Physics

January, 2011

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Letter From the Chair

Dear Friends of the Department:

It is hard to believe that another year has passed. The number of students at OSU has increased dramatically this year, and Physics is no exception. This has had a very positive effect on our financial state, offsetting last year's budgetary woes that resulted in furloughs for faculty and staff. The increased enrollment does present some space and logistical problems and puts extra demands on our teaching staff, but on balance, it is a good problem to have!

Viktor Podolskiy has moved to the University of Massachusetts, Lowell, after 6 very productive years in our department. We wish him well in his new east coast home. We will be searching for two new faculty members this year, one in experimental and one in theoretical biophysics. We look forward to enhancing our connections to our colleagues in Biology, as some of our faculty members are already conducting biology-related research.

Oksana Ostroverkhova was promoted to Associate Professor with indefinite tenure. Both **Dedra Demaree** and **Corinne Manogue** received special grants from the National Science Foundation in the Course, Curriculum, and Laboratory Improvement program. Our Department has also been very successful in attracting support from ONAMI, receiving $863,000 for projects starting in 2010 and anticipating $977,000 for projects starting in 2011. **Ethan Minot** was responsible for a funding "first" in our department. He is collaborating with biologist Dr. Kerstin Blank (Radboud University, The Netherlands), and was awarded a prestigious grant from the Human Frontiers in Science Program. This international program awards grants of $700,000 to support collaborations between biologists and physicists/mathematicians/engineers, focusing on problems at the frontiers of the life sciences.

The department is hosting two visiting researchers this year. **Prof. Ji-Yong Park** from Ajou University, Korea, is spending his sabbatical in our Department. Prof. Park is an expert in the physics on nanoelectronic devices and the applications of novel scanning probe microscopy techniques. **Dr. Tom Novet** is a researcher from Voxtel Inc. (an Oregon-based nanotechnology company). At OSU he is developing new techniques to produce monodisperse carbon nanotubes for electronics applications. Both Prof. Park and Dr. Novet are collaborating with Ethan Minot's group. We welcome them to our department.

Another "first" was the award to **Jason Francis** of the recently established Whiteley Fellowship in Materials Science. This was the first year summer fellowships were awarded, and we are very grateful to the Whiteley family for establishing this fellowship.

As always, I invite you to come and visit our Department when you are in town. We will be happy to show you our new SCALE-UP classroom and our faculty members are always eager to discuss their latest research efforts!

I wish you a great 2011,

Henri Jansen
Chair of the Physics Department

INSIDE:

OSU
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Physics

Degrees Awarded

Peter Sprunger, PhD (Physics), to an internship with the AAAS Center for Science, Technology, & Security Policy in Washington DC.
Jared Stenson, PhD (Physics) to a physics lectureship at Lane Community College in Eugene, OR.
Sukosin Thongrattanasiri, PhD (Physics) to a post doctoral research position in the nanophotonics group of Prof. Garcia-Vidal in Madrid, Spain.
Kenneth C. Walsh, PhD (Physics) to a physics lectureship at Western Oregon University in Monmouth, OR.
Andriy Zakutayev, PhD (Physics) to a post doctoral research position in materials physics at the National Renewable Energy Labs in Golden, CO.

Jessica Armstrong, BS (Engineering Physics)
Patrick Bice, BS (Physics, Engineering Physics)
Steven Brinkley, BS (Physics)
Alexander Brummer, BS (Physics - Magna Cum Laude) to grad school at University of Arizona
Matthew Cibula, BS (Physics - Cum Laude) to grad school at Oregon State University
Alex Dauenhauer, BS (Physics - Cum Laude)
Craig Francisco, BS (Physics)
Daniel Gruss, BS Honors (Engineering Physics, Computational Physics, Physics - Summa Cum Laude) to grad school at Oregon State University.
John Hart, BS (Physics)
Howard Hui, BS (Physics - Cum Laude) to grad school at Cal Tech.
Michael Lindsey, BS (Physics - Cum Laude)
Michael Nielson, BS (Computational Physics)
Joseph Omundson, BS (Engineering Physics)
Colin Shear, BS Honors (Physics - Summa Cum Laude)
Andrew Stickel, BS (Physics - Magna Cum Laude)
Sol Torrel, BS (Physics)
Ben Weston, BS (Physics)

Student Awards

The annual graduate awards in the department went to **Josh Russell** (Peter Fontana Outstanding Graduate Teaching Assistant Award), **Andy Platt** (Graduate Research Award), and **Jason Francis** (Whiteley Fellowship in Material Sciences). This is the first year we have awarded the Whiteley Fellowship and we are grateful for this generous endowment. Our graduate students are an essential part of the research and teaching missions of the department and it is a pleasure to acknowledge them each year.

Graduate students **Whitney Shepherd** and **Nick Kuhta** were both awarded with SPIE scholarships in Optical Science and Engineering this year. Whitney also received a Spectra-Physics-Newport travel award to present her work at the SPIE Photonics West meeting in San Francisco, CA in January 2010.

Undergraduate physics majors **Garrett Banton** (Ostroverkhova lab) and **Jessica Gifford** (McIntyre/Ostroverkhova lab) received URISC awards for their respective projects "Preliminary Study of Charge Transfer in Organic Semiconductor Materials" and "Optical Trapping and Fluorescence Spectroscopy of Nanoparticle Sensors in Microfluidic Devices". **Colin Shear** won an Honors College "Outstanding Poster Award" for his physics thesis work with Brady Gibbons. **Kris Paul**, **Shaun Kibby** and **Jeff Holmes** received an Oregon Space Grant Undergraduate Research Scholarship Award for their project "Redesigning the OSU Radio Telescope" under the supervision of Prof. Bill Hetherington.

Research: Organic Photonics and Electronics

Oksana Ostroverkhova
Oksana joined the OSU faculty in 2005. She received an NSF CAREER award in 2008. Her main research focus is on charge carrier dynamics and light-matter interactions in molecular materials and their applications.

We work on a variety of projects, but our main research quest is to understand fundamental physics of charge and energy transfer in molecules and organic solids. Organic (opto) electronic materials are of interest due to their applications in thin-film transistors, light-emitting diodes (OLEDs), solar cells, sensors, 3D displays, and many other devices. Low cost, easy fabrication, and tunable properties make organic optoelectronics technologically attractive. Many applications are already on the market: OLED displays in cell phones, car radios, digital cameras, and TVs, thin-film solar cells built into laptop cases, to name a few. New applications such as thin-film multi-color updateable 3D displays, are emerging. This is a very exciting time for this field. All these applications rely on our understanding of how molecular solids transport electric charge and/or interact with light, which is not well-understood due to the complexity of interactions.

Our group takes a systematic approach to understand and manipulate optical, luminescent and photoconductive properties of organic materials, from macroscopic level (thin films) to microscopic level (single molecules). Therefore, we study both types of systems: (i) single molecules, using single-molecule fluorescence microscopy and (ii) thin-film devices, using time-resolved photocurrent and photoluminescence spectroscopy. We are privileged to collaborate with organic synthesis group of Prof. J. Anthony at the U of Kentucky who synthesizes the best organic semiconductors currently available. In addition to experimental work, we perform computational modeling of charge photogeneration and transport processes in our materials. Also, we collaborate with Prof. G. Schneider at OSU on density functional theory calculations. One of our main goals is to understand how dynamics of charge and energy transfer between two molecules translates into optical and (photo) conductive properties of a solid composed of these molecules. Then we want to manipulate these processes towards crafting molecules and composites optimized for a particular application.

Figure 1 shows one of our molecules, ADT, and data obtained from ADT thin-film devices (top) and

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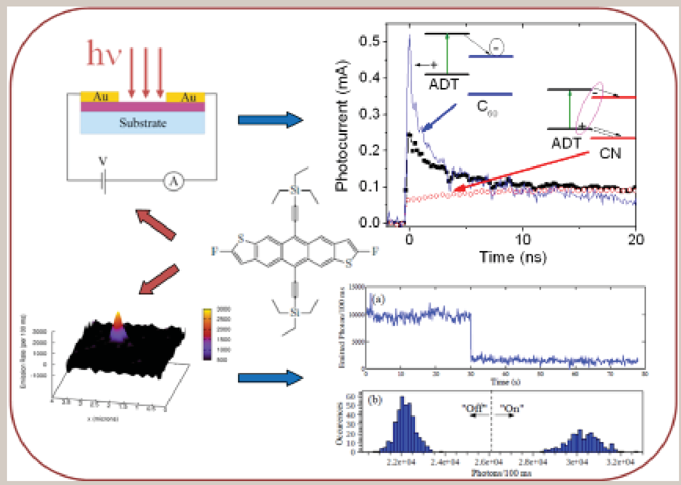

Figure 1: Center: Molecular structure of an ADT molecule.

Top left: Schematics of a thin-film device structure: thin ADT film on a glass substrate with Au electrodes. The film is photoexcited with short laser pulses, and the photocurrent under applied voltage is measured.

Top right: Time-resolved photocurrent in pristine ADT film (black squares), ADT with a small amount of C_{60} (blue line), and ADT with a small amount of CN (red circles). Insets show relative energy levels of the ADT and C_{60} (favoring electron transfer) and ADT and CN molecules (favoring energy transfer).

Bottom left: Spatial profile of fluorescence of a single ADT molecule.

Bottom right: (a) Fluorescence time-trace of a single ADT molecule. Single-step decay is due to photobleaching and is one of the distinct characteristics of single-molecule emission. (b) Example of single-molecule data analysis: distribution in timing and strength of photon emission for the "on" (emissive) and "off" (non-emissive) states of an ADT molecule. Intermittent non-emissive states happen as a result of transitions of the molecule to "dark" (e.g. triplet) states, changes in conformations, and interactions with neighboring molecules

Research: Organic Photonics and Electronics

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ADT single molecules (bottom). Upon photoexcitation of ADT molecules with a short laser pulse, bound electron-hole pairs (excitons) form, which need help dissociating into free charge carriers due to relatively large exciton binding energies of 0.1-1 eV. Under applied voltage, some excitons dissociate, and photogenerated carriers (mostly holes, as they are more mobile) move towards the electrodes, what results in a transient photocurrent (see upper right figure). The peak amplitude of the photocurrent depends on charge photogeneration efficiency and charge carrier mobility, and decay dynamics reflects trapping and recombination processes. As seen from the figure, if the ADT molecule senses the presence of a molecule of a different type in its vicinity, carrier dynamics can be drastically changed, depending on the relative energy levels of these molecules. For example, a C_{60} molecule in the vicinity of the ADT acts as a strong acceptor; an ultrafast electron transfer occurs from the photoexcited ADT to C_{60}. This helps separate the bound electron-hole pair, which sets a hole free to propagate, resulting in a dramatic increase in the photocurrent amplitude (see figure). In contrast, if a weaker acceptor molecule such as CN is used, electron transfer is less efficient, and it competes with energy transfer. This leads to a completely different photocurrent dynamics (see figure). In our experiments at microscopic scales, we photoexcite individual ADT molecules and probe their relaxation to the ground state by monitoring dynamics of photon emission. These are sensitive to the molecular packing, polarity, relative energy levels of the molecules surrounding the ADT molecule, and many other factors. This sensitivity makes the ADT molecule a reporter of local nanoenvironment.

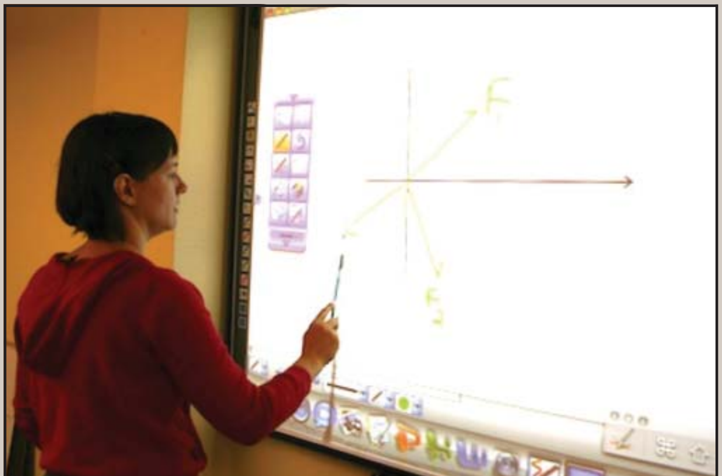
Our group is excited to be involved in a variety of other projects related to light-matter interactions and their applications. We collaborate with a team of Prof. N. Peyghambarian at the U of Arizona on development of 3D updateable photorefractive displays. We are involved in a large collaboration (with Profs. D. McIntyre, V. Remcho, S. Prasad, S. Reed, and Dr. Shvarev at OSU) towards development of bionanosensors, which combines holographic optical tweezer trapping and fluorescence imaging capabilities. One of our most unusual collaborations is that with Prof. S. Rao at OSU Entomology, which resulted in our discovery and quantitative description of a phenomenon of “super-normal stimulus” in a variety of native bees (e.g. bumble bees). In particular, it turns out that bumble bees are extremely attracted to artificial objects with sunlight-induced fluorescence emission at particular wavelengths. Our discovery is currently being implemented across Oregon helping growers attract native bees to agricultural sites (such as blueberry and cranberry fields) for pollination.

Our research has been supported by the National Science Foundation, Air Force Office of Scientific Research, ACS Petroleum Research Fund, Office of Naval Research through ONAMI, and Agricultural Research Foundation.

As for our group’s general philosophy, we are not afraid of challenges and of breaking through interdisciplinary fields. We are fascinated by the complexity of the molecular world and strive to make an impact in unraveling mysteries of this world. We work hard and with a lot of enthusiasm, and nature rewards us with a constant reminder of why we chose this exciting path of scientific research, and we are extremely grateful for that.

Teaching: Cutting-edge physics studio helps big classes learn in new ways

by Theresa Hogue.
Appeared in Life@OSU and on the website CampusTechnology.com



Dedra Demaree demonstrates the touch-screen capabilities of one of the Starboards in her new physics studio. (photo: Theresa Hogue)

When students walk into the new physics studio in Weniger Hall, they immediately know they're not in a typical classroom. For one, instead of desks assembled in rows facing a lectern, the room is filled with a series of round tables surrounded by brightly colored chairs. The walls are covered in Starboards, which are like whiteboards that double as giant touch screens. There's no "front" to this classroom, no teacher-centric orientation.

Dedra Demaree, assistant professor of physics at Oregon State University and the driving force behind the physics studio, said her sister, an adult education specialist, likened the room to a kindergarten for adults. It immediately invites participation instead of being a static learning environment.

The studio classroom is modeled after an innovative project out of North Carolina State University called SCALE-UP. The name stands for "Student-centered active learning environment for undergraduate programs," and it is based on years of research about ways to approach student-centered learning for large groups of students. It's a problem faced by many faculty teaching required undergraduate courses. How do you teach in innovative, engaging ways when you're trying to educate 75 or 100 students at one time?

"We know when students are actively engaged with course material they'll be more successful," Demaree said, based on more than three decades of research in college-level physics education. "It's important to give students the opportunity to do things in a more authentic way, to not just listen but to engage in the practices of their field."

The physics department has been at the cutting edge of student-centered learning with its innovative upper-division courses, but now the department is focusing on enhancing its large introductory courses. Demaree's own research demonstrates that learning gains have been higher in her large classes than in most large physics classes in the country.

The OSU space is the only SCALE-UP classroom in Oregon, and is one of the most state-of-the-art SCALE-UP classrooms in the nation, Demaree said. A number of other universities, including MIT, have adapted SCALE-UP classrooms. At OSU, students are grouped into three sets of three at each table, and each group has their own laptop to work from. They also work on traditional whiteboards at their table, as well as the Starboard nearest to them. Everything is interconnected, so Demaree can communicate to her students via the laptops or send information over the Starboards, displaying everything from group assignments to ideas and solutions generated by their classmates.

The studio, which was first used during Spring Term, serves students in Demaree's introductory physics course, which is a requirement for all science and engineering students. The 185 students she taught during Spring Term had two hours of lecture each week, two hours of lab work, and two hours in the studio, where they had a series of physics problems to solve as small groups each week. This replaced three hours of lecture and three hours of lab previously offered for the introductory class.

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Teaching: Cutting-edge physics studio helps big classes learn in new ways

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A low-friction surface in the center of the room provides space for students to physically engage in experiments, such as pushing each other on wheeled carts to learn about force and inertia. This detail is unique to the OSU studio. At their desks, they can draw diagrams on the Starboards and then have Demaree or one of the two TAs in the classroom look at their work, and even make changes from across the room via computer. And Demaree can also show the entire class one group's solution, and have them discuss the results, by simply holding up the whiteboard to a nearby camera, displaying the work on all the monitors in the room.

Bright colors meet high tech function in the new physics studio. (photo: Theresa Hogue)

Discussing different methods of solving a problem, and whether or not their methods were sound, is an important part of the class. "It promotes the goal of thinking about reasoning rather than trying to match a textbook answer," she said. "It puts students in charge of generating the solutions."

But that approach doesn't always go over well. In fact, Demaree has met resistance from students who want to be told what to do, and who believe the goal should be to get the textbook answer rather than to be able to generalize the process to new situations."

Demaree's assistant, Sissi Li, a Ph.D student in science education, said some students resent the idea of student-driven learning. "A lot of them want to know 'Am I right?'" Li said. "They say, "Tell me what I'm supposed to think, what I'm supposed to do."

That black and white approach doesn't work well in the world outside the classroom, and Li thinks Demaree's approach is more realistic. "The ability to assess a problem is more important," than learning one approach to every answer and then parroting it back, she said.

The studio project was funded by private donations and TRF funds.

Facilities services had to tear down eight storage units to create the classroom space.

The lighting and aesthetic design was designed by undergraduate Holly Needham, who chose low chemical paint and low impact carpeting.

Media Services and COSINe worked together to design and set-up the technological infrastructure.

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Teaching: Cutting-edge physics studio helps big classes learn in new ways

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As the classroom evolves, the technology can easily be adapted to new uses. Demaree said other physics faculty also will teach in the space, and one day envisions combining lab with the studio. For now, she's looking to make a few changes to her activities for the fall courses she'll teach, and trying to utilize the unique opportunities the studio provides to their best advantage.

Demaree knows focusing on the scientific process rather than the final number will pay off for the students academically. "I think this method is really powerful."

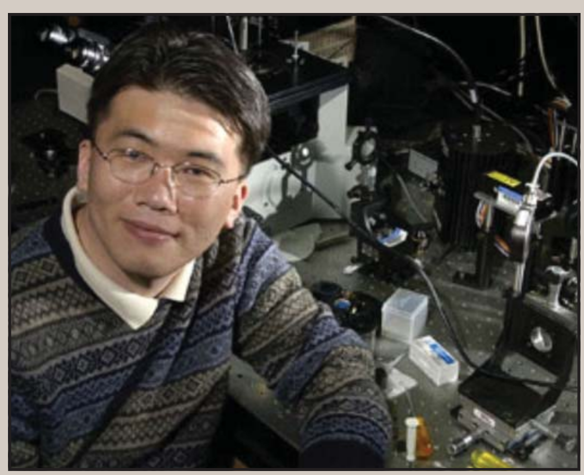
Convia system

One of the reasons the physics studio space is such a standout is the Convia wiring system used in the room. Convia, an offshoot of Herman Miller, provides ceiling tracks that allow users to run cables and electric wires from the ceiling and then reroute those wires when the room's configuration changes, eliminating the need for expensive rewiring. It also provides for easily controlled lighting systems that allows users, via computer, to dim or brighten different portions of the room at different times. It's also power-efficient and environmentally friendly.

The 2010 Yunker Lecture

Prof. Taekjip Ha, University of Illinois Urbana-Champagne, presented this year's Yunker lecture "Single Molecule Nanometry for Biological Physics". The talk introduced the field of single molecule biophysics, highlighting recent achievements and future challenges for experimental physicists interested in probing biological activity at the smallest length scales.

Prof. Ha is a pioneer of single-molecule fluorescence energy transfer, a technique which has revolutionized our understanding of biology at the single molecule level. His group continues to develop and apply new techniques, publishing frequently in Science and Nature. Prof. Ha is a Howard Hughes Medical Institute Investigator and co-director of the NSF Center for the Physics of Living Cells.



We were very pleased that Elaine Yunker Whiteley and Ben Whiteley were able to attend Dr. Ha's lecture. Mrs. Whiteley is the daughter of former Physics Department Chair Edwin Yunker, in whose honor the family endowed the lectureship.

The video of this year's lecture can be watched online at http://oregonstate.edu/media/rmlsg

Physics

FEI Field Trip

On May 7, 2010, eight Physics graduate and undergraduate students visited FEI, a company that makes advanced electron microscopes in Hillsboro, OR.

The trip was initiated by Brandon van Leer, a former student in our department, who now works at FEI. Brandon and the FEI staff were wonderful hosts who went to great lengths to show the students how their physics knowledge would be used in the high-tech workplace.

Physics students (left to right) Sean Caudle, Chris Reidy, Tim Mathews, Jeff Holmes, Rachel Burton, Matt Cibula, Seongweon Park, Matt Leyden pose outside FEI after their visit in May.

The day began with a welcome and an introductory tutorial about scanning electron microscopy (SEM) and transmission electron microscopy (TEM) imaging. The FEI recruiter also gave the students some valuable interviewing and job searching advice. Some more advanced research presentations followed, and then after lunch it was hands-on time.

The students spent several hours watching the microscopes in action, from the huge, ultra-high vacuum Titan TEM with atomic-scale resolution to the “environmental” SEM, which allows imaging in water. They watched as a salt crystal dissolved and recrystallized before their eyes. A popular favorite was the dual beam SEM that has a focused ion beam (FIB) in addition to the electron beam. The FIB can be used to cut and shape surfaces. (OSU now owns such an instrument – it is housed in the Electron Microscopy facility.

Junior Tim Mathews was enthusiastic: “The FEI trip was awesome. I really enjoyed seeing the cutting and then soldering using an ion beam of some material used to repair a circuit that was only a few micrometers across,” he said.

The FEI technical staff answered the many questions the students had about microscopy and employment in the high-tech sector.

Many thanks to Brandon and his colleagues at FEI for their friendly and professional event. Brandon did his senior thesis with Janet Tate’s group and graduated with a B.S. in Physics is 1998, and an M.S. in Engineering in 2002. OSU physics alum Scott Fuller, who did his Ph.D. under Bill Warren’s direction, is also employed at FEI.

Physics

Alumni Update

Thanks for contacting us! We're always pleased to hear news of your careers and activities. Drop an email to individual faculty members, update us via our alumni page at the departmental website, or post to the facebook group "Physics Alumni & Friends - Oregon State University". Please keep your address current with the OSU alumni office, so we can mail you a copy of the newsletter.

Warren Washington (B.S. 1958)

Undergraduates:

Warren Washington (B.S. 1958) was one of 10 recipients of the National Medal of Science. He is a senior scientist at NCAR and an internationally recognized expert on atmospheric science and climate research and a pioneer in using computer models. He also received an honorary doctorate from OSU in 2006.

Brandon van Leer (B.S. 1998) has moved to FEI Inc. in Hillsboro. In May, Brandon organized a visit by OSU Physics students to the FEI campus. He and his wife, alumna Sarah Svoboda (B.S. 2000), welcomed their child, Ethan, to the world last October. Sarah works at Intel, Hillsboro.

Jonathon Gillen (B.S. 2003) finished his PhD in 2009 at Harvard University in the group of Markus Greiner, working on cold atomic gases. He spent the last year in Washington, D.C. working for the US patent office. He is now a postdoctoral fellow in Wolfgang Ketterle's group at MIT.

John LaFollet (B.S. 2003) graduated with a Ph.D. in physics from Washington State University.

Adam Rand (B.S. 2004) is the head sailing instructor at Bitter End Yacht Club in the British Virgin Islands.

Connelly Barnes (B.S. 2006) received a Ph.D. in computer science from Princeton University where he studied with the Princeton Graphics Group.

Scott Clark (B.S. 2008) is studying metagenomics at the Cornell University Center for Applied Mathematics. Scott won a Department of Energy Computational Science Graduate Fellowship. An essay about his research is featured in the 2010 issue of Deixis (annual newsletter published by the Department of Energy).

Graduate Students:

Jeanette Roberts (Ph.D. 1997) works at Intel, Hillsboro. At the March APS meeting, she participated with Janet Tate in a tutorial session for graduate students in Physics on jobs in government and industry.

Peggy Lopez (M.S. 1997) is a senior Optical Test Engineer at Orb Optronix, Inc. in the Seattle area.

Matthew Des Voigne (M.S. 1999) is still at Shodor, a national resource for computational science education, located in Durham, N.C. He added an MS in accounting to his MS in Computational Physics, and recently passed all his CPA exams. He's more on the business side now, although he still does Tech Support, teaching, and a bit of development.

Kerry Browne (Ph.D. 2001) spent two years in the Peace Corps. He and his wife, Rachel, are now both science teachers at Rivendell Academy, a middle/high school in New Hampshire.

Jeff Loats (Ph.D. 2004), spotted at the March 2010 APS meeting, is teaching physics at the Metropolitan State College in Denver, CO.

Josh Mellon (B.S. 2007, M.S. 2009) has joined a small acoustics company, Blue Ridge Research and Consulting, in Asheville, NC. Putting his Professional Science Masters skills to good use, he is the manager of business operations and contracts officer as well as a scientist.

Faculty and Staff:

The good works in Haiti of our emeritus colleague, **Peter Fontana**, are reported in the New Yorker (see page 6 of this article): http://www.newyorker.com/reporting/2010/05/10/100510fa_fact_seabrook?currentPage=1

John Gardner, Prof. Emeritus and Founder of View Plus Inc., will serve on a panel at the National Professional Science Master's Association conference in Atlanta, GA this year along with OSU PSM graduate **Josh Mellon**. View Plus has employed several physics interns over the past years.

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Alumni Update (continued from page 9)

Kazushi Sugawara, research associate with John Gardner's group in 1978, joined Sharp labs in Japan, then Nippon Institute of Technology as a professor in 1993. He retired in 2007 to pursue solar cell research.

For more updates, follow us on facebook.

We post significant news to the page "Department of Physics - Oregon State University" (you can find a link to this facebook page at www.physics.oregonstate.edu).

On the facebook page find links to the video of this year's Yunker Lecture, and recent news articles about research in our department (including reports of work by Yun-Shik Lee, Corinne Manogue and Dedra Demaree).

Become a fan of the page to have updates automatically forwarded to your facebook account.

Physics

College of Science

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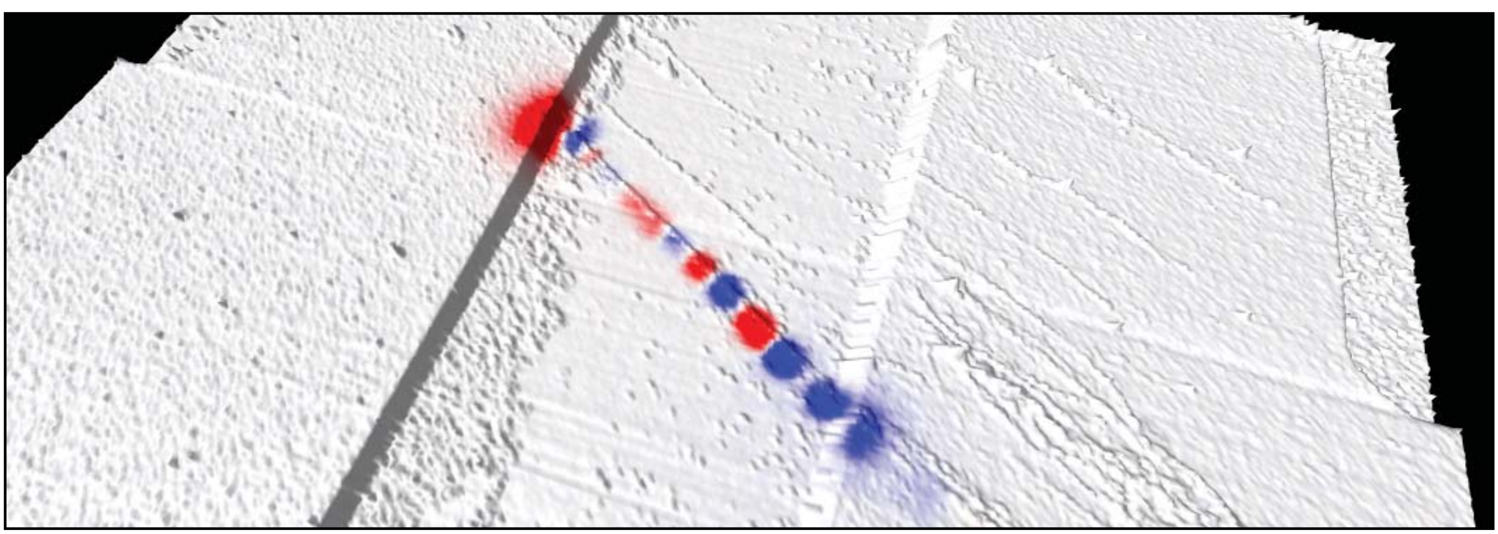

Photocurrent hotspots in a carbon nanotube device measured by a new photocurrent microscope. The instrument was built by graduate student Tristan DeBorde in Ethan Minot's research group. Scale: The image area is 10 x 20 microns. The topography of the nanotube device was first imaged by atomic force microscopy. Then photocurrent response was then measured by scanning a tightly focused laser over the device. The information was overlayed to produce this image, with color indicating the intensity of the photocurrent (white = zero, red = positive current, blue = negative current). The photocurrent "hotspots" are caused by built-in electric fields in the nanotube.