature electrochemical devices based on solid electrolytes, vapor-phase catalyst synthesis, and redox flow batteries.

Long Phan (B.S. '11 Materials Science) and **David Ordinario** (B.S. '11 Materials Science), graduate students at the University of California, Irvine, recently published the paper, "Infrared invisibility stickers inspired by cephalopods," in the *Journal of Materials Chemistry C*. Phan and Ordinario are members of the Gorodetsky Group for Biomolecular Electronics and are studying the development of infrared camouflage and reconfigurable biomimetic shapeshifter technology. The group's research has been featured in several popular news articles including, "In the Future, You May be Able to Turn Invisible with This Roll-on Squid Tape" in the *Washington Post,* "Squid-Inspired Tape Could Help Camouflage Soldiers" in *Popular Science*, and "Can Squid Help Make Soldiers Invisible?" on CNN.

William T. Sha (M.S.'60, Eng.Sc.D.'64 Nuclear Engineering) authored a book, *Novel Porous Media Formulation for Multiphase Flow Conservation Equations*, published by Cambridge University Press in 2011, and a paperback edition in 2013. Last year he published "Recent Improvements on Novel Porous Media Formulation for Multiphase Flow Conservation Equations," in the *International Journal of Heat and Mass Transfer* 73 (2014): 859-874. He has developed a theoretically derived multiphase flow conservation equation for the first time. He writes, "This is a major milestone for conservation of mass, momentum, and energy equations for multiphase flow." **(Spring 2015 Engineering Newsletter)**

Prof. Siu-Wai Chan connected with Oratai Jongprateep (B.S. '00, M.S. '02) & Papot Jaroenapibal (B.S. '02), during a trip to Bangkok in January 2015. Prof. Chan was Oratai's master's thesis advisor.



In Memoriam - Vinod Kumar Vemuri (B.S. '11 Applied Math)

Vinod Kumar Vemuri passed away on December 30, 2014, at Mt. Sinai Hospital in New York City. He was born in Columbus, OH, and grew up in Murrysville, PA. While studying at Columbia, he was a member of the Columbia Hindu Students Organization, the Columbia Raas Dance Troupe, and was an active volunteer in the Morningside Heights community. After graduating in 2011, he joined Novantas, Inc., a financial services management consulting firm. A tribute written by a fellow classmate was published in the Spring 2015 *Columbia Engineering Newsletter*.
http://engineering.columbia.edu/web/newsletter/spring_2015/memoriam

Samantha John (B.S. '09): Programming the Future

Samantha John

by Jennifer Ernst Beaudry
Columbia Engineering Magazine

It may not have been her degree, but **Samantha John**, B.S. '09 Applied Mathematics, found the keys to a whole new career path — and to launching a company that lets her pursue a passion — at Columbia Engineering.

John cofounded Hopscotch, an iPad app aimed at children that lets any of its users create their own game. The app, which she co-developed in 2011 with Jocelyn Leavitt '07 BUS, went live in April 2013. Today, it sees 50,000 projects published each week, with users playing their games more than 3 million times each month. But founding a company and becoming a programmer wasn't in the plan when John enrolled at the Engineering School as an applied mathematics major on a premed track.

"I took a couple of programming courses that were required and made a website for a student club, and I got really into it," she said. "Before that, I hadn't been exposed to programming very much, and I didn't think of it as something I would like or I could do. But I realized between programming and math, I was having more fun with tech stuff than my premed stuff, and decided that it was what I want to be doing."

This late-blooming interest in the programming world was the inspiration for Hopscotch. "All these guys we know had started programming at 11 or 12 because they played video games and they wanted to make mods for them, and we thought, 'We wish we had had a toy that got us into engineering as kids,' " John said. "And then we thought, 'We need to make that toy.' "

Hopscotch is a gender-neutral platform, but making it a welcoming place for girls is a top priority for John and her business partner. And while the data is limited (because the app is designed for children, privacy laws restrict what user information the company can collect), the strategy seems to be working; anecdotally, John said, their audience seems to be 50-50 girls and boys.

"We've been very deliberate in making it feel girl-friendly," she said. "A lot of beginning programming tools skew boyish, even with the example projects they give. We want to make sure we're not shutting out girls."

John credits her Columbia experience for not only exposing her to programming, but also putting her in the mindset of conquering problems.

"I got used to looking at a problem set I'd been assigned and thinking, 'I don't know if I'm smart enough to complete this problem set,' " she said. "And so I got very comfortable with this feeling of, 'This might not happen!' which is how I feel every day as an entrepreneur."

And most critically, she said, her time at Columbia Engineering put her in great company.

"I think my main takeaway was just being around so many great, smart people," she said.

John and Hopscotch cofounder Leavitt were introduced by mutual friend David Albert BS '09, a cofounder of the programmer retreat the Recurse Center (formerly known as Hacker School). Today, three of the seven employees at Hopscotch are Columbia grads, including one of the company's newest hires, a friend of John's from the College who has really "discovered his inner engineer," she said.

Going forward, Hopscotch has big plans. To grow the burgeoning community, the company is looking to add ways for users to easily share and collaborate on projects, as well as adding a video feature to completed projects. Who knows, maybe there will be more alums coming on board in the future to help support that goal.

"I wouldn't mind hiring more Columbia people!" said John with a laugh.

John was also featured in the article, "Wonder Women: Five female tech entrepreneurs who never got the memo that the field was dominated by men," by Erin Brady, Nicholas DeRenzo, and Chris Wright published in United Hemispheres.

Benjamin Jack (B.S. '07): BoardRounds Upgrading Emergency Care for the Mobile Age

Benjamin Jack (B.S. '07 Applied Mathematics) was featured in this excerpt from the article, "Start Me Up," by Rebecca Shapiro in the Fall 2014 edition of *Columbia Magazine*.

According to the Centers for Disease Control and Prevention, there are close to 130 million emergency-room visits in America every year. For many people, these visits are the only time they will see a physician.

As a medical student at Cornell, **Benjamin Jack**, B.S. '07 Applied Mathematics, became fascinated with the revolving door of emergency medicine, and specifically with what he perceived as the significant problem that ERs had following up with patients and ensuring that they took the next step in their care.

"When patients get discharged from the ER, they leave with a piece of paper that tells them what to do next," he says. "Eighty percent of them don't understand the instructions and don't get the care that they need."

He found that patients who didn't take control of their post-discharge care became a strain on hospitals and insurance companies. The less vigilantly a patient continued his care after leaving the hospital, the more likely he was to quickly get sick and start the cycle again.

It seemed that only human intervention would help, but the caseloads of ER doctors are far too heavy for them to follow up individually with each of their patients. Jack wondered what would happen if a third party got involved.

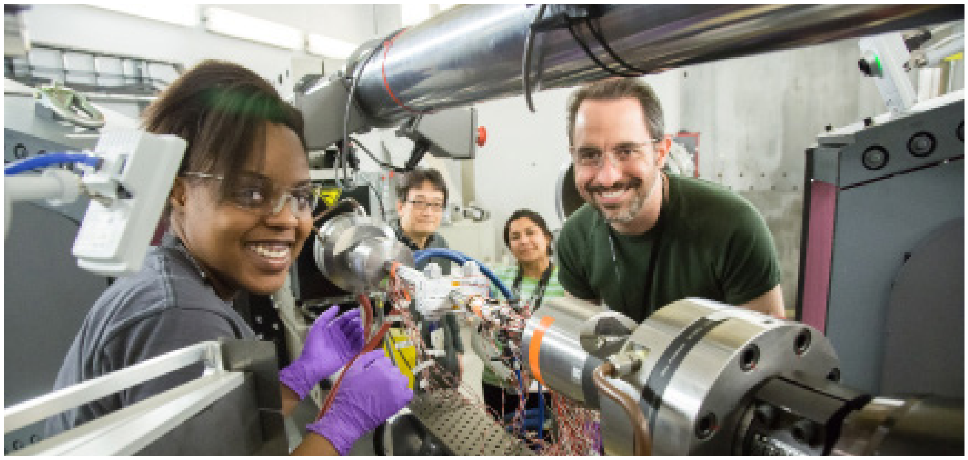
Jack teamed up with Aditya Mukerjee '12 CC, who had a degree in computer science and a few years of startup experience under his belt. As Jack finished his last year of medical school (he graduated in '14), he and Mukerjee developed the idea for BoardRounds, a cloud-based service that identifies and arranges post-discharge care for emergency-room patients. Doctors using BoardRounds will be able to enter a patient's information and follow-up instructions into their system. From there, BoardRounds will contact the patient and handle the logistics of the next steps. "Let's say a patient is diagnosed with asthma and instructed to see a pulmonologist. BoardRounds would be able to make the appointment, arrange for transportation to the appointment, and send reminders about the appointment," Jack says.

The service doesn't stop with the actual medical care. BoardRounds also works with insurance companies to provide interventions for patients, and provides detailed analytics to hospitals and providers about patients' post-discharge behaviors, such as appointment completion rates. **(Continued on page 11)**

VULCAN Users from Columbia Study Suspension Bridge Cable Design

by Katie Bethea, Oak Ridge National Laboratory

A team of researchers led by **I.C. Noyan**, Professor and chair of the APAM Department, is conducting experiments at VULCAN, SNS beam line 7, at the Oak Ridge National Laboratory as part of an ongoing study of suspension bridge cable design. Shown here are **Janelle Mills, Seung-Yub Lee, Srishti Goel,** and **Adrian Brügger** examining a wire bundle they are testing at VULCAN. Not shown are principal investigator, I.C. Noyan, and Amine Oueslati from the University of Maryland.



(left-right) Janelle Mills '15, Seung-Yub Lee, Srishti Goel '15, & Adrian Brügger
Image: Genevieve Martin / ORNL

Suspension bridge cables are made up of parallel wire strands bundled together. Moisture, local defects in the wire, and contaminants can cause corrosion and cracking in the wire. The team is using neutron diffraction to understand the effects of these breaks on the overall strength of the cable. These experiments will help quantify the effect of mechanical interference of the outer wires with the central wire on the strain transfer to a broken wire. Essentially, they want to find out if there's a break in one of the hundreds of wires that makes up a cable, at what distance from the break does the wire begin to carry the load due to friction and wire twist.

Using neutron diffraction allows for nondestructive study of the wires, and thus more accurate measurements of the wire strain. Other methods of making these measurements, like adding sensors to the wire, disrupt the contact mechanics of the whole system. Additionally, VULCAN offers a unique environment for their experiment where the team can apply torsion to the wire specimen, twisting it to represent the natural curving that the wires exhibit as a result of coiling the cables during the manufacturing process.

(Above) Prof. Chris Wiggins (Below) Prof. Chris Wiggins & Prof. C.K. Chu, *Emeritus*. Photos by David Dini/Columbia Engineering

SEAS 150th Celebration

Five APAM faculty members spoke at the SEAS 150th Anniversary Symposium, *Columbia's Engineering Renaissance: Foundation for the Future*, on November 14, 2014, in Roone Arledge Auditorium. The symposium featured a series of TEDx-like talks which showcased past and current research, the School's historic achievements, and plans for the future.

Chris H. Wiggins, Applied Mathematics
"Data Science: Transforming the 21st Century"

Chris Marianetti, Materials Science & Engineering
"Computation and Materials Discovery"

Latha Venkataraman, Solid State Physics
"Frontiers of Molecular Engineering"

Michael Mauel, Plasma Physics
"Pioneering Computational Fluid Dynamics"
- a special tribute to Professor *Emeritus* C. K. "John" Chu

Adam Sobel, Atmospheric Science
"Computational Earth and Atmospheric Science"

Watch the videos online at:
http://tiny.cc/klpiux

Frequency of Tornadoes, Hail Linked to El Niño, La Niña

by Francesco Fiondella, Columbia Engineering News

Climate scientists can spot El Niño and La Niña conditions developing months ahead of time, and they use this knowledge to make more accurate forecasts of droughts, flooding, and even hurricane activity around the world. Now, a new study shows that El Niño and La Niña conditions can also help predict the frequency of tornadoes and hail storms in some of the most susceptible regions of the United States. The study appears in the current issue of the journal *Nature Geoscience*.

"We can forecast how active the spring tornado season will be based on the state of El Niño or La Niña in December or even earlier," said lead author John Allen, a postdoctoral research scientist at the International Research Institute for Climate and Society (IRI).

The El Niño-Southern Oscillation, or ENSO, is a naturally occurring climate cycle in which sea-surface temperatures in the equatorial Pacific Ocean fluctuate. When waters are warmer than normal, as they are currently, it is described as El Niño; when cooler, La Niña.

Allen and his coauthors show that moderately strong La Niña events lead to more tornadoes and hail storms over portions of Oklahoma, Texas, Kansas, and other parts of the southern United States. El Niño events act in the opposite manner, suppressing both types of storms in this area.

While the information can't pinpoint when and where storms will wreak havoc, it will nevertheless be useful for governments and insurance companies to prepare for the coming season, Allen said. In recent weeks, researchers from IRI and other institutions have detected El Niño conditions over the Pacific, which implies that this spring will be a relatively quiet one for severe storms in the southern United States.

"The big contribution of the paper is that it looks at the changes in environmental conditions associated with ENSO," said Harold Brooks, a senior research scientist at the U.S. National Oceanic and Atmospheric Administration (NOAA), who was not an author of the study. "Previous efforts have focused on tornado reports, but the connection with changes in large-scale conditions hadn't been made," he said.

Last year, 47 people died in tornadoes. But in 2011 — a La Niña year — tornadoes killed more than 550 people, higher than in the previous 10 years combined. Hail storms and tornadoes cause an average estimated $1.6 billion in insured losses each year in the United States, according to the insurer Munich RE. Powerful, isolated events such as the 2011 Joplin, Missouri, tornado can smash that average. That storm alone caused several billion dollars in damage and killed 158 people.

The idea that ENSO can affect the frequency and locations of tornadoes and other severe storm systems isn't new. It is already known to exert a strong influence on temperatures and rainfall in the United States, and affect the position of the jet stream. Yet scientists have had difficulty quantifying ENSO's role in tornadoes, for two reasons. First, a variety of other factors can make them seemingly random: one year can see hundreds of twisters, while another sees few. Also, historical weather records are not reliable for long enough to make strong statistical connections. This is true especially for tornadoes, which often flare up and die quickly.

"Trying to tease out an ENSO signal from both the natural noise and the human noise becomes quite complicated," said coauthor **Michael Tippett**, Lecturer in the Discipline of Applied Mathematics in the APAM Department. "You can't get a robust correlation using the observational record alone."

A tornado brews near El Reno, Oklahoma, May 2013. A new study links the frequency of tornadoes and hailstorms in parts of the southern United States to ENSO, a cyclic temperature pattern in the Pacific Ocean. Image: John Allen

Past studies that have relied on eyewitness records alone have had limited success, said Allen. "For example, previous work has shown a clear linkage between ENSO and winter activity, but spring — the season when most of tornadoes occur in the southern U.S. — remained an enigma until now," Allen said.

To get around these challenges, the Columbia University team created indices derived from environmental conditions such as wind shear, temperature, and moisture. Each is a key ingredient in severe storm formation, and each is influenced by ENSO. The scientists then verified the indices using available observational records.

Adding a forecasting component was relatively straightforward. "We're already set up to monitor and forecast ENSO," said Tippett. "We know that ENSO affects the large-scale environment, and the large-scale environment affects the tornado occurrence." During La Niña, both vertical wind shear and surface warmth and moisture increase significantly in the southern states, making conditions favorable to severe storm occurrence.

Agencies such as NOAA and its counterparts all over the world constantly monitor conditions in the Pacific to spot a developing El Niño or La Niña, so the authors say it wouldn't be too difficult to issue a warning for tornadoes or hail based on the ENSO state.

They note caveats, however. First, ENSO is not the only driver of severe storms. "Any kind of extreme weather is at most only loosely controlled by coherent, predictable climate phenomena like ENSO, and tornadoes are no exception," said coauthor **Adam Sobel**, Professor of Applied Physics and Applied Mathematics and of Earth and Environmental Sciences. Second, the current study shows robust correlation only in the southern states, where the ENSO signal is especially clear. "A lot of the year-to-year variability is for all practical purposes random and unpredictable," said Sobel, who also directs a new Columbia University Initiative on Extreme Weather and Climate.

Tippett & Sobel were also featured in the *Scientific American* article, "Experimental Forecast Projects Tornado Season: A seasonal forecast of the devastating extreme weather event may be available as soon as 2016" and in the *NOAA MAPP News* article, "Can ENSO forecasts help predict severe thunderstorm activity?"

Qiang Du

Developing New Mathematical & Computational Tools for Science & Engineering

by Amy Biemiller
Columbia Engineering Magazine

More and more researchers are using computational analysis to understand data and effectively model scientific solutions for needs that range from designing safer airplanes to understanding molecular structures and predicting social behavior. Key to a computer's capability in solving complex, real-world problems are mathematical models and numerical algorithms.

"We live in an age where computational science is becoming a nascent interdisciplinary field and the advent of computing technology is rapidly transforming how mathematics get used in applications. What has intrigued me the most in my research are the challenging questions that have strong practical motivations and demand new mathematical and computational tools for their solutions," says **Qiang Du**, the Fu Foundation Professor of Applied Mathematics.

As an applied and computational mathematician, Du is internationally recognized as one of the world's leading researchers in the study of Ginzburg-Landau theory, the mathematical theory used to describe phase transitions and the captivating phenomena of superconductivity. His research in this area gives a better understanding of how superconductors work, and helps scientists leverage superconductors' unique capabilities most effectively.

He has also developed approaches to mathematically model and simulate other defects and interfaces in nature—in essence, portraying physical reality using equations, computer codes, and pictures that help explain complex systems. Some of those systems include materials phase boundaries, biological membranes, and quantized vortices in Bose-Einstein condensates—a type of flow pattern exhibited by certain collections of confined atoms at extremely cold temperatures. He has also contributed to the design of space tessellation and mesh generation strategies, and developed mathematical models to explore hidden structure and information in images and data.

"I am very proud to have worked with mathematicians to make advances in theory, and at the same time, to have teamed up with scientists in various disciplines to perform numerical simulations for challenging problems, validate theoretical findings, and provide practical solutions," he says.

Du is continuing his research with a focus on developing mathematical tools and numerical algorithms for applications in physical, biological, materials, data, and information science. In the last few years he has become particularly interested in the mathematical and computational study of nonlocal models. Physical and biological interactions frequently involve the redistribution of organisms or molecules in space. It is difficult to collect data and pass through information over numerous time and spatial scales. Nonlocal mathematical models may be an effective alternative to bridge the different scales and help scientists make more accurate predictions and explore new questions.

"These new mathematical models, along with improved simulation techniques, have begun to populate in research areas like the study of materials damage, anomalous diffusion, and collective dynamics, and have great potential to help scientists and engineers," says Du. His work in this direction is now partially supported through the newly funded Air Force Office of Scientific Research Multidisciplinary University Research Initiative (AFOSR MURI) center for Material Failure Prediction through Peridynamics.

Prior to joining the APAM Department at Columbia University, Du was the Verne M. Willaman Professor of mathematics and also a professor of materials science and engineering at Pennsylvania State University. He is a faculty affiliate of Columbia's Data Science Institute. In 2013, he was selected as a Society for Industrial and Applied mathematics (SIAM) Fellow for contributions to applied and computational mathematics with applications in materials science, computational geometry, and biology.

Faculty Updates

Prof. Irving Herman was named the Director of the Columbia Optics & Quantum Electronics IGERT. The National Science Foundation began the IGERT (Integrative Graduate Education and Research Traineeship) Program "to establish new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries."

Richard Osgood, Jr., Higgins Professor *Emeritus* of Electrical Engineering and Professor *Emeritus* of Applied Physics and Applied Mathematics, marked a milestone recently as he celebrated the graduation of his 60th graduate student, Zhisheng Li.

Prof. Adam Sobel moderated "Preparing for Extreme Weather: Global Lessons from Sandy" on February 23, 2015 in the Low Rotunda. The event, which focused on the Columbia Initiative on Extreme Weather and Climate, was part of the Columbia University World Leaders Forum, co-sponsored by The Earth Institute, the Lamont-Doherty Earth Observatory, and the Office of the Executive Vice President for Research.

Prof. Chris H. Wiggins was elected a Fellow of the American Physical Society (APS) "For pioneering work in computational biology, including the applications of machine learning, statistical inference, and information theory for the investigation of biological networks."

Adjunct Faculty Updates

Anthony Del Genio, NASA Goddard Institute for Space Studies (GISS) Researcher and APAM Adjunct Professor, was featured in the *Nature* article, "Climate scientists join search for alien Earths: NASA initiative seeks to bolster interdisciplinary science in hunt for extraterrestrial life" by Jeff Tollefson.

Adjunct Professor, Supratik Guha, was elected a member of the National Academy of Engineering "for contributions to field effect transistor technology that allow continued scaling of silicon microelectronics." Dr. Guha is the director of physical sciences at the IBM T. J. Watson Research Center in Yorktown Heights, NY. He is responsible for setting strategy and directing IBM's worldwide research in the physical sciences. His own research interests are in the area of new materials for energy conversion and logic devices. He is a member of the IBM Academy of Technology, the National Academy of Engineering, and is a Fellow of the American Physical Society and the Materials Research Society.

(continued on page 11)

Latha Venkataraman

Nanoscience, Getting a Charge Out of Nanotechnology

by Amy Biemiller
Columbia Engineering Magazine

Ever since the dawn of the electronic age, science has been on a quest for miniaturization, making transistors smaller in order to integrate many into a circuit and further miniaturizing to build microprocessors. The potential for further miniaturization is predicated on physics: The tiniest transistors must still be large enough to control the on or off flow of electrons. The smallest transistors that can be envisioned consist of just a few atoms or a small molecule. The potential for making such small electronic circuits has captivated **Latha Venkataraman**, associate professor of applied physics.

"By developing circuits with components that consist of a single molecule (a collection of a few atoms), I am working at a size regime that is close to the fundamental limit," she says. "There's something exciting about exploring how things work at such an extreme and largely uncharted scale."

The underlying focus of Venkataraman's research is to fabricate single-molecule circuits, a molecule attached to two electrodes, with varied functionality where the circuit structure is defined with atomic precision. That's the holy grail of molecular electronics and a goal Venkataraman had been pursuing even when popular science relegated the idea to theory.

"When I started at Columbia, the field of molecular electronics was plagued with uncertainty. No one could imagine that a single-molecule circuit could actually function reliably and reproducibly," she explains. Through collaboration with chemistry groups at Columbia, a method was devised to create workable single-molecule devices.

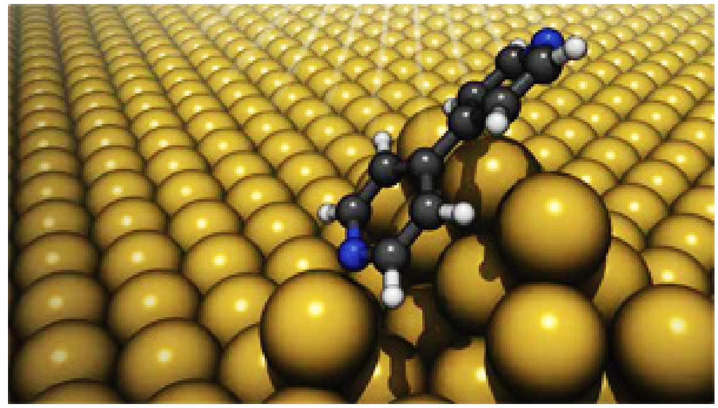
"This was a major breakthrough, because we could finally probe the properties of such circuits and relate these to the chemical and physical natures of the molecules," she says.

Now, Venkataraman is focused on learning how these circuits work and how to optimize their function as active device components. Her findings will also enhance the understanding of charge transport in molecular systems and across metal-organic interfaces, with impact on the fields of organic electronics, photovoltaics, catalysis, and even biological processes (such as photosynthesis and respiration).

"We are now measuring how electronic conduction and single bond-breaking forces in these devices relate not only to the molecular structure but also to the metal contacts and linking bonds. Our experiments provide a deeper understanding of the fundamental physics of electron transport, while laying the groundwork for technological advances at the nanometer scale," she says.

Improving the understanding of how molecules transport charge can help in development of next-generation devices, and Venkataraman is on the verge of technological breakthrough. A team in her lab recently substituted layered materials for a gold electrode in a molecular circuit.

"We've always used gold metal electrodes to contact molecules in our circuits, but when we switched to using multilayered graphene flakes as one electrode, these devices ended up functioning as diodes, which are the basic building blocks for a transistor," she explains. That research was published in *Proceedings of the National Academy of Sciences* this summer.



(Above) Illustration of a molecule on gold surface bonded through chemical and van der Waals interactions. The forces required to break these bonds were first measured in Venkataraman's lab.

The next step for Venkataraman is to figure out how to make more interesting circuit components such as switches or optically active elements and build these into circuits. In this process she is also exploring new ways to control the interface between molecules and electrodes.

"We are working on creating molecular devices with varied functionalities that are controlled through chemical design," she says. To understand the interplay of physics, chemistry, and engineering at the nanometer scale, Venkataraman works with a range of scientists and encourages the graduate students in her lab to get comfortable with collaboration.

"Collaboration is really what makes my research possible and fun," she says. "Most of my graduate students and I are trained as physicists. We do not know much chemistry, and all the work that we do requires understanding molecular structures to relate them to the electronic functions that we measure. Without our spending hours talking with our chemistry collaborators, none of this would be possible."

Venkataraman & APAM Students Featured in *Nature Chemistry*

Prof. Latha Venkataraman and colleagues (including APAM students, Brian Capozzi and Haixing Li) were featured in *Nature Chemistry*'s editorial, "Molecular electronics under the microscope."

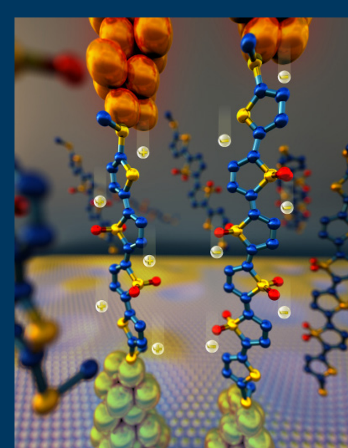


Image: "Understanding the intrinsic electronic properties of building blocks in conjugated materials can provide powerful design guidelines to control charge transport, such as tuning the nature of the charge carriers. Here, single-molecule transport studies of a family of oxidized oligothiophenes show that the molecular length determines the carrier type."

Unusual Electronic State Found in New Class of Unconventional Superconductors

by Karen McNulty Walsh, Brookhaven National Laboratory

A team of scientists from Columbia Engineering, the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, Columbia Physics, and Kyoto University has discovered an unusual form of electronic order in a new family of unconventional superconductors. The finding, described in the journal Nature Communications, establishes an unexpected connection between this new group of titanium-oxypnictide superconductors and the more familiar cuprates and iron-pnictides, providing scientists with a whole new family of materials from which they can gain deeper insights into the mysteries of high-temperature superconductivity.

"Finding this new material is a bit like an archeologist finding a new Egyptian pharaoh's tomb," said Simon Billinge, a physicist at Columbia University's School of Engineering and Applied Science and Brookhaven Lab, who led the research team. "As we try and solve the mysteries behind unconventional superconductivity, we need to discover different but related systems to give us a more complete picture of what is going on—just as a new tomb will turn up treasures not found before, giving a more complete picture of ancient Egyptian society."

Harnessing the power of superconductivity, or the ability of certain materials to conduct electricity with zero energy loss, is one of the most exciting possibilities for creating a more energy-efficient future. But because most superconductors only work at very low temperatures—just a few degrees above absolute zero, or -273 degrees Celsius—they are not yet useful for everyday life. The discovery in the 1980s of "high-temperature" superconductors that work at warmer temperatures (though still not room temperature) was a giant step forward, offering scientists the hope that a complete understanding of what enables these materials to carry loss-free current would help them design new materials for everyday applications. Each new discovery of a common theme among these materials is helping scientists unlock pieces of the puzzle.

One of the greatest mysteries is seeking to understand how the electrons in high-temperature superconductors interact, sometimes trying to avoid each other and at other times pairing up—the crucial characteristic enabling them to carry current with no resistance. Scientists studying these materials at Brookhaven and elsewhere have discovered special types of electronic states, such as "charge density waves," where charges huddle to form stripes, and checkerboard patterns of charge. Both of these break the "translational symmetry" of the material—the repetition of sameness as you move across the surface (e.g., moving across a checkerboard you move from white squares to black squares).

Another pattern scientists have observed in the two most famous classes of high-temperature superconductors is broken rotational symmetry without a change in translational symmetry. In this case, called nematic order, every space on the checkerboard is white, but the shapes of the spaces are distorted from a square to a rectangle; as you turn round and round on one space, your neighboring space is nearer or farther depending on the direction you are facing. Having observed this unexpected state in the cuprates and iron-pnictides, scientists were eager to see whether this unusual electronic order would also be observed in a new class of titanium-oxypnictide high-temperature superconductors discovered in 2013.

"These titanium-oxypnictide compounds are structurally similar to the other exotic superconductor systems, and they had all the telltale signs of a broken symmetry, such as anomalies in resistivity and thermodynamic measurements. But there was no sign of any kind of charge density wave in any previous measurement. It was a mystery," said

Team members conducting research at BNL, led by Simon Billinge (seated), include (left-right) Columbia graduate student Ben Frandsen, and Weiguo Yin, Yimei Zhu, and Emil Bozin of BNL's Condensed Matter Physics and Materials Science Department

Emil Bozin, whose group at Brookhaven specializes in searching for hidden local broken symmetries. "It was a natural for us to jump on this problem."

The team searched for the broken rotational symmetry effect, a research question that had been raised by Tomo Uemura of Columbia, using samples provided by his collaborators in the group of Hiroshi Kageyama at Kyoto University. They conducted two kinds of diffraction studies: neutron scattering experiments at the Los Alamos Neutron Science Center (LANSCE) at DOE's Los Alamos National Laboratory, and electron diffraction experiments using a transmission electron microscope at Brookhaven Lab.

"We used these techniques to observe the pattern formed by beams of particles shot through powder samples of the superconductors under a range of temperatures and other conditions to see if there's a structural change that corresponds to the formation of this special type of nematic state," said Ben Frandsen, a graduate student in physics at Columbia and first author on the paper.

The experiments revealed a telltale symmetry breaking distortion at low temperature. A collaborative effort among experimentalists and theorists established the particular nematic nature of the order.

"Critical in this study was the fact that we could rapidly bring to bear multiple complementary experimental methods, together with crucial theoretical insights—something made easy by having most of the expertise in residence at Brookhaven Lab and wonderfully strong collaborations with colleagues at Columbia and beyond," Billinge said.

The discovery of nematicity in titanium-oxypnictides, together with the fact that their structural and chemical properties bridge those of the cuprate and iron-pnictide high-temperature superconductors, render these materials an important new system to help understand the role of electronic symmetry breaking in superconductivity.

As Billinge noted, "This new pharaoh's tomb indeed contained a treasure: nematicity."

This work was supported by the DOE Office of Science, the U.S. National Science Foundation (NSF, OISE-0968226), the Japan Society of the Promotion of Science, the Japan Atomic Energy Agency, and the Friends of Todai Inc. Brookhaven National Laboratory is supported by the Office of Science of the U.S. Department of Energy. The Office of Science is the single largest supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov.)

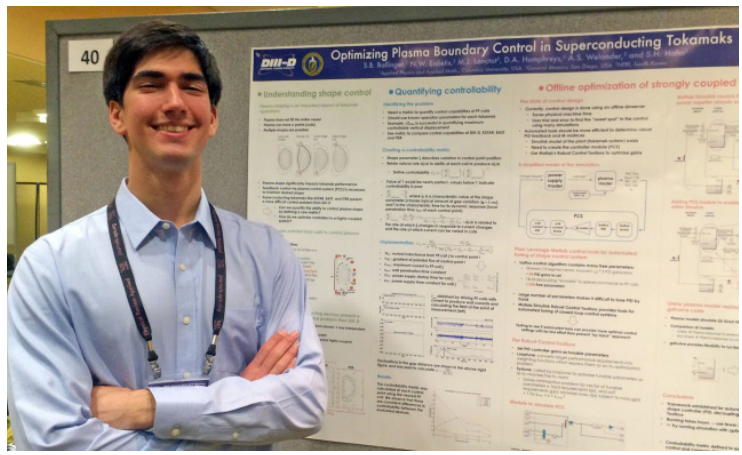
56th Annual Meeting of the APS Division of Plasma Physics

APAM faculty, researchers, students, and alumni attended the 56th Annual Meeting of the American Physical Society (APS) Division of Plasma Physics in New Orleans, LA, from October 27-31, 2014.

During a celebration of Columbia University Plasma Physics, seven scientists were recognized for their invitations to present talks about their research on magnetically confined high-temperature plasma. Columbia plasma physics alumni, including **Andrea Garofalo** (Ph.D. 1997), **Brian Grierson** (Ph.D. 2009), **Jeffrey Levesque** (Ph.D. 2012), and **Steve Sabbagh** (Ph.D. 1990), presented new research on the stability and control of tokamak discharges. **Max Roberts**, a plasma physics Ph.D. candidate, reported how local current injection can be used to control plasma convection in magnetospheric configuration. Francesco Turco, a Columbia research scientist working at the DIII-D tokamak in San Diego, CA, lectured during the special session for ITER physics, and Chris Hansen, a visiting scientist working at Columbia's Plasma Physics Laboratory, spoke about using distributed diagnostic arrays to validate high-performance computer simulations of magnetized plasma. Links to the titles and abstracts of these seven talks can be found online: (Bulletin of the APS, Vol 59, Number 15, http://meeting.aps.org/Meeting/DPP14/Content/2782)

Two Columbia undergraduates also presented research they conducted over the summer at General Atomics, San Diego, as National Undergraduate Fusion Fellows. Cole Stephens, Class of 2015, presented his study of the heat flux from a tokamak plasma during edge instabilities. Sean Ballinger, Class of 2016, used a tokamak "simulator" to test real-time feedback control systems that may be implemented in the a Korean tokamak made with superconducting magnets. Scientists judged Sean Ballinger's presentation highly, and he received the "Outstanding Undergraduate Poster Presentation Award" from the APS Division of Plasma Physics.

Photos: (top, left-right): Jeffrey Levesque '13, Steve Sabbagh '90, Max Roberts '15, Chris Hansen, Brian Grierson '09, Francesco Turco, and Andrea Garofalo '97; (bottom) Sean Ballinger '16



Adjunct Faculty News (Continued from page 8)

Steve Sabbagh (APAM alumn, Adjunct Professor, and Senior Research Scientist) and Young-Seok Park (APAM Associate Research Scientist) recently visited the National Fusion Research Institute (NFRI) in Daejeon, South Korea to conduct an experiment on the KSTAR superconducting magnetic fusion tokamak device attempting to demonstrate plasma operation at high ratios of plasma pressure to magnetic field and plasma current (normalized beta) and to extend the understanding of plasma rotation control in the device. The machine was successfully operated at reduced toroidal field as low as 0.9T and record values of normalized beta for the device exceeding 4.3 were produced transiently over a range of plasma internal inductance from 0.65 – 0.85 as computed using full KSTAR equilibrium reconstructions. The maximum normalized beta exceeds by 50% the theoretical global MHD mode ideal no-wall beta limit, and is more than 85% of the design value for the device. These experimental plasmas may be limited in performance by global plasma instabilities. These experiments are a proof-of-principle for the existence of this high normalized beta operational regime in KSTAR, and further experiments will attempt to maintain these plasmas for the maximum duration allowed by the device (presently several tens of seconds). Initial examination of the expanded rotation control experiments confirm the favorable lack of hysteresis previously found as the applied 3D braking field magnitude is changed.

Benjamin Jack (B.S. '07): BoardRounds (Continued from page 5)

"We wanted to make sure that we were always looking at the bigger picture. The analytics piece helps our providers see that as well," Jack says.

With their software mostly complete, Jack and Mukerjee are focused on raising money and forming partnerships with hospitals and medical providers. To date, they have raised more than $300,000 in seed capital, with backing coming from the Dorm Room Fund — a student-run venture firm that invests in student-run companies — among others. The system is already in place at a major New York City hospital and a dialysis-care center, with new partnerships imminent.

Jack didn't start his medical training intending to go into business, but he is unusually qualified to do so; before starting at Cornell, he studied applied math at Columbia and worked for two years in finance. Though he hasn't ruled out practicing medicine at some point, he says that this feels like the best use of his skills right now.

"I went to medical school to save lives. That's our mission at BoardRounds, too, but on a bigger scale," he says.

APAM Students Visit Indian Point

Seventeen medical physics graduate students and one applied physics graduate student enjoyed an all-day visit at the Indian Point Nuclear Power Plant in Buchanan, NY last November. The tour was led by Lori Glander, Emergency Planning Manager at Entergy Nuclear.

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