Physics Matters

Department of Physics & Astronomy | No. 16 | 2012-2013

Pushing the Limits

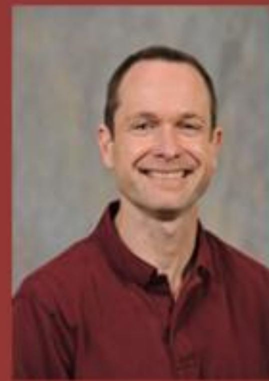
WASHINGTON STATE UNIVERSITY

Physics Matters

2012-2013

Table of Contents

Greetings from the Chair



The Department of Physics and Astronomy is leading the way in research and education. Our graduate program is one of the fastest growing programs at WSU, increasing from 40 to 71 Ph.D. students from 2005 to 2011. In 2012, we graduated 11 physics Ph.D. students. Our undergraduate majors are going on to excellent jobs and graduate programs, and lower-division undergrad enrollments are at record levels.

To continue this momentum, we are hiring outstanding new faculty. Dr. Michael Forbes, a many-body theorist, will be joining our department as an assistant professor. We are currently searching for an experimentalist. More new professors are on the horizon.

As you can see from this issue of Physics Matters, the Department is excelling in all respects. A key ingredient to this success is the generous support from our alumni and friends. Thank you!

Dr. Matt McCluskey
Professor and Chair

Good News Around the Department

Faculty & Staff

Michael Allen gave the annual Honors College Invited Lecture in April 2013. This event is student-nominated and voted upon by the Honors College student body.

Doerte Blume published a paper titled “Universal four-body bound states in heavy-light mixtures with a positive scattering length,” *Phys. Rev. Lett. 109*, 230404 (2012). Dr. Blume also co-organized a workshop (with Barbara Capogrosso-Sansone and Seth Rittenhouse) on “Finite-temperature and low-energy effects in cold atomic and molecular few- and many-body systems,” March 25-27, 2013. The workshop was held at the Institute for Theoretical Atomic Molecular and Optical Physics (ITAMP) at Harvard University.

Sukanta Bose gave three invited talks in early 2013: “Status of LIGO-India,” at the conference on “Gravitational Waves: New Frontier” in Seoul, Korea (January); “Compact Binary Coalescence: Computational Challenges,” at a meeting titled “Astronomy with the Global Gravitational-Wave Detector Network” in Cardiff, UK (February); and “Compact binary coalescences as progenitors of short hard GRBs: What can gravitational wave searches tell us?” at the International Meeting on Transients and Timing in Pune, India (March).

Nicholas Cerruti chaired this year's Society of Physics Students (SPS) zone meeting on April 5 and 6, 2013. He, along with members of the Physics and Astronomy Club, hosted more than 40 students from Washington, Oregon, and Idaho. There was a poster session as well as tours of the Institute for Shock Physics (ISP) and **Kelvin Lynn's** positron laboratory. Invited guest speakers included Dr. Harlan Robins (Fred Hutchison Cancer Research Center) and Professors Ruprecht Machleidt (University of Idaho) and **Sukanta Bose**. SPS promotes undergraduate physics education.

Gary Collins attended the International Conference on Hyperfine Interactions in Beijing, China, in fall 2012. He presented a plenary paper on atom-scale properties of palladium compounds that was based on experiments by graduate student **Qiaoming Wang**. Gary also presented a poster paper on research carried out with **Lee Aspitarte (B.S. 2011)**, now a physics doctoral candidate at Oregon State University, and **Egbert Nieuwenhuis** of Groningen, The Netherlands, who carried out research in the physics department at WSU some years ago.

(continued next page)

Sue Dexheimer and former graduate student co-workers **Fran Morrissey (M.S. 2007)**, **Jason Mance (Ph.D. 2013)**, and **Aaron Van Pelt (M.S. 1999)** published an invited paper, "Femtosecond Dynamics of Exciton Localization: Self-Trapping from the Small to the Large Polaron Limit," in the *Journal of Physics*: *Condensed Matter* special issue on "Ultrafast and Nonlinear Optics in Carbon Nanomaterials." Their work was highlighted in an *Institute of Physics LabTalk* news article called "Ultrafast Dynamics of Polaron Formation," which can be found at http://iopscience.iop.org/0953-8984/labtalk-article/52783. The paper was also selected for inclusion in *IOPselect*, a special collection of journal articles selected by the editors.

Tom Dickinson received a Samuel H. and Patricia W. Smith Teaching and Learning Grant from WSU's University College in the amount of $5000. The citation reads: "Expansion and improvement of questioning and tutoring tools for instruction and assessment in physics incorporating wolfram Mathematica." In conjunction with Tom's grant, we are pleased to announce a new undergraduate topics course, PHYS 481, with the first topic being "Mathematica."

Fred Gittes was selected by the entire membership of the WSU OSA-SPIE Student Chapter to receive the 2012-2013 Outstanding Lecturer Award. To be nominated, a professor had to have taught a class that at least one of the members had taken. The citation reads: "Dr. Gittes blends his passion for physics with his enthusiastic teaching style to inspire, encourage and motivate his students. His excitement is unmistakable as he incorporates demonstrations in classroom lectures enabling students to grasp complex ideas and understand subtle details. His availability outside the classroom, his genuine support of each graduate student, and his ability to offer meaningful insight to students' individual research projects make him an exceptional professor at Washington State University." The presentation was made during the Department of Physics and Astronomy's chair's Annual Appreciation Social in April.

Yi Gu is one of two newly elected members of the American Physical Society (APS) Northwest Section's Executive Committee. The appointment runs for four years. Last year's annual meeting was hosted by Simon Fraser University in Vancouver, BC, in October 2012 - for more information, see the meeting website: http://www.sfu.ca/phys/NWAPS2012/.

Gu's research group published three papers in fall 2012:

- **Elham Mafi, Afsoon Soudi (Ph.D. 2012),** and **Yi Gu,** "Electrically driven amorphization in phase-change In2Se3 nanowires," *Journal of Physical Chemistry C 116*, 22539 (2012)
- **Afsoon Soudi, Cheng-Han Hsu,** and **Yi Gu**,"Diameter-dependent surface photovoltage and surface state density in single semiconductor nanowires," *Nano Letters 12*, 5111 (2012)
- **Cheng-Han Hsu, Qiaoming Wang, Xin Tao,** and **Yi Gu**, "Electrostatics and electrical transport in semiconductor nanowire Schottky diodes," *Applied Physics Letters 101*, 183103 (2012)

Yi Gu and co-PIs **Matthew McCluskey** and Wenguang Zhu (University of Tennessee) received a National Science Foundation (NSF) Focused Research Group grant totaling $609,981 for three years. This grant supports research, both experimental and theoretical, on phase-change memory materials. Specifically, Gu et al. will study the thermodynamics and kinetics of phase transformations as well as the electrical properties of these nanomaterials. The acquired knowledge will provide the fundamental basis for the development of next-generation memory devices that are faster, more reliable, and have larger capacity than current technologies (e.g. Flash memory). See article, page 2.

Mark Kuzyk is now a Fellow of the American Physical Society. His citation reads: "For outstanding contributions to the development of an understanding of the origins of the nonlinear optical response and applying this understanding to the development of novel nonlinear optical materials." Mark is also a fellow of the International Society of Optics and Photonics (SPIE) and the Optical Society of America (OSA). For a list of all our "fellows" and other faculty awards, please visit http://www.physics.wsu.edu/Spotlight/index.html

Kelvin Lynn was one of five Washington State University scientists elected last fall to the Washington State Academy of Sciences. The organization was established to offer policymakers advice on science-related issues. Read about the Academy and its members at http://www.washacad.org/

Phil Marston is an appointed Optical Society of America (OSA) senior member. According to the OSA website, "members are well-established individuals with a designation that recognizes their experience and professional accomplishments or service within their field that sets them apart from their peers. Senior Members have at least 10 years of significant professional experience and are active OSA Individual Members." More information can be found at http://www.osa.org/membership/member _categories/senior/2011_OSA_Senior_Members.aspx

Phil Marston and his group have had considerable press regarding acoustic beams: in *Physics Today* (June 2012) and more recently in the Search and Discovery section of *Physics Today [66(4), 20 (2013).* Marston was able to use Bessel beams (nonscattering light) to both trap particles - "optical tweezing" - and force them to move backward toward the beam's source (for more, see http://www.physicstoday.org/resource/1/phtoad/v66/i4/p20_s1?ver=pdfcov). Further coverage can be found here: http://physicsworld.com/cws/article/news/2013/jan/24/optical-tractor-beam-sorts-tiny-particles. An article on Marston's work appears in this edition of *Physics Matters*. The analysis of forces on particles in beams was extended by **Likun Zhang (advisor: Marston)** in his 2012 PhD dissertation.

The article "Nitrogen is a deep acceptor in ZnO," by **Marianne Tarun**, **M. Zafar Iqbal,** and **Matthew McCluskey,** was the most cited *AIP Advances* article of 2012. For more information, see http://aipadvances.aip.org/resource/1/aaidbi/v1/i2/p022105_s1

David B. Thiessen and Jorge A. Bernate (Stanford University) have a video of WSU physics capillary experiments that were presented at the November 2012 American Physical Society (APS) – Division of Fluid Dynamics (DFD) meeting. The DFD's website says, "The Division…exists for the advancement and diffusion of the physics of fluids with special emphasis on the dynamical theories of the liquid, plastic, and gaseous states of matter under all conditions of temperature and pressure." (For more, see http://www.aps.org/units/dfd/.) The video can be found at http://www.aps.org/units/dfd/pressroom/videos/2012.cfm; more information can be found at http://arxiv.org/abs/1210.4100)

PROMOTIONS

Nicholas Cerruti
from Instructor to Senior Instructor

Michael Forbes
Assistant Professor (new to the department)

Fred Gittes
from Clinical Associate Professor to Clinical Professor

Yi Gu
from Assistant Professor - granted tenure and promotion to Associate Professor

The College of Arts and Sciences held its first annual Appreciation and Recognition Social on April 23, 2013, in the CUB Senior Ballroom. Two of our faculty were honored for their service to the University:

Tom Dickinson (right, above) received the first College of Arts and Sciences Faculty Recognition Award for Outstanding Career Achievement in Scholarship/Creative Activities.

Yogendra Gupta (right) received the first College of Arts and Sciences Faculty Recognition Award for Distinguished Faculty.

Defying Gravity

Zero-G experiments in phase separation

The enormous jet thunders upward into the wide Texas sky, tilting at a nearly 45-degree angle. The noise in the cabin is deafening – no one can really speak, or even turn their heads to look around them, as the plane approaches 36,000 feet. Ten more seconds...then five...then....

Everything seems to happen in slow motion as the plane begins to level out. People begin to rise from their places...and float towards the ceiling.

Welcome to the G-Force One, a Boeing 727 jet with a stripped-down, padded interior that takes passengers on a wild ride, alternating between nearly 2 G (twice Earth's gravitational force) and zero G. The plane is operated by the Zero G Corporation, whose website (www.gozerog.com) describes the process: flying in giant parabolas, or "hill-and-valley" arc patterns: up, down, up, down, across a stretch of sky approximately 10 miles long. As the plane goes up and over the top of each parabola, those inside experience the weightlessness of outer space for approximately 30 seconds, only to return to a crushing 1.8 G as the plane rushes downward and then into the next climb. (Flights are available to the general public for a hefty sum of nearly $5,000.)

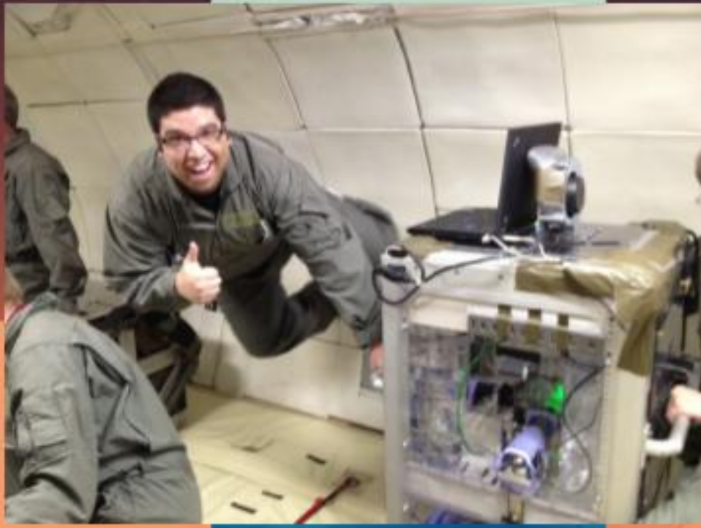
In addition to the public, G-Force One serves the scientific community, helping researchers do experiments that can only be carried out in zero-G environments. Maverick Terrazas and Dr. David Thiessen of Washington State University recently went up on a pair of parabolic flights out of Johnson Space Center in Houston, Texas, to perform experiments involving separating fluids in a zero-G environment. They hope to demonstrate a way to separate water from air without assistance from gravity, a technological leap that would allow engineers to use highly-efficient Rankine-cycle power plants in spacecraft and thus provide less-expensive, improved systems such as life support to those spacecraft.

Separating fluids without gravity is complicated. Oil and water, for instance, separate because they have different densities – the denser fluid (water) is heavier and sinks, while the less dense fluid (oil) floats. Without gravity, there is no weight to speak of, so the oil and water mix freely, and must be separated by alternative means. Terrazas and Thiessen separated water and air in zero-G using a property of various fluids called "capillary action": the tendency of fluids to move along solid structures such as a wire. (A commonly-seen example is a water droplet appearing to defy gravity by moving along the underside of a curved faucet.)

Article by Sabrina Zearott, Department of Physics & Astronomy Staff Writer

Terrazas and Thiessen set up a closed chamber containing a set of springs connected to a water reservoir, then filled the springs with water set at a pressure lower than the air around it. Once in zero-G, the researchers flowed air and water droplets with pressure higher than that of the water in the springs through the chamber. The water droplets were "caught" on the springs and absorbed into the water reservoir via capillary action; the air remained outside the springs, separating it from the water. The goal of the experiment was to demonstrate that water droplets could be consistently separated from air using capillary action.

Maverick during a
period of weightlessness



While it has great potential, this technology is not easy to test. According to its website, the G-Force One is an ideal place to do zero-G experiments at a fraction of the cost and difficulty of actually going to space. However, it is somewhat challenging to do experiments on a plane that alternately hurtles skyward and ground-ward. There isn't much room for error, either – each period of zero-G lasts about 30 seconds and there is a limited number of parabolas, in this case 40 per flight: not much time to validate the work of more than a year. Terrazas and Thiessen had two flights to gather their data: about 80 parabolas in total, not much time if anything went wrong.

Simply turning on the equipment was difficult enough. The researchers had to deal with the problem of getting to and from their equipment, which was attached to the side of the foam-padded plane to keep it from floating around the cabin. Terrazas says, “I'll never forget how fast the first parabola went. I only had enough time to get up, stabilize myself, run the program, and stop the program.” He and Thiessen had to use foot straps to keep themselves anchored during the short ~30-second bursts of weightlessness; once, Terrazas found himself floating away while handling equipment and had to be pulled back by a crew member.

Communication was also difficult. Terrazas and Thiessen had planned to coordinate their work, but as Terrazas said, due to severe time constraints and the fact that “you can't really hear during the flight,” they decided to work separately once in the air. Factor in computer problems and you have a picture of what scientific work often looks like: planning only goes so far, and things often happen differently during the actual experiment. In Terrazas' case, the computer program did not work as expected once it was in a zero-G environment. Fortunately, he had made several versions of the program in case something like this happened

The experiment was a mixed success – some of the springs did not end up filled with water, so that pressure data is under examination. However, enough data was obtained to allow Terrazas and Thiessen to proceed with their work – they are currently redesigning the system that fills the springs, or “channels,” with water.

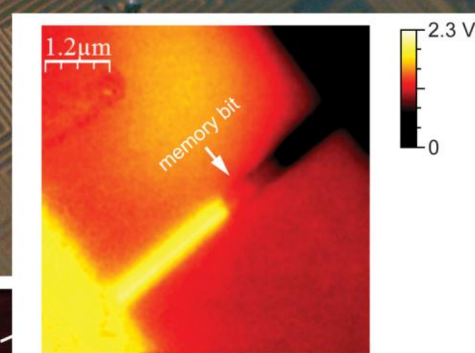
True phase separation – liquid water and steam – is the ultimate goal of the research. Various phase separation technologies are being researched by teams across the country: if achieved, phase separation in zero-G conditions could have multiple consequences for space exploration, among them the abovementioned improved life-support systems and higher-efficiency propulsion technologies. Happily, the research does not require scientists to actually journey into space, which could significantly slow down progress – instead, the zero-gravity environment necessary is just a flight away.

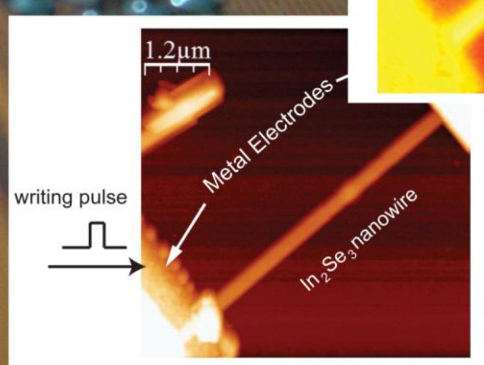
Maverick Terrazas (advisor: Dr. David Thiessen) is a Ph.D. student in physics at Washington State University.

[Nano]wired:
semiconductor technology to the next level

Technology always seems to get smaller, but for Dr. Yi Gu of Washington State University's Department of Physics and Astronomy, "small" is being taken to another level: structures called nanowires, 1000 times thinner than a human hair.

Nanowires are the nanostructure form of the ordinary semiconductors found in electronics. They resemble wires, but at 10 nanometers in diameter, they are vastly smaller (one nanometer is a billionth of a meter). Yet these tiny wires have tremendous potential. In fact, it is their size that gives them properties that their larger counterparts don't have: at the nanoscale, semiconductor materials have significantly improved abilities to conduct electricity, among other things. These properties have made nanowires the subject of a great deal of scrutiny by the scientific community: the technology has the potential to transform industries. (*continued next page*)





Above: atomic force microscope topography image of a prototype In2Se3 nanowire phase-change memory

Left: a map of electrical potential showing the position of a memory bit written by a single voltage pulse

Images courtesy of Dr. Yi Gu

Article by Sabrina Zearott, Department of Physics & Astronomy Staff Writer

One possible application is in the field of solar energy – Gu explained that in solar cells, photons (light) are absorbed and then the energy is deposited into the surrounding material. This addition of energy generates free electrons, which are then transported to a collector and then to circuitry (i.e. converted to electricity). Nanowires can “trap” solar light, thereby increasing absorption, and also provide a much more efficient method of transporting these electrons; consequently, their applications to solar energy production are being “very extensively explored.” In conventional solar cells, the maximum achievable efficiency is 33 percent; nanowires technology has already pushed that number to 40 percent, and this could go even higher with optimized material and device designs.

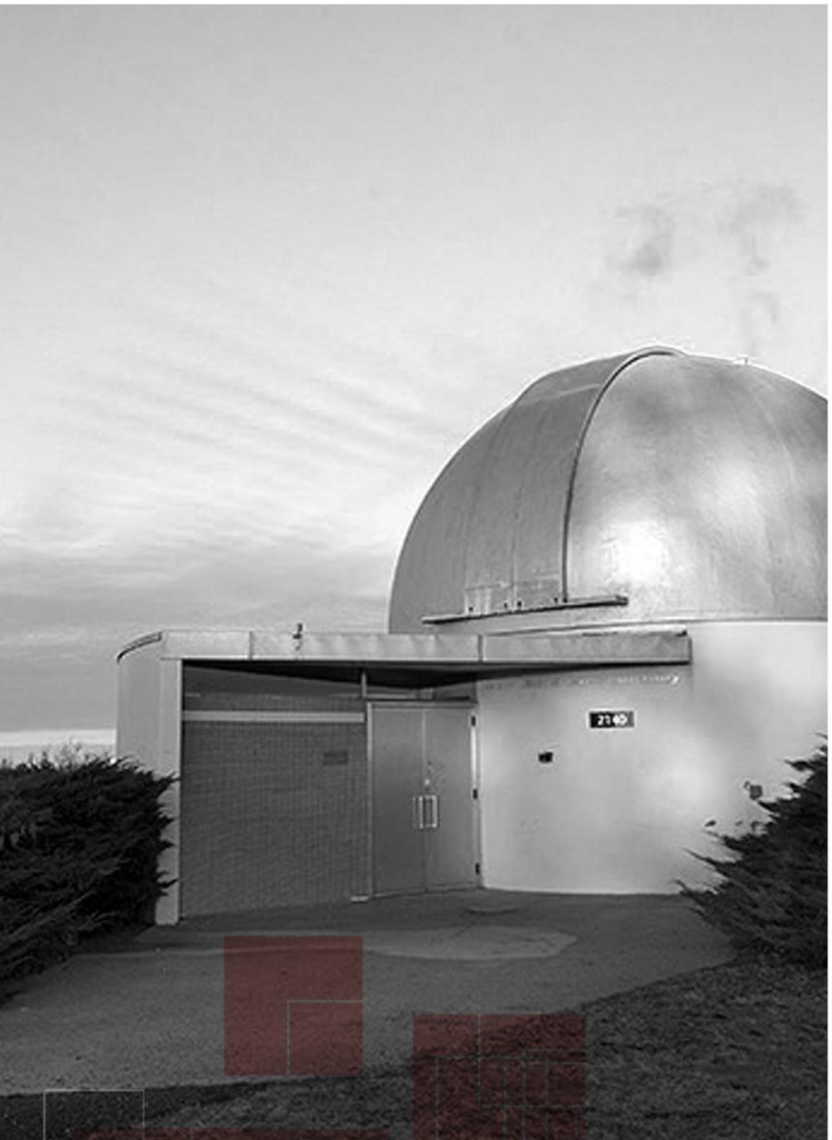
Another significant area of research is in memory storage. Gu and his colleagues, Drs. Matt McCluskey (WSU) and Yanfei Gao (University of Tennessee and Oak Ridge National Laboratory), are being funded by the National Science Foundation (NSF) to investigate the transformations that occur when nanowires are exposed to high temperatures or pressures. These transformations may provide a way to store information in a “multilevel memory” format: multiple states (≥3) can exist, rather than the standard 0-or-1 binary system used by today’s computer electronics, since the information is stored in a material’s structure rather than via electrons. Not only do nanowire-based memory systems use less energy to “write” information on storage devices, with much greater storage density, they are also more reliable, so information can be stored for far longer.

Of course, working with something over a thousand times smaller than a human hair is not simple. Gu and his colleagues use multiple scanning probe microscopy techniques to – along with numerical simulations – directly observe and study the electron transport process. Another important aspect is discovering any mechanisms that might limit electron transport – Gu has found that surface effects (where electrons are trapped while being conducted) play a major role in semiconductor nanowires. This work is being supported by a prestigious five-year NSF CAREER Award.

In the future, Gu plans to investigate structural phase transitions in two-dimensional layered materials that are only a few atoms thick. These fundamental studies are already producing exciting results: for example, some structural phases that were thought to be unstable at room temperature can persist in these ultra-thin layers, which means that even more states are available for information storage.

Yi Gu earned his master’s degree in materials science and engineering and his Ph.D. in applied physics, both from Columbia University. After postdoctoral research at Northwestern University, Gu joined WSU’s Department of Physics and Astronomy in 2007. For more information, visit Dr. Gu’s faculty page: http://www.physics.wsu.edu/Research/Yi-Gu/Home.html

GOOD NEWS AROUND THE DEPARTMENT: STUDENT NEWS



Elizabeth Bernhardt (advisor: Kuzyk) was awarded a NASA grant in which she plans to do research regarding absorption spectra studies in order to characterize how DV01 (disperse violet 01) interacts with PMMA - Poly(methyl methacrylate), a plastic - to cause self-healing.

Carl Brannen (advisor: Bose) gave a talk at LIGO Hanford last fall on some applications of field programmable gate arrays in physics.

Thilina Dayanga (advisor: Bose) gave an invited talk at the Kavli Institute for Theoretical Physics at the University of California–Santa Barbara, on “Rattle and Shine: Gravitational Wave and Electromagnetic Studies of Compact Binary Mergers.” He presented research on binary black hole searches in LIGO and Virgo data. Thilina plans to defend his doctorate in the fall and then assume a postdoc position at Rhodes University in South Africa, where he will work on strengthening the collaboration between numerical relativity experts who model signals from black hole mergers and gravitational wave data analysis groups that search for those signals. For more information, see http://www.kavlifoundation.org/institutes

Shaon Ghosh (advisor: Bose) attended a workshop on gravitational wave astronomy at the Inter University Centre for Astronomy and Astrophysics (Pune, India), where he discussed his work on searching for gravitational-wave counterparts of short hard gamma-ray bursts. Shaon has accepted a postdoctoral offer from Radboud University, The Netherlands, to explore the integration of information provided jointly by gravitational-wave detectors and electromagnetic observatories and thereby enrich our understanding of compact astrophysical objects and their host galaxies. Shaon successfully defended his Ph.D. this summer.

Zhaozhe (David) Li (advisor: Miller) was the recipient of a Leon and Barbara Radziemski Graduate Fellowship from the WSU College of Arts and Sciences. David was one of two students this year to receive the award and summer stipend of $2,000.

Fatemeh Hossein Nouri (advisor: Duez) gave a talk at the April 2013 American Physical Society (APS) meeting in Denver, Colorado, titled "General Relativistic Simulations of Magnetized Plasmas around Black Holes." In addition, she was selected by the WSU OSA-SPIE Student Chapter officers to receive the 2012-2013 Distinguished Member award for "Outstanding Service and Dedication to the Chapter." The citation reads: "*For three consecutive years, Fatemeh has independently organized and ensured the successful operations of the OSA-SPIE Graduate Student Lecture program. Always acting in the absence of direction from the OSA officers, Fatemeh gave her time and energy to help enrich the physics student body. She is a credit to herself, the physics department, and Washington State University*." Fatemeh received the award during the chair's Annual Appreciation Social, held on April 26, 2013.

Debraj Rakshit (advisor: Blume) accepted a postdoc fellowship at the Quantum Information and Computation (QIC) group, Harish-Chandra Research Institute (HRI), in India. He earned his Ph.D. in summer 2012.

Shoresh Shafei (advisor: Kuzyk) received the 2012 President's Award for Leadership at WSU. He also received a 2012 International Society for Optics and Photonics (SPIE) scholarship for "potential contributions" in photonics, optics, and related areas. Under the supervision of **Mark Kuzyk** and in collaboration with Dr. **Rick Lytel**, Shoresh is working on the nonlinear optical properties of nanoscale quantum graphs as the molecules for future optical device materials. His work on the theory of fundamental limits was highlighted in the Optical Society of America (OSA)'s Spotlight on Optics. Shoresh successfully defended his Ph.D. this summer for a December 2013 graduation.

Shoresh and fellow graduate student **Sean Mossman** wrote a short article, dedicated to **Mark Kuzyk**, called "How to Find the Right Advisor." It was published on the Optical Society of America's Optics & Photonics News (OSA-OPN) *Bright Futures* blog. The post can be found here: http://blogs.osa-opn.org/BrightFuturesBlog/post/How-to-Find-the-Right-Advisor.aspx

Yangqian Yan (advisor: Blume) was a visiting student at the Institute for Theoretical Atomic, Molecular and Optical Physics (ITAMP) for the month of March 2013.

Xiangyu (Desmond) Yin (advisor: Blume) spent November 2012 as a visitor at ITAMP. He attended the conference "Few-Body Physics in Cold Atomic Gases," held April 11-14, 2013, in Beijing, China.

GRADUATE STUDENT PUBLICATIONS

Daily, Kevin. M. (Ph.D. 2012, advisor: Blume), Rakshit, D., & Blume, D. (2012). Degeneracies in trapped two-component Fermi gases. *Phys. Rev. Lett., 109*, 030401. Selected as an Editor's Suggestion.

Francois Foucart, **M. Brett Deaton, Matthew D. Duez**, Lawrence E. Kidder, Ilana MacDonald, Christian D. Ott, Harald P. Pfeiffer, Mark A. Scheel, Bela Szilagyi, Saul A. Teukolsky: Black hole-neutron star mergers at realistic mass ratios: Equation of state and spin orientation effects. *Phys. Rev. D, 87*, 084006 (2013). See http://prd.aps.org/abstract/PRD/v87/i8/e084006.

Gharashi, S. Ebrahim., Daily, K. M., & Blume, D. (2012). Three s-wave interacting fermions under anisotropic harmonic confinement: Transition from three-dimensional to effectively one-dimensional and two-dimensional dynamics. *Phys. Rev. A, 86*, 042702.

Rakshit, D., & Blume, D. (2012). Hyperspherical explicitly correlated Gaussian approach for few-body systems with finite angular momentum. *Physical Review A, 86*, 062513.

DEGREES EARNED

Summer 2012

Grant Eastland (Marston)	Ph.D.
Randal Newhouse (Collins)	Ph.D.
Shiva Ramini (Kuzyk)	Ph.D.
Dipongkar Talukder (Bose)	Ph.D.
Samuel Teklemichael (McCluskey)	Ph.D.

Fall 2012

Kevin Daily (Blume)	Ph.D.
Jharana Dhal (Bandyopadhyay)	Ph.D.
Narendra Parmar (Lynn)	Ph.D.
Afsoon Soudi (Gu)	Ph.D.
Christopher Varney (Selim)	Ph.D.
Khalid Emshadi (McCluskey)	M.S.
Szymon Steplewski (Bose)	M.S.
Ivan Bower	B.S.
Katrina Higa	B.S.
Aaron Kunkle	B.S.

Spring 2013

Jason Mance (Dexheimer)	Ph.D.
Debraj Rakshit (Blume)	Ph.D.
Fatema Abobaker (Vincent)	M.S.
Justin Eld (Worthey)	M.S.
Aaron Gunderson (Gupta)	M.S.
Michele Moore (Wisor)	M.S.
Fatemeh Hossein Nouri (Duez)	M.S.
Anya Rasmussen (McCluskey)	M.S.
William Buck	B.S.
Kristopher Cote	B.S.
Ethan Crowell	B.S.
Jenna DeWald (née DeGreef)	B.S.
Catherine Erickson	B.S.
Lauren Laxton	B.S.
Ryan Stewart	B.S.
Geoffrey Tanay	B.S.

Summer 2013

JiaJia Chang (Engels)	Ph.D.
Liyanagamage (Ranga) Dias (Yoo)	Ph.D.
Charles David Bergman (Kuzyk)	M.S.
Tong Wan (Allen)	M.S.
Bianca Danilet	B.S.

UNDERGRADUATE STUDENTS

Bernard Hall was the recipient of a $3000 WSU College of Arts and Sciences Undergraduate Summer 2013 Minigrant.

Jenna DeWald (née DeGreef) was named a 2013 WSU College of Arts and Sciences Outstanding Senior. According to the College of Arts and Sciences website, this award is given to an individual who has “excelled in academic performance and in service to their school or department and the university community. Awardees are selected by their department faculty and chairs.”

Molly Wakeling led one of the key workshops and was the keynote speaker this spring for “Expanding Your Horizons,” an annual Girl Scouts of America event held in Lewiston, Idaho. This event helps teach girls in the 6th-9th grades about how exciting and fun STEM (Science, Technology, Engineering, and Math) fields can be. Molly says there is a big push to get girls into STEM fields, and the Girl Scouts is making a big effort towards this goal.

HELPING THE NEXT GENERATION

Two of our alumni know that you’re never too young to help the next generation of students.

Bobbie Riley (B.S. 2009) and **Kevin Daily (Ph.D. 2012)** recently donated two HP Z220 workstations and two 22” monitors to the Department of Physics & Astronomy. The equipment is something from which Bobbie and Kevin felt they could have benefited during their time as students here, and they hope to do a second donation next fall based on student feedback. Bobbie said, “I feel it is important to emphasize that donating back to your university doesn’t have to wait until you retire....Showing our peers that people their age are giving back so soon after leaving might encourage them to do the same, improving the department even further.” The department sincerely thanks Bobbie and Kevin for their thoughtful and generous gifts.

Optical Society of America - OSA/SPIE Student Chapter

The Washington State University OSA-SPIE Student Chapter was established in January 2011. It has evolved into a strong academic and professional development program for its members. In fall 2012, the chapter invited a prestigious visiting lecturer for a meet-and-greet luncheon and dinner at which members learned about the speaker's optics research. The event allowed students the opportunity to interact with the speaker in a relaxed atmosphere.

One of the most successful activities thus far has been the chapter's Graduate Lecturer Program, which allows students to present current work to their peers in a non-stressful format. The lunchtime presentations help the student presenters prepare for future public speaking events, practice question-and-answer sessions, and gain self-confidence. Additionally, the chapter provides social events for its members. Since its inception, it has hosted activities such as the "Welcome Back Picnic" for all new and returning physics and astronomy students. Future activities may include taking a professional development trip to tour corporations such as FEI, Paradigm Optics, and Intel. The chapter also hopes to include an outreach program for a K-12 audience.

OSA-SPIE STUDENT OFFICERS

2012-2013	2013-2014
President: Kasey Lund	President: Anya Rasmussen
Vice President: Michele Moore	Vice President: Josef Felver
Secretary: Anya Rasmussen	Secretary: Elizabeth Bernhardt
Treasurer: Samaneh Tabatabaei	Treasurer: Sean Mossman

College of Arts and Sciences "Golden Grads Luncheon," April 24, 2013

Top: Dr. **Larry Kirkpatrick** (left) and Dr. **Paul Spencer** (right), recipients of bachelor's degrees in physics in 1963.

Bottom: WSU Faculty Emeritus **Edward E. Donaldson** received his doctorate in physics at Washington State College in 1953. His advisor was Paul A. Anderson. Ed was chair of the Physics Department from 1980-1984. He and **Tom Dickinson** (not shown) represented the department at this year's luncheon.

The tractor beam has arrived

By Eric Sorensen, WSU science writer. Reproduced from **Washington State Magazine** ***(fall 2013, pp. 8-9)*** **with permission of the author.** ***© 2013*** **WSM.** ***Images courtesy of Dr. Phil Marston.***

Phil Marston is not a Trekkie, nor has he given much thought to the *Star Trek* tractor beam that can use focused beams of energy to attract and repel derelict spacecraft or, in one case, *USS Enterprise* Capt. James T. Kirk. He was just intrigued by something, in this case, the way an acoustic beam is scattered by a sphere.

"Basically, it goes into the category of a problem you solve because it would be curious to see what the answer is and whether there is something there that you didn't anticipate," he says. "That was true."

Moreover, in the serpentine path from abstract musing to basic science to demonstrated phenomenon, the WSU physicist sowed the seeds for a small-scale but real-life tractor beam that could have applications in both nanotechnology and medicine.

In his original inquiry, published in 2006, Marston noticed that when he plotted the forces of a beam of sound around a sphere, certain places on a graph would have negative force. In other words, the beam was acting on an object in such a way that it would attract it, not repel it. If a lot of sound was being scattered back from an object, it would be pushed forward. However, he reasoned, if no sound was scattered back, there was some chance the object could be pulled toward the source.

He had pondered this for another four years or so when researchers in Hong Kong moved his thinking along. Where Marston had used math and sound, they used a geometric diagram and light canted at different axes, creating a sort of cone. By coming in at different angles, the light—which behaves similarly to sound for experimental purposes—had different total forces. In their case, the angles were such that their total forces could in effect be a pulling, negative force.

Earlier this year, a team of Czech and Scottish researchers focused two laser beams with a lens in a way that let them control the light's polarization. To explain this, Marston produces from his cluttered shelves a heavily bookmarked copy of James Clerk Maxwell's *Treatise on Electricity and Magnetism*. "I bought this book in a bookstore in downtown Seattle in the 1960s," Marston says. He spends a few minutes riffling for what he calls "the most important picture in theoretical physics from the nineteenth century," then brings the diagram up on his laptop.

According to Maxwell, when an electromagnetic wave is propagated in space, the electric and magnetic fields are perpendicular to each other. Light, he theorized, would behave similarly. The Czech and Scottish researchers went beyond theory, building an apparatus in which they could rotate the electric field in a way that the objects they were working with—polystyrene particles as small as 400 nanometers, or less than 1/1,000th of a millimeter—could be drawn toward the light source. David Grier, a New York University physicist who has also worked on tractor beams, told *Physics World*: "This really is a clean demonstration of Marston's principle in action."

It's still a far cry from the *Enterprise's* tractor beam, as the Czech and Scottish researchers were working with small objects and similarly small forces, says Marston. "It turns out they don't care," he says, "because they're less interested in attracting people"—or spaceships. "They're interested in tracking biological cells or small objects you would like to assemble in some controlled way," he says.

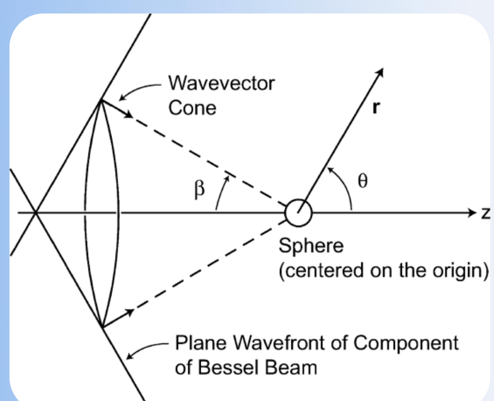


Figure for a situation that can produce negative forces. From P. L. Marston, "Axial radiation force of a Bessel beam on a sphere and direction reversal of the force," *J. Acoust. Soc. Am.* 120, 3518-3524 (2006).

Philip Marston earned his M.S. in electrical engineering and Ph.D. in physics from Stanford University. His research interests include scattering and radiation forces.

Background image: diagram from Maxwell's 1873 work, A Treatise on Electricity and Magnetism.

From Solvent to Superconductor

Yoo

Dias

This article by **Eric Sorensen**, WSU science writer, appeared in *WSU News* on Monday, July 1, 2013, and is reprinted with author's permission. © 2013 WSU. (Original title: "Researchers create superconductor from solvent.")

A study led by Washington State University researchers has turned a fairly common nonmetallic solvent into a superconductor capable of transmitting electrical current with none of the resistance seen in conventional conductors. "It is an important discovery that will attract a lot of attention from many scientific communities - physics, chemistry and materials science," said Choong-Shik Yoo, a professor in chemistry and in the Institute for Shock Physics. The National Science Foundation-funded discovery, which grows out of research by Yoo doctoral student Ranga Dias, appears in the Proceedings of the National Academy of Sciences.

The field of superconductivity has a wide variety of potentially revolutionary applications, including powerful electromagnets, vehicle propulsion, power storage and vastly more efficient power transmission. Three years ago, Yoo used super-high pressures similar to those found deep in the Earth to turn a white crystal into a "super battery," or what he called "the most condensed form of energy storage outside of nuclear energy." This time, Yoo saw how carbon disulfide subjected to high pressure and cold started to act like a metal, taking on properties like magnetism, high-energy density and super-hardness as its molecules reassembled in three-dimensional structures like those found in diamonds.

Typically, nonmetallic molecules are too far apart from each other - three times farther apart than metal molecules - for electrical energy to move across them. But Yoo and his colleagues, including researchers at the Carnegie Institution of Washington, compressed the compound in the small space of a diamond anvil cell to 50,000 atmospheres - a pressure equivalent to that found 600 miles into the Earth. They also chilled the compound to 6.5 degrees Kelvin, or nearly -447 F. The pressure and temperature not only brought the carbon disulfide molecules together but rearranged them into a lattice structure in which the natural vibrations of the molecules help electrons move so well that the material becomes a resistance-free superconductor.

The research provides new insight into how superconductivity works in unconventional materials, an area that has intrigued scientists for several decades, Yoo said. These unconventional materials are typically made of atoms with lower atomic weights that let them vibrate at higher frequencies, increasing their potential as superconductors at higher temperatures.

Yoo acknowledged that electronic materials are not about to be cooled to near absolute zero or subjected to extreme pressures. But he said this work could point the way to creating similar properties under more ordinary conditions, much as science paved the way to make synthetic diamonds at lower temperatures and pressures. "This research will provide the vehicle for people to be clever in developing superconductors by understanding the fundamentals that guide them," said Yoo.

Read the article: www.pnas.org/content/early/2013/06/26/1305129110.full.pdf+html?sid=d8803c43-100f-4968-bf89-fe51368cd0e3

Pearl Harbor Day

The Bands' Journey Through China Remembered

Friday, December 7, 2011, marked the 70th anniversary of the bombing of Pearl Harbor. The Japanese attack brought the United States of America into World War II. As a direct result of that event, one of our former faculty members, Dr. **William Band** (professor of physics, 1949-1971, and physics department chair, 1962-1966), and his wife, Claire May Band, began a walk through the interior of China that lasted for two years.

In 1927, Dr. Band took a position as lecturer at Yenching University in Beijing, China, where he later served as assistant professor and department chair until December 7, 1941. Pearl Harbor changed his life in a significant way: the occupying Japanese army in China began rounding up Americans in Beijing and imprisoning them in internment camps. For the next two years Dr. Band and his wife lived in the forests and mountainous regions of China, where they survived a "harrowing" situation.

Eventually they made their way to the city of Chunking, where Dr. Band worked as the science representative in the British embassy's Liaison Office until January 1945. After leaving China, he worked as a research associate at the Institute for Metals and was a fellow at the Institute for Nuclear Studies at the University of Chicago. In 1949, Dr. Band became a professor at Washington State University.

This article was written in 2011 but did not appear in our previous version of Physics Matters.

Dr. Band (right) with Dr. Edward E. Donaldson.

Friends of Physics & Astronomy

Silver Laureates
(Lifetime gifts of $1,000,000 - $4,999,999)
*Claire May Band
*William Band
Battelle
M.J. Murdock Charitable Trust

Benefactors
(Lifetime gifts of $100,000 to $499,999)
*Neva Abelson
*Philip Abelson
Hewlett Packard Company
Laurie Johnson and Dawn Smith
Robert La Porte
Dean Millsap
Robert Nilan and Betty Clark-Nilan
*Winona Nilan
SGI

Silver Associates
(Annual gifts of $5,000 - $9,999)
Dale and Leila Martin

President's Associates
(Annual gifts of $2,500 - $4,999)
June Bills
Eugene and Margaret Burke
Richard and Annette Gordon
Dean Millsap

Bryan Society
(Annual gifts of $1,000 - $2,499)
James Anderson and Shirine Boulos Anderson
John Anderson
Richard Casper
Daniel Michael
Schwab Fund for Charitable Giving
Paul Swinehart

**deceased*

Tower Club
(Annual gifts of $500 - $999)
Cleo and Gary Bennett
Burton and Karen Berringer
Miles and Muriel Dresser
Scott and Judy Jones
Chelcie and Katherine Liu
Bryan Morgan
L. Stephen and Cherri Price

Sustaining Donors
(Annual gifts of $1 - $499)
Warren and Lynn Brown
Alexandra Danilet
David DeBruyne
Dale Doering and Toyoko Tsukuda
James and Carmela Estes
Daniel and Sandra Fisher
Marc Fleisher
John and Patricia Gould
Douglas Habib and Rebecca Dueben
Larry and Karen Kirkpatrick
Lawrence and Brigid Larson
Richard and Madelon Lindsay
Gary and Paula Lucas
David and Patricia McDaniels
Gregory and Kathlene McGhee
Palouse Astronomical Society
Warren and Bernice Quinn
Carl and Wendy Rosenkilde
Robert Sharp
Melissa Skala and Matthew Phelps
Paul Spencer and Susan Daniels
Grant and Karen Thorsett
United Way Silicon Valley
Theodore Watanabe
Western Digital
Kevin and Jerri Williams
Perry and Gerda Wilson
Guy and Diane Worthey

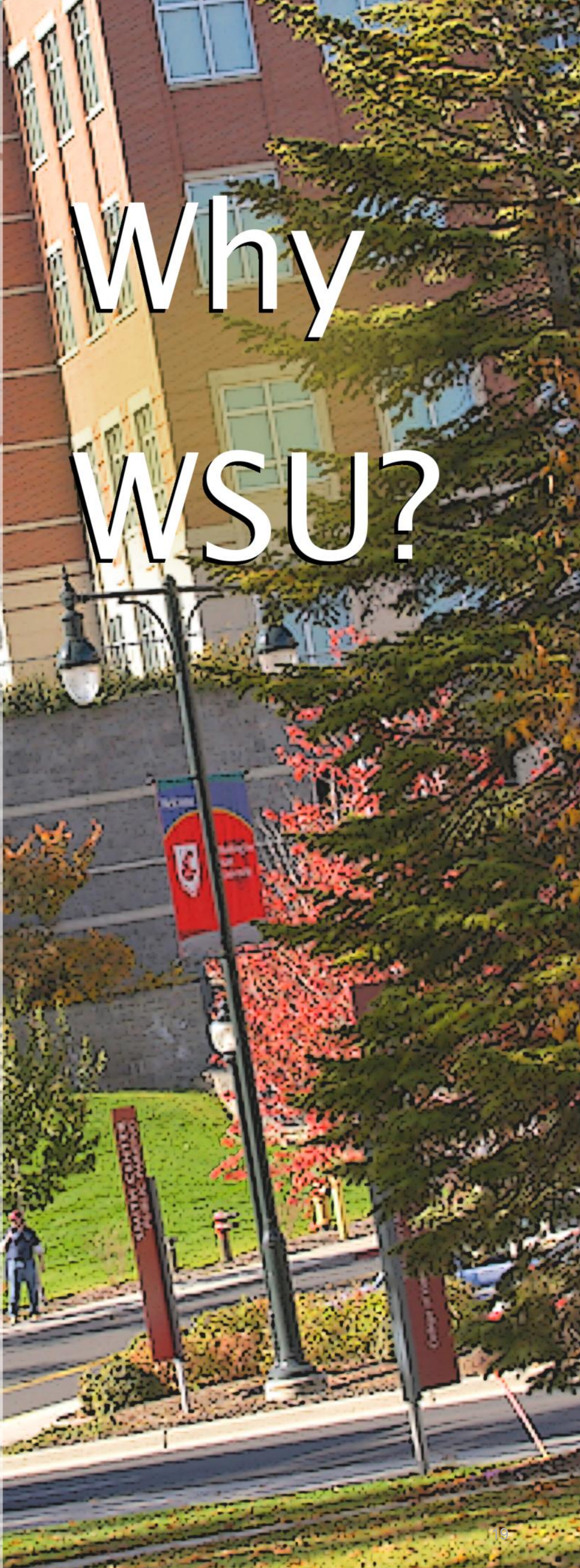
On behalf of the students and faculty who benefit from your gifts, we send all our donors a sincere thank you: your generosity helps open doors to worlds of opportunity.

Support Science!

The Department of Physics and Astronomy is grateful for the generosity of alumni who help support and sustain a large group of talented and hard-working faculty and students. Making a gift to one of our scholarships helps create a positive difference in a student's life, and it is an excellent way to give back to the discipline that you love.

Scholarships are coordinated through the department; questions about the process can be directed to Sabreen Yamini Dodson at physics@wsu.edu or (509) 335-9532.

Why WSU?



Set among a patchwork sea of gorgeous fields that changes colors throughout the year, with easy access to spectacular vistas and a variety of outdoor activities, the small city of Pullman, Washington, is home to a wealth of exciting programs for our undergraduate and graduate students.

Along with our annual field trip to LIGO (Hanford, Washington) and our weekly teas and colloquia, Washington State University's Department of Physics and Astronomy offers casual, fun-filled events: our tremendously popular twelve-story Pumpkin Drop during Dad's Weekend, Solid State Ski Day in early spring, and weekly departmental ice hockey matches throughout the winter. WSU is less than 10 miles from the University of Idaho (located in neighboring Moscow, Idaho), adding a rich, culturally vibrant community element to one of the most beautiful natural settings in the United States. We should add that you can see the Milky Way from your backyard.

Contact our department:

(509) 335-9532

physics@wsu.edu

Department of Physics & Astronomy
PO Box 642814
Pullman, WA 99164-2814

Melissa Skala

B.S. Physics 2002

Melissa Skala has been very busy since earning her bachelor's degree from WSU in 2002. In 2004, she received a master's in biomedical engineering from the University of Wisconsin – Madison, and three years later she earned her doctorate at Duke University, where she continued as a postdoc for another three years. Since 2010, she has been an assistant professor of biomedical engineering at Vanderbilt University.

Melissa's research interests are with the interface of engineering and cancer research, with a focus on optical sensing of therapeutic response in tumors. Optical imaging technologies have been developed to sense the metabolic state of tumor cells, which provides a sensitive indicator of early drug response. This technology has the potential to define optimal treatment strategies before treatment is actually given to a patient, and to greatly accelerate the availability of new cancer drugs to patients.

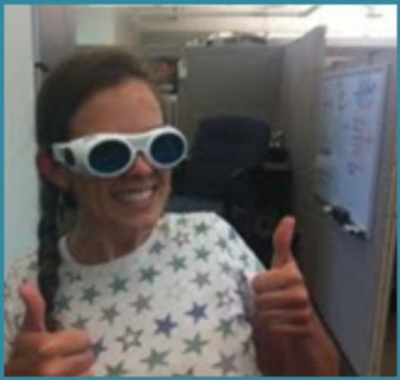
Her work has been solicited for numerous invited presentations in the US and abroad, and has been supported by the National Institutes of Health, the Department of Defense, and the American Heart Association.

Spotlight: Women in Science

When **Emily Cragerud** decided to take time off after completing her undergraduate degree in 2009, it seemed nearly impossible to find a job in optics: "I searched for a long time after graduating, and while there were plenty of engineering jobs out there, there weren't many that were hiring people without the 'engineering' in their degree."

That didn't stop her, however. She decided to start "at the very bottom and [work] my way up." Emily found an entry-level operator position at nLight, a company that, according to its website, "deliver[s] world-class performance in high-power semiconductor lasers" (http://www.nlight.net/). Her hard work is paying off, with slow but steady upward progress: "Last I wrote...I was in an engineering tech position. Since then, I've been given another promotion and have joined the newly-formed (and still being built) kW fiber laser team as a Fiber Laser Engineer (finally!). It's extremely fascinating stuff...."

In addition to her regular duties, Emily works as an AP calculus tutor at nConnect, a student tutoring/mentoring program co-founded by nLight CEO Scott Keeney. As a result, she was recently asked to speak at a fundraiser with Washington State Senator Patty Murray. It was a bit "nerve-wracking, but exciting."



Emily Cragerud

B.S. Physics 2009

Blast from the Past

Physics & Astronomy Alumni

W. Patrick Arnott (Ph.D. 1988, Marston) is a faculty member in the physics department at the University of Nevada at Reno (UN–Reno). Dr. Arnott recently shared his group's research with Dr. Phil Marston, which includes "actively measuring aerosol optical properties, *in situ* with our photoacoustic instruments, but now also with remote sensing using ground based sun photometers and radiometers as well as satellite remote sensing." Dr. Arnott says that the research contains a lot of physical content, which is well suited for both student projects and an instrumentation class at UN-Reno.

Collin Atherton (B.S. 2010) is one of four team members at Minapsys Software Corporation, a startup that focuses on productivity software that provides a "new and innovative communication and collaboration tool." Collin is the team's software engineer and operations leader and works along with fellow WSU alumnus **Aaron Colby (B.S. 2009)**, the team's software engineer. Prior to joining Minapsys, Collin held an internship at Seattle-based social media startup Lockerz. He also worked as an engineer for the Redmond, Washington-based optics companies Laser Guidance and Stellar Photonics, where he designed aviation optics and researched non-lethal laser weapons. (In his free time, he studied for and passed the Chartered Financial Analyst exam I, as well as heavily studying computer science.)

Regina Barber DeGraaff (Ph.D. 2011, Blakeslee) is currently an instructor of both physics and mathematics at Bellevue College. However, she recently informed us that she plans to return to her alma mater, Western Washington University (Bellevue, Washington), as a lecturer this fall.

Kevin Daily (Ph.D. 2012, Blume) is a postdoc with Chris Greene at Purdue University.

Nathan Dawson (Ph.D. 2010, Kuzyk) is starting a position as a post-doctoral researcher in Dr. Kenneth Singer's organic optoelectrics lab at Case Western Reserve University. Nathan is "currently working on columnar liquid crystals and self-assembled fibers for organic photovoltaic applications."

Grant Eastland (Ph.D. 2012, Marston) is a contract scientist for Frank Orth & Associates working for NOAA's NW Fisheries Science Center in Seattle as a Physics Research Scientist II. He works on image analysis and determining material properties utilizing acoustical methods.

Aubrey España (Ph.D. 2009, Marston) was a panelist on an Acoustical Society of America webcast (now archived at http://www.aipwebcasting.com). Aubrey, a member of University of Washington's Applied Physics Laboratory, discussed "the detection of unexploded ordnance with acoustics."

Todd Hefner (Ph.D. 2000, Marston), who works for University of Washington's Applied Physics Laboratory, is the recipient of the A. B. Wood Medal. From the Institute of Acoustics (IOA)'s website (http://www.ioa.org.uk/medals-and-awards/): "The A B Wood medal and attendant prize is awarded in alternate years to acousticians based in the UK/Europe and in the USA/Canada. It is aimed at younger researchers whose work is associated with the sea." It is named after Albert Beaumont Wood, who "became one of the first two research scientists at the Admiralty to work on antisubmarine defence. He designed the first directional hydrophone and was well known for the many contributions he made to the science of underwater acoustics and for the help he gave to younger colleagues."

Katherine Hegewisch (Ph.D. 2010, Tomsovic) is currently a postdoctoral researcher for Dr. John Abatzoglou in the Applied Climate Science Lab at the University of Idaho's Department of Geography. Her work includes the statistical downscaling of global climate model (GCM) outputs from the newest generation of the Intergovernmental Panel on Climate Change (IPCC)'s Coupled Model Intercomparison Project (CMIP5). Statistical downscaling is a method of "interpolating" climate outputs from the GCM-provided coarse scale (i.e. 300-500 km) down to a finer scale (4 km), using statistical relationships provided by historical datasets. Katherine is currently working on several different projects providing tailored datasets and advice for those needing climate inputs to their hydrology, vegetation, entomology, drought, or fire models.

Jon La Follett (Ph.D. 2010, Marston) has been working in research and development for Shell Oil in Houston, Texas since 2011. The focus of his current project is on developing fiber optic sensors for use in seismic surveys. This technology can transform any 1-meter subsection of a normal straight optical fiber into a low-frequency microphone. It can be used to detect acoustic signals on fibers several kilometers in length. Jon is also working to develop signal processing techniques for extracting useful information from the vast amounts of data acquired using these dense sensor arrays.

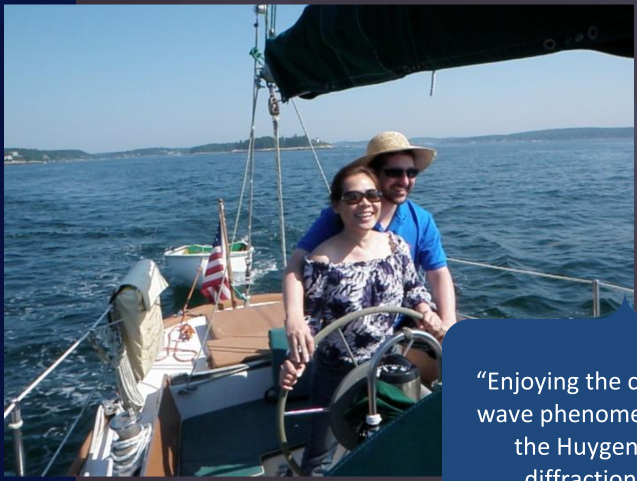
Blast from the Past

Physics & Astronomy Alumni

Dr. **Phil Marston's** son, **Timothy Marston,** is a research scientist at the Naval Surface Warfare Research Center in Panama City, Florida. Timothy received a Meritorious Civilian Service Award for work he did on synthesis aperture sonar (SAR) signal processing. For more information, visit http://www.doncio.navy.mil/chips/ArticleDetails.aspx?ID=4535 - photo and description are in the lower right corner.

Fran Morrissey (M.S. 2003, Dexheimer; Ph.D. 2007, Mat. Sci.) is a laser scientist in the Laser Technology and Applications Group at MIT Lincoln Laboratory, Lexington, Massachusetts. Experimental work focuses on the characterization of multi-kW cw diode pump solid-state cryogenic laser amplifiers and the investigation of novel materials and resonator designs for underwater laser applications. Theoretical work involves the development of new methods for determining higher-order transverse modes of unstable resonators in order to predict the onset of multimode oscillation for design of high power large aperture single transverse mode power oscillators. Fran and his wife Thuy live six miles from downtown Boston and enjoy frequent ski excursions to Maine, Vermont, and New Hampshire, as well as regular attendance at the Foxwoods resort to partake in stochastic modeling. Fran plans to chair the first annual MIT Solid-State Day in 2014.

Below: Fran and his wife Thuy.



"Enjoying the complexity of wave phenomenon beyond the Huygens-Fresnel diffraction integral (destination: Squirrel Island, Maine)"

Curtis Osterhoudt (Ph.D. 2007, Marston) joined the University of Alaska at Anchorage's Department of Physics and Astronomy as an assistant professor. Curtis said that when he first arrived in July 2012, "the sun shone way too much and things were warm and mosquito-y."

Shiva Ramini (Ph.D. 2012, Kuzyk) is a research and development physicist at Wyatt Technology Corporation in Santa Barbara, California. His research team "develops and manufactures analytical instrumentation sold [worldwide] for macro-molecular characterization."

Gunnar Skulason (B.S. 2009) is a researcher at Stanford. He writes: "I am currently designing and characterizing ultrafast pulsed electron sources, as well as examining ways to manipulate electrons for use in a new type of electron microscope. I am enjoying my work here very much and am deeply grateful to Peter Engels for helping me find my position here."

Afsoon Soudi (Ph.D. 2012, Gu) received the Dorothy M. and Earl S. Hoffman Award during the American Vacuum Society (AVS)'s 59th International Symposium and Exhibition in Tampa, Florida (2012). The AVS website states that the award was "established…to recognize and encourage excellence in graduate studies in the sciences and technologies of interest to AVS" (for more, see http://www.avs.org/About/Awards-Recognition/National-Student-Awards/Dorothy-M-and-Earl-S-Hoffman-Award). Afsoon continues to receive awards from WSU even after graduating last December. She earned a 2nd place Rigas Award, one of the Outstanding Graduate Student Awards given by the WSU Association for Faculty Women (AFW). (For more about the Rigas award, visit http://www.wsu.edu/afw/awards/Rigas_Award.html.) Currently, Afsoon is working as a postdoc at the Institut National de la Recherché Scientifique (INRS), which is part of the Université du Quebec network.

Ryan Stewart (B.S. 2013) is currently working as a reactor technician at WSU's Nuclear Radiation Center. In addition to helping maintain the reactor, he irradiates samples requested by various companies; he also uses Genie 2000 software to perform gamma ray spectroscopy and analyzes the resulting data to give a clear picture of the reactor's behavior.

(continued next page)

Blast from the Past

Physics & Astronomy Alumni

Dipongkar Talukder (Ph.D. 2012, Bose) is a postdoc in the High Energy Physics Group, Department of Physics, University of Oregon–Eugene. His dissertation on “Multi-Baseline Searches for Stochastic Sources and Black Hole Ringdown Signals in LIGO-Virgo Data” was selected for honorable mention by the Gravitational Wave International Committee.

Aaron Van Pelt (M.S. 1999, Dexheimer) has held positions at various Bay Area optical technology companies, including New Focus (applications engineer), Physical Sciences Inc. (senior research scientist), and now Picarro, where he is an applications scientist. His current work at Picarro focuses on developing applications of the company's optical cavity ringdown technology in various environmental areas that utilize stable isotope and greenhouse gases measurements. He is also leading efforts with natural gas utilities as they deploy the technology on vehicles for detecting natural gas leaks.

Below: Aaron in Greenland

“Here's a pic of me on the Greenland Ice Sheet at the multi-national NEEM camp, supported by NSF-funded C-130 aircraft, where our customers are studying water isotopes in ice cores and greenhouse gases using our cavity ring down based analyzers.”

Wei Wei (Ph.D. 2005, Marston) has been working at Intel since 2006 as an electronic engineer. Her work includes “developing, documenting and propagating thermal, electrical and reliability test metrologies to improve the test quality on Intel product[s].” She lives in Oregon with her family.

Likun Zhang (Ph.D. 2012, Marston), David B. Thiessen: “Capillary-wave scattering from an infinitesimal barrier and dissipation at dynamic contact lines,” published in the highly selective *Journal of Fluid Mechanics*, *719* (2013), pp. 295-313. The article can be found online at http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=8834766&fulltextType=RA&fileId=S0022112013000050

Weiya Zhang (Ph.D. 2006, Kuzyk) left the University of California–Merced and joined Teledyne Scientific & Imaging in 2011, where he is working as a research scientist in the optics division. His work involves applying cutting-edge optical technologies to solve challenging problems for a broad range of customers, including industrial partners and government agencies such as DARPA and the NSA.

Kirill Zhuravlev (Ph.D. 2004, McCluskey) is currently working as a beamline specialist at Argonne National Laboratory's Advanced Photon Source (Sector 13, GSECARS). In addition to his own research, Kirill helps users with their experiments at the beamline and keeps equipment and systems operating. Sector 13 specializes in geological and geophysical sciences; Kirill's work deals with extreme pressures and temperatures (up to that of the surface of the Sun, 6000 Kelvin, or more than 10,000 degrees Fahrenheit). Additionally, Kirill's work includes using Brillouin spectroscopy (Sector 13 houses the only online Brillouin scattering system) to measure a sample's “density and elastic parameters” and thereby improve scales for measuring high pressure and ruby fluorescence, which Kirill says means advancement in “all high pressure research, not just geologically related.”

WSU Department of Physics & Astronomy
PO Box 642814, Pullman, WA 99164-2814
(509) 335-9532
physics@wsu.edu
www.physics.wsu.edu