College of Science Department of Physics Newsletter

THE SPECTROMETER

SPRING 2017

Physics alumni, faculty, students and research

Oregon State UNIVERSITY

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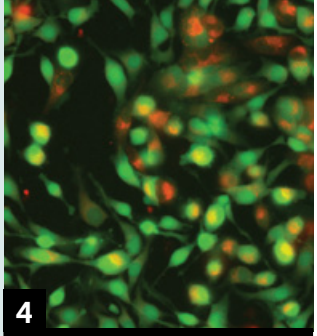

SPECTROMETER

SPRING 2017

OSU
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FROM THE HEAD

After a two-year hiatus, welcome back to our newly designed newsletter!

You may have noticed that I am not Henri Jansen. I'm Heidi Schellman, and in 2015, after 24 years at Northwestern University, I joined Oregon State, drawn to the special nature of this department. This is a place where faculty really care about students and where students become colleagues.

As a new Head, I came in with lots of great ideas for innovation, only to find that the department had been doing most of them for years. My predecessors, Henri Jansen and Ken Krane, have left very big shoes to fill!

Since I arrived, we have three new hires: Astronomy Instructor Kathryn Hadley, Program Assistant Clarissa Amundsen and Assistant Professor Liz Gire. Read about them and the rest of our amazing faculty in this newsletter.

Innovations in physics support the College of Science's five-year strategic plan, launched in 2015, that will continue to define our path to global excellence (read more online: **science.oregonstate.edu/sp**).

With support from the National Science Foundation and others, we launched Paradigms 2.0 last year, a rethink and redesign of the junior year courses that we have taught for 20 years. The major change has been moving two pre-courses to the sophomore year to lighten the load of the intense junior and senior years. (I recently drove three of our students to present their posters at the annual Nuclear Physics Conference in Vancouver, BC. They did homework all nine hours up and nine hours back. They don't complain, but they do need time for research and fun.)

We have continued to expand active learning to introductory courses, from "flipped" classroom techniques to enhanced studio discussions in engineering physics courses. These new methods have increased student confidence and lowered the dropout rate. And our major courses are now so popular that we had to move them into larger classrooms. We are seeking funding to equip them with the technology (and gazillions of white boards) necessary for active learning.

Our outreach efforts to local schools keeps expanding, too. Read more about that and preparations for this summer's Total Solar Eclipse events on page 9.

Please drop me a note about your time at Oregon State. Our students love these stories.

Heidi Schellman, Head, Physics

EVENTS

APRIL 27, 2017

SPRING DISTINGUISHED LECTURE

"Does Diversity Matter in Science," was delivered by Sylvester James Gates, Jr., a Distinguished University Professor of Physics at the University of Maryland.

MAY 2–3, 2017

DISCOVERY DAYS

Two days of hands-on science activities for local elementary schools sponsored by the Colleges of Science and Engineering.

MAY 4, 2017

YUNKER LECTURE

Nigel Lockyer, Director of Fermilab, will speak on campus on "Particle Physics and its relation to Medical Physics."

MAY 8, 2017

SCIENCE PUB

Astronomy instructor Randall Milstein will preview the total eclipse of the sun.

AUGUST 21, 2017

SOLAR ECLIPSE REUNION BASH

All Physics alumni are invited to an eclipse party. Details coming soon.

On the move

Students gain traction with transformative experiences

SOCIETY OF PHYSICS STUDENTS (SPS)

SPS students have been active in outreach and professional development this past year.

First of all, at the annual College of Science fall and spring welcome social mixers, SPS members did physics demonstrations and discussed current research and academic programs, making a positive impact on both incoming physics majors and students in other science departments.

Secondly, in cooperation with Linn-Benton Community College (LBCC) students and faculty, SPS secured funding to send eight Oregon State undergraduates and three LBCC students to the quadrennial Sigma Pi Sigma Congress. Students presented their research, networked with leading researchers in the field and toured scientific facilities around the San Francisco area, including Google X and the Stanford Linear Accelerator. This was a tremendous opportunity for undergraduates to experience a professional conference and discover career opportunities in physics.

Finally, last November SPS hosted an applications workshop to get undergraduates involved in Research Experiences for Undergraduates (REU), internships and scholarship opportunities. Over 20 students enjoyed pizza and coffee at events with hosted faculty speakers. Sujaya Rao (head of undergraduate research at Oregon State) presented on Undergraduate Research Scholarship and the Arts (URSA) and other Oregon State-funded research opportunities; Dr. Randy Milstein from NASA/Oregon Space Grant Consortium (OSGC) talked about NASA/OSGC internships and scholarships; and physics professor Janet Tate discussed professionalism in applications. We also shared REU opportunities and one-on-one advice with first-time applicants to improve their chances for experiential learning at OSU and beyond.

GOLDWATER SCHOLAR AWARD

Gregory "Mirek" Brandt, a physics and mathematics junior, won a 2017 Goldwater Scholarship! He is one of only 240 undergraduates selected across the country for this premier undergraduate STEM award based on academic merit.

UNDERGRADUATE RESEARCH, INNOVATION, SCHOLARSHIP AND CREATIVITY (URISC) AWARDS

The URISC program creates opportunities for students to engage in scholarly and creative activities with our diverse, world-class faculty. It provides resources for students to work with artists, engineers, scientists, public policy specialists, humanists, health experts and a wide range of other professionals. Congratulations to these four award winners of 2016:

Alex Quinn (Ostroverkhova Lab), for his project on using a fungus-derived pigment in optoelectronic devices.

Graham Founds (Ostroverkhova Lab) for his project on using optical tweezers on organic semiconductors.

Ryan Bailey-Crandell (Minot Lab) for his project on nanoelectronic biosensors.

Jeremy Meinke (Qiu Lab) for his project on molecular motors in plant cell-wall synthesis.

POSTER AWARD

Daniel Lin (Sun Lab) was recognized for his outstanding poster on a new line detection algorithm at the 2015 American Physical Society (APS) meeting in San Antonio, Texas.

TRAVEL & CONFERENCES

Undergraduates **Gabe Nowak**, **Tymothy Mangan** and **Evan Peters** each presented posters at the APS Division of Nuclear Physics conference in Vancouver, BC, last October. They did summer internships at Jefferson and Los Alamos National Labs.

GRADUATE STUDENT AWARDS

James Haggerty (Tate Lab) received a Materials Research Society (MRS) poster award at the MRS fall 2016 meeting, and, together with lab partner Bethany Matthews, for a second poster at the Fall 2015 MRS meeting!

Andrew Stickel (Ph.D., '16, Lee Lab) received the 2016 Frolander Award for OSU's Outstanding Graduate Teaching Assistant of the year.

Hiral Patel (Graham Lab) won Best Poster Prize at the 2016 Conference on Lasers and Electro-Optics from the Optical Materials Optical Society of America group.

Nicole Quist (M.S., '16, Ostroverkhova Lab) received a SPIE Travel Award, Graduate School Travel Award, and OSU's President's Commission on the Status of Women Award to present her work on nanophotonics at the 2017 SPIE Photonics West meeting.

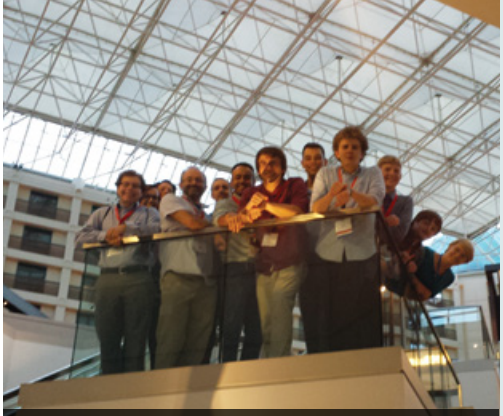
Lee Aspitarte (Minot Lab) received the 2015 Ben and Elaine Whiteley Materials Fund Fellowship award.

Jay Howard (M.S., '16, Minot Lab) received the 2016 Peter Fontana Outstanding Graduate Teaching Assistant Award.

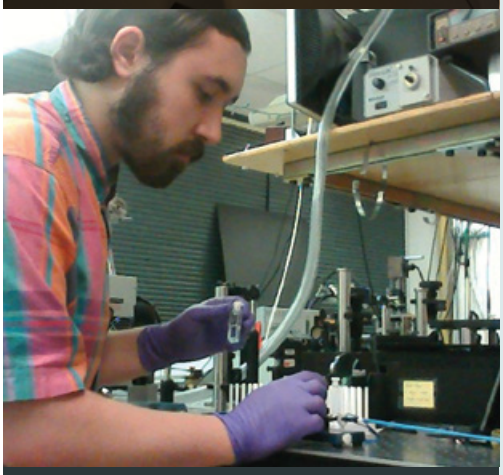
Chris Jones (Sun Lab) received the 2016 Physics Department Graduate Research Award.

Brian Johnson (Ph.D., '15, Ostroverkhova Lab) received the 2015 Physics Department Graduate Research Award.

Zach Thompson (Ph.D. '15, Lee Lab) received the 2015 Peter Fontana Outstanding Graduate Teaching Assistant Award.

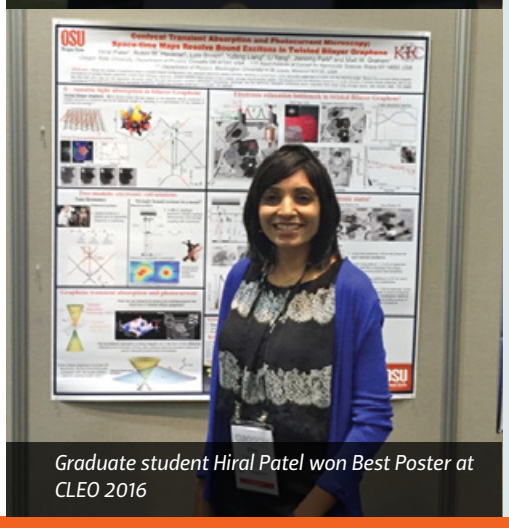


The OSU SPS group at PhysCon 2016.



Alex Quinn

Andrew Stickel



Graduate student Hiral Patel won Best Poster at CLEO 2016

SURE SCIENCE

The Summer Undergraduate Research Experience (SURE) program supports students with stipends of up to $5,000 for hands-on summer research that can have real-world impact. Many use the program to get a head start on their Honors thesis or help define their career path.

Students in the program speak highly of the experience:

"This has been the best experience of my college career at Oregon State! I love being able to learn hands-on in the laboratory environment and to have time to work one-on-one with my mentor. This experience motivated me to apply to the PharmD program," says biology major Heather Wisner.

"I have learned more in this summer alone about what it means to think critically and how to write thoughtfully than what any textbook has tried to teach me in the past four years," says biology major Wendy Saepharn.

Congratulations to **Jeremy Meinke** (Qiu Lab), **Mirek Brandt** (Graham Lab), **Ikaika Mckeague-McFadden** (Graham Lab) and **Katelyn Chase** (Sun Lab), who were recipients of the 2016 SURE Scholarships, supported by generous alumni and donors from the College of Science.

Waves of impact

Faculty hires, awards and far-reaching research

NEW HIRES

Elizabeth Gire joined the Physics Department as an assistant professor in 2015. She received her B.S. in astrophysics from the University of California, Los Angeles, and her M.S. and Ph.D. in physics from the University of California, San Diego. Before joining us, Gire was a post-doctoral researcher with the Paradigms in Physics group at Oregon State and with the Physics Education Research Group at Kansas State. Prior to that, she was an assistant professor of physics at the University of Memphis.

Gire's research focuses on teaching and learning physics, specifically the mental activities students and experts use to make sense of physical systems. In order to help students learn to think like experts in physics, she studies how different ways of representing physical relationships (equations, graphs, diagrams, manipulatives and conceptual stories) affect reasoning and learning.

In addition, Gire studies the strategies students and experts use to evaluate their own solutions to physics problems. (Physics faculty are sometimes asked to solve problems in her lab under the watchful eyes of a graduate student and a video camera—a rather humbling experience.) She primarily conducts her research in the context of the Paradigms in Physics and calculus-based introductory physics courses.

Kathryn Hadley joined the Department as an instructor in 2016. Kathy received a B.S. in physics from Central Washington University in 2003 and a Ph.D. in physics from the University of Oregon in 2013. In her Ph.D. work, she specialized in theoretical astrophysics with a focus on computational modeling of protostellar systems as well as work in plasma shocks and the modeling of exotic compact objects such as strange quark stars.

As a graduate student, Hadley taught at Lane Community College and became active in the Adopt-a-Physicist Program in the American Physical Society, where she mentored high-school students from the Philippines. She also taught various physics classes at the University of Oregon and at the American Public University System. Before OSU, Hadley also had a two-year sabbatical replacement appointment at Whitman College.

Currently, Hadley is teaching online astronomy courses and an introductory physics course as well as developing a new special topics course on the upcoming solar eclipse. She also actively mentors research students via the Undergraduate Research, Scholarship and the Arts Engage project, which gives first- and second-year students and transfer students an opportunity to pursue research or a creative activity.

Program Assistant **Clarissa Amundsen** joined us in 2015 after serving as the technical support expert and facility manager at Perriwinkle Elementary School in Albany, OR. This was the perfect training for her current work organizing huge physics classes, coaching lost undergraduates, iteratively scheduling 80 courses and sections each term, and managing the quirks of Weniger Hall. She also brings connections with local schools which have greatly enhanced valuable outreach efforts (see page 9).

CONGRATULATIONS!

Janet Tate was named the Dr. Russ and Dolores Gorman Faculty Scholar, elected a Fellow of the American Physical Society (APS), named an OSU Alumni Association Distinguished Professor and received the F.A. Gilfillan Award for Distinguished Scholarship.

Corinne Manogue was named the APS Woman of the Month for August 2016.

Corinne Manogue and **Tevian Dray** were named the 2016 Outstanding Educators in Science and Mathematics for Higher Education by the Oregon Academy of Sciences.

Oksana Ostroverkhova received the 2016 Milton Harris Award in Basic Research and the 2016 Loyd Carter Award for Outstanding and Inspirational Teaching at the graduate level, both in the College of Science.

Matt Graham received the 2016 Starter Annual Grant Award for the National

Spectroscopy Society of Pittsburgh and the 2017 International Society for Optics and Phototonics (SPIE) Rising Researcher Award, which given to 10 under 40 scientists in photonics, sensing or defense research.

Chris Coffin received the 2016 Loyd Carter Award for Outstanding and Inspirational Teaching at the undergraduate level in the College of Science.

Tevian Dray received the 2017 Deborah and Franklin Tepper Haimo Award for Distinguished University Teaching of Mathematics from the Mathematical Association of America (MAA).

Henri Jansen received the 2015 Olaf Boedtker Award for Excellence in Undergraduate Advising in the College of Science.

Heidi Schellman received the 2015 Mentoring Award from the American Physical Society Division of Particles and Fields.

IN THE LAB

Six new faculty have joined us since 2013, and their labs are generating fascinating new discoveries!

Bo Sun Lab

Assistant Professor **Bo Sun**'s lab recently obtained National Science Foundation (NSF) funding to study collective cell behavior in multicellular

Distinguished Professor Janet Tate

Corinne Manogue

Oksana Ostroverkhova

Chris Coffin

ONE YEAR, TWO AWARDS

Physicist **Oksana Ostroverkhova** demonstrates that great teaching and great research can go hand in hand. In 2016 she received two prestigious College of Science awards, the Milton Harris Award in Basic Science Research and the Loyd F. Carter Award for Outstanding and Inspirational Teaching in Graduate Science.

The Milton Harris Award recognized Ostroverkhova's exceptional achievements in the studies and development of organic optical and optoelectronic materials. She joined OSU in 2005 and was a National Science Foundation CAREER award recipient.

The Loyd F. Carter Award recognizes Ostroverkhova's effective and inspirational teaching in physics at the graduate level. Students themselves nominate faculty for the award and make the final selection.

"My main teaching principle is that learning should take place in an atmosphere of mutual respect, and it must be challenging and fun," says Ostroverkhova, who iteratively refines her curriculum and teaching methods using frequent student feedback. She also strives to connect her students' work to current research and real-world applications.

systems, trying to understand an apparent contradiction. Most animal cells live in large groups, such as skin cells and neurons. Typically, cell groups sense the environment through chemicals, a highly accurate process called chemosensing. However individual cells within a cell group often perform poorly as chemosensors. So where does the group wisdom come from?

To address this question, the researchers studied the calcium response of fibroblast cells to external adenosine triphosphate (ATP). They found that with cell-cell communication and nonlinear signaling dynamics, a group of cells can precisely encode not only environmental information but also the number of their neighbors at the same time. Furthermore, when fibroblast cells are mixed with breast cancer cells, cancer cells behave as defects in the otherwise communicating network. The result offers a new perspective of how cancers undermine our normal functionality.

Qiu Lab

Assistant Professor **Weihong Qiu** recently obtained NSF funding to study kinesins, which are "motor" proteins that move on train track-like structures called microtubules to generate directional movement and forces in animal and land plant cells. To study kinesins, the Qiu Lab uses a wide range of tools from cell biology, biochemistry and physics, including single-molecule light microscopy. These tools allow researchers to directly visualize the movement of individual kinesin motors on the microtubules. Kinesins are involved in a number of essential intracellular processes, such as transport of cargos inside cells and segregation of chromosomes during cell division.

Current research in the Qiu Lab is focused on understanding the evolution, mechanism and regulation of kinesin-14s, a subset of kinesins that are poorly understood. Research in the Qiu Lab has led to discoveries that significantly expand our knowledge of kinesins-14s. In a recent *Nature Communications* article, Qiu and his colleagues reported that KlpA from a filamentous fungus is a novel kinesin-14 that demonstrates context-dependent bidirectional motility (see illustration). This is a total unexpected finding, as all other kinesin-14s that have been studied over the past 20-plus years are exclusively one-way "vehicles" lacking the ability to switch direction on microtubules autonomously.

In collaboration with Bo Liu's Lab at University of California, Davis, the Qiu Lab has also discovered that OsKCH2, a kinesin-14 motor from the rice plant, is the first land plant kinesin-14 to demonstrate the ability to generate continuous motility without clustering (manuscript in preparation). Research on the rice kinesin-14 OsKCH2 in the Qiu lab is currently funded through a three-year NSF award. These novel findings have placed the Qiu Lab in a unique position to reveal the evolution, mechanism and regulation of kinesin-14 motor proteins.

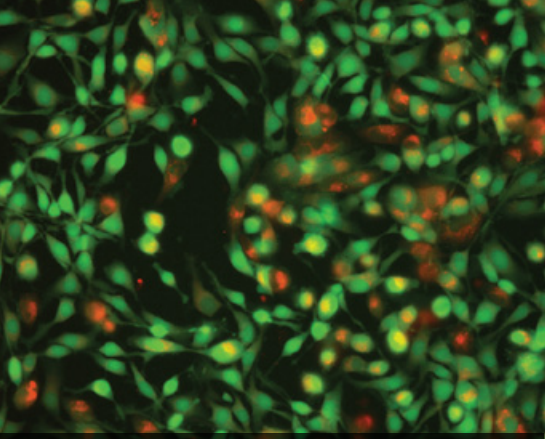
Graham Lab

Matt Graham's Micro-Femto Energetics Lab recently resolved a puzzle in electron dynamics—with a twist!

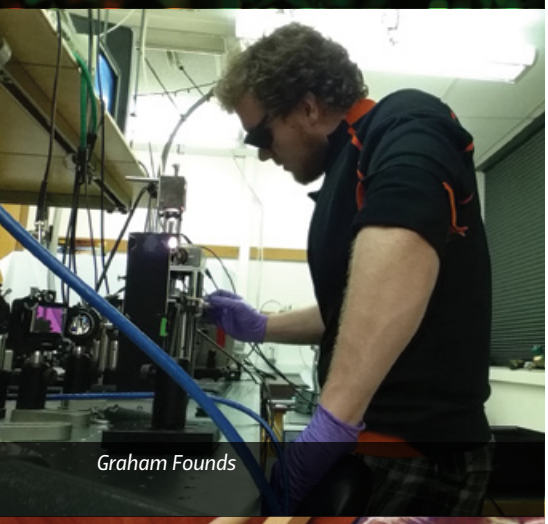
How can the electrons in new nanoscale devices and materials be harvested for energy generation, light emission or electronic applications? To answer such questions, the Lab films photoexcited electrons' journey with both micron spatial resolution and femtosecond time resolution. By filming the journey of photoexcited electrons from light absorption to electron extraction, researchers can identify electronic recombination bottlenecks that control the photoconversion efficiency of next-generation solar voltaic and fast photosensor materials.

Recently graduate student **Hiral Patel** and collaborators used this approach to examine the interlayer electronic interactions in bilayer 2D materials such as graphene. In her paper, published in *Nano Letters*, Patel examines photoexcitations in bilayer graphene when it is stacked at a twisted angle. Previously it was known that the interlayer 2p orbitals will rehybridize to give absorption resonances that are tunable with the bilayer stacking angle. However, Patel proved that these optical resonances are actually strongly bound exciton states. Even more surprising, she shows how the remarkable symmetry of this material results in decoupling of lowest lying excitons from the graphene electron continuum through a physical phenomenon known as a "ghost-Fano" resonance effect. This is the first known 2D (or 3D) metallic material that can also form stable, strongly bound excitons.

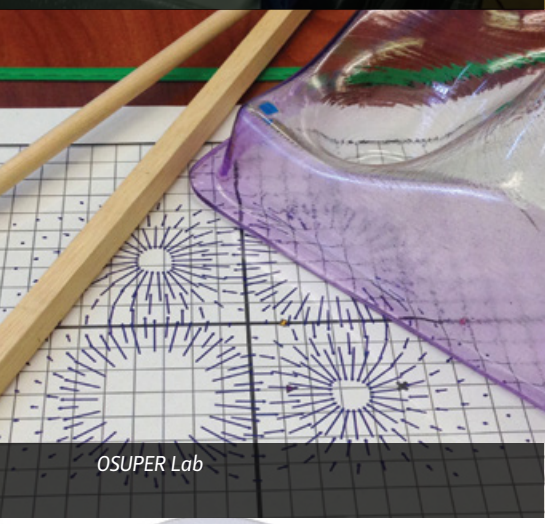
Patel presented this work at the American Physical Society meeting and at Graphene Week in Manchester, UK. At the Conference on Lasers and Electro-Otics Conference in San Jose, CA, she was awarded The Optical Society Optical Materials Group Best Poster Prize. Patel has further



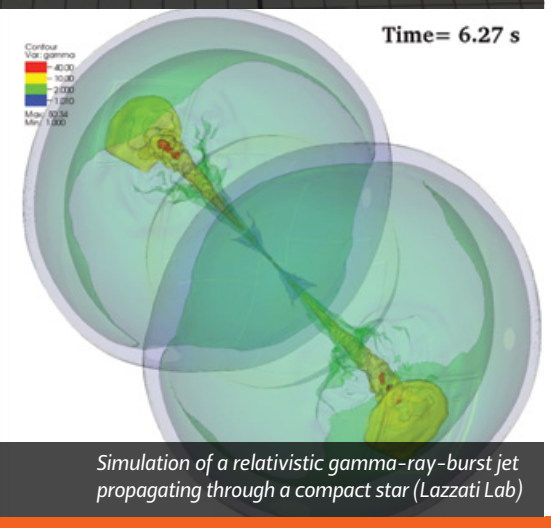
Green: fluorescent imaging of both cancer and fibroblast cells. Red: breast cancer cells. (Sun Lab)



Graham Founds



OSUPER Lab



Simulation of a relativistic gamma-ray-burst jet propagating through a compact star (Lazzati Lab)

discoveries for this remarkable material under peer review. Stay tuned!

OSUPER Lab

Liz Gire's OSU Physics Education Research (OSUPER) Lab supports continuing innovation by studying how students learn physics and developing innovative ways of teaching.

OSUPER starts by examining how physicists think and the kinds of reasoning they use. We then look at student reasoning and ask, "How can we build on these understandings? What kinds of experiences will help them think like physicists?"

OSUPER also studies how physicists and students check their own solutions, a critical skill in real world situations where no solution manual exists. Physics experts habitually check their work and have multiple ways of evaluating their reasoning. What teaching strategies help students to learn these habits?

OSUPER also designs props like dry-erasable surfaces and vector maps that help students understand abstract concepts like the functions of two variables in a physical system. Through manipulables, students develop intuitive geometric understandings of relationships that can then be formalized into algebraic equations. These activities help students understand an equation not as a mysterious recipe producing a correct answer, but as a logical description of the relationships in a physical system.

Astrophysics Research Group

Davide Lazzati joined as an associate professor in 2013. Before joining Oregon State, he was a Theory and Particle Physics and Astronomy Research Council postdoctoral fellow at the Institute of Astronomy of the University of Cambridge (UK), a senior research associate at JILA, at the University of Colorado and an assistant professor at North Carolina State University.

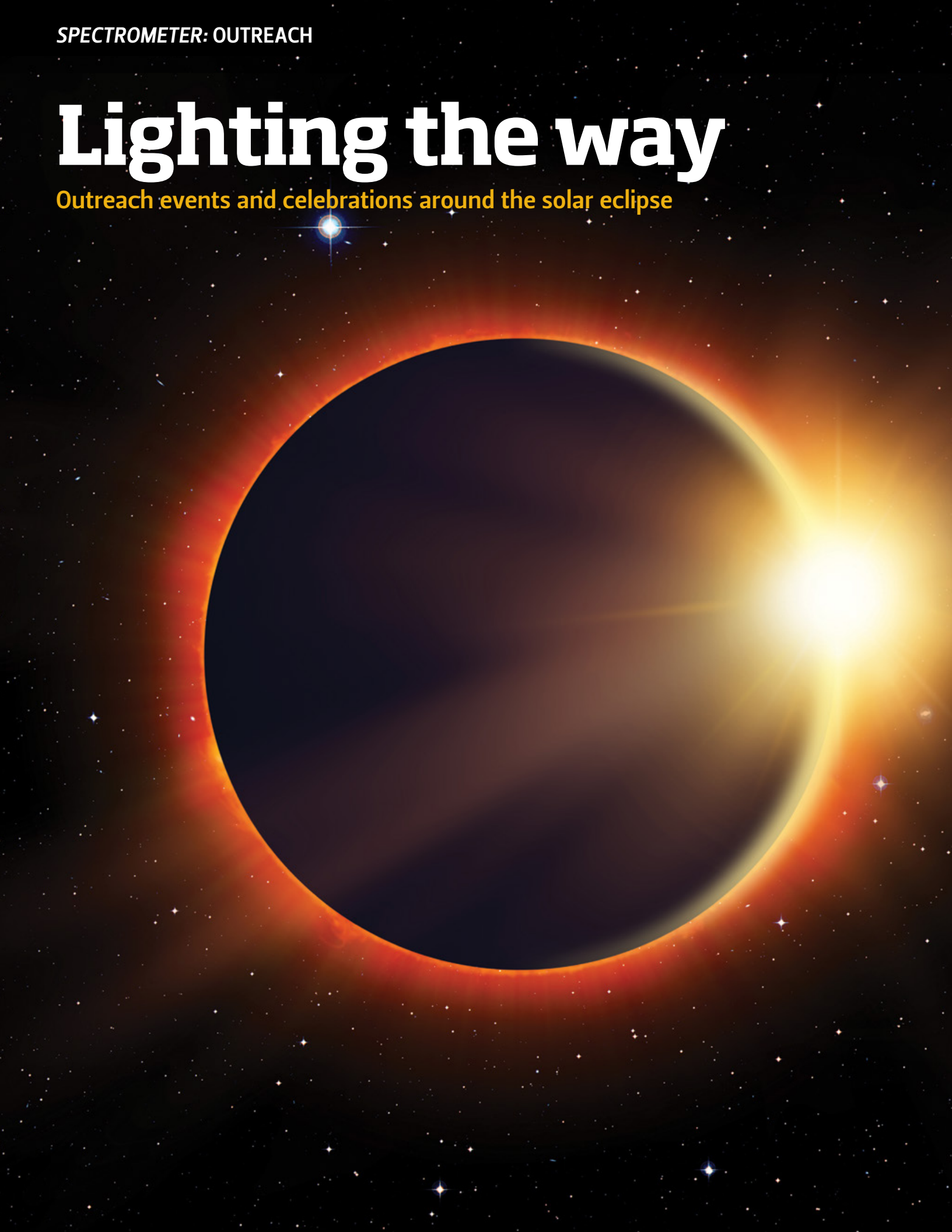
Lazzati's Astrophysics Research Group (ARG) has been performing research in two areas: cosmic dust formation and gamma-ray bursts.

The scientific highlight of the year was Caltech's discovery of gravitational waves from the merging of a binary system composed of two black holes made in their Laser Interferometer Gravitational-Wave Observatory (LIGO). (Alumnus and astrophysicist Shane Larson was part of the LIGO team—see page 16–17). ARG responded to the discovery by publishing research in *Astrophysics* suggesting that black hole mergers could be accompanied by short bursts of gamma-ray radiation. ARG also published research on radiation transfer in gamma-ray burst jets and on three-dimensional simulations of unsteady outflows in gamma-ray bursts.

Cosmic dust research was instead focused on understanding the microphysics of the formation of nano-scale grains in the ejecta of massive stellar explosions. Two papers were published on the subject in *Astrophysics* and *Planetary and Space Science*.

Lighting the way

Outreach events and celebrations around the solar eclipse



Graduate student Lee Aspitarte chats with kids and their parents at the Hoover Elementary School Family Science Night.

Kids learned about air pressure and inertial forces before riding the ever-popular "OSU Hoover Craft".

Astrophotographer Tom Carrico creates a stacked image of the Milky Way in real time for an appreciative audience.

TOTAL SOLAR ECLIPSE 2017

A physics team (led by **Davide Lazzati**, **Randall Milstein** and **Kathryn Hadley**) is preparing a series of events celebrating one of the most exciting astral events of the decade: this summer's total solar eclipse on August 21. Plans include solar telescopes for safe public viewing, informative public lectures and more.

Hadley is developing a one-credit online special topics class on the Solar eclipse. The course will cover Sun, Earth and Moon system dynamics; information about eclipse events (including safe viewing tips and eye protection); shadow maps; Eclipse 2017 specifics, and solar structure, especially how the eclipse helps us to study the corona. Hadley will also cover eclipses in general, including lunar eclipses, and how the eclipse of 1919 was instrumental in the first experimental test of Einstein's theory of general relativity.

ASTRONOMY OUTREACH

The Astrophysics Group organized three 2016 Astronomy Open House events led by **Davide Lazzati** and graduate students **Atul Chhotray** and **Tyler Parsotan**. They were attended by over 500 participants from the community. In addition, Dr. Lazzati became an Oregon Museum of Science and Industry (OMSI) communication fellow and participated at a "Meet a Scientist" event at OMSI. Finally, the astrophysics group participated in outreach activities in three local K–12 schools.

Randall Milstein was appointed Astronomer-in-Residence to the Oregon NASA Space Grant Consortium. He delivered a series of public lectures including "Star Wars and Popular Culture" at the University of Oregon Museum of Natural and Cultural History and "The Cultural and Technological Implications of Star Trek" at Oregon State. He will also lecture about the solar eclipse at an upcoming Science Pub on May 8, 2017 sponsored by the College of Science.

INSPIRING YOUNG SCIENTISTS

Physics had an exciting year of community outreach, spearheaded by **Ethan Minot**, who also became an OMSI Science Communication Fellow last year. Student volunteers made a huge impact at events like Discovery Days, Family Science Nights and Astronomy Open Houses. Discovery Days alone reached over 3,000 kids. A top-rated activity was the hovercraft, with many other hands-on physics demos following close behind.

The outreach team comprises more than 30 undergraduate and graduate students who are passionate about inspiring kids to interact with physics.Team members say their top reasons for participating are investing in the future of physics, giving back, increasing awareness of physics-related careers, promoting the department, practicing science communication and having fun. A wonderful spin-off of their participation is the community and camaraderie among volunteers as they create such meaningful and engaging events.

To continue growing our outreach program, the outreach team launched a new page on the Department's website. This webpage helps us spread the word about our events and encourages local teachers to invite a physicist into their classroom.

A laser focus

Removing obstacles to student success

PARADIGMS IN PHYSICS

In 2016, the Department began the Paradigms 2.0 revision of the curriculum for physics majors, spearheaded by a faculty committee which consisted of **Corinne Manogue**, **David Roundy**, **Liz Gire** and **Ethan Minot**, assisted by **Emily van Zee**.

The committee began with a survey of students and faculty, followed by individual interviews with the faculty teaching each course to establish what is currently being taught. They then brainstormed with faculty ways to improve on student- and faculty-identified challenges in the curriculum. After developing a specific proposal, they brought in individual faculty members to talk through the new curriculum and get feedback. Finally, the new curriculum plan was presented to the faculty as a whole, who voted unanimously to implement it.

The physics major as a whole will still look very familiar. The intense seven-hour-per-week junior year composed of sequential Paradigms still exists. However, these are now two five-week, three-credit Paradigms per quarter rather than three (3) three-week, two-credit Paradigms with an odd week. This will give students more time to digest the material, take tests and get feedback before the final exam. Also, the Math Methods course has been replaced with "Math Bits," which are integrated into the Paradigms themselves.

Perhaps the biggest change is the introduction of two new sophomore-year courses, Physics of Contemporary Challenges and Techniques of Theoretical Mechanics, which replace Modern Physics and the Classical Capstone. The new courses will better prepare our students for the Paradigms, although transfer students will take them in their junior year.

Other changes involve reducing the required electronics sequence to one quarter, and requiring the PH 36x computational lab sequence rather than PH 265. On the whole, the faculty believe we have addressed several challenges and that the new curriculum will bolster student success.

FLIPPED CLASSROOMS

Senior Instructor **KC Walsh** has led some big changes in how the introductory algebra-based physics sequence is taught. Class time is no longer spent on traditional lectures, where top-down content delivery is the focus, but instead devoted largely to students' work on physics problems. The theory behind this type of "flipped classroom" is that most people learn by doing rather than just watching.

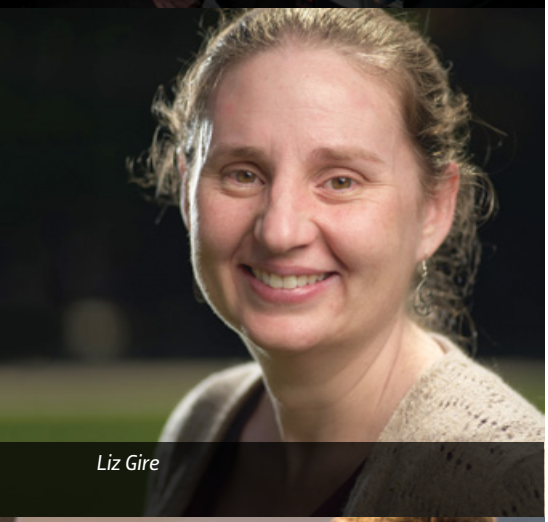
As Walsh explains, "in learning a new subject, it is helpful to practice with direct feedback from professional instructors. So now content delivery in Introductory Physics, like that of a traditional lecture, is set up as pre-class 'homework' via The Daily Learning Guide, a schedule of pre-lecture videos, open source textbook readings, simulations, problem sets, and a whole host of other resources. During class time students are posed a set of conceptual and quantitative problems while Teaching Assistants, Learning Assistants (LAs), and the instructor field questions. This all happens in a large 200-person lecture hall during a standard 50-minute class."

Another change to the introductory sequence is the addition of LAs, undergraduate students who performed well in the course as students and were then trained in both general and physics-specific pedagogy. The LAs help out in the classroom, hold homework help sessions and curate a social media support page.

One possible weakness in the flipped classroom model inspired an additional innovation. Worrying that students weren't reading the textbook or watching the pre-class videos of his lectures, which had been crafted over the years to cover the content comprehensively, Walsh brainstormed Project BoxSand.

"The goal of BoxSand," explains Walsh, "is to collect data on students' engagement with digital resources. A few grants, two years, and a number of undergraduate and graduate students' stipends later, we have created a website full of the best open source online resources we could find."

Ethan Minot



Liz Gire

Senior Instructor KC Walsh has led some big changes in how introductory physics is taught

New instructor Kathy Hadley

The BoxSand site also has a lot of customized course content. Students are directed to BoxSand resources through the Daily Learning Guide and their engagement is tracked and correlated with performance in the class. Last fall was the first term collecting data. Over 350 students agreed to the study and generated almost 200,000 useful data points that are now being studied. "Hopefully the BoxSand data will help us improve evidence-based instructional practices here at Oregon State and the larger teaching community," says Walsh.

E-NNOVATIONS IN ASTRONOMY

Instructor **Kathy Hadley** joined in 2016 to create and teach new courses in online astronomy (she also teaches introductory physics and mentors undergraduate researchers). In the process, she's gained some insights into e-teaching, generally.

"Probably the hardest aspect of creating and running an online course is effectively nurturing student-to-student interaction. My current practice is to break up the typical weekly online discussion, requiring students to choose a topic and interact with others in small groups to research interconnected subtopics. They research more deeply on the second week and read and comment on other groups' threads on the third week. The fourth week they discuss homework problems to prepare for the midterm exam, and then the cycle starts over. This seems to work well to create a feeling of community and camaraderie.

"However, last term, I simultaneously taught an online section and a hybrid (a mix of online and in-class) section of PH 206, and my hybrid section scored about 5% better on identical exams. Granted, the numbers of participants were really too small to draw conclusions. Still, it seemed like in-class activities gave my hybrid students an edge."

Hadley surmised that the in-class format combining individual with group work gave the hybrid students an advantage in mastering complex information. In class, students outlined the material individually, then combined their efforts and prepared in groups for any one individual, randomly chosen by Hadley, to present the outline from memory. As a result, says Hadley, "the whole class was pulling for every person in the room, and nearly everyone came away with a strong understanding."

Hadley is currently adapting this format for online students through a combination of individual preparation and online groupwork, culminating in a live group meeting where she randomly calls on one individual. "I know the dynamics won't be the same as physically sitting in a room with their peers," Hadley admits. "However, this should start to approach real group interactive learning."

Star talks

An expanding galaxy of discussions and debates

YUNKER LECTURE: BLACK HOLES

The 2016 Yunker Lecture featured physicist **Meg Urry**, who gave an engaging talk on the physics of black holes. Black holes formed at the centers of galaxies in our young universe and, over the next 13 billion years or so, accreted enormous amounts of matter. Over time, galactic center black holes and their host galaxies have grown in mass by factors of a million or more, possibly in lockstep.

Urry discussed alternative descriptions of a black hole, explained how recent multi-wavelength surveys have allowed us to take a census of black hole growth, and presented the big picture: What the evolution of the universe over the last 13 billion years looks like based on computer simulations and future prospects for observing black hole growth.

Urry is the Israel Munson Professor of Physics and Astronomy at Yale University. She is the Director of the Yale Center for Astronomy and Astrophysics and the past president of the American Astronomical Society. Her research is on actively accreting supermassive black holes, also known as Active Galactic Nuclei, and the co-evolution of these black holes with normal galaxies.

The annual Yunker lecture honors Dr. Edwin A. Yunker, who was part of the OSU physics faculty from 1925-68, and served as department chair from 1949-66. He helped transform the Department of Physics into a modern, research-oriented physics department. In 1981, he and his wife Gertrude established the Yunker Lecture Series to bring outstanding physicists to OSU, presenting talks for students and a general audience. The 2017 Yunker Lecturer will be Dr. Nigel Lockyer, director of Fermilab, on particle physics and its relation to medical physics.

GILFILLAN LECTURE: A MATERIALS WORLD

A global leader in the field of materials physics, **Janet Tate**, the Dr. Russ and Dolores Gorman Faculty Scholar and physics professor, is the 2015 recipient of the F.A. Gilfillan Award for Distinguished Scholarship.

The award recognizes distinguished scholarship in in the College of Science by honoring a faculty member who demonstrates a long and exceptional scientific career and scholarly achievements that are widely recognized nationally and globally by her or his peers. Tate has received national and international honors as well as numerous prestigious research and teaching awards. She was recently elected a fellow of the American Physical Society for outstanding contributions to structural, transport and optical properties on various electronic and superconducting materials.

Dr. Tate presented the College of Science 2016 F.A. Gilfillan Memorial Lecture titled "It's a Materials World," in which she discussed the fascinating world of transparent conductors (most commonly experienced through touchscreens) and superconductors and illuminated the surprising and contradictory properties of these materials that are transforming our lives and our economy. An outstanding teacher and mentor, Tate delivered an engaging public lecture on what makes these materials so interesting and useful as a potential green technology.

The F.A. Gilfillan Memorial Award for Distinguished Scholarship in Science was established by the family of Francois A. "Doc" Gilfillan to honor his life, service and contributions to Oregon State, the College of Science and the field of pharmaceutical chemistry. Doc Gilfillan served as the dean of the college from 1938 to 1962 and as acting president of Oregon State from 1941 to 1942. A popular cultural and scientific community event, the annual Gilfillan Lecture attracts nearly 200 local residents, students, alumni and faculty to hear acclaimed OSU scientists share their revolutionary scientific breakthroughs and discoveries as well as their personal and intellectual journeys in science.

WOMEN IN PHYSICS CONFERENCE

The Department is proud to have hosted one of nine American Physical Society Conferences for Undergraduate Women in Physics (CUWiP) that took place simultaneously across the United

APS Conferences for Undergraduate Women in Physics (CUWiP) are three-day regional conferences for undergraduate physics majors. See a gallery on the next two pages.

States in January 2016. At the **Oregon State CUWiP**, 140 undergraduate women physicists from the Northwest gathered to present their research, participate in workshops and network with professionals and peers. They spent an evening over dinner asking professionals from industry, academia and national labs about the many different careers they might pursue. They heard an inspiring talk, "What Access Really Means," by Mary James, Dean of Diversity at Reed College. Together with 1400 peers from the other CUWiP sites across the country, they participated in a live webinar with Ginger Kerrick, who described how a physics degree paved her way to become capsule commander at NASA.

In addition to enjoying stellar lectures, the young women engaged in workshops to help them chart a path through graduate school and learn about careers in technology, medicine and education, among others. They discussed concerns over being women in science and took the microphone to address their peers. They learned how to craft a compelling resume and present their achievements confidently. They left with new skills and knowledge, a network of peers, and the confidence that they will be successful in a field still dominated by men. As one student observed, "there were so many great takeaways from this conference and I am extremely grateful and appreciative."

The CUWiP event was coordinated by **Janet Tate**, graduate student **Allison Gicking** and a committee of a dozen motivated and hard-working female and male graduate students, assisted by department staff and the College of Science. The conference was sponsored nationally by the National Science Foundation and the Department of Energy Office of Science, and locally by Oregon Nanoscience and Microtechnologies Institute, The Oregon State University Research Office and Division of Student Affairs, and others.

NOBEL LAUREATE CARL WIEMAN TALKS

Miss the Fall 2016 Distinguished Lecture with physicist and Corvallis native Carl Wieman? No problem. Enjoy a video of the lecture as well as a bonus interview with our own Heidi Schellman online.

CUWiP 2016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SERVICE ABOVE SELF

As this newsletter went to print, we received the very sad news that Ben Whiteley had passed away. We are greatly saddened to have lost such a great friend of Oregon State Physics.

Elaine and Ben Whiteley were honored with the College of Science Distinguished Service Award last November at a dinner and award ceremony in the Memorial Union. The Whiteleys are Oregon State alumni who graduated in 1951 and 1953 respectively, and are long-time friends of the Physics Department and the College of Science. They contribute generously to the endowment for the Yunker Lecture series, in honor of Elaine Yunker Whiteley's father, Edwin A. Yunker, who was on the physics faculty for 43 years and was department chair from 1949 to 1966. They have also created a scholarship for students in Materials Science that bears their name. Many of our students have received the Whiteley Materials Science Fellowship and we all continue to enjoy the intellectual vibrancy that the annual Yunker Lecture brings.

YOUNG ALUMNI AWARD

Physics and mathematics alumnus **Scott Clark** ('08) is the recipient of the 2016 College of Science Young Alumni Award in honor of the extraordinary professional accomplishments he achieved so early in his career. Named one of Forbes' 30 under 30 in 2016 from among 15,000 nominees, he is one of 600 of America's best and brightest young entrepreneurs, innovators and leaders.

Clark grew up in Tigard, OR, and attended Central Catholic High School in Portland before arriving at Oregon State to study mathematics and physics. He is a very proud fourth generation Beaver; his parents, grandparents and great-grandparents graduated from OSU. Clark's parents majored in journalism during the 1970's and his father served as the editor of *The Barometer*.

A high-achieving undergraduate student who earned three bachelor's degrees in physics, mathematics, and computational physics in just four years, Clark picked Oregon State not only because of his family's extensive ties but because the university has a strong reputation in both physics and mathematics.

Clark received a National Science Foundation's Research Experiences for Undergraduates (REU) grant to study quantum physics at the Max Planck Institute in Dresden, Germany. There, Clark pursued extreme value statistics for chaotic quantum systems. "It was my first taste of getting some of the biggest computers in the world to solve math and physics problems," recalled Clark.

Yet another REU award enabled Clark to work on a project in computational biophysics related to protein folding at the University of California, Davis. Clark published the results of this research in a well-regarded academic journal. Still at Oregon State, Clark worked closely with mathematician Malgo Peszynska on his thesis, "Finite Element Modeling on Uncertain Surfaces," supported by an Undergraduate Research, Innovation, Scholarship and Creativity (URISC) award.

After graduating, Clark earned a Ph.D. in applied mathematics at Cornell University. While completing his degree, Clark observed researchers tweaking what they had built via trial and error in the final stage of their research. So he developed MOE, a global, black box metric optimization engine to solve this problem.

Clark was one of the first Ph.D.'s hired at Yelp, where he used his MOE to help Yelp improve its web analytics, resulting in higher click-through rates and an enhanced user experience.

In 2014, Clark left Yelp and co-founded SigOpt, a software company that uses machine learning and complex algorithms to optimize user experiments for websites and other applications. The software is used widely by globally recognized leaders across insurance, credit card, algorithmic trading and consumer packaged goods industries. To date, SigOpt has raised $8 million in funding from Andreessen Horowitz, Y Combinator, Data Collective and others.

Winners of the College of Science Alumni Awards. From left: Kenneth Hedberg, Ben and Elaine Whiteley, Gretchen Schuette, Dean Sastry Pantula and Scott Clark

LIGO'S NEW VIEW OF THE COSMOS

Physics alumnus **Shane Larson** (B.S. '91) returned to Corvallis to discuss one of the most important physics discoveries of the century to a packed Science Pub last spring: "Black Holes & Gravitational Waves: LIGO's New View of the Cosmos."

A professor at Northwestern University in the Center for Interdisciplinary Exploration and Research in Astrophysics, Larson is also an astronomer at the Adler Planetarium in Chicago. He is part of the Laser Interferometer Gravitational-Wave Observatory (LIGO) Scientific Collaboration, an international team of more than 1,000 scientists. Last year, they announced an amazing discovery: evidence of gravitational waves.

Einstein first predicted the existence of gravitational waves in his general theory of relativity in 1915 but doubted they would ever be detected because they are so incredibly small. All that changed on September 14, 2015, when LIGO scientists recorded the sound of two black holes colliding and uniting to form a third black hole, an event that occurred more than a billion light years away. Gravitational waves can convey data about the origins of the universe, black holes, neutron stars and supernova explosions, providing insights into the workings of the universe unobtainable by traditional means. Larson's contribution included analyzing data, making detection predictions and interpreting the gravitational wave search results.

At the Science Pub, Larson spoke eloquently about the momentous discovery of gravitational waves, the process of detection by LIGO and the still unfolding meaning for science, society and our future.

Larson grew up in Eastern Oregon and earned a Ph.D. in theoretical physics from Montana State University. An award-winning teacher and a Fellow of the American Physical Society, he is a regular public science blogger and tweets with the handle @sciencejedi. He also just won the Vth Fermilab Physics Slam, a public contest in which scientists are given 10 minutes on stage to explain "what the heck they do" to over 1,000 people in a sold-out auditorium.

A PIONEER RETURNS HOME

Alumna **Shirley Dow Stekel** (B.A. '58, M.A. '61) retired as a University of Wisconsin physics professor and came back to visit us last year with her husband Frank, daughter and son-in-law. As a sophomore in 1955, she was the only woman in her math and physics classes and felt very alone walking into the old men's gym for mass exams. What motivated her to continue? "I just liked physics and math, and wanted to see how far I could go with it."

Stekel was also supported by a group of 30–35 women friends who lived together at Winston House. Many shared electives with her like German or Music (Stekel had room for extra courses because she was not required to take ROTC).

Stekel got her Masters in physics at Oregon State, moving on to faculty positions in Washington and Michigan and finally an assistant professorship at Whitewater with a sabbatical at the Indiana Synchrotron. During her visit, she toured the Minot and Lee Labs and sat in on a 212 studio. She observed the same group methods that had engaged her as an undergraduate in botany class and that she had used in her teaching in Wisconsin. We're happy that Stekel, a long term supporter of physics, rediscovered the same inspiration she experienced 55 years ago.

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