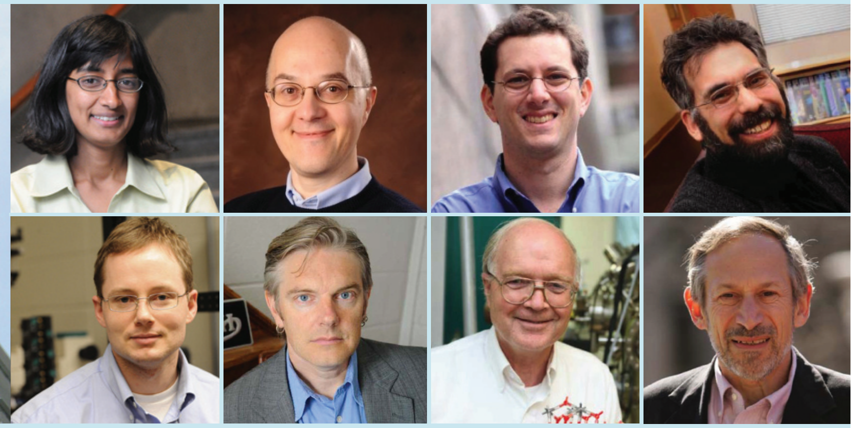
Spring 2011, Vol. 5 Issue 2

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



(left) **Northwest Corner Building** (right) **Faculty featured in *Engineering News*:** (top) **L. Venkataraman, L. Polvani, A. Sobel, M. Spiegelman** (bottom) **D. Englund, S. Billinge, R. Osgood, M. Cane**

Dear Alumni and Other Friends of APAM:

We once again celebrate another glorious year!

In this issue we highlight the wonderful graduates of our undergraduate and graduate programs this academic year, and note those who won departmental prizes and have received other forms of recognition!

In this issue we also report on the many exciting recent activities in APAM. We highlight the major awards and recognition received by Dirk Englund, David Keyes, Tom Marshall, and Latha Venkataraman. We also review the activities and breakthroughs by Simon Billinge, Mark Cane, Chris Marianetti, Richard Osgood, Lorenzo Polvani, Adam Sobel, and Marc Spiegelman.

Our department hosted a memorial service for our colleague, Professor Gertrude Neumark. I would like to deeply thank Cev Noyan and Igor Kuskovsky for organizing this moving event.

Please stay in contact, and follow us on Facebook and Twitter!

Best,

Irving P. Herman
Chair, APAM

In This Issue

(left-right) **Dr. Bryant Williams, Dr. Melinda Han, Prof. Irving Herman, Dr. Jane Faggen & Prof. Aron PInczuk**

2011 Simon Prize Award Winner: Dr. Melinda Han

The Robert Simon Memorial Prize is awarded annually by the APAM Department to the graduate student who has completed the most outstanding dissertation. The Simon Prize was established in 2001 by Dr. Jane Faggen with additional support from friends and relatives of Mr. Simon. Dr. Melinda Han is the recipient of the 2011 award.

Dr. Han received a B.Sci. degree in Engineering Physics and a B.A. in Applied Math from the Univ. of California at Berkeley in May 2004. In September 2004, she started her studies in the APAM Department in Applied Physics. She received her M.S. degree in May 2005 and then joined Prof. Philip Kim's group, as a Graduate Research Assistant in January 2005. She was a National Science Foundation Graduate Student Fellow from 2007-2009.

In her Ph.D. thesis, "Electronic Transport in Graphene Nanoribbons", Dr. Han reported on the electronic properties of graphene nanostructured into 1-dimensional structures whose widths are in the tens of nanometers. This work demonstrates the lithographic fabrication of graphene nanoribbons and reports the observation of a length- and orientation-independent transport gap whose size is inversely proportional to the channel width. Through low temperature and temperature-dependent measurements it is observed that in the gap, electrons are localized, and charge transport exhibits a transition between thermally activated behavior at higher temperatures and variable range hopping at lower temperatures. By varying the geometric capacitance, it is determined that charging effects constitute a significant portion of the activation energy. Her thesis work also presents evidence that the treatment of etched graphene nanoribbons with diaminopropane results in charge doping from covalent chemical functionalization that is selective to the graphene edges.

While at Columbia, Dr. Han published nine journal papers including two first author papers in *Physical Review Letters* (2007 & 2009). These papers, which form the core of her thesis, have been very well recognized. The 2007 paper has been cited more than 800 times and the 2009 paper was chosen to be highlighted as an "Editors' Suggestion" as well as a featured article in APS Synopses, February 2010. She is currently a Postdoctoral Fellow in the National Renewable Energy Laboratory in Golden, CO, working on solar cell research.

Robert Simon (1919-2001) received a B.A. degree *cum laude* in Classics from the City College of New York in 1941, where he was elected to Phi Beta Kappa, and an M.A. in Mathematics from Columbia University in 1949. From 1941-1944, he was a Lieutenant in the U.S. Armed forces serving in England, France, and Italy. He participated in the D-Day operation as a navigator for a plane that dropped paratroopers in the vicinity of Omaha Beach. General Dwight Eisenhower personally shook his hand and wished him well the night before the D-Day assault. He spent a lifetime making valuable contributions to the field of computer science. Starting in 1953, 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 spent a year working 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. Between 1969-1973, he was a partner with American Science Associates, a venture capital firm. Mr. Simon was a founder and Vice President of Intech Capital Corporation and served on its board from 1972-1981 and a founder and member of the board of Leasing Technologies International, Inc. from 1983 until his retirement in 1995.

Undergraduate Awards

Outstanding seniors were recognized at the APAM Senior Dinner on May 6. Award winners received a plaque and a check for $500, have their names inscribed on plaques in the department, and are listed on the APAM web site.

(left-right) **Daniel Cosson, Daniel Gledhill, Prof. Irving Herman, Michael Wang (class salutatorian), and Kyler Siegel**

Applied Physics Faculty Award
Daniel Cosson

Daniel has done exceptionally well at Columbia. Pursuing a rigorous academic program, he maintained a 3.9 GPA and completed a total of 147.5 points. He gave an excellent talk on quantum computing in the Applied Physics seminar. He also worked on several research projects in the CNT lab, most recently on a project with graduate student Xabi Sarasola Martin where he helped build and operate an array of capacitive probes that enabled detailed measurements of the spatial structure of oscillations in non-neutral plasmas. The results of these measurements show surprising new physics and are now being written up for publication.

Materials Science and Engineering Francis B. F. Rhodes Prize
Daniel Gledhill

Daniel came to Columbia as part of the 3-2 program after spending his first three years at Colgate in Physics. He has maintained a 3.88 GPA and was involved with research in Prof. Im's group, where he worked on laser processing of Si. His project was to develop a process to monitor the time evolution of the Si melt at 1000 °C when irradiated by an excimer laser pulse.

Applied Mathematics Faculty Award
Kyler Siegel

Kyler started as a double major in Applied Mathematics and Applied Physics and has taken numerous difficult classes. After this semester, he will have completed a total of 179.5 points and maintained at 4.0 GPA. In addition to being a mathematician and physicist, Kyler is a jazz musician who has played guitar with the Columbia Jazz Ensemble.

2010-2011 APAM GRADUATES

October 2010

M.S. Kate Eckerle (AM), Matthew Faudree (MSE/CVN), Jessica Gould (AM/CVN), Tanbir Haque (AM/CVN), Anthony Rea (MP), Mikhail Treger (MSE), Alena Tsioplaya (MP), Iva Vukicevic (AM), Zhilong Wang (MSE)

M.Phil. Owen Clancey (MP), Timur Dykhne (MSE), Nicholas Hoell (AM), Francois Monard (AM)

Ph.D. Ethan Coon (AM), Benoit Durand de Gevigney (PP), Chad Husko (SS), Matthew Lanctot (PP), Avishai Ofan (SS), Andrew Ying (MSE)

February 2011

B.S. Leonid Fishler (AM), Min Ho Han (AM), Meghan Mannion (AM)

M.S. Shira Abraham (MP), Paul Atkinson (AM/CVN), Patrick Byrne (PP), Jing Tu Cen (AM), Buxin Chen (MP), Heng-Che Chen (MSE), Bonnie Chinsky (MP), Thomas Cummings (MP), Kofi Deh (MP), Andrew Durocher (MP), Oswald Espinoza (AM/CVN), Ting-Chung Ferng (MSE), Matthew Goldhirsh (AM), Eric Haviland (MP), Guanghui He (MSE), Yi-Tang Ho (MSE), Tzu-Cheng Hsu (MSE), Wenxiang Jiang (AM), Christopher Lease (MP), Dario Leone (MP), Ting Li (MSE), Bingqian Li (PP), Dustin Lynch (MP), Usman Mahmood (MP), Yu-Min Peng (MSE), Ryan Pennell (MP), Thomas Roberts (PP), Zhijie Ruan (AM), Simon Schiess (MP), Bradley Stroud (MP), Nadia Whittington (MP), Po-I Wu (MSE), Xiang Zheng (AM)

Ph.D. Yikang Deng (MSE), Kirk Knobelspiesse (Atmos), Kyle Krouse (Atmos), David Lazanja (AM), Xuefei Yuan (AM), Yuri Zuev (SS)

May 2011

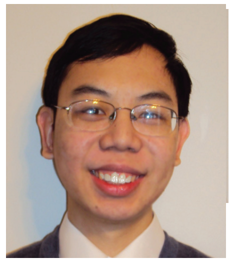
B.S. Avanti Adhia (AM), Kyle Armington (AM), Vivian Bailey (AM), Rachel Bhak (AM), Alex Blumenthal (AM), Chagit Braiman (AM), Chananel Braiman (AM), Samuel Chen (AM), Fei Fei Chu (AM), Alexander Comiskey (AM), Daniel Cosson (AP), Nathan Dadap (AP), Stephen Dee (AM), Irina Dimitrova (AM), Joseph Ferrone (AM), Bruce Garro (AM), Daniel Gledhill (MSE), Daniel Goltz (AM), Matthew Hamilton (MSE), David Kim (AM), HeeSoo Kim (AM), Ji Yon Kim (AM), Jinhwan Kim (AM), Martha Koroshetz (AP), Dan Lee (AM), Amir Mazaheripour (MSE), Vaidehi Nayar (AM), David Ordinario (MSE), Charles Palen (AM), Jessica Park (AM), Adit Patel (AP), Khoa Pham (AM), Long Phan (MSE), Blake Pollard (AP), Alexander Quinlan (AP), Owais Rasool (AM), Joseph Romero (AM), Sushant Sabnis (AP), Axel Saenz-Rodriguez (AM), Matthew Schwartz (AM), Sahil Shah (AM), Kyler Siegel (AM), Diane Taylor (AM), April Trusty (AM), Vinod Vemuri (AM), Michael Wang (AM), Earle Wilson (AP), Eliot Wycoff (AM)

M.S. Brian Capozzi (SS), Edward Chen (SS), Nicholas Choi (MSE), David Dralle (Atmos), Akanksha Gajbhiye (MSE), Joseph Ganser (AP), Chenxi Guo (AM), Paul Hughes (PP), Michael Jenkinson (AM), Jong Gwang Kim (AM), Michelle Legatt (MSE/CVN), Yu Li (MSE), Erik Mets (AP), Joseph Morin (AM/CVN), Hande Ozturk (MSE), Qian Peng (SS), Peter Traverso (AP), Matthew Trusheim (SS), Andrew Weisman (SS), Hanyu Zhang (MSE)

M.Phil. Sriharsha Aradhya (SS), Sean Berry (MP), Philip Chuang (MSE), David Goluskin (AM), Theodore Kramer (MSE), William Martin (Atmos), Clara Orbe (Atmos), Erika Penzo (SS), Jonathan Widawsky (SS)

Ph.D. Paul Brenner (PP), Robert Caldwell (SS), Charlton Chen (MSE), Nicholas Hoell (AM), Zhang Jia (MSE), Wenjia Jing (AM), Braxton Osting (AM), Sean Polvino (MSE), Xabier Sarasola Martin (PP)

Wang Named SEAS Class Salutatorian



Michael Hao Wang

Michael Hao Wang, an Applied Mathematics Senior in the APAM Department, has been named the 2011 SEAS class salutatorian.

Michael has a GPA of 4.098 and has earned 149 points. He was a National Merit Scholarship semi-finalist and a USA Biology and Physics Olympiad semi-finalist. He also earned the Valley Hospital Junior Volunteer Award for Exemplary Volunteer Commitment. Michael has worked with Prof. Zhishun Wang at the New York State Psychiatric Institute, where he statistically analyzed fMRI images using MATLAB. He has tutored math and science to middle and high school students with Columbia's Double Discovery Center and the Let's Get Ready program. He has worked as a General Educational Development (GED) Specialist at Columbia's Community Impact Program and volunteered at the Lenox Hill Hospital's Emergency Room. Michael is also a member of Columbia University's Badminton Club. After graduation, he will be taking some time off before applying to medical school.

Michael follows in the footsteps of other APAM alumni; Seth Davidovits, the 2010 class valedictorian, Stanley Snelson, the 2009 class salutatorian, and Isaac Greenbaum, the 2006 class valedictorian.

Ying Wins 2011 Julian David Baumert Ph.D. Thesis Award

Andrew Ying

Andrew Ying (Ph.D. 10/2010, Materials Science and Engineering) is the winner of the 2011 Julian David Baumert Ph.D. Thesis Award given by the National Synchrotron Light Source (NSLS) at the Brookhaven National Laboratory. This award, given to a researcher who has recently conducted a thesis project that included measurements at the NSLS, was established in memory of Julian David Baumert, a young Brookhaven Research Associate who worked on x-ray studies of soft-matter interfaces at the NSLS before his death in June 2006.

Dr. Ying, who was nominated by his advisor, Prof. I. C. Noyan, will receive the award at the 2011 Joint NSLS/CFN Users' Meeting on Tuesday, May 24, 2011. The award includes an honorarium, travel expenses to the meeting, and the winner's name engraved on a plaque located in the NSLS. Following the award presentation by the Photon Sciences Deputy Operations Director, Dr. Ying will give a brief talk about the work performed for his thesis entitled "A Rigorous Analysis of the Applicability of Kinematical X-Ray Diffraction Theory to Nanostructure Characterization."

Berry Wins 1st Place in RAMPS Young Investigator Symposium

Sean Berry

Sean Berry, a Ph.D. student under the supervision of Prof. Cheng-Shie Wuu, won first place in the annual Young Investigator Symposium sponsored by the Radiological and Medical Physics Society of New York (RAMPS). Sean was the only doctoral student in the competition; all others were post-doctoral research scientists from Memorial Sloan Kettering Cancer Center (MSKCC) and from Columbia.

The title of Sean's paper and talk was "EPID Based Transit Dosimetry for *In-Vivo* Patient Treatment Verification." Electronic portal imaging device (EPID) *in-vivo* treatment verification was approved for clinical trial by the IRB at Columbia Presbyterian Medical Center a few weeks ago. Currently four patients there are under *in-vivo* treatment verification.

Sean, a part-time doctoral student in APAM's medical physics program, is currently employed as a medical physicist at MSKCC.

Tulika Bose (Ph.D. '06, Applied Physics) is an Assistant Professor in the Physics Department at Boston University.

Ming S. Chu (Ph.D. '71, Plasma Physics) was featured as a co-author with APAM Adjunct Professor, Steve Sabbagh, in a recent *Nuclear Fusion* news item on a paper first-authored by K. C. Shain "Broken toroidal symmetry in tokamaks enhances particle, energy and momentum transport". Dr. Chu is a theorist in the Theory and Computational Sciences division at General Atomics, San Diego California. His main interest is the development and application of ideal and resistive MHD theories to fusion devices. Phenomena studied include the kink ballooning mode, the tearing mode and the resistive wall mode at high plasma beta. His recent interest is on the dependence of the plasma response to external perturbations on various plasma models. He has authored or co-authored more than 150 papers on plasma equilibrium and stability. He is a Fellow of the American Physical Society. (*Columbia Engineering Magazine*, Sp'10)

Nicholas C. M. Fuller (Ph.D. '02, Solid State Physics) recently received the Black Engineer of the Year Award (BEYA) for Outstanding Contribution in Industry from the Career Communications Group at the Annual Awards Convention held in Baltimore, MD, in February 2010. Dr. Fuller, who is a research staff member and manager at IBM's Thomas J. Watson Research Center, received this award for his technical contributions in the field of plasma science technology entailing: (i) enablement of 90 nm and beyond CMOS (complementary metal-oxide semiconductor) chip technologies; (ii) determination of plasma interactions with low dielectric constant, patterning, and other technologically relevant materials; (iii) 24 patents; and (iv) more than 50 publications. (*Columbia Engineering Magazine*, Sp'11)

David Gates (Ph.D. '94, Plasma Physics) was recently featured in the article "From tokamaks to stellarators" in *R&D Magazine*. Gates, the Stellarator Physics Leader at the Princeton Plasma Physics Laboratory (PPPL), was offered a visiting professorship last summer at the National Institute for Fusion Science (NIFS) in Japan, where he spent three months working on the Large Helical Device (LHD).

Jeremy Goren (B.S. '07, Applied Physics) "I have lived in Shanghai, China since September 2007. In January 2009 I finished the courses at Shanghai Jiaotong University and reached fluency in Mandarin Chinese. Since then I have tutored students in Math, Physics, and Mandarin Chinese. I was the Head Consultant of Undergraduate Studies at The Princeton Review Shanghai from August 2009-July 2010. I recently founded a company called Elite College Link (ECL), aimed at assisting Chinese high school students in applying to universities in the United States. Recently, I formed a partnership with ONLY Education group, with 57 locations in Shanghai, over 10,000 students, 800+ employees, and 16 years of experience to assist Chinese students with their college applications. We expect to make a minimum of 200,000 USD profit in the 2011 calendar year, with minimum 100% growth year on year for 3 years. I am currently applying to business schools, and my top choices are MIT, Stanford, Wharton, Harvard, Chicago and Columbia. Ideally I would like to defer admission until September 2012 so I can help my new partnership achieve a moderate success. Upon completing my MBA, I intend on returning to China to help grow the ONLY-ECL partnership into a multi-million dollar a year venture. After a couple years, I intend to hire a manager to run my end of the partnership while I maintain a small role share some of the profits, while focused on other ventures. I currently have a couple internet start-ups in mind that I would like to start within the next couple of years."

Bob Gottschall (Eng.Sc.D. '75, Materials Science and Engineering) "After earning my Eng.Sc.D., I accepted a 2-year postdoctoral appointment at the Materials Research Laboratory at the University of Illinois at Urbana Champaign, where one of my activities was electron

Bob Gottschall (continued)

microscopy studies of dislocation structures in tungsten carbide. I then accepted a position in program management in the Materials Sciences Program office under the Office of Basic Energy Sciences at the newly formed U.S. Department of Energy in 1977. I remained with that organization in various capacities through the rest of my career. My program management responsibilities were for the coordination, funding, management, and oversight of fundamental research in materials science that was carried out almost entirely under contracted Department of Energy national laboratories and university research grants. I was actively engaged in an originating and leadership role for 21 workshops that identified and publicized research needs and opportunities for fundamental research in materials science, for which the proceedings were published in archival scientific journals. I was a co-organizer for 4 major scientific symposia under professional societies, a member of advisory and organization committees for numerous domestic and international scientific symposia, and co-editor of the published proceedings for 2 major international research symposia. During the course of my career I was elected to the rank of Fellow by both the American Ceramic Society and ASM International (formerly known as the American Society of Metals) and awarded the 2004 Burgess Memorial Award by ASM International for leadership in fundamental research in materials science and advancements of electron beam microcharacterization facilities in the U.S. My career at the Department of Energy progressed into several management positions from 1986 until my retirement in 2005. Since retirement, my wife, Yukiko Tani, and I have trekked, climbed, and done photography in Patagonia, the European Alps, and the Himalaya. We also engage ourselves in local hiking and photography, and via attendance at operatic, symphonic, and classical ballet programs." (*Columbia Engineering Magazine*, Sp'10)

David Graff (M.S. '06, Medical Physics) completed a postdoctoral fellowship in medical imaging physics at Johns Hopkins, performing research in small animal SPECT camera design, artifacts associated with truncated tomography, and the clinical effectiveness of cone-beam CT in interventional radiological procedures. He now works as a research scientist at Quantason LLC in Philadelphia, developing novel types of ultrasound to screen for breast cancer. He lives in Reading, PA, with his wife, Vicky, and their three kids. Their third child, Abraham Spinoza Graff, was born on January 6. (*Columbia Engineering Magazine*, Sp'11)

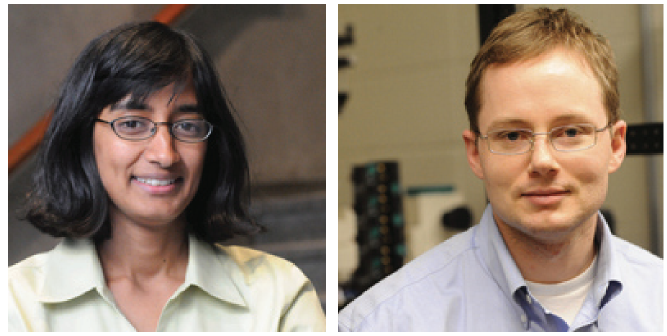
Sam Gralnick (Ph.D. '72, Plasma Physics) is currently VP and senior applications architect for the Global Risk Management organization of JP Morgan Chase & Co. and is a member of the recruiting team for the Risk Organization, which seeks to attract talented graduates seeking careers in financial services risk management. Columbia students and graduates at all levels should feel free to contact him to discuss these opportunities at samuel.gralnick@jpmchase.com. (*Columbia Engineering Magazine*, Sp'10)

Brian Grierson (Ph.D. '09, Plasma Physics) took a position as an associate research physicist at Princeton Plasma Physics Laboratory. His research is performed in San Diego, CA, at General Atomics on the DIII-Tokamak. (*Columbia Engineering Magazine*, Sp'11)

Ralph Izzo (Ph.D. '81, Plasma Physics) was the keynote speaker for the Columbia Engineering's Class Day ceremony, held on Monday, May 16, 2011. Izzo is currently Chairman, President, and CEO of Public Service Enterprise Group (PSEG) in New Jersey.

Chrysanthe Spyropoulos Munn (Ph.D. '99, Applied Math) is married to Tobin Munn and has two children, Gabriella and Axel. As a geophysicist, she works for British Petroleum in Houston as executive assistant to Ian Cavanagh, the senior vice president in technology. (*Columbia Engineering Magazine*, Sp'11)

Venkataraman & Englund Named Sloan Fellows



Latha Venkataraman & Dirk Englund

Latha Venkataraman, Assistant Professor of Applied Physics, and Dirk Englund, Assistant Professor of Electrical Engineering and Applied Physics, are two of this year's 118 outstanding recipients of Alfred P. Sloan Research Fellowships. In addition, Englund was recently awarded an Air Force Office of Scientific Research Young Investigator Research Program (AFOSR YIP) grant and Venkataraman was awarded a Packard Fellowship in Science and Engineering.

Awarded annually since 1955, the fellowships are given to early-career scientists and scholars in recognition of their achievement and the potential to contribute substantially to their fields.

"I am honored to receive the Sloan Research Fellowship in Chemistry," Venkataraman says. "This will allow me to pursue interdisciplinary work understanding fundamental properties of matter at the nanoscale."

As electronic devices become ever smaller, and the demand for ever tinier components grows, Venkataraman is concentrated on understanding how current flows through these materials at the nanometer (billionth of a meter) scale. Her research is on the molecular level, where she focuses on probing, manipulation, and control of single molecules as active elements in electrical circuits.

She is working on understanding the interplay of physics, chemistry, and engineering at the nanometer scale, noting that "a single molecule circuit is the ultimate limit one can achieve, and understanding how to control and transfer charges on this scale allows us to push the frontier."

Englund is working on transmitting information securely through the use of quantum photonics - the sending and receiving of data in the form of photons, the tiniest particles that make up light. By sending data encoded in photons, the data stream becomes a single-use, self-destructing key.

Controlling single photons and their interactions with atomic systems could also lead to new types of quantum information processors that could perform difficult tasks such as prime number factorization or simulations of currently intractable problems in physics and chemistry. Englund and his Quantum Photonics Group at Columbia Engineering are developing chip-based photonic networks to implement such quantum technologies, with primary applications in communications, computation, and sensing.

"The support of the Sloan Foundation will substantially impact the pace and scope of our research in chip-based networks for quantum optics," Englund says.

Venkataraman and Englund and the other fellows were drawn from 54 colleges and universities in the U.S. and Canada. The fellows represent an extraordinarily broad range of research interests, including an astronomer who studies the birth of new planets, a computer scientist who examines how changes in computer network architecture can save energy, an economist who investigates the game-theoretical foundations of cooperation, and a mathematician who uses geometry to model how the brain represents stimuli.

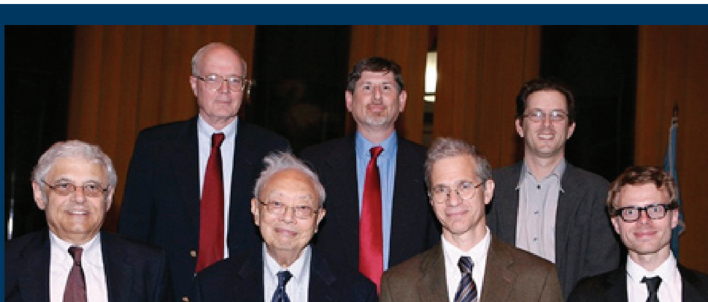
"The scientists and researchers selected for this year's Sloan Research Fellowships represent the very brightest rising stars of this generation of scholars," says Dr. Paul L. Joskow, President of the Alfred P. Sloan Foundation. "The Foundation is proud to be able to support their work at this important stage in their careers."

Administered and funded by the Sloan Foundation, the Fellowships are awarded in close cooperation with the scientific community. Potential fellows must be nominated for recognition by their peers and are subsequently selected by an independent panel of senior scholars.

The $50,000 fellowships are awarded in chemistry, computer science, economics, mathematics, evolutionary and computational molecular biology, neuroscience, and physics. In 2012, in recognition of the important work done by Sloan-sponsored researchers working on the Census of Marine Life, the award program will be expanded to include fellowships in ocean sciences.

Venkataraman and Englund join previous Sloan Research Fellows in the APAM Department, Professors Guillaume Bal, Simon Billinge, and Gerald Navratil, in this honor.

This story was originally published on the Columbia Engineering web site.



(left-right) front row: Aron Pinczuk, C.K. Chu, Michael Weinstein, Pierre Gentine, back row: Richard Osgood, Irving Herman, Adam Sobel (photo by Charlene Smullyan)

SEAS Faculty Excellence Celebration

APAM faculty were honored at the SEAS Faculty Excellence Celebration on October 14, 2010 - an annual event which celebrates the awards, honors, and recognitions earned during the previous academic year. Simon Billinge (Hanawalt Award), Allen Boozer (Alfvén Prize), Adam Sobel (Meisinger Award), Michael Weinstein (SIAM Fellow), and Steve Sabbagh (Best Paper Award) were honored for their achievements. Named professors, Pierre Gentine (Chu Foundation Assistant Professor), David Keyes (Fu Foundation Professor of Applied Mathematics), Gerald Navratil (Thomas Alva Edison Professor), Richard Osgood, Jr. (Higgins Professor of Electrical Engineering) were also recognized.

Simon Billinge

Billinge Helps Make Thermoelectric Discovery

Prof. Simon Billinge is part of a team of scientists to discover that a class of materials known to convert heat to electricity and vice versa behaves quite unexpectedly at the nanoscale in response to changes in temperature. The discovery - described in the Dec. 17, 2010, issue of *Science* - is a new "opposite-direction" phase transition that helps explain the strong thermoelectric response of these materials. It may also help scientists identify other useful thermoelectrics, and could further their application in capturing energy lost as heat, for example, in automotive and factory exhaust.

The scientists - from Columbia University's School of Engineering and Applied Science, the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, Argonne National Laboratory, Los Alamos National Laboratory, Northwestern University, and the Swiss Federal Institute of Technology - were studying lead chalcogenides (lead paired with tellurium, selenium, or sulfur) using newly available experimental techniques and theoretical approaches that allow them to "see" and model behavior of individual atoms at the nanoscale, or on the order of billionths of a meter. With those tools they were able to observe subtle changes in atomic arrangements invisible to conventional probes of structure.

To understand the phase transition the scientists observed, think of the everyday response of a gas like steam cooling to form liquid water, and then freezing to form solid ice. In each case, the atoms undergo some form of structural rearrangement, explains Billinge, a physicist at Columbia Engineering and Brookhaven Lab and a lead author on the Science paper. He is a professor of Materials Science and of Applied Physics and Applied Mathematics.

"Sometimes, further cooling will lead to further structural transitions: atoms in the crystal rearrange or become displaced to lower the overall symmetry," Billinge says. The development of such localized atomic distortions upon cooling is normal, he says. "What we discovered in lead chalcogenides is the opposite behavior: At the very lowest temperature, there were no atomic displacements, nothing - but on warming, displacements appear!"

The techniques the scientists used to observe this nanoscale atomic action were high-tech versions of x-ray vision, aided by mathematical and computer analysis of the results. First the lead materials were made in a purified powder form at Northwestern University. Then the scientists bombarded the samples with two kinds of beams - x-rays at the Advanced Photon Source at Argonne and neutrons at the Lujan Neutron Scattering Center at Los Alamos. Detectors gather information about how these beams scatter off the sample to produce diffraction patterns that indicate positions and arrangements of the atoms. Further mathematical and computational analysis of the data using computer programs developed at Brookhaven and Columbia allowed the scientists to model and interpret what was happening at the atomic level over a range of temperatures.

Columbia/Brookhaven physicist Emil Bozin, first author on the paper, was the first to notice the odd behavior in the data, and he worked tenaciously to prove it was something new and not a data artifact. "If we had just looked at the average structure, we never would have observed this effect. Our analysis of atomic pair distribution functions gives us a much more local view - the distance from one particular atom to its nearest neighbors - rather than just the average," Bozin says. The detailed analysis revealed that, as the material got warmer, these distances were changing on a tiny scale - about 0.025 nanometers - indicating that individual atoms were becoming displaced.

The scientists have made an animation to illustrate the emergence of these displacements upon heating. In it, the displacements are represented by arrows to indicate the changing orientations of the atoms as they flip back and forth, or fluctuate, like tiny dipoles. According to the scientists, it is this random flipping behavior that is key to the materials' ability to convert heat into electricity.

"The randomly flipping dipoles impede the movement of heat through the material in much the same way that it is more difficult to move through a disorderly wood than an orderly apple orchard where the trees are lined up in rows," Billinge says. "This low thermal conductivity allows a large temperature gradient to be maintained across the sample, which is crucial to the thermoelectric properties."

When one side of the material comes in contact with heat - say, in the exhaust system of a car - the gradient will cause charge carriers in the thermoelectric material (e.g., electrons) to diffuse from the hot side to the cold side. Capturing this thermally induced electric current could put the "waste" heat to use. This research may help scientists search for other thermoelectric materials with exceptional properties, since it links the good thermoelectric response to the existence of fluctuating dipoles.

"Our next step will be searching for new materials that show this novel phase transition, and finding other structural signatures for this behavior," Billinge said. "The new tools that allow us to probe nanoscale structures are essential to this research.

"Such studies of complex materials at the nanoscale hold the key to many of the transformative technological breakthroughs we seek to solve problems in energy, health, and the environment." This research was funded by the DOE Office of Science, the Office of Naval Research, and the National Science Foundation.

This story was originally published on the Columbia Engineering web site.

Faculty Updates

Prof. Siu-Wai Chan was issued her fifth U.S. patent for U.S. #7,820,596, Thick Film High Temperature Superconducting Device Supporting High Critical Currents and Method for Fabricating Same.

Prof. Lorenzo Polvani was recently featured in the article "Atmospheric science: Tug of war on the jet stream" in *Nature Climate Change*, Vol. 1, April 2011. Read more about his research in: Focus on Faculty Activities.

Prof. Steven Sabbagh was featured as a co-author in a recent *Nuclear Fusion* news item on a paper first-authored by K.C. Shain "Broken toroidal symmetry in tokamaks enhances particle, energy and momentum transport".

Prof. Chris Wiggins was named one of "NY's Coolest Tech People in 2010" by *Business Insider* for being a founding member of HackNYC. The program also received recognition from Mayor Michael Bloomberg in the *NY Observer*.


Chris Marianetti

Marianetti Discovers Graphene's Outer Limit

Chris Marianetti has determined how and why the strongest known material breaks.

An assistant professor in the APAM Department, Marianetti used quantum theory and supercomputers to reveal the mechanisms of mechanical failure of pure graphene under tensile stress. In a paper recently accepted for publication in the journal *Physical Review Letters*, he shows that, when graphene is subject to strain equal in all directions, it morphs into a new structure which is mechanically unstable. Under sufficient strain, graphene develops a particular soft-mode that causes the honeycomb arrangement of carbon atoms to be driven towards isolated hexagonal rings. This new crystal is structurally weaker, resulting in the mechanical failure of the graphene sheet - a single layer of graphite only one atom thick.

"This is exciting on many different levels," Marianetti says. "Soft modes were first recognized in the 1960s in the context of ferroelectric phase transitions, but they have never been directly linked to fracture. Typically, defects in a material will always cause failure to happen prematurely, but the pristine nature of graphene allows one to test our prediction. We have already outlined some interesting new experiments to directly observe our theoretical prediction of the soft mode."

Marianetti's work, funded by the National Science Foundation, builds upon the groundbreaking research two years ago of colleagues James Hone and Jeffrey Kysar, associate professors in the Department of Mechanical Engineering. Hone described graphene then as 200 times stronger than structural steel, noting that it would take an elephant to break through a sheet of graphene the thickness of plastic wrap.

Marianetti says this is the first time a soft optical phonon has ever been linked to mechanical failure and that therefore it is likely that this novel failure mechanism is not exclusive to graphene but may be prevalent in other very thin materials.

"With nanotechnology becoming increasingly ubiquitous, understanding the nature of mechanical behavior in low dimensional systems such as graphene is of great importance. We think strain may be a means to engineer the properties of graphene, and therefore understanding its limits is critical."

This story by Holly Evarts was originally published on the Columbia Engineering web site. He was also featured in the Dec. 7, 2010 issue of *The Record*.


David Keyes

Keyes named 2011 SIAM Fellow

The Society for Industrial and Applied Mathematics (SIAM) named David Keyes one of 34 academics and professionals to the 2011 Class of Fellows for outstanding contributions to applied mathematics and computational science through research in the field and service to the larger community. Fellows will be recognized at the 7th International Congress on Industrial and Applied Mathematics in Vancouver this summer.

Prof. David Keyes is the Fu Foundation Professor of Applied Mathematics in the APAM Department. "He also holds several faculty affiliate positions at the U.S. Department of Energy's national labs, and is a professor of applied mathematics and computational science at King Abdullah University of Science and Technology in Saudi Arabia. He is being honored for his long-standing dedication to serving the scientific community and his research into implicit methods for the solution of partial differential equations. Keyes served as SIAM's Vice President-at-Large from 2006-2009 and has been a SIAM Visiting Lecturer since 1992. He is a past member of the SIAM Council and a SIAM book author."

Reprinted from the SIAM Press Release: *SIAM Names 2011 Fellows.*


Thomas Marshall

Marshall Named Outstanding Referee

Thomas Marshall, Professor Emeritus of Applied Physics, was named one of 144 Outstanding Referees of the *Physical Review* and *Physical Review Letters* journals. The American Physical Society (APS) initiated this highly selective lifetime award program to recognize scientists who have been exceptionally helpful in assessing manuscripts for publication in the APS journals. "In initiating the program, APS expresses appreciation to all referees, whose efforts in peer review not only keep the standards of the journals at a high level, but in many cases also help authors to improve the quality and readability of their articles - even those that are not published by APS."

Reprinted from the press release: *American Physical Society announces Outstanding Referees* by Amy Halsted.

Applied Physics Faculty, Students, & Scientists Honored at APS Meeting

The 52nd Annual Meeting of the American Physical Society, Division of Plasma Physics, took place from November 8-12, 2010, in Chicago, IL. Columbia University plasma physics research was well represented at the meeting of over 1,800 scientists from around the world with 20 contributed presentations from Columbia faculty, scientists, and students.

Steven Sabbagh was named Fellow of the American Physical Society. Prof. Sabbagh's award was presented at the meeting for leadership in advancing the understanding of magnetohydrodynamics equilibrium, stability, rotation damping, and active feedback control of high-beta tokamak and low-aspect ratio tokamak plasmas. Sabbagh was also invited to lecture about his latest research results conducted at the National Spherical Tokamak Experiment (NSTX), entitled "Progress Toward Stabilization of Low Internal Inductance Spherical Torus Plasmas in NSTX". Dr. Matthew Lanctot, who recently received his Ph.D. under the mentorship of Prof. Gerald Navratil, was invited to lecture on his research results conducted on the DIII-D tokamak (located in San Diego), entitled "Measurement and Modeling of 3D Equilibria in DIII-D". Xabier Sarasola Martin, a doctoral student studying with Prof. Thomas Pedersen, was invited to lecture on his results with the Columbia Non-neutral Torus (CNT), entitled, "Plasmas of arbitrary neutrality".

APAM Professors Simon Billinge, Mark Cane, Richard Osgood, Jr., Lorenzo Polvani, Adam Sobel, and Marc Spiegelman were featured in the Fall 2010 "Impact on Sustainability" issue of *Columbia Engineering* magazine. This issue, and previous issues of the magazine, are available online at: engineering.columbia.edu/web/newsletter

Photos by Eileen Barroso

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Simon Billinge, Materials Science & Engineering

Characterizing Nanoparticles for Fuel Cells

The solid oxide fuel cell, which runs on hydrogen and oxygen to produce water as exhaust, is seen as a promising technology of the future for transportation. These fuel cells are now used on an experimental basis to power city buses. But the fuel cells have proved unreliable because the nanoparticles of platinum that serve as a catalyst for the chemical reaction sometimes do not function optimally, which results in inefficient operation.

"Scientists want to exploit the nanoparticle in the device but still don't know that particle's basic properties," said Simon Billinge, Professor of Materials Science. "Sometimes it works, and sometimes it doesn't."

These catalysts, nanoparticles of platinum, are one-millionth of a millimeter in thickness. The properties of the metal change when they are so small, and scientists have yet to fully characterize their properties. By determining the nanoparticle's structure and properties - its electrical conductivity, thermal conductivity, melting point, and stiffness - scientists will be better able to predict a fuel cell's performance, based on what particular nanoparticle is used as the catalyst.

To help provide a solution, Billinge is developing new methods to characterize the structure of nanoparticles, figuring out the arrangements of atoms in particles that are made up of a few hundred to a few thousand atoms. He uses intense x-ray and neutron-source technology, carrying out his research in particle accelerators at the Brookhaven National Laboratory in Long Island, the Los Alamos National Laboratory in New Mexico, and the Argonne National Laboratory in Illinois.

In these accelerators, the nanoparticles of platinum circle at high energy, with the x-ray beam providing data on the defraction patterns revealed in the experiment. Billinge has made important breakthroughs by developing novel Fourier Transform methods to analyze the data.

He also has worked on measuring the surface energy of the platinum catalyst. The surface atoms, like those on the meniscus of a water droplet, have higher energy than those inside of the particle. And it's the surface area of the nanoparticles that provides the reactivity for the hydrogen and oxygen that come together to produce the energy that propels the vehicle.

Mark Cane, Applied Mathematics

Predicting El Niño

Mark Cane spent much of his early twenties protesting against the war in Vietnam and volunteering with the civil rights movement in the South. He remains a social activist, but today he does so from his position as one of the world's top climate modelers. As science-based predictions of the weather a few days in advance were becoming routine, predicting the weather three or four months in advance was left to the likes of *The Farmer's Almanac*.

All that began to change in 1985 when Mark Cane and his student, Steve Zebiak, published the results of a model they developed to predict the movement of warm water across the tropical pacific ocean in a cyclical phenomenon known as the El Niño southern oscillation, or ENSO. When it forms, El Niño's meteorological reach spans the globe, causing a well-known pattern of extreme weather events. The 2009 El Niño, for example, resulted in deep droughts in India and the Philippines and deadly rains in Uganda. Aside from the regular progression of the seasons, no other phenomenon influences Earth's short-term climate as profoundly as ENSO.

The Zebiak-Cane model showed a moderate El Niño developing in late 1986. People in Peru, Australia, and elsewhere still had vivid memories of the devastating effects of the powerful El Niño that formed in 1982 and 1983, so many scientists opposed publishing forecasts they didn't yet understand.

"People said, 'What if you're wrong?'" said Cane, the G. Unger Vetlesen Professor of Earth and Climate Sciences and a Professor in the APAM Department and the Department of Earth and Environmental Sciences. "I said, 'What if we're right and we don't tell anyone?'"

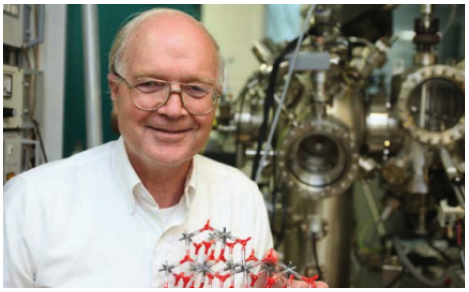
Cane and Zebiak published their forecast in *Nature* in June of that year, which gave anyone who cared to listen time to prepare. Despite a delay in its formation early in the forecast window, by the autumn of 1986, the predicted El Niño developed, bringing its associated weather patterns to much of the globe.

Though most of his work is physical climate science, Cane continues to work on the impacts of human-induced climate change and natural climate variability on people around the world, such as a seminal paper studying the implications of El Niño on maize yields in Zimbabwe. He has also created a highly successful master's degree program in climate and society that prepares students to understand and cope with the impacts of climate variability and climate change on society and the environment.

"Science should be more than just an academic exercise," said Cane. "We're not just predicting this thing in the Pacific; we're trying to predict all these consequences around the world that people care about."

Richard Osgood, Jr., Applied Physics

Looking at Light



Sometimes, to solve big problems, you have to think small. Richard Osgood Jr. thinks very small. One of the biggest energy questions today is how to make solar cells more efficient and more affordable. This is particularly important for the billion or so people who live in poverty and, in most cases, entirely off the grid.

Osgood and the other members of the surface group in his research laboratory for fundamental and applied science study the basic processes that allow some materials to convert light to electricity. It is a phenomenon that makes photovoltaic cells and fuel cells possible and that lies at the foundation of many hopes for a more sustainable future. But for all its promise, the process is surprisingly not well understood.

"This is a very basic question we're trying to address," said Osgood, Higgins Professor of Electrical Engineering and a Professor in the APAM Department. "We need to know more about the fundamentals that limit the efficiency of charge transfer."

He and his team use ultrashort bursts of laser light to watch individual molecules of titanium dioxide accept or reject electrons. They also have made some of the first studies of titanium dioxide nanoparticles using the atomic-level resolution of a scanning tunneling microscope (STM) to understand how these novel structures can be used to improve solar cells.

Titanium dioxide is of particular interest because it is used in graetzel cells, a type of low-cost photovoltaic cell that is easy to manufacture from readily available materials. Most low-cost cells are sensitive to only a narrow band of sunlight. The graetzel cell, however, contains a layer of organic dye that produces free electrons from a wide spectrum of sunlight, much like chlorophyll does in plants. These electrons are then taken up by the titanium dioxide semiconductor to produce a current. The trouble is, graetzel cells are only about 7 to 10 percent efficient, meaning that, at best, only one out of ten free electrons produces a current. Osgood and others would like to improve on this, but the reasons why one electron is captured and another is not remain elusive. By firing extremely short (10–15 femtosecond) bursts of laser light at a titanium dioxide crystal and simultaneously watching with an STM, Osgood and his team are nearing the ability to observe individual electrons being taken up or rejected by the crystal matrix.

The rise of far-reaching, basic science studies like his - that span physics, chemistry, and engineering - gives him hope that, by focusing on the small stuff, answers to the big questions are not far off. "The world is changing in the way things are done," he said. "The number of people doing interdisciplinary work is growing every day. It's an exciting time."

Prof. Lorenzo Polvani and APAM postdoc, Dr. Sarah Kang, co-authors of "Impact of Polar Ozone Depletion on Subtropical Precipitation" published in *Science* magazine on 4/21/11, were featured in several news sources. Their study shows the first link between ozone depletion and climate change in the entire southern hemisphere.

Lorenzo Polvani, Applied Mathematics

Reevaluating the Role of the Ozone Hole

We don't hear much about the hole in Earth's ozone layer these days, and for good reason. Collective international action has been successful in reversing a decades-long deterioration of the protective layer in the stratosphere. The hole, which grows and shrinks seasonally over Antarctica, is expected to close by sometime midcentury.

Now, however, models and observations of Earth's atmosphere are showing that the ozone hole may be having an effect on global climate patterns that may be masking the full impact of global warming. "The ozone hole has been ignored for the past decade as a solved problem," said Lorenzo Polvani. "But we're finding it has caused a great deal of the climate change that's been observed."

Polvani, who holds appointments in the APAM Department as well as the Department of Earth and Environmental Sciences, has studied atmospheric dynamics from the surface to the upper stratosphere and from both poles to the equator. In the last few years, he has focused on understanding the effects that ozone depletion, and its eventual recovery, has on Earth's climate. Ozone - a molecule made up of three atoms of oxygen - absorbs much of the sun's UVB radiation. In the mid-1980s, it was discovered that chlorofluorocarbons, a chemical used as aerosol propellants, were collecting in the stratosphere over Antarctica, where they were very quickly breaking down the planet's ozone. In 1987, world governments signed the Montreal protocol to ban the manufacture and use of chlorofluorocarbons, and the success of the agreement has been held up as a model for an eventual international climate treaty.

Ozone warms the stratosphere when it absorbs UV radiation. Its relative absence over Antarctica for the past 40 years has had a cooling effect on the upper atmosphere over the South Pole that is as much as ten times as strong as the warming effect associated with increasing carbon dioxide concentrations.

The effects of this cooling already appear to be affecting the location of the Southern Hemisphere's mid-latitude jet stream. Like its twin in the north, the southern jet stream is associated with the formation and movement of weather patterns around the globe. Cooling of the upper troposphere - the highest part of the lower atmosphere - has been connected to a shift of the southern mid-latitude jet stream toward the south by a few degrees.

This shift has resulted in precipitation patterns moving south as well, and in the tropical dry zones expanding. The evidence is not yet conclusive, but Australia's lengthy drought may be the result of this rearrangement of southern hemisphere weather patterns. If so, Polvani's next task is to find out what will happen as the ozone hole closes and the full brunt of global warming is felt throughout the atmosphere.

"These next couple of decades are going to be interesting times," said Polvani. "We're going to see these climate changes play out in our lifetimes.

Adam Sobel, Applied Mathematics

Modeling Monsoons

Adam Sobel once bought a plane ticket to the city of Darwin in Australia's tropical north based on a colleague's weather prediction. That in itself is nothing new, but the prediction he followed was for the start of the monsoon rains three weeks hence, a prediction that was virtually unheard of just a decade earlier for the length of its foresight. When he got off the plane, no one was happier to see the sky open up and the rain begin right on schedule.

"We had half a meter of rain in ten days," said Sobel, who holds a dual appointment in the APAM Department and the Department of Earth and Environmental Sciences. "It was exciting."

For more than one billion people, the seasonal monsoons are both a life-giving annual event and a potential disaster. Although much is known about how the monsoons occur, very little is understood about how they vary. The monsoons are an atmospheric circulation pattern that develops in the tropics at fairly well-defined times of year. The sun warming Earth's surface draws moisture from ocean waters and forms the iconic, seasonal rains of south and southeast Asia or sub-tropical Africa and South America. The people who live in these regions, particularly the rural poor, rely on the monsoon rains to water crops and recharge aquifers.

When the monsoons are weak, drought and famine can result; if they come with too much gusto, flooding and disease occur. The fine line between life and death makes monsoon forecasting one of the most important topics within climate modeling these days. Sobel is trying to develop models to predict the variations within a monsoon season, known as "active" and "break" cycles, which have so far been beyond the ability of climate modeling. Recently, he helped demonstrate the central importance of heat stored in the oceans, particularly in the so-called mixed layer that encompasses the top 10 to 50 meters of water, on the formation of active and break cycles.

The atmospheric patterns that drive the monsoon - the Madden Julian Oscillation in particular - are also responsible for spawning tropical storms in distant ocean basins and may influence the formation of El Niño and La Niña cycles in the Western Pacific. As a result, Sobel's work may one day have an impact on people who live well beyond the reach of the monsoon rains.

"We need a central theory that can be stated simply that explains the variations we see," said Sobel. "Weather prediction can look two weeks in the future, max. Climate models can give us the probability for a strong or weak monsoon a year in advance. This is in between. It's kind of the Holy Grail right now."

For more APAM news, see:
www.apam.columbia.edu/directory/announcements.html

Marc Spiegelman, Applied Mathematics

Studying Earth's Mantle & Crust

Growing up, Marc Spiegelman dreamed of one day being the next Jacques Cousteau. The only problem was he enjoyed hiking more than diving and he excelled at math and physics rather than oceanography. Two summers spent working as a ranger for the U.S. Forest Service and the discovery that the planet often reveals its secret inner workings through calculus sealed his future.

Today, Spiegelman studies the interior of the planet using the tools of a computational physicist - computer models and equations describing fluids and solids deforming far beyond human eyes and time scales. In combining his love of dry land with his interest in physics and math, Spiegelman treats the planet as one, big physics problem and, at the same time, is helping advance understanding of how Earth's crust and mantle behave in tectonically active regions of the world - places dominated by volcanoes and earthquakes. More recently, he has begun considering a problem that has traditionally attracted scientists with a more airy focus: what to do with all the carbon dioxide in the atmosphere.

Spiegelman's principal expertise involves applying theories that describe the migration of magma and fluids in the solid earth, and the behavior of solid materials under the immense heat and stress of the deep earth. His efforts are helping create a more general understanding of the interactions between solids and fluids in the mantle and crust. This work has applications to understanding the behavior and output of volcanoes around the globe like Eyjafjal-lajökull, the volcano in Iceland that erupted in early 2010 and shut down air travel over much of Europe for nearly one month. His work also provides insights into problems such as the interactions between reactive fluids and a variety of minerals found in the earth.

His expertise is attracting attention from new circles because it turns out that one of the more promising ideas for dealing with excess carbon emissions involves the solid earth. Geological carbon sequestration, a problem that Spiegelman's colleagues at the Lamont-Doherty Earth Observatory are actively investigating, entails injecting carbon dioxide into certain mineral formations found in many places around the world.

Spiegelman's ability to work between the worlds of observation and modeling may one day prove crucial in understanding what happens when carbon dioxide under immense pressure reacts with mineral formations containing magnesium. Such reactions produce extreme heat, which crack the rock, and form solid magnesium carbonate, locking the carbon dioxide away safely and permanently.

It is this ability to model unobservable interactions between solids, fluids, and heat deep underground that gives him a leg up on his old hero, Jacques Cousteau. Instead of a view into the depths of the ocean, Spiegelman has been able to see through his equations and models into deepest recesses of the upper earth.

IN MEMORIAM

Gertrude Neumark Rothschild
(1927-2010)

Gertrude Neumark Rothschild, Howe Professor *Emerita* of Materials Science and Engineering, passed away on November 11, 2010, after a long illness. She was 83. A memorial service was held for her on Wednesday, December 15, 2010 at 5:00 PM, at St. Paul's Chapel.

Professor Neumark started teaching at Columbia University in 1982 and in 1999 became the first woman to hold a named chair in The Fu Foundation School of Engineering and Applied Science.

Gertrude Neumark graduated *summa cum laude* from Barnard College in 1948, received a Master of Science degree in chemistry from Radcliffe in 1949, and, in 1951, received a Ph.D. in chemistry from Columbia's Graduate School of Arts and Sciences. Prior to joining the Columbia faculty, Dr. Neumark worked in industry at Sylvania Research Laboratories (1952-1960) and at Philips Laboratories from 1960-1985. She was elected a Fellow of the American Physical Society in 1982. From 1982-1985 Dr. Neumark was also an Adjunct Professor at Columbia. She started teaching and conducting research here full-time from 1985. She was appointed Howe Professor of Materials Science and Engineering in July 1999. In 2005, the Henry and Gertrude Rothschild Professorship was established at Columbia University in recognition of her contributions to science.

Professor Neumark was cited as one of 83 women whose work appears on the archival website maintained by UCLA entitled, "Contributions of 20th Century Women to Physics." She also was listed in *Who's Who in America*, *Who's Who in Science and Engineering*, and *American Men and Women of Science*. She is the author of more than 140 publications and a contributor to *McGraw-Hill Yearbook of Science and Technology*. She served as a panelist for the National Research Council.

She received an honorary degree from Columbia University in May 2008 and also was selected as a recipient of Barnard's Distinguished Alumna Award for 2008 for her outstanding achievements in materials science and engineering. In 2008, Philips Electronics created a Professorship in Columbia's Department of Applied Physics and Applied Mathematics in The Fu Foundation School of Engineering and Applied Science in honor of Professor Neumark Rothschild's pioneering role as a woman engineer.

It was during her research work at Columbia Engineering that Dr. Neumark conceived the doping process that has been the basis for devices improving the quality of consumer products ranging from flat screen TVs to mobile phone screens. Commercial uses for blue and shorter-wavelength lasers range from increasing the sharpness of laser printers to increasing the information storage capacity of DVDs. In addition to these lasers, her patented processes led to blue and ultraviolet LEDs (light-emitting diodes), which are now used for computers, traffic lights, instrument panels, as the background color for mobile-phone screens, in multicolor displays, flat screens and in numerous other lighting applications.

She is survived by her husband, Henry Rothschild, a former commodities trader at Philipp Brothers, now retired.

Department News

Former APAM postdoc, Sarbajit Banerjee, Assistant Professor of Chemistry SUNY at Buffalo, received a 2010 Cottrell Scholar Award from the Research Corporation for Science Advancement. Dr. Banerjee's research will focus on understanding the influence of finite size on phase transitions and intercalation processes in vanadium oxides.

Former APAM postdoc, James Dickerson was awarded a National Science Foundation Faculty Early Career Development grant. Dr. Dickerson is currently an Assistant Professor of Physics at Vanderbilt University.

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Prof. Latha Venkataraman's group moved to the new Northwest Corner Building on 120th Street & Broadway. (Photos by Jason LaFerrera)

2011 SEAS Alumni Reunion Weekend

Thursday, June 2 - Sunday, June 5

alumni.engineering.columbia.edu/reunion

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Photos/Images: Eileen Barroso, *Columbia Engineering News*, Jason LaFerrera, Wesley Hatten, Charlene Smullyan

Design: Christina Rohm