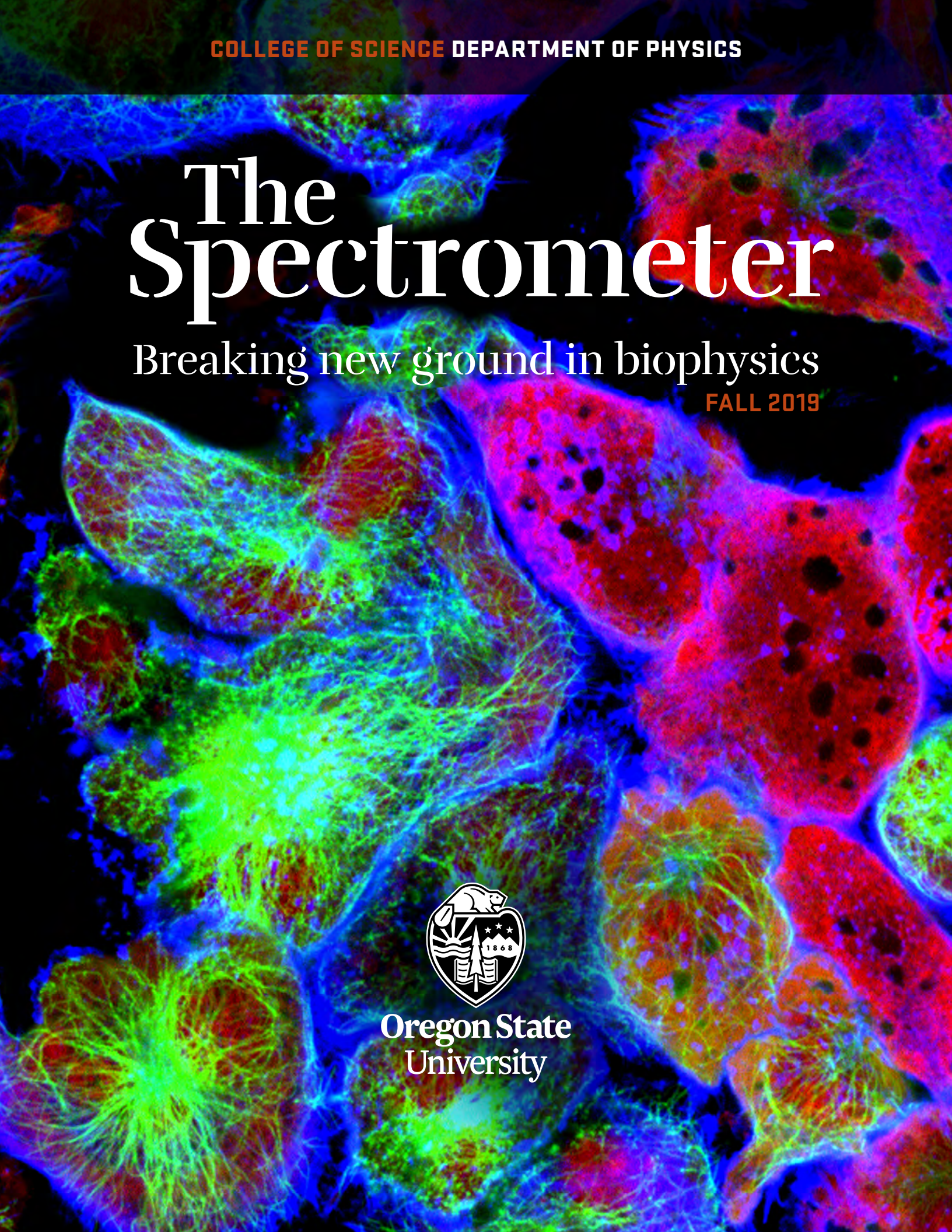
COLLEGE OF SCIENCE DEPARTMENT OF PHYSICS

The Spectrometer

Breaking new ground in biophysics

FALL 2019



Oregon State University

Fall 2019

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On the cover

An image of cancer tumor cells. Two physics faculty members are driving high-impact research that reveals the inner workings of movement and force at the molecular and cellular levels. Their discoveries are laying the groundwork for better cancer therapies. See p. 8.

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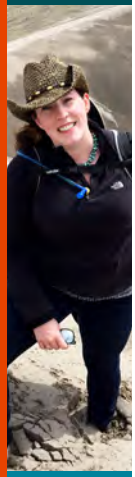

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FROM THE HEAD

Heidi Schellmann
Department Head

Welcome to the Physics Department's annual newsletter!

This is our chance to update you on changes and accomplishments at Oregon State Physics over the past year.

Sadly, we lost three long-time friends, colleagues and supporters in 2018. Jim Ketter, the guru of all labs, died after a long illness in June 2018. Jim was part of the glue that held the department (and Weniger Hall) together. One year later, we still miss him every day.

Elaine Whiteley died in early January. Elaine was Edwin Yunker's daughter and grew up in the department before graduating from Oregon State in 1953. She and her husband Ben were pillars of philanthropy in the state of Oregon, and we are extremely grateful for the support and encouragement they and their family have given to the department through the Yunker Physics Lecture Series and the Ben & Elaine Whiteley Materials Research Fund.

Finally, Shirley Dow Stekel (B.A. '58, MS '61) died the previous summer. Shirley was the only woman in the program during her time here and went on to teach physics at Wisconsin-Whitewater. She was an early adopter of active learning techniques in physics and keenly interested in OSU's Paradigms program. She and her husband Frank donated funds to the department for a second active learning classroom.

In happier news, Dr. Fred DeAngelis joins us as Lab Manager/Instructor from Queen's University. Fred started out doing nuclear theory and has held positions in industry and teaching physics in North Carolina. He's actively updating our labs and equipment.

Prof. Xavier Siemens joins us from the University of Wisconsin-Milwaukee. Xavier is PI on the NSF Physics Frontier Center for the NanoGrav experiment which uses pulsar timing to detect gravitational waves on cosmic scales.

Finally, Prof. Tomasz Giebultowicz is retiring this year. Tom joined our faculty in 1995 and taught a wide range of courses, notably electronics and the fun courses for non-majors – Energy Alternatives, Sound and Music and Light and Vision.

We'd like to thank the many donors to the department and the College of Science, some of whom are former faculty, who continue to support undergraduates and graduate research through scholarships and fellowships. Notably, this year, an anonymous donor contributed over $200,000 to support graduate student fellowships. Many of our students struggle financially and your gracious support makes a huge difference for them.


Ryan Tollefsen

ON THE MOVE

Our stellar students

National awards

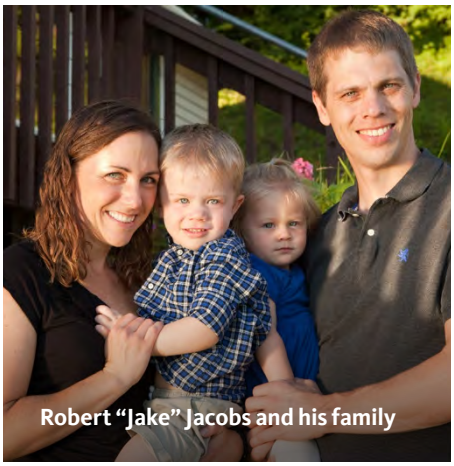
Ryan Tollefsen, an Honors double major in physics and mathematics, won a 2019 Goldwater Scholarship – the nation's top undergraduate award in the fields of science, technology, engineering and mathematics! A senior, Tollefsen pursues research on developing stable and durable thin-film semiconductors in the lab of physics professor Oksana Ostroverkhova. He has created a code in Python and Labview to help automate and control complex experiments on semiconductors for his laboratory. In summer 2018, a Research Experiences for Undergraduates (REU) fellowship took him to the Massachusetts Institute of Technology.


Tyler Parsotan

Morgan Brown (Ph.D. '18) received an NIH Postdoctoral fellowship award to work at University of Oregon's Institute of Neuroscience. His OSU adviser was Ethan Minot.

Tyler Parsotan was awarded the NASA Future Investigators in NASA Earth and Space Science and Technology (FINESST) award in 2019 in the extremely competitive astrophysics category. His proposal, titled "Demystifying the interplay between Explosion Dynamics and Electromagnetic Radiation in Gamma Ray Bursts," was one of the 11 percent of selected proposals in this category. Parsotan works with Davide Lazzati on understanding the most powerful explosions in the Universe known as Gamma Ray Bursts. Originally from New York, he is a first-generation student whose family is from Trinidad and Tobago. He also received the Physics Department Graduate Research Award this year.

Robert "Jake" Jacobs was awarded a NASA Future Investigators in NASA Earth and Space Science and Technology (FINESST) award for 2019 in the competitive Earth Science Division. With this award, Jacobs is developing a method to analyze latitudinal circulation utilizing satellite measurements of ocean surface vector winds measured by the QuickSCAT and ASCAT scatterometers. This research aims to improve understanding of climatological atmospheric circulation patterns and how surface winds in the tropical Pacific influence El Niño-Southern Oscillation (ENSO) events. Improved accuracy of the boundaries between large-scale atmospheric cells can advance our understanding of climate and weather models. Jacobs credits his advisor Larry O'Neill with helping him to greatly advance his knowledge of atmospheric and oceanic sciences.


Robert "Jake" Jacobs and his family

University and Physics departmental awards

Zachary Colbert received a 2018 SURE Science Scholarship to work with physicist Matt Graham on developing a spectrally resolved fluorescence microscopy to measure on-chip spectrum at the diffraction limit from the visible to near-IR range.

Andrew Collins and **Clark Embleton** each received a 2018 SURE Science Scholarship to work with physicist Ethan Minot on exciton polaritons using MoS2.

Haelyn Epp and **Jiadi He** each received a 2019 SURE Science Scholarship to work with physicist Weihong Qiu on understanding kinesin-5 directionality to better understand the mechanism and regulation of cell division.

Kailie Franco received a 2018 SURE Science Scholarship to work with biophysicist Bo Sun to conduct research on the calcium dynamics of communicating neuron cells in response to pulsating stimuli.

Michelle Jeliazkova received a URSA-ENGAGE 2019 award to work with physicist Matt Graham to study light emission of low bandgap light-emitting diodes near zero-bias, and how this thermally driven emission can be harvested to enhance overall efficiency.

Jin Kiatvongcharoen received a 2019 SURE Science Scholarship to work with physicist David Roundy to develop and test a Monte Carlo simulation to efficiently test a model for the dynein motor protein.

Mackenzie Lenz received the 2019 physics department's Travel Award to attend the national meeting of the American Association of Physics Teachers and Physics Education Research Conference in Provo, Utah.

Duy Nguyen received a 2019 SURE Science Scholarship to work with physicist Ethan Minot on CNTs for quantum light sources.

Acacia Patterson received a 2019 SURE Science Scholarship to work with physicist Janet Tate on measuring temperature-dependent electrical properties to understand how charge is transported in TiO2, which is used in energy-storage and energy-generating devices.

Yi Peng Teo received a 2019 SURE Science Scholarship and a URSA-ENGAGE 2019 award to work with physicist Matt Graham on harvesting energy from an optical excitation electron in a confined 2D material known as bilayer graphene.

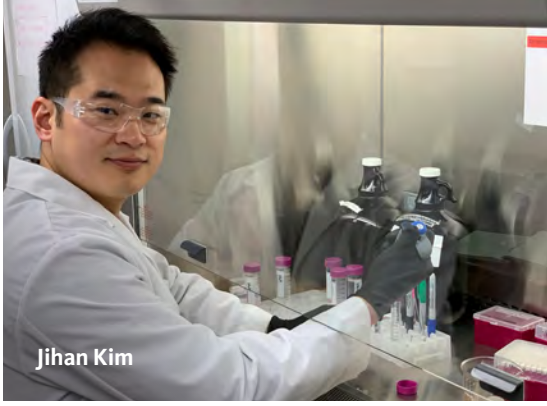
Dustin Treece received a 2019 SURE Science Scholarship to work with physicist Elizabeth Gire on expanding and validating a learning progression on units and dimension analysis to solve physics problems.

Kaseylin Yoke received a 2018 SURE Science Scholarship with physicist Heidi Schellman to work on validating neutrino data from the MINERvA experiment at Fermilab.

Okan Agirseven of the Tate Lab received last year's Graduate Student Travel Award from the OSU Graduate School. He attended the 30th International Conference on Defects in Semiconductors. Agirseven gave a contributed talk at the Seattle conference about his work on amorphous titania thin films.

Yuan Gao received the Wei Family Private Foundation Scholarship, which is awarded to graduate students of Chinese descent who pursue a degree in science or mathematics.

Azhar Hussein received a 2019-20 OSU Provost's Distinguished Graduate Fellowship.


Jihan Kim

Jihan Kim won the 2018 physics department's Graduate Research Award. Kim works with Bo Sun on biophysical problems, focusing on the mechanics of cancer-extracellular medium interactions.

Guanyu Li received the Wei Family Private Foundation Scholarship.

Dublin Nichols received a 2019-20 OSU's Provost's Distinguished Graduate Scholarship.

BEYOND THE CLASSROOM

McKenzie Meyer, **Austin Mullins**, **Acacia Patterson**, **Elena Wennstrom** and **Kasey Yoke**, accompanied by graduate students **Mackenzie Lenz** and **Nicole Quist**, participated in the Conference for Undergraduate Women in Physics at the University of Washington last January to hear from successful women in physics, to learn about graduate school and employment and to meet other physicists.

CLASS OF 2019

In June, our students completed another successful year with 29 students receiving their bachelor's degrees, down from previous year's record 35 – but more than in any other previous year except 30 graduates in 2014. Seven graduate students received master's degrees and six finished their doctorates. This year, we anticipate even more graduates as there are 45 juniors finishing the Paradigms in Physics series this spring.

FACULTY EXCELLENCE

WAVES OF IMPACT

National and global honors

Physics professor **David Roundy** received a one-year, $299K NSF grant for his project "Paradigms in Physics: Representations in Quantum Mechanics" to develop an enhanced website giving faculty access to teaching resources and an online textbook for teaching the mathematical skills students need to be successful in advanced physics courses. Physics professors **Elizabeth Gire** and **Corinne Manogue** and mathematics professor **Tevian Dray** are co-PIs on the project.

David Roundy

Matthew Graham was selected to serve as an Optical Society of America (OSA) Ambassador for 2019. This lifetime distinction recognizes OSA Early Career Professionals who are leaders in the optics and photonics community. Graham joins seven other early career professional researchers around the world to officially represent the OSA for 2019 as one of their Global Ambassadors. OSA Ambassadors provide career advice, technical knowledge and mentorship through serving as a traveling lecturer for chapters and sections, supporting professional development events at OSA meetings and engaging with their communities.

Davide Lazzati received a three-year $337K NSF grant for his project, "Combining Theory with Observations to Unlock the Multi-messenger Physics of Compact Binary Mergers."

Davide Lazzati also won a $55K NASA grant for his project "Prompt Gamma-ray Emission from Cocoon Internal Shocks in Binary Neutron Star Mergers." Lazzati and his team of theorists have confirmed that last year's union of two neutron stars did, in fact, cause a short gamma-ray burst. The findings, published in Physical Review Letters, represent a key step forward in astrophysicists' understanding of the relationship between binary neutron star mergers, gravitational waves and short gamma-ray bursts.

Ethan Minot received the College of Science's **Milton Harris Award in Basic Research** for his impressive accomplishments as a scientist. Minot has built a world-class materials physics laboratory for the study of the structure and properties of carbon nanomaterials and devices

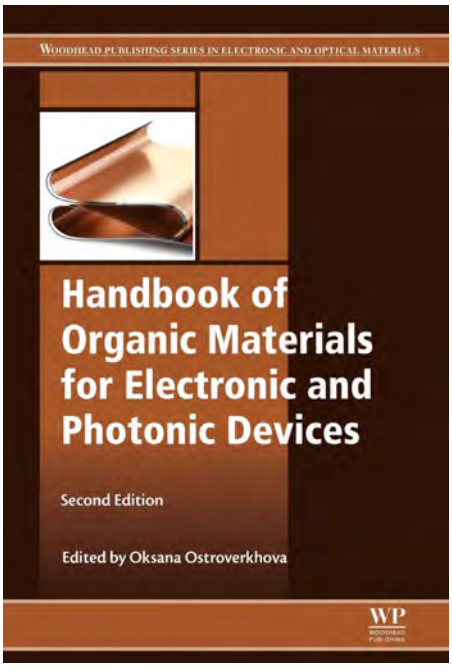
Oksana Ostroverkhova

Left: Xylindein is a pigment produced by fungi from genus Chlorociboria. This pigment causes green staining of wood infected by the fungi.

for nanoelectronics. His research at Oregon State has pushed the limit of fundamental properties of nanoelectronic devices, which have a broad range of applications to biosensing and solar energy harvesting. Some of his achievements include: identifying the fundamental noise mechanism that limits the performance of graphene biosensors in liquid environments; becoming the first to electrically generate and detect single point defects; reaching a new level of control over point defect chemistry; and other pioneering advances in the development of high-quality nanodevices and biosensors. Ethan recently received a collaborative two-year $400K NIH BRAIN initiative grant for the project "Flexible active electrodes for frequency-multiplexed large-scale neural recording."

Physicist **Oksana Ostroverkhova**, a leading expert on organic electronics, is the editor of the second edition of Elsevier Publishing Company's "Handbook of Organic Materials for Electronic and Photonic Devices." This 911-page handbook provides an overview of the materials, mechanisms, characterization techniques, and structure property relationships of organic electronic and photonic materials and describes the latest advances in the field. Oksana selected the topics, solicited contributions from the authors, and edited the entire book. The result is a comprehensive overview of a quickly-developing field. This is the second handbook that Oksana has edited. The first, "Handbook of Organic Materials for Optical and (Opto)Electronic Devices," appeared in 2013 and was published by Woodhead Publishing.

Oksana Ostroverkhova received a three-year, $450K NSF grant for her project "Designing light-matter hybrid states for high-performance organic (opto)electronics." She also leads a project supported by another three-year $410K NSF grant entitled "Naturally produced fungal compounds for organic (opto)electronics." Here she is furthering research on the discovery she and collaborators made of a highly durable organic pigment that has been used by humans in artwork for hundreds of years, that has a promising possibility as a semiconductor material. Findings suggest it could become a sustainable, low-cost, easily fabricated alternative to silicon in electronic or optoelectronic applications where the high-performance capabilities of silicon aren't required. Optoelectronics is technology working with the combined use of light and electronics, such as solar cells, and the pigment being studied is xylindein. This research, whose findings were recently published in MRS Advances and ACS Omega, represents the first use of a fungus-produced material in a thin-film electrical device.



Weihong Qiu has received a five-year prestigious National Institutes of Health award for $1.5M to further his research project, "Mechanistic Analysis of Kinesin-14 Motility and Regulation for Bipolar Spindle Assembly."

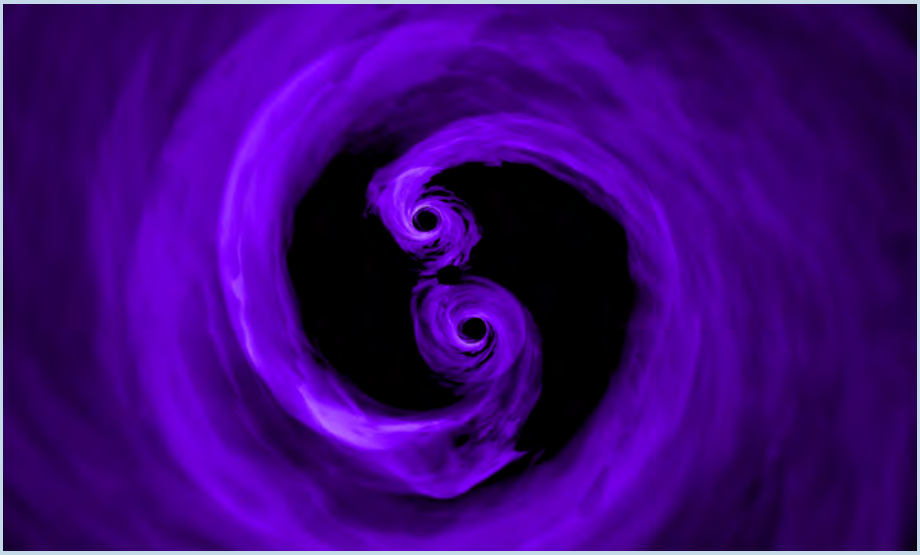
Physics Department Head **Heidi Schellman** received a three-year, $665K NSF award for her project "Experimental Neutrino Physics." Schellman's project studies the properties of neutrinos using what we know and what we can learn about neutrinos as probes of Physics Beyond the Standard Model to address open questions about the universe, as well as fundamental questions including why the Higgs mass has the value it has and why there is no antimatter in the universe.

Heidi Schellman and graduate student **Maggie Greenwood** are working on the data handling and analysis systems for the Deep Underground Neutrino Experiment, an ongoing global collaboration at CERN, often referred to as the European Laboratory for Particle Physics. The project signals the start of a new chapter in the story of the international Deep Underground Neutrino Experiment (DUNE) after the largest liquid-argon neutrino detector in the world has just recorded its first particle tracks.

Gravitational waves from supermassive black holes

Gravitational wave astronomy brought the first direct observations of collisions of black holes in 2016 – an observation that *Science* magazine deemed "the discovery of the year." In 2017, the new field brought us observations of two neutron stars colliding – which Science magazine again proclaimed the discovery of the year.

Physicists and astronomers are now searching for gravitational waves from the collisions of supermassive black holes. Galaxies host supermassive black holes at their cores which are expected to form binaries and collide when two galaxies merge.



An image from a simulation of the light emitted by a supermassive black hole binary system surrounded by a disk of gas viewed from above the plane of the system.
Credit: NASA's Goddard Space Flight Center

Congratulations to **Bo Sun** who was awarded $740K as part of a five-year National Science Foundation (NSF) CAREER Award for his project, "Understand the multiplexing and communication in multicellular sensory response."

Bo Sun also won this year's Medical Research Foundation of Oregon 2019 Richard T. Jones New Investigator Award. The award recognizes a new investigator who shows exceptional promise early in a career in biomedical research. It includes a cash award of $3,000, a commemorative award and a ceremony at OHSU this fall.

Physicist **Janet Tate** received $25K from the Alliance for Sustainable Research – National Renewable Energy Laboratory (NREL) for her project, "Center for Next Generation Materials by Design – OSU."

Welcome Xavier Siemens

EXPANDING OUR ASTROPHYSICS PROGRAM

Xavier Siemens joined the Physics Department in spring as professor of physics. His focus is "super-massive black holes," the largest type of black holes which are millions to billions of times the mass of the Sun.

Siemens comes most recently from the University of Wisconsin-Milwaukee (UWM). A leading expert in gravitational-wave astronomy, he has been a member of the Laser Interferometer Gravitational-Wave Observatory (LIGO) Scientific Collaboration since 2002. The LIGO project was created to detect gravitational waves from the cores of exploding stars, from colliding black holes and from rapidly rotating neutron stars in our galaxy. He participated in its Burst Search Group, as well as the Neutron Star Search Group.

Siemens is part of the Leonard E. Park Center for Gravitation and Cosmology and Astrophysics at UWM. The group, which includes around 50 researchers, searches for gravitational waves from gamma-ray bursts, neutron-star and black-hole collisions, cosmic strings and rapidly spinning neutron stars. Recently,

their work was instrumental in the LIGO discovery of gravitational waves from colliding black holes in 2015, which was awarded the 2017 Nobel Prize in Physics. Their work led to the subsequent discovery of multi-messenger emission from colliding neutron stars.

At UWM, Siemens directed a National Science Foundation Physics Frontiers Center, the North American Nanohertz Observatory for Gravitational Waves, or NANOGrav. It contributes to three of NSF's 10 Big Ideas: Multi-messenger astrophysics, Harnessing the data revolution and NSF INCLUDES. Siemens hopes to establish a similar center at OSU.

Siemens, who is originally from Madrid, Spain, will significantly expand physics' Ecampus presence by teaching numerous online courses, including a new introductory course called "Descriptive Astronomy: Stars and the Universe."

To date, Siemens has received more than $29.34 million in funding from NSF and has authored over 250 publications. He received a 2010 NSF CAREER award for his project, "Gravitational wave astronomy and a new generation of gravitational wave astronomers."

Meet Fred DeAngelis

ENHANCING LAB LEARNING

We are pleased to welcome **Fred DeAngelis** as the Physics Department's new director of laboratories and instructor. He supervises the undergraduate physics labs, supporting the lab curriculum and teaches introductory courses.

DeAngelis' initial goals are to modernize the lab curricula, develop student instructors and streamline operations of the physics labs.

DeAngelis earned a B.S. in engineering physics from Washington University in St. Louis, and a M.Ph. in astronomy and Ph.D. in physics from Rutgers University. He has authored 14 peer-reviewed articles and holds 28 U.S. patents. As a postdoc, he researched theoretical nuclear physics at the University of Paris and the Hahn-Meitner Institut in Berlin. Next, he worked in the Research Division of Milliken & Company, a privately held textile and chemical manufacturer in Spartanburg, South Carolina, where he specialized in thermal and electrical conductivity in textiles, switching his focus to patents and products.

He then worked as associate professor at Queens University of Charlotte where he reinstituted introductory physics courses, adding calculus-based physics to the curriculum, created a new major in physics and developed "Physics in Motion," a program that introduces physics to elementary students using professional dancers. He also served as vice president of the Charlotte Amateur Astronomers Club.

SPOTLIGHT

MOVEMENT AND FORCE

Bridging the laws of physics and the complexity of life through biophysics research

Using advanced imaging and analytic tools, two physics faculty members are driving high-impact research that reveals the inner workings of movement and force that drive phenomena at molecular and cellular levels. Their groundbreaking discoveries shed new light on biological systems and processes that could lay the groundwork for better cancer therapies.

An exciting frontier in physics, biophysics uses the principles and techniques of physics to study living things and how they work, from the functioning of biological molecules like proteins to the activities of cells and living organisms. Directional movement and force generation – two subjects that are central to a wide array of pure "physical" phenomena that physicists are keenly interested in studying – are readily manifested in complex biological systems.

Inside human cells, many protein molecules need to travel long distances between their birthplaces (the places proteins are made) and workplaces (the places proteins conduct biological functions). In most cases, proteins rely on active directional transport rather than passive diffusion to complete the travel. Biophysicist **Weihong Qiu**'s research lab studies these processes deeply. His team discovered new knowledge on the design of molecular motors, paving the way toward novel cancer treatment. Qiu's research team uses an interdisciplinary approach that combines chemical biology, structural biology and single-molecule light microscopy – a microscopy method that makes it possible to directly visualize the movement of individual motor proteins.

His research involves kinesins, focused on understanding the design and operation principles of kinesin-14 motors. These tiny, protein-based motors utilize microtubules to carry cargo between the center and the periphery of a cell. Microtubules are microscopic tubular structures that have two distinct ends: A fast-growing plus end and a slow-growing minus ends. Microtubules help make up a cell's skeleton.

The motors convert chemical energy into mechanical energy to generate the directional movements and forces necessary to sustain life. Most kinesins only interact with one microtubule at a time; however, kinesin-14 prefers to bind to two different microtubules. Qiu's research reveals that to accommodate that functional need, these kinesin-14s have evolved to have a rigid middle piece. His team discovered that when the stiff waist was replaced by a flexible polypeptide linker, the ability of the kinesin to function normally was severely compromised and it was no longer able to bind two microtubules at once. The results imply a novel therapeutic approach to cancer therapy: To target the waist region of the motor protein to hinder its mobility, thereby thwarting the transport of cancer cells.

A theoretical physicist by training, **Bo Sun** has shifted his research focus to biophysics, a rare feat. His team investigates the plasticity of metastatic cancer cells — that is, the ability of cancer cells to change their physiological characteristics. Cancer cell plasticity contributes critically to the process of metastasis, which occurs when cancer cells break away from where they first formed, travel through the blood or lymph system and form new tumors in other parts of the body.

Even though metastasis causes 90% of cancer-related deaths, there are no effective treatment options. Sun and his team aim to change that. By uncovering the causes and consequences of cell plasticity, they are discovering new knowledge that will lay the groundwork for better approaches to cancer screening and treatment.

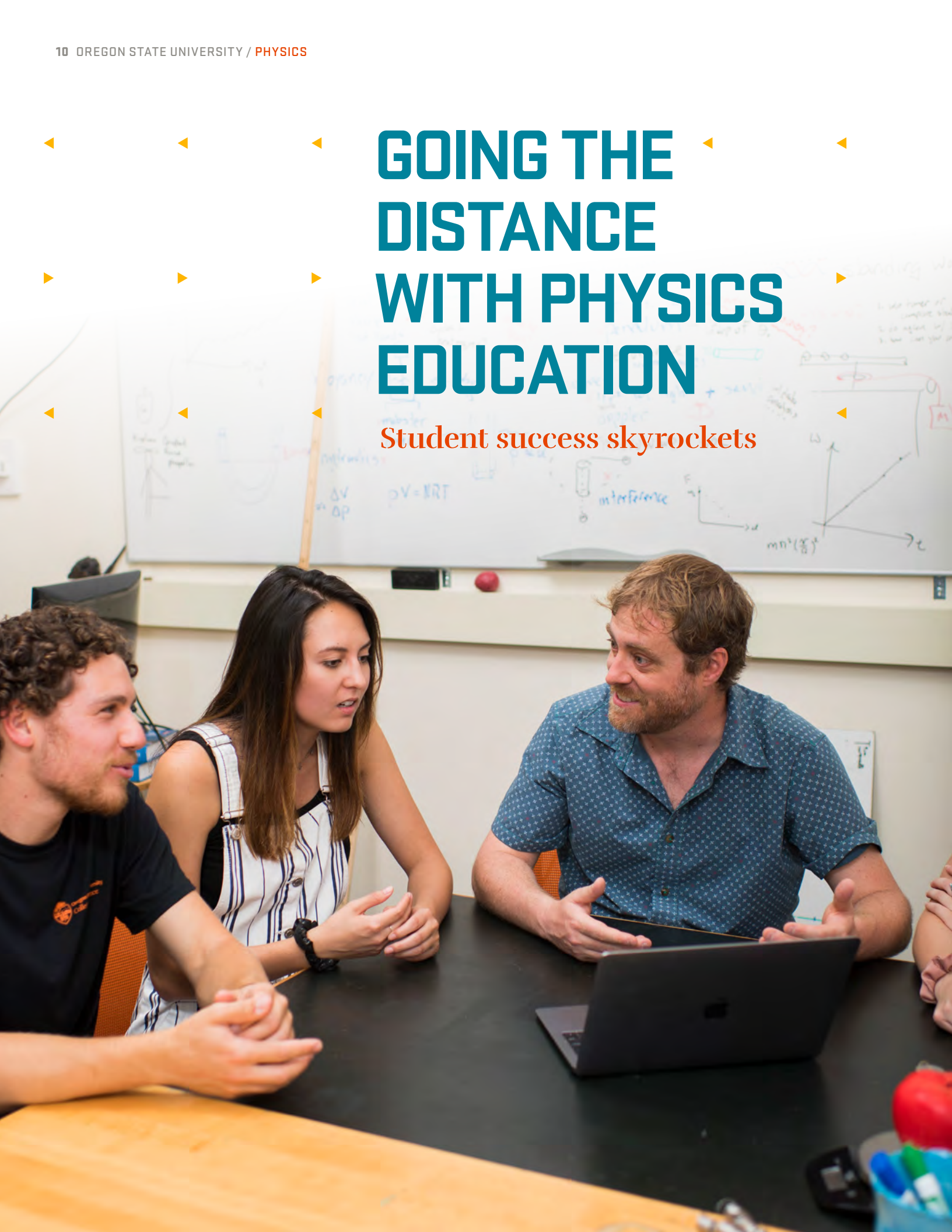
Sun's Collective Cell Biophysics Lab has developed methods for cell phenotype tracking with deep-learning, bioengineering of the cancer microenvironment, and computational modeling of 3D cell migration. Testing breast cancer cells in the lab, Sun determined that cancer cells can easily transition from different phenotypes – the microbes' observable characteristics and behavior – via multiple pathways. When one mode is inhibited by therapeutics, cancer cells simply switch to another phenotype. The transitions occurred spontaneously, facilitated the invasion of a tumor, and were sensitive to the mechanics of the extracellular matrix.

He seeks to further clarify the internal dynamics of multicellular metastatic solid tumors, which will shed more light on potential cancer therapies. If scientists are able to inhibit a cell's path and its switch into another migration phenotype, they can stop the cancer cells from metastasizing.

Bo Sun

GOING THE DISTANCE WITH PHYSICS EDUCATION

Student success skyrockets



KC Walsh "flipped the classroom" in the Introductory Algebra-based Physics series.

Successful Physics 20X series goes online

Following the tremendous success modernizing the curriculum in the Introductory Algebra-based Physics series, instructor KC Walsh and a team of faculty members and students have designed a fully online version of the flipped classroom curriculum. The sequence is going live this fall.

The Physics Department, recognized as one of the country's most pioneering undergraduate physics programs, was one of three in the country to win the American Physical Society's award for Improving Undergraduate Education in 2018.

Five years ago, Walsh transformed introductory physics classes at OSU by reversing the traditional learning environment. In flipped classrooms, students receive course content online outside of the classroom, freeing up "precious classroom time" for active learning. Research shows active learning to be a far more effective way to learn and understand the material.

"The flipped classroom model is a student-centric classroom model where the attention is on the students rather than the instructor," Walsh said. "Much of physics education research for the past 30 years can be summarized into two major statements: Students learn best by actively engaging in problem-solving and critical thinking; and they learn physics best by talking with peers, guided by experts."

The results of the flipped classroom model were dramatic, leading to a marked increase in course satisfaction and a change in the drop-fail-withdraw rate from 36 percent to only 12 percent, all without decreasing learning gains. "That's a huge difference. That means that we're passing 25 percent more students," he said.

Now Walsh and his team are bringing the whole course online, broadening the reach of accessible physics education. As in the campus classes, distance learners receive course content on the class website via links to high-quality recorded lectures, practice problems, open-source textbooks, educational websites and simulations. Their work will be directed by the course's Daily Learning Guide on the class website.

Vitally important, the active engagement component of the flipped online classroom will be robust – with distance students applying key concepts guided by peers, just as in the physical classes. In the live online "virtual classroom," students will work in groups on problem-solving and critical thinking using real-time polling, video and shared digital whiteboards.

Walsh's team addresses some of the major hurdles students experience in distance learning, such as lack of community engagement, by creating opportunities for students to connect in real-time online. Distance learners will receive unprecedented real-time help from teaching assistants, learning assistants and supplemental instruction in a new virtual "Wormhole" study center that parallels the physics on-campus study center.

Labs will focus on experimental design and data analysis, progressing from "prescribed labs" where students follow instructions, to inquiry-based labs in which students design the experiments themselves.

This project is an exciting opportunity to satisfy OSU's land grant initiative to bring education to the masses. Walsh and his team aim to address students' challenges and to continually innovate new curriculum and learning technologies. We will report on successes and challenges in the next department newsletter. Stay tuned!

Congratulations to our 2019 Ph.D.s!

LEE GROUP
Ali Moussavian. *Now at KLA Tencor.*

QIU GROUP
Allison Gicking. *Postdoc, Pennsylvania State University.*

SUN GROUP
Amani Alobaidi. *Faculty member, King Saud University, Saudi Arabia.*

TATE GROUP
James Haggerty. *Engineer,Intel.*

Bethany Matthews. *Postdoc, Pacific Northwest National Laboratory.*

Chris Reidi. *Now at Apple.*

GIRE GROUP
Michael Vignal. *Postdoc, University of Colorado, Boulder.*

OUTREACH AND ENGAGEMENT

Bringing physics education to the world

GLOBAL OUTREACH

Theoretical physicist **David Craig** is the co-chair of the American Physical Society's EP3 Project – Effective Practices for Physics Programs. They are leading a five-year, multimillion-dollar effort to help physics departments at colleges and universities around the nation improve their programs and instruction. The NSF funded project aims to increase representation in what is historically one of the least diverse STEM disciplines.

"Whether the task is increasing the number of physics majors, improving climate and inclusivity or introducing research-based pedagogical practices into physics classrooms, we can help. We want to make current know-how readily available to every physics department in the U.S.," Craig said.

Collaborating with the American Association of Physics Teachers, the EP3 Project's first mission is creating a self-assessment guide for undergraduate physics programs founded on documented practices and linked to measurable outcomes. They will provide training and support structures to assist with implementing the information in the guide, allowing departments to create, assess and improve their individual programs while responding to local constraints, resources and opportunities.

"In recent years there has been a growing emphasis on accountability in higher education, but individual departments frequently create programs and their assessments entirely on their own, without the benefit of the experience of the broader physics community or from published research," Craig said.

Craig noted that many challenges face the discipline of physics as a whole, including:

- Students, especially from underrepresented groups, are not learning as much as they could in physics courses.
- Many undergraduate physics programs prepare students better for research positions, even though over 65 percent of students graduating with bachelor's degrees in physics do not pursue a graduate degree in physics or astronomy.
- Physics programs are not producing enough well-prepared high school physics teachers to meet national demand.

Project leaders like Craig believe the EP3 Guide will have the potential to transform how physics departments engage students in their education. More information about the EP3 Project is available online at ep3guide.org

Overcoming obstacles for physicists in the developing world

Kennedy Reed, a theoretical atomic physicist for the Lawrence Livermore National Laboratory, presented our 38th annual Yunker Lecture. In his talk, "Physics in Africa," Reed shared his own experiences as a visiting scientist in African universities. His lecture highlighted challenges many physicists face when conducting research

Kennedy Reed

and training students in African universities, particularly the lack of widespread funding and resources.

Reed also chairs the International Union of Pure and Applied Physics Commission on Physics for Development, a massive worldwide organization with 60 member countries and 20 commissions. The organization fosters international cooperation in physics, working to improve the conditions for physics in the developing world.

The Department of Physics' annual Yunker Lecture was first established in 1981 in honor of Dr. Edwin Yunker by his wife, daughter, and their family. An Oregon State physics professor (1925-68) and department chair (1949-66), Yunker's legacy continues to live on through the generous support of friends through the years.

Taking physics out there

TAPPING BIG INDUSTRY APPLICATIONS

Matthew Graham has always taken a global outlook to physics, coloring outside-the-lines of traditional academe. Coming from a background in spectroscopy of novel condensed-phase electronic materials, his lab's novel optoelectronic measurement tools have resulted in substantial lead-PI industry-related grants from Apple, Voxtel, ThemaWatts and Hewlett Packard. These synergistic relationships have resulted in numerous publications, seven grants and internships for his undergraduate and graduate students. Ph.D.s are given the opportunity to develop as scientists as they are forced into expert-role relationships within the industry.

While this approach may slow down student publication output, the results suggest that students benefit greatly from the experience and excitement of seeing fundamental optical physics solve real-world problems, in many cases providing a novel solution that cannot be contracted out by the company. In partial recognition of his outward-looking approach to physics and photonics, this year Graham was one of 10 ambassadors elected to represent the Optical Society of America (OSA) in 2019. As an ambassador, Graham will receive funding to give lectures for OSA Member Chapters at universities in the West/Central America and Canada. Ambassadors also help create OSA policy and programs through multiple conferences. While the substantial travel funding will only last one year, Graham will remain an ambassador to the Optical Society indefinitely.

Mathew Graham

Illuminating the greats

David McIntyre presented a public lecture in spring on the 2018 Nobel Prize in Physics, awarded to Arthur Ashkin, Gérard Mourou, and Donna Strickland for their "groundbreaking inventions in the field of laser physics." McIntyre, who now uses Ashkin's novel optical tweezers in his own lab, discussed the significance of this invention for him, as well as what Strickland and Mourou's discovery of "high-intensity, ultra-short optical pulses" means for students and researchers around the world.

Next generation scientists

Last January, undergraduate volunteers from the Department of Physics presented kid-friendly science demonstrations at the annual Family Science Night at Franklin School, Corvallis, among a series of local outreach events. Their hands-on demonstrations focused on the electromagnetic spectrum, from invisible infra-red wavelengths to ultra-violet wavelengths, and everything in between. With an infra-red camera, kids could discover warm hand prints on the table, or even show their parents heat leaks in a model house. At the other end of the spectrum, kids played with fluorescent markers, using a UV lightbox to bring their artwork to life.

MAKING US PROUD

Alumni continue the tradition of success

THE APOLLO CHRONICLES – HIGHLIGHTING THE EARTH-BOUND ENGINEERS BEHIND AMERICA'S ICONIC MISSION

To coincide with the 50th anniversary of the first moonwalk by the astronauts of Apollo 11, alumnus **Brandon Brown** (Ph.D. '97) published *The Apollo Chronicles: Engineering America's First Moon Missions* this summer with Oxford University Press.

Unlike many accounts that focus on the journey of astronauts, Brown's book recounts the experiences of the earthbound engineers – the men and women who worked behind the lights. Brown, the son of an Apollo engineer, chronicles the work of the engineers driving the endeavor, carrying audiences through tense deadlines and technical miracles.

A review of *The Apollo Chronicles* in the July 8 edition of *Nature* and *American Scientist* explained, "Brown shows the engineers meeting tough deadlines and performing technical miracles, drawing schematics around the clock, making mistakes, coping with warning lights that blinked at the worst possible time, and regrouping after the tragic death of three astronauts in a fire that broke out in the capsule during a simulated countdown early in 1967."

Brown earned his Ph.D. at OSU studying vortex depinning in single-crystal YBaCuO in Janet Tate's group. He subsequently spent a year studying science writing at the University of Santa Cruz, earning a post-doctoral certificate in science communication. Now, a professor and chair of physics at the University of San Francisco, Brown's research includes work on superconductivity and sensory biophysics.

"Brown shows the engineers meeting tough deadlines and performing technical miracles, drawing schematics around the clock..."

NATURE* AND *AMERICAN SCIENTIST

WHERE ARE THEY NOW?

Physics graduate and undergraduate students pursue a wide range of careers, using the technical skills and scientific communication skills they acquire at OSU Physics in many different ways. We checked in on some of our graduates from the 2000's to see where they are now. We found them in different careers, different states and different countries, all making their mark on the world in a positive way.

Zach Evenson (B.S. '04) was recently promoted to editor in Physics and Materials Science at Springer Nature, part of the Nature family of premier scientific journals. Evenson earned his master's and Ph.D. degrees in Germany at the Universität Saarlandes, studying bulk metallic glasses. He then took postdoctoral appointments at the Universität Saarlandes and the German Aerospace Center, followed by a research scientist position at the Technical University of Munich. He moved to Springer last year as an associate editor.

Briony Horgan (B.S. '05) is an assistant professor of Planetary Sciences at Purdue University in Lafayette, Indiana. She did her senior thesis in Janet Tate's lab and went on to earn a Ph.D. in Astronomy and Space Sciences at Cornell University, followed by a postdoctoral fellowship and a faculty research associate position at Arizona State University. An expert on lunar and Martian geology, Horgan is also a Participating Scientist on NASA's Mars Science Laboratory rover mission and a co-investigator on NASA's upcoming Mars 2020 rover mission. She has been in the news recently as several lunar and Martian probes are currently active.

Jeff Macklem (B.S. '09) is a high school science teacher in the San Juan Unified School District in California. He has been with the district for nine years and is currently teaching in the classroom where he himself learned science in high school. At OSU, Macklem was a member of the Society of Physics Students and did his senior thesis in David McIntyre's lab. He loves being in the classroom and has participated in a number of programs to strengthen his range of teaching capabilities.

Connor English (B.S. '05) is an entrepreneur, founder and CEO of PVBid, a company of Solar Estimating Consultants near Denver, Colorado. Building on his experience of nine years as an engineer at Sun Light & Power designing and building solar electrical systems, English branched out with his own start-up company. PVBid was awarded a DOE SunShot Catalyst Grant in 2015.

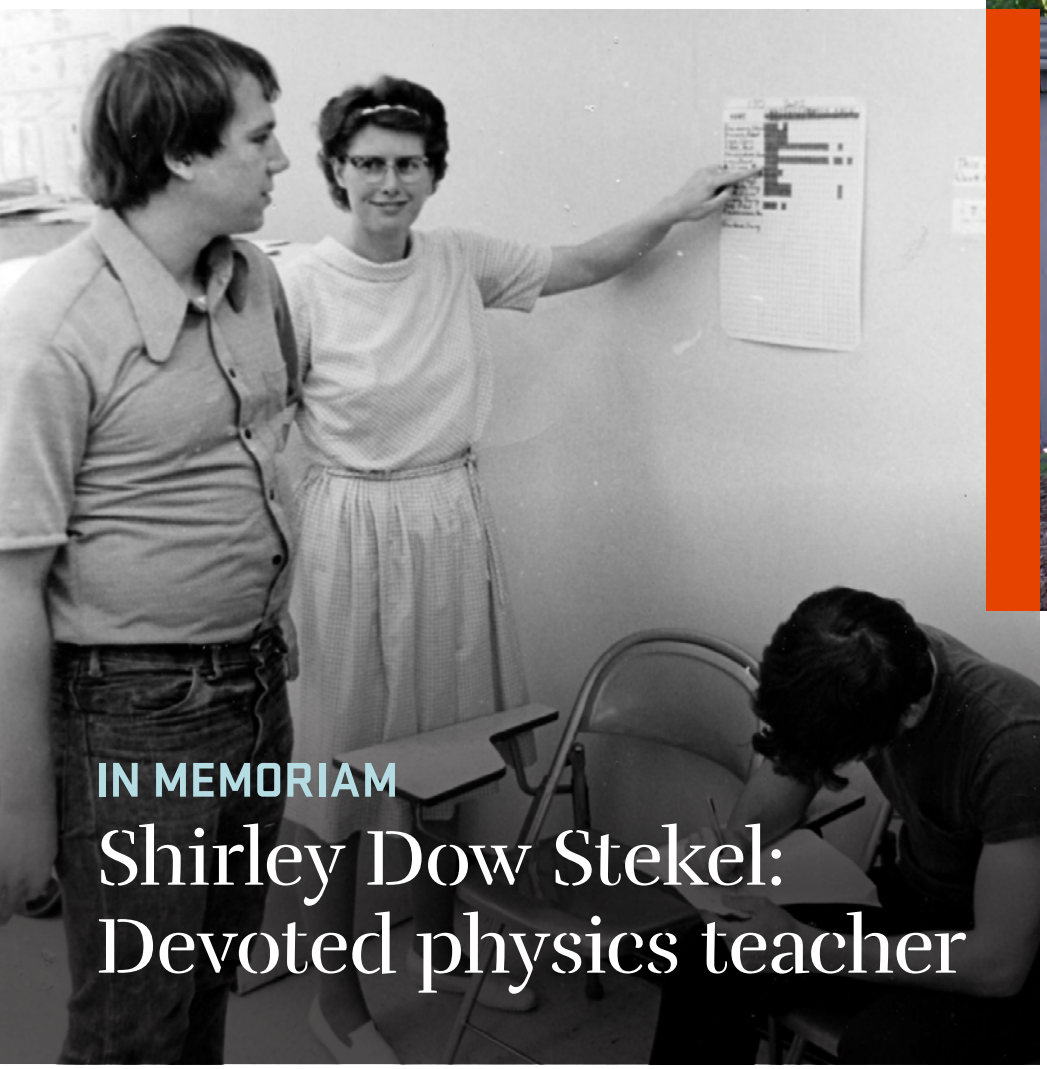
EQUIPPING YOUNG SCIENTISTS

Tektronix, a Beaverton-based maker of high-quality advanced measurement electronics equipment such as oscilloscopes, has donated 12 arbitrary function generators to the Physics Department. A function generator is a piece of electronic equipment that can output user-designed electronic waveforms, and has a wide range of uses for both testing and measurement in the laboratory. The donation, valued at nearly $11K in retail prices, was an in-kind donation supporting laboratories in a range of undergraduate physics courses, including electronics, computer interfacing and Paradigms in Physics. Tektronix has a long history of close partnership with Oregon State University, and hires many OSU graduates.


Zach Evenson


Briony Horgan


Jeff Macklem



IN MEMORIAM

Shirley Dow Stekel: Devoted physics teacher

Shirley Dow Stekel (B.A. '58, M.A.'61) was a physics trendsetter and a teacher at heart. As the first woman to earn a physics master's degree at OSU, her deep interest was in physics the discipline –which she perceived as "fundamental to everything from elementary education to engineering" – and all the more in teaching physics effectively. A physics professor for 30 years at the University of Wisconsin-Whitewater, Shirley worked tirelessly to make physics an accessible subject for students and school teachers. When Shirley and her husband Frank visited OSU's campus in 2015 and toured the Department of Physics, they were impressed. Shirley especially appreciated its leading-edge teaching methods similar to those that she and Frank had also developed at Whitewater – such as, individualized instruction, hands-on work in small groups and the incorporation of computers, rather than simply giving "black board talks" in large lecture halls.

When Shirley died in the spring of 2018, Frank thought it fitting to donate to OSU's Department of Physics in her honor. His generous $150K donation to renovate a second physics studio classroom commemorates Shirley's devotion to effective physics teaching and her zeal to pass its fundamental concepts along.

"Shirley was proud of the science instruction she did with prospective elementary teachers," Frank said. "Traditional elementary teachers often avoided teaching physics because they thought it was hard and scary. She worked hard to integrate physics activities while preparing them to teach, like having them build their own circuit boards using aluminum foil instead of wire. Then they would actually do logic tests and determine if they had completed the circuit by testing it with a battery and a bulb. It was the sort of thing to show them that they could do it and it was not scary but, indeed, it makes sense."

This was in the 80's, but Shirley continued teaching well beyond her retirement, including as a master gardener helping with elementary school student programs until her death at age 83.

Raised much of her childhood in Rogue River, Oregon, Shirley always considered herself to be an Oregonian, a sentiment reinforced when she earned B.A. and M.A. degrees in physics from OSU. In 2016, Shirley wrote an article for the Spectrometer sharing her account as an eye-witness of the Physics Department's move to Weniger Hall. "The new building was a delight with lots of windows, good lighting, bright new labs with storage closets, many comfortable offices and a library/meeting room," she wrote.

Left: Shirley Dow Stekel was the first woman to earn a physics master's degree at OSU.

After a stint of teaching at Wayne State, in 1963 Shirley accepted a position as an assistant professor in the Physics Department of what is now the University of Wisconsin-Whitewater in 1965. It was at Whitewater that Shirley met Frank, a newly hired physics instructor at the university. After working together for several years, they were married in August 1967.

The first in her family to go to college, Shirley continued as a trendsetter through her role as a female physics professor and by continuing to work once they started a family. Frank shared home duties, but he readily acknowledges she did more. The couple had two daughters – Sharon, who became an industrial engineer at UTC Aerospace, died in January 2017; Sandra, a nutritionist, works at a dialysis clinic. Frank now lives with Sandra at Bristol, Wisconsin.

Shirley and Frank were on the faculty at Whitewater until their retirement. A lover of classical music, Shirley developed and taught a popular course that is still taught today: Physics of Sound and Music. In 2000, Shirley received a Lifetime Achievement Award from the Wisconsin Chapter of the American Association of Physics Teachers.

The renovated physics studio classroom will feature movable tables for 24 groups of three students, with computers and the ability to share their work with the rest of the class through the computers and cameras. The room is intended to be highly configurable to accommodate a wide range of teaching styles. Remodeling of the new physics studio classroom is likely to start next summer as the classroom is in use during the academic year.

Congratulations, alumni!

Weimin Han (Ph.D. '92) has been selected as an Intel Fellow. Weimin joins a select group of people so honored by one of the world's largest tech companies. He is currently Director of Thin Film Technology at Intel's campus in Hillsboro, Oregon, and has been with Intel since 1992.

Alex Dauenhauer (B.S. '10), was recently featured in Aerospace America for his work on helmet mounted displays for Lockheed Martin's F-35 stealth fighter. After graduating into a historically dismal job market, Dauenhauer first worked as a laboratory technician before landing a job with Rockwell Collins, which later became Collins Aerospace. Initially, Dauenhauer worked on the F-35 helmet mounted display sustaining team, which handles production issues, until he was hired as an engineer in the optical engineering department. Now his work focuses on ensuring displays offer pilots consistent video presentation at desirable brightness levels, by fine-tuning the luminosity of images produced with organic light-emitting diodes — carbon-based materials that turn electricity into light. The technology gives pilots unparalleled situational awareness allowing them to be more successful during night missions, such as aircraft carrier landings under overcast night skies without display symbols such as altitude and horizon line obstructing their field of view.

This summer **Leto Sapunar** (B.S. '18) taught at Astrocamp, a science academy in Idyllwild, California. He is now studying journalism in New York University's Science Health and Environmental Reporting Program.

Lockheed Martin F-35 stealth fighter

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