Fall 2011, Vol. 6 Issue 1

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

Dear Alumni and Other Friends of APAM:

We again welcome our new undergraduate and graduate students, postdoctoral scientists, and research scientists to the APAM Department. You will have a brilliant career and life here at Columbia!

This issue details the awards and honors bestowed upon our faculty, research scientists, alumni, and graduate students, including John Dwyer, Clara Orbe, Yutian Wu, Bahram Jalali-Farahani, Dirk Englund, and Guillaume Bal. We highlight the research of Aron Pinczuk and summer activities of our undergraduate, Julio Enrique Herrera Estrada, and proudly note that two of our adjunct faculty, C. Julian Chen and Edward Nickoloff, have just published superb textbooks. We are also very proud of the excellent performance of our medical physics masters students and alumni on the recent American Board of Radiology exam.

We welcome three new faculty this term: Katayun Barmak — the inaugural Philips Electronics Professor (a position established by Gertrude Neumark), Tiffany Shaw, and Vincent Duchêne. We sadly note that two of our distinguished faculty, Thomas Pedersen and David Keyes, have left us, but, on the bright side, they are maintaining strong ties to APAM as adjunct faculty. Finally, we look forward to two new professors joining us in January.

In addition to downloading our Newsletter from our website, you can now download "Did you know?" posters that highlight recent APAM faculty and alumni achievements and recognitions. (Did you know that Dr. Ralph Izzo, Ph.D. 1981 Plasma Physics, delivered the SEAS Class Day speech? See page 3 for details.)

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

Best,

Irving P. Herman
Chair, APAM

New Faculty Members: (top left) Vincent Duchêne, Chu Assistant Professor of Applied Mathematics; (bottom left) Tiffany Shaw, Assistant Professor of Applied Mathematics and of Earth and Environmental Sciences, and (right) Katayun Barmak, Philips Electronics Professor

In This Issue

Undergraduate Research Report

Julio Enrique Herrera Estrada, Applied Mathematics Senior

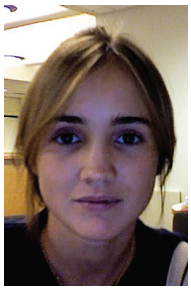
Julio Enrique Herrera Estrada

This past summer I worked with Professors Eric Wood, Kelly Caylor, and Justin Sheffield from the Department of Civil and Environmental Engineering at Princeton University. The project that I worked on was sparked by a World Bank report that stated that there is enough rain in the Guinea Savanna to support a large expansion of agriculture in the region. This would help combat hunger, which is a pressing issue throughout Africa. Nevertheless, crops do not only depend on the amount of water that falls throughout the rainy season, but also on the distribution of rain events (i.e. its variability). Agriculture would not succeed if all of the rain came in only a few episodes, for example, even if the total amount seems right. This is something that the World Bank did not take into account, yet it is crucial given that embarking on an expansion of agriculture is expensive. Without a rigorous analysis on how the variability of rain in the region affects the probability of crop failure (or success), such an expansion would put at risk resources that are not abundant in the area in the first place.

This research opportunity was funded by the Columbia University Scholars Program Summer Enhancement Fellowship. Furthermore, this semester, I will be working with Professors Adam Sobel (from the APAM Department and the Lamont-Doherty Earth Observatory) and Michela Biasutti (from the Lamont-Doherty Earth Observatory) on a project that studies the effect of intraseasonal variability in the Sahel region in Africa.

NASA Graduate Student Award Winners

John Dwyer



Clara Orbe

Yutian Wu

The APAM Department is pleased to announce that three of our graduate students have received NASA Fellowships.

John Dwyer, an Applied Mathematics graduate student who works with Prof. Adam Sobel (APAM) and Prof. Michela Biasutti (Lamont-Doherty Earth Observatory), received a NASA Earth and Space Science Fellowship. 57 awards were given out of 331 applications.

Dwyer commented that, "My research is on the seasonal cycle of temperature. I'm studying how and why the seasons might change under global warming. Global climate models all expect the seasons to start a few days later and have more warming in winter than summer at high latitudes and more summer warming than winter warming at low latitudes. The projected high latitude changes are probably due to sea ice loss in the models: as sea ice melts because of global warming, the newly exposed open ocean slows and damps the surface temperature's response to the sun. To understand this phenomenon, I'm using global climate models, observations, and simple models. I've been studying this problem since June 2010 under the auspices of my advisors, Adam Sobel and Michela Biasutti, who have been very supportive and helpful. We are finalizing a manuscript on this research for submission."

Clara Orbe, an Applied Mathematics graduate student, won a NASA/Goddard Space Flight Center Graduate Student Researchers Program fellowship. Clara is very grateful for the guidance she has received from her advisors Lorenzo Polvani (Columbia University) and Mark Holzer (Columbia University and the University of New South Wales).

Yutian Wu, who works with Prof. Mingfang Ting at the Lamont-Doherty Earth Observatory and Prof. Mark Cane, was a recipient of the NASA Earth Science fellowship from September 2008 to August 2011. Her research topic is "Changes in the Location and Intensity of the Midlatitude Storm Tracks in a Warmer Climate." The work includes using climate models to understand how the midlatitude storm activity is projected to change as a consequence of increased carbon dioxide and the underlying dynamical mechanisms. Yutian successfully defended her Ph.D. dissertation on October 10, 2011. Her recent publications include:

(1) Wu, Yutian, Mingfang Ting, Richard Seager, Mark A. Cane and H.-P. Huang, 2011: Changes in storm tracks and energy transports in a warmer climate simulated by the GFDL CM2.1 model. *Climate Dynamics*, 37 (1-2), pg. 53-72.

(2) Wu, Yutian, Richard Seager, Mingfang Ting, Naomi Naik and Tiffany A. Shaw, 2011: Atmospheric Circulation Response to an Instantaneous Doubling of Carbon Dioxide Part I: Model Experiments and Transient Thermal Response in the Troposphere. *J. Climate*, in revision.

(3) Wu, Yutian, Richard Seager, Tiffany A. Shaw, Mingfang Ting, 2011: Atmospheric Circulation Response to an Instantaneous Doubling of Carbon Dioxide Part II: Atmospheric Transient Adjustment and its Dynamics. In preparation.

The Medical Physics faculty congratulates the 20 current students and recent alums who passed Part 1 of the American Board of Radiology (ABR) exam in August 2011. We are very proud of you all!

Izzo '81 Delivers Speech at SEAS Class Day

APAM alumnus, Dr. Ralph Izzo (Ph.D. 1981, Plasma Physics), Chairman, President, and CEO of Public Service Enterprise Group (PSEG) in New Jersey, presented the following keynote speech at the SEAS Class Day ceremony on May 16, 2011.

Thank you for inviting me to speak on this wonderful occasion. First, I wish to applaud the graduates. Your Columbia degree is a significant achievement. You have successfully completed a rigorous program of study in one of the world's leading universities and schools of engineering and applied science. You have every reason to feel proud. So do your friends and especially your families. Congratulations.

Having been in your shoes, I would like to discuss the value of an engineering education in a world faced with many challenges but also offering great opportunities. Clearly, there is value attached to the specific knowledge you have gained in your chosen field. But my intention is not to dwell on one field versus another. Rather, it is to stress that an engineering education cultivates an approach, or approaches, to problem solving that can be applied to help our society address major challenges such as energy policy.

The world has a tremendous need for leaders with the knowledge and skills associated with your degree, the value of which goes well beyond any one technical field. Speaking personally, it has been over 25 years since I routinely solved magneto-hydrodynamic equations. Yet, there hasn't been a moment during all these years when I doubted what I learned from solving those equations far beyond plasma physics. Equations have a way of sticking with you, at least for a period . . . but trust me, after 25 years, they don't stick the way they once did. Fortunately, certain habits did stay with me . . . habits associated with doing research, working with others, and identifying solutions to problems. For this and much more, thank goodness there is such a thing as an engineering education.

Thank goodness there are parents who care that you get your education. And thank goodness there are outstanding institutions of higher education such as Columbia. Some of my fondest memories of Columbia were hours spent with friends solving the problems of the world. We did this around a coffee table and lounge chairs that could have won an award as the most dilapidated furniture in New York.

As you can imagine, the furniture didn't concern us terribly. (The administration, in its wisdom, must have recognized that better décor would have been wasted on us.) However, what struck me at the time was the way the intensity of our conversations varied in direct proportion to our struggles with our own work. This happened almost with mathematical precision (which itself was a pretty good lesson). It's called procrastinating.

Another thing I remember is being in a hurry. I was eager to wrap up the research on my thesis. My advisor, Prof. C.K. Chu told me, "Wait a moment. There is more work to do." Probably this was the most valuable lesson of all. There is always more to do and more to learn.

Undoubtedly, quite a number of you will be pursuing careers in teaching or research. But even if you do not, the value of your education will stay with you — in your work, in exercising your role as citizens and in other ways that you cannot anticipate, let alone predict. Your education is profoundly part of you, but also something more: it is an invaluable resource in a world that has an endless need for science, for innovation, and for sound technical reasoning in order to reach informed decisions on issues that matter if we are to secure a sustainable future.

It is common for commencement speakers to give advice, often plenty of it. But, before giving some advice, I think it is only fair that I ask for your help. Guess what: we did not solve the problems of the world as we sat around that coffee table. There remains plenty to do. Energy is a perfect example. We have been talking about our energy dependence for a long time (at least since the OPEC oil embargo of 1973).

Probably your parents and grandparents remember when President Carter wore a sweater and urged us to conserve energy by turning down the thermostat. That was in 1977, I believe. My generation listened to the words, but acted as if there was no problem.

30 years ago, we imported a third of our oil. Today, we import two-thirds of our oil. We remain dependent on fossil fuels for 85% of our energy, and for nearly 100% of our motorized transportation. I strongly believe our energy choices matter and can put us on the path to something better.

My industry is responsible for a third of the nation's greenhouse gas emissions. We need to clean up our act. To do this, my company is emphasizing a 3-fold approach involving first, energy efficiency; second, renewables such as solar and wind energy; and third, power stations that are as clean as possible across diverse fuels and technologies. This is one approach among many that are possible to address our energy and environmental challenges.

As our society debates questions such as whether to conserve or to drill (or do both in some combination), it will be in a better position to make appropriate decisions if there are people at the table with the knowledge and skills to evaluate a variety of inputs and to weigh the consequences of the choices we make today, not only for ourselves but for our children.

Frankly, I worry about the consequences for future generations when the response to various proposed investments, in areas from education to health care to science research, is that we cannot afford it.

Of course, we need to control costs if we care at all about the implications of the ballooning deficit, or the pressures on many household budgets. But we also need to ask: What do we need to pay today, or even to sacrifice, for the sake of tomorrow? We need an honest discussion about this and other tough questions. Graduates like you can make a meaningful contribution in dealing with challenges confronting the world.

In any discussion of energy, we cannot forget that one-quarter of the world's population lacks access to electricity and other things we take for granted. The infrastructure to support energy, food and water for the world's growing population will be an immense undertaking over decades. It must be ramped up now.

(continued on page 7)

Alumni Reunion Lunch

SEAS Alumni from all class years visited the Columbia campus for the Alumni Reunion and Dean's Days Weekend from June 3-4, 2011. As part of the festivities, the Dean sponsored departmental luncheons. APAM alumni in attendance included: **Yuri Baransky** (Ph.D. 1987, Applied Mathematics), **Nora Dolatabadi** (B.S. 2006, Applied Mathematics), **Danielle Scott** (B.S. 2001, Applied Mathematics), and **Jiatao Wang** (B.S. 2006, Applied Mathematics).

Alumni Updates

Bahram Jalali-Farahani (Ph.D. 1989, Applied Physics) was elected a Fellow of the American Physical Society (APS) and has also been appointed the Northrop Grumman Endowed Chair in Optoelectronics at UCLA.

Andrew J. Salthouse (B.S. 1969, Applied Physics) "I've been married 29 years; one daughter is married, the other is getting married very soon. I am an analyst at Sprint Nextel company."

Katayun Barmak

Katayun Barmak, Philips Electronics Professor

The Department is pleased to announce the appointment of Philips Electronics Professor Katayun Barmak to our Materials Science and Engineering program.

Dr. Barmak obtained her B.A. (First Class Hons.) and M.A. degrees in Natural Sciences, Metallurgy and Materials Science from the University of Cambridge, England in 1983 and 1987. She completed her M.S. in Metallurgy and Ph.D. in Materials Science at the Massachusetts Institute of Technology in 1985 and 1989, respectively. During her doctoral work she was a recipient of an AT&T Foundation Fellowship. Prior to her appointment to the Faculty at Lehigh in 1992, Dr. Barmak spent three years at IBM T.J. Watson Research Center and IBM East Fishkill development laboratory working on materials, structures and processes for advanced generations of field effect and bipolar junction transistors. She joined the Materials Science and Engineering Department at Carnegie Mellon University in 1999 and was promoted to the rank of Full Professor in 2002. Dr. Barmak received the National Young Investigator in 1994 and a Deutscheforschunggemeinschaft Fellowship the same year. She received an NSF Creativity Award in 2001. She was one of four Technical Chairs of the Materials Research Society Meeting in Spring 1999. She was a Visiting Scientist at the IBM T. J. Watson Research Center 1998-2004. She is an Associate Editor of the *Journal of Electronic Materials* and a member of the International Materials Review Committee.

Dr. Barmak works to discover, characterize, and develop materials for engineered systems; to develop theories and models for phase transitions and structure and morphology evolution in metallic materials; and to establish relationships between structure and property. Her aim is to quantify and to understand the differences in materials structure at the macro-, micro- and nano-scales and to investigate the impact of these differences on the properties exhibited by the material. Her studies of materials structure immerse her in the exhilarating and powerful world of electron microscopy.

Her research interests include high throughput electron diffraction-based metrology of nanocrystalline materials; identification of a next generation metal to replace copper in semiconductor interconnects; the discovery and development of rare-earth-free advanced permanent magnets; and quantitative kinetic experiments and models of alloys for extremely high density magnetic recording media. She is also working collaboratively with colleagues in applied mathematics on the development of theories for evolution of materials structure and morphology.

Dr. Barmak is a member of the Institute of Electrical and Electronics Engineering (IEEE); Materials Research Society (MRS); American Physical Society (APS); The Minerals, Metals, Materials Society (TMS); ASM International (ASM); Microscopy Society of America (MSA); and Microbeam Analysis Society (MAS).

Vincent Duchêne

Vincent Duchêne

Chu Assistant Professor of Applied Mathematics

Prof. Duchêne received his Ph.D. in Mathematics in 2011, from the Université Pierre et Marie Curie in Paris (France), under the supervision of Prof. David Lannes. His work focused mainly on mathematical issues concerning models that arise in Oceanography. In particular, he studied the propagation of internal waves at the interface of two layers of fluids, such as fresh and salted water. These waves are able to carry large amount of energy, affecting everything from ships and submarines, drilling rigs and undersea cables, and the ecosystem of the ocean. He developed and rigorously justified mathematical models that seek to explain the mechanisms at stake, and the influence of various parameters on the system. Together with Prof. Michael Weinstein and Prof. Jeremy Marzuola, he also studied the scattering properties of materials composed of microstructures, such as photonic crystals (a class of dielectrics which are the photonic analogues of semiconductors). These materials have recently received considerable attention, as they open up variety of possible applications. A very precise theoretical understanding of their behavior is crucial in order to employ the high-technology potential of such materials. In particular, Prof. Duchêne and Prof. Weinstein study the influence of singularities and defects in the microstructure on the large-scale behavior of the material.

The Chu Assistant Professorship is a rotating two-year position. During his first semester in the APAM Department, Prof. Duchêne will be teaching APMA E3101: Linear Algebra.

Tiffany Shaw

Tiffany Shaw

Assistant Professor of Earth and Environmental Sciences and of Applied Mathematics

Prof. Shaw studies the basic dynamics of the atmosphere and climate, with a particular emphasis on the role of wave dynamics and transport. She uses applied math tools such as multi-scale asymptotics and Hamiltonian geophysical fluid dynamics along with a hierarchy of numerical models of varying complexity to understand the mean structure and variability of the atmospheric circulation, including the role of waves, and how they will respond to climate change. Most recently, she has been interested in the role of momentum transports by small-scale waves in shaping the general circulation of the atmosphere, the coupling between the troposphere and stratosphere and the role of water vapor (latent heat) in the general circulation.

Prof. Shaw received a Bachelor's degree from the University of British Columbia and an M.Sc. and Ph.D. from the University of Toronto. Following her doctorate, she spent one and a half years at the Courant Institute of Mathematical Sciences Center for Atmosphere Ocean Science studying the meridional transport of water vapor by waves and its role in the general circulation of the atmosphere. She won the 2011 Holton Award from the American Geophysical Union (AGU) and will be recognized at the Atmospheric Sciences Banquet on December 6, 2011 in San Francisco at the Annual AGU Meeting. The award recognizes outstanding scientific research and accomplishments of early-career scientists in the field.

Faculty News

Simon Billinge was named co-editor of the *Journal Acta Crystallographica* Section A: Foundations of Crystallography in 2011. He also received a Fulbright Scholarship for 2011-2012 and is currently on sabbatical.

C. Julian Chen's book, *Physics of Solar Energy*, a comprehensive guide to the most abundant and most promising source of alternative energy — solar power, was recently published by John Wiley & Sons, Inc.

Pierre Gentine, the '09-'11 Chu Assistant Professor of Applied Mathematics, is now as an Assistant Professor in Columbia's Earth and Environmental Engineering Department. His research was featured in the *Columbia Engineering News* article "Major Step in Improving Forecasts of Weather Extremes".

David Keyes won the SIAM Prize for Distinguished Service to the Profession for his leadership and long-term advocacy of high performance computing and computational science and engineering. We wish him well in his new role as Dean of Mathematical and Computer Sciences and Engineering at KAUST.

Edward Nickoloff's book *Applications of Statistics in Medicine and Medical Physics,* was recently published by Medical Physics Publishing (MPP). He is a member of the APAM Department's Medical Physics faculty and a Professor of Radiology at NYPH/CUMC.

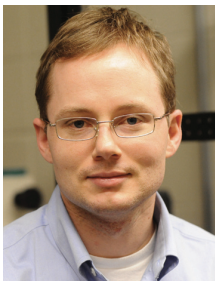
The Department bid farewell to Thomas Pedersen this past summer. He accepted a position as the Director of the Stellarator Edge and Divertor Physics Division at the Max Planck Institute for Plasma Physics (IPP) at Garching / Greifswald.

Adam Sobel was featured in the *New York Times* article "Hurricane Lost Steam as Experts Misjudged Structure and Next Move" by Henry Fountain. He also appeared on *The Takeaway* (WNYC) and spoke on "Why Hurricane Irene Did (or Did Not) Prove Forecasters Wrong".

Latha Venkataraman was recently featured in a video on the SEAS website. She discusses her most recent research that looks at the interplay of physics and chemistry at the nanometer scale. Watch the video online at www.apam.columbia.edu/announcements/Venkataraman_Video_2011.html

Michael Weinstein was invited by the University of Minnesota to be a Distinguished Ordway Visitor in the School of Mathematics for a one month period during the 2011-2012 academic year.

Chris Wiggins was featured in several articles including "People to Watch in Silicon Alley" in *Crain's* New York Business.com, "Tech Jobs Move East in Silicon Alley Reboot" in FINS Technology, and "Computer Science's 'Sputnik Moment'?" in the Opinion Pages of the *New York Times*.



Dirk Englund

Englund Wins Presidential Award (PECASE)

Dirk Englund, Assistant Professor of Electrical Engineering and of Applied Physics, has been awarded the Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government on outstanding scientists and engineers beginning their independent careers.

Englund, who is developing integrated quantum photonic networks to encode and shuttle information in the form of single photons, electrons, and nuclei, was nominated by the Air Force Office of Scientific Research for his "pioneering contributions to the theory and experiment of photonic nanostructures for controllable light/matter interactions at the level of single photons and single emitters, and for his development of quantum optics in semiconductor chips for applications in quantum information processing, quantum metrology, and novel optoelectronic devices and systems for optical interconnects." The award includes $500,000 in research funding, to be used over five years.

"I am extremely honored to receive this prestigious award," said Englund, whose research addresses important problems in communications, computation, sensing, and efficient information technology. "I'm fortunate to work with many excellent colleagues at the intersection of physics, engineering, and biology, which presents hundreds of interesting scientific questions, but also many exciting opportunities for new technologies that can have a major positive impact on society. For me, the PECASE is an important validation of the promise of this research, and I'm thrilled to be able to expand my group's efforts with the additional support that is associated with the award."

Englund and his Quantum Photonics Group are developing new technologies that use the rules of quantum mechanics to process information and make precision measurements in new ways, including a possible new type of massively parallel computer built in photonic integrated chips that use electron spins in diamond as memories and pass information via single photons through optical waveguides. In other projects, they are exploring how to use spin states of electrons and nuclei for diverse applications, such as imaging electrical signals in the brain, or building extremely precise clocks for high-precision global positioning systems and next-generation wireless communications. (continued on page 7)

Guillaume Bal

Bal Wins 2011 Calderón Prize

Prof. Guillaume Bal is the winner of the 2011 Calderón Prize. The prize is awarded by the Inverse Problems International Association (IPIA) to a researcher under the age of 40 who has made distinguished contributions to the field of inverse problems broadly defined. The award, which was previously only awarded in 2007 and 2009, was presented at the Applied Inverse Problems Conference held in College Station, Texas, from May 22-27, 2011. The award included a certificate, a $500 prize, travel reimbursement, and an invitation to give a plenary lecture at the conference.

Researchers Create Artificial Graphene
Prof. Aron Pinczuk

Aron Pinczuk

Prof. Aron Pinczuk was featured in the following article which was originally published on the Columbia Engineering news website.

A team of researchers from Columbia Engineering, the Italian National Research Council, Princeton University, the University of Missouri, and the University of Nijmegen (Netherlands) has developed an artificial semiconductor structure that has superimposed a pattern created by advanced fabrication methods that are precise at the nanometer scale. The pattern is similar to the honeycomb lattice that occurs in graphene. The device, called "artificial graphene" (AG), simulates quantum behavior of strongly interacting electrons. The research team sees the AG-device as a first step towards the realization of an innovative class of solid-state quantum simulators to explore fundamental quantum physics.

The research is reported in the June 3rd, 2011, issue of *Science*. The work is co-authored by Vittorio Pellegrini and Marco Polini of the NEST Laboratory of Istituto Nanoscienze-Cnr and Scuola Normale Superiore of Pisa; and by Aron Pinczuk, Applied Physics Professor at The Fu Foundation School of Engineering and Applied Science and Physics Professor at the School of Arts and Sciences, Columbia University; along with researchers from the Universities of Nijmegen, Missouri, and Princeton.

In order to study quantum phenomena that are difficult to be directly observed, scientists use artificial ad-hoc designed systems — quantum simulators — that can be controlled and manipulated in the laboratory. Researchers have only just begun to develop quantum simulators using different technologies. The AG-device is the first quantum simulator to be based on a semiconductor material that is designed with the goal of uncovering quantum behavior of electrons.

Phenomena such as high-temperature superconductivity, ferromagnetism, and exotic states of matter such as quantum Hall liquids and spin liquids originate from mutual interactions among many electrons. Exact calculations of the behavior of these complex systems are an impossible task even for the more sophisticated and powerful computers. Quantum simulators help bypass the problem by replacing the "uncomputable" quantum system with a controllable artificial one that is able to emulate the dynamics of the original system.

"Quantum simulators based on novel artificial semiconductor structures are at the crossroads of quantum science and innovative technologies," says Pinczuk. "While the frontiers of quantum physics are being explored with giant accelerators, in this branch of condensed matter science we employ advanced methods that expand the state-of-the-art in growth and processing of semiconductors. We could describe our work on quantum simulators as 'probing quantum weirdness in a nano-nut-shell.'"

The simulator developed by the researchers consists of a honeycomb lattice realized on the surface of a Gallium Arsenide (GaAs) heterostructure using advanced nanofabrication methods. The artificial honeycomb lattice structure replicates that of graphene, a material in which electrons behave in a peculiar way because of the crystal-lattice geometry. With the ability to modify key parameters such as the lattice constant of the artificial lattice, the researchers are in the position to explore different regimes of electron-electron interactions in graphene-like systems. Vittorio Pellegrini and Marco Polini from NEST Laboratory of Istituto Nanoscienze-Cnr and Scuola Normale Superiore note that the AG-device has been tested with a "first run" trial that generated an unexpected peculiar quantum state.

> ***"This is a state-of-the-art that should open access to physics and materials science that has not yet been explored!"***
>
> **- Aron Pinczuk**

"The early data we collected are quite promising and show the great potential our device has," they say. "The next step in this research is a fine-tuning of the AG-device". The researchers are excited about the potential of creating venues for the uncovering of novel quantum states that could, eventually, lead to new device concepts and eventually to an array of applications, for instance, in advanced information processing or in cryptography.

Pinczuk added that they hope next to achieve new breakthroughs through the creation of smaller nanofabricated structures reaching limits in which individual units in patterns have lengths of five nanometers. "This is a state-of-the-art that should open access to physics and materials science that has not yet been explored!"

Research at two of the U.S. universities has been supported by grants from the National Science Foundation.

Prof. Pinczuk's research was also featured in the article "Creating Nanoscale Devices" in Columbia Engineering's *Excellentia*.

Creating the next generation of electronic devices – be they computers, smart phones or displays – will depend on understanding the properties of materials on the nanoscale – one-billionth of a meter. Pinczuk's research projects employ advanced optics methods in condensed-matter science, with a focus on understanding the properties of novel materials and the physics of exotic states of matter that emerge in semiconductors at extremely low temperatures. His research findings address issues used by scientists seeking the development of quantum computing and cryptology. The research on graphene, a single atomic layer of graphite, contributes to the quest to initiate a new era in the creation of electronic components.

EXCELLENTIA

Download *Excellentia* and read more APAM faculty research profiles:

engineering.columbia.edu/strategic-areas

Download the new "Did you know?" APAM faculty and alumni excellence posters at:

www.apam.columbia.edu/directory/announcements.html

(Izzo Delivers Speech at SEAS Class Day, continued from page 3)

If progress is to be made, it will take people with the dedication and know-how to diagnose problems, come up with solutions and be the catalyst for action. In short, we need you. Now, in turn, allow me to give a few words of advice.

- Some say showing up is 80% of the battle. Don't believe it. Anything worth your time requires much more than showing up if you truly want to make a difference.
- Scientists and engineers wrestle with complex problems and issues that can seem intractable. Inevitably, you will encounter bumps in the road. At times, you may feel your ideas are getting less than a full or fair hearing.
- To be heard, we also need to listen. Whatever the circumstances, I urge you to keep in mind the importance of communication based on trust and respect.
- I believe that growth comes by embracing complexity, by remaining open to learning, by welcoming diverse ideas, by being willing to change our minds and to have the courage to go where the evidence takes us.

Today, it seems fitting to quote the words of a great scientist. Max Planck was awarded the 1918 Nobel Prize for Physics for his discovery of energy quanta. Max Planck was a member of the remarkable generation of scientists who revolutionized our understanding of the universe and unlocked the mysteries of the atom. Experimental evidence led Max Planck to a new idea that was radical at the time — namely, that energy did not flow in a steady continuum. 80 years ago, Max Planck wrote, "We have no right to assume that any physical laws exist, or if they have existed up to now, that they will continue to exist in a similar manner in the future."

Grappling with complexity and uncertainty is part of what our era demands. But, in my view, it would be wrong, indeed dangerous, if this led to the cynical conclusion that there is no truth, or that the only way to deal with a problem is to muddle through. We must continue to ask hard questions that go with science, but at the same time, not lose belief in the vast possibilities of applying knowledge to improve the condition of humanity. Max Planck said, faith "is a quality that scientists cannot dispense with." So I urge you, keep the faith. Keep believing in yourself. And never stop learning. Thank you.

(Englund Wins Presidential Award, continued from page 5)

A leading researcher in the emerging fields of chip-based quantum optics and nanophotonics, Englund focuses on examining fundamental questions in physics: how to control the radiative properties of an emitter through its electromagnetic surrounding, how to interact single photons and single emitters, or how to create non-local correlations between distant particles through the use of quantum entanglement. Work by Englund and his peers has brought many of the same phenomena into the realm of solid state physics on semiconductor chips, an approach that has enabled fundamental advances to the field of quantum optics and opened the door to chip-based applications of quantum optics phenomena in computing, communications, and metrology.

"We are very happy that Dirk Englund has won this prestigious award for his pioneering research that addresses important problems in communications, computation, sensing, and efficient information technology," said Columbia Engineering Dean Feniosky Peña-Mora. "He is well-deserving of such an honor and we offer him our hearty congratulations. Prof. Englund is the epitome of our superb faculty here at Columbia Engineering — an extraordinary researcher, inspired teacher, and outstanding colleague — and we are proud to have him on our team."

Englund, who was also awarded a Sloan Research Fellowship in Physics earlier this year, holds a B.S. in physics from the California Institute of Technology and an M.S. in electrical engineering and Ph.D. in applied physics from Stanford University.

After postdoctoral work in Harvard's Physics Department, he joined Columbia's Electrical Engineering Department in 2010 as an assistant professor, with a secondary appointment in the Department of Applied Physics and Applied Mathematics.

The article "Englund Wins Presidential Award" was originally published on the Columbia Engineering news website.

In Memoriam

Faculty, alumni, students, and friends greatly mourn the loss of our beloved benefactor, Z.Y. Fu, whose extraordinary generosity was transformational for the Columbia Engineering School, ensuring its role as a global leader in science and technology for the 21st century. For more information, please see: www.engineering.columbia.edu/news

DEPARTMENT OF APPLIED PHYSICS & APPLIED MATHEMATICS FUND

Yes, I want to support the APAM Department with my gift of:

☐ $1,000 ☐ $500 ☐ $250 ☐ $100 ☐ Other: _____

I have enclosed my check in the above amount made payable to Columbia University. Please direct my gift to:

☐ APAM Special Projects Fund ☐ Other: _____

Name _____

Address _____

City _____ State _____ Zip Code _____ Email _____

This gift is tax deductible as allowed by law. Please return this form and your check to:

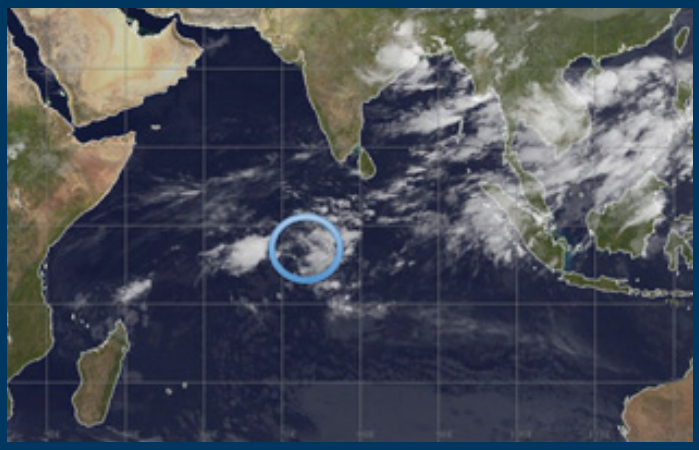
Prof. Irving P. Herman, Chair
Department of Applied Physics & Applied Mathematics at Columbia University
500 W. 120th Street, 200 Mudd, Mail Code 4701, New York, NY 10027

FACULTY GALLERY

(Below and top right) Prof. Adam Sobel and Dr. Shuguang Wang (APAM), along with Dr. Daehyun Kim (LDEO), are part of an international team of scientists from Columbia University, Colorado State University, and Harvard University who are on a 6-month data-gathering effort in the Indian Ocean to try and unravel the workings of the Madden-Julian Oscillation (MJO). The goal of the campaign, known as DYNAMO (Dynamics of the Madden-Julian Oscillation), is to help meteorologists improve long-range weather forecasts and seasonal outlooks. Most of the research will be coordinated from the Maldives, with instruments deployed on land, at sea and in the air. For more information, see:

"Investigating a Tropical Weather Pattern with Global Reach"
www.ldeo.columbia.edu/news-events/investigating-tropical-weather-pattern-global-reach

Follow the Madden-Julian Conversation blog:
maddenjulianconversation.blogspot.com



(Above) NCAR/EOL's S-Pol radar on Gan Island — an advanced, transportable, ground-based dual-polarimetric 10 cm wavelength (S-band) weather radar.

(Below) Prof. Chris Wiggins moderated the Columbia Alumni Association Entrepreneurship Networking Night on Sep 15, 2011. For more photos, see: www.engineering.columbia.edu/galleries

The Applied Physics & Applied Mathematics Department
The Fu Foundation School of Engineering & Applied Science
Columbia University in the City of New York
500 W. 120th Street, Room 200 Mudd, MC 4701
New York, NY 10027
Phone: 212-854-4457
Fax: 212-854-8257
www.apam.columbia.edu

Please stay in touch. Send your news to:
seasinfo.apam@columbia.edu

Find us on Facebook at:
Applied Physics & Applied Mathematics Department, Columbia University

Follow us on Twitter at:
APAMMSECU

Editors: Irving Herman, Dina Amin, Christina Rohm

Contributing Authors: Katayun Barmak, *Columbia Engineering News*, John Dwyer, Vincent Duchêne, Julio Enrique Herrera Estrada, Holly Evarts, Irving Herman, Tiffany Shaw, Yutian Wu

Photos/Images: Eileen Barroso, *Columbia Engineering News*, Julio Enrique Herrera Estrada, Daehyun Kim, Adam Sobel

Design: Christina Rohm