THE PHYSICS MAJOR

Department of Physics and Astronomy

SONOMA STATE UNIVERSITY

New SSU Observatory Grand Opening on September 8, 2017!

By Prof. Scott Severson

The Department of Physics & Astronomy is proud to announce the installation of a new observatory building! Responding to issues with the original 41-year old structure, we have replaced it with a state-of-the-art split roof observatory. We are in the process of refurbishing the telescopes and moving back to the new building in preparation for a Grand Opening on Friday, September 8, 2017. We are honored to have SSU President Judy Sakaki joining us for the ceremony (7:30 pm arrival, 8 pm ribbon cutting, followed by a reception and public viewing). So mark your calendars!

The original observatory, a 12 by 24 foot sliding roof structure that was constructed in 1976 through the efforts of Professors George Johnston, Joe Tenn and Gordon Spear, had served us well. The observatory was established at the darkest location on campus, on the southeast corner of campus just southeast of what was originally a football field and track. But the ravages of time required a plan for replacing a building that was losing its structural integrity. The roof had issues with the sliding mechanism and had recurring issues with water leaks. There had been water damage and mold in the interior because of the roof, the cinderblock walls had cracked in several places, and there had been intrusion of several species of pests. While the rodents and black widow spiders were unappreciated, the lizards have served as an unofficial mascot of the observatory.

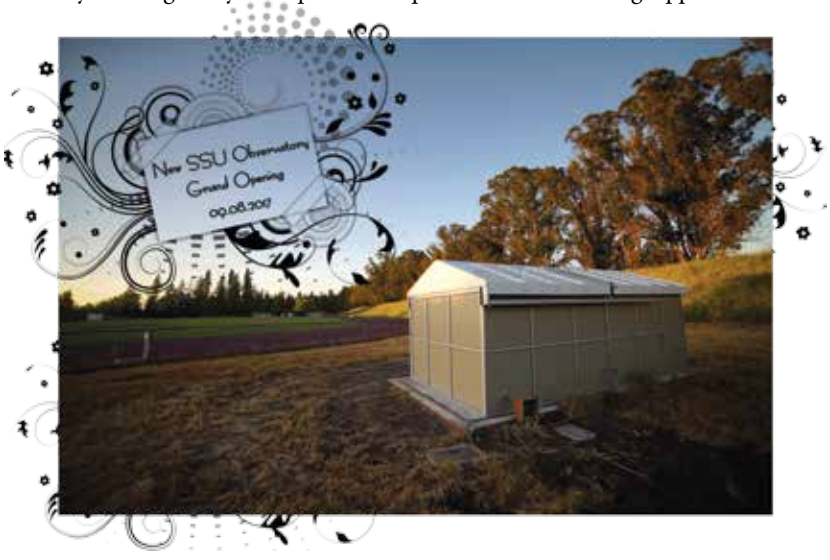
Bringing these issues last year to School of Science & Technology Dean Lynn Stauffer, we found an ally who helped us persuade Provost Andrew Rogerson to fund the demolition of the existing observatory and the construction of a replacement observatory on the original foundation. This allowed us to use the existing telescope piers, which are sunk into the ground to provide stability. The new building, a TELE-STATION 5 by Pier-Tech, is a 10 by 20 foot walk-in split roof observatory. Many a future student will appreciate that the powered roof opens with the touch of a button!

Throughout its history the observatory has been used to support classroom instruction, to support student-faculty research, and to provide Public Viewing Nights (PVNs) for the campus and for our surrounding communities. Courses that regularly use the observatory include: Astronomy 100, which now has a yearly enrollment of approximately 1000 students; Astronomy 231, the introductory lab; Astronomy 331, Astronomical imaging; and Astronomy 482, Advanced Observational Astronomy. Additionally, many student research projects (special studies and senior capstones) have used the observatory. These projects are a key defining part of our department's degree programs.

Public Viewing Nights have been scheduled approximately once a month during the academic year since the dedication of the observatory in 1976, routinely drawing hundreds of visitors. Faculty, staff, and student assistants and volunteers staff the events. The telescopes are pointed to various objects and the crew describes the nature of the objects and answers questions. There is generally a mix of students and people from the community. We have recently added amazing night photography of attendees (*http://www.phys-astro.sonoma.edu/observatory/index.html*) which introduces our guests to the power of digital astronomy.

The observatory instrumentation consists of two main, pier-mounted telescopes with capable drives and computer control, as well as one additional large (16" diameter) portable Newtonian and other small telescopes used on public viewing nights. The Epoch telescope, a 10-inch Newtonian f/5 optical system intended to be used for wide field digital photometry, rests on the west pier. And the Mathis Celestron 14-inch Schmidt-Cassegrain telescope that rests on the east pier is used for visual observing and spectroscopy. The instrumentation consists of a spectrometer and a modest format but fast CCD camera and astronomical filters.

The new observatory building will allow us to continue and expand our wonderful tradition of observational astronomy and public engagement. We are always looking at ways to improve the experience and are seeking support to upgrade the telescopes, astronomical instrumentation, and visualization equipment. I would be remiss if I didn't take this opportunity to thank the many current and former faculty, staff, and students who have devoted their time and energy to the observatory. While there are too many to mention them all by name, I'd like to thank: Lynn Cominsky, Gordon Spear, Tom Targett, Joe Tenn, Wes Fariss, Steve Anderson, Ryan McDaniel, and the many others who make this one of the real pillars of our department's success!



Capstone Research:
Fabrication and Characterization of Aluminum Oxide Nanopores

By Adam Smithson

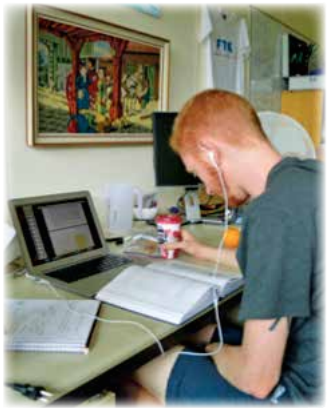
Anodization is an electrochemical process which induces oxidation on the surface of a metal substrate, similar to rusting, while part of the oxidized layer gets dissolved in the same acidic solution. Under ideal circumstances an ordered porous oxide can be created on the surface of the metal with nanometer scaled pores, creating ordered nanostructures. The purpose of this project is to use anodization to consistently fabricate hexagonally ordered nanopores on the surface of aluminum, along with observing the relationship between pore diameter and anodization voltage.

In this work, we used the Keck Microanalysis Laboratory to identify the parameters during the electropolishing and anodization processes to produce consistent pore sizes and hexagonal ordering. When I first joined Dr. Hongtao Shi in this project, the samples I created had nanopores in them, but with the parameters we were using the pores were not consistent in size, and did not have the hexagonal structure we were looking for. Most samples had a variety of tiny punctures in the surface, clusters of moderately sized pores connected to each other, and deep, large diameter pores all at the same time, and in seemingly random positions. We then optimized the variables of applied voltage for anodization, duration of anodization, number of anodizations, and duration of acid etching for a given anodization time.

This optimization led to the construction of hexagonally ordered nanopores with consistent diameters in our samples anodized at 40 V and 60 V. This ordered nanopore template can be used for practical applications such as magnetic data storage media, or the construction of nanowires for the discovery of new physics originated from such low-dimensional systems. After graduating from Sonoma State with my degrees in physics and mathematics, I plan to take some time working as a tutor while applying to graduate schools to get a Ph.D. in mathematics.

Capstone Research:
Particle Physics at CERN

By Michael Dobbs



The European Organization for Nuclear Research (CERN) is the largest physics laboratory in the world and home to the highest energy particle collider, the Large Hadron Collider (LHC). Physicists at CERN are on the brink of discovering new physics that can explain dark matter, dark energy, and the origin of the universe. The Higgs Boson was theoretically predicted by Peter Higgs and Francois Englert to explain why fundamental particles have mass and has been a staple of many new ideas in the field. In collaboration with Stanford physicists Zihao Jiang, Lauren Tompkins, and Michael Kagan, an attempt was made to characterize a machine learning algorithm that detects b-quarks. B-quarks primarily decay from the Higgs. Thus b-tagging is an important process in capturing interesting events occurring in the ATLAS experiment (such as $H \to b\bar{b}$, and the $t\bar{t}$ semi-leptonic and hadronic decays). A large improvement of the capturing efficiency of data and background rejection was made through analysis of the algorithm's response to various inputs. Two variables (pTFrac and dR) were consequently added to the algorithm input without compromising the classification errors of the algorithm. Consequently an increase in both the b-tagging-efficiency and non-b-rejection by ten percent was observed. The algorithm is currently undergoing further scrutiny in order to obtain higher tagging efficiencies.

Throughout this project, I have gained a thorough knowledge of machine learning algorithms and how they operate, studied particle physics under the instruction of physicists who have been working in the field for a lifetime, and gained cultural awareness from my encounters with the Swiss and French locals. After obtaining my physics and mathematics undergraduate degrees, I will attend the Wolfram Summer School in Waltham, MA, and afterwards travel to Italy to conduct particle physics research at INFN FAMU, Trieste.

Capstone Research:
Measuring an Exoplanet Transit

By KB Smith

My Capstone project involved measuring the change in brightness of star HAT-P-13 as one of its planets, HAT-P-13b, passed in front of it. The first part of the project was target selection. I knew that I wanted to measure the change of a star's brightness while experiencing a planetary transit, but some work was required to select the star. I used various calculations to find a star that would undergo a short and conveniently timed planetary transit: HAT-P-13 met these criteria. The next step involved taking the measurements using the Sonoma State Observatory's Newtonian telescope and CCD camera to capture images of the transit over the course of several hours.

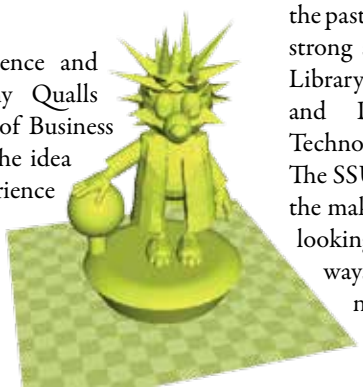
The images were then processed using PyRAF, an astronomical software package. The analysis involves using functions to combine the images to gather the information taken over the course of several hours, calibrate with the brightness from surrounding stars, and graph the change in brightness over time. This was a challenge due to the change in weather over the hours. However, after some corrections were made, a more precise measurement was found. It was a finding consistent with what was expected.

I would like to offer Dr. Severson my sincerest thanks for his assistance with this project. After my years of astronomy courses and tinkering with imaging technology, I am glad to have put this to use for my final project.

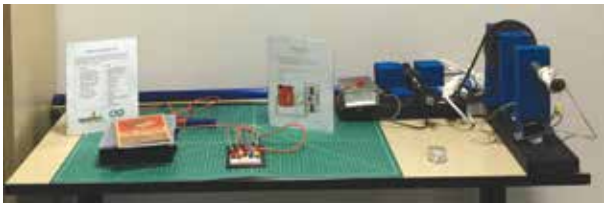
NSF Awards $580K for Innovation and Making

By Prof. Jeremy Qualls

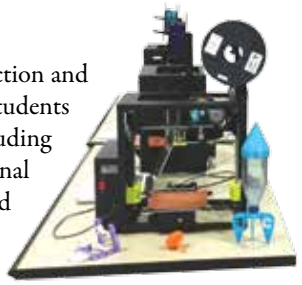
During the last decade there has been an increasing emergence of the "Maker" or Do It Yourself (DIY) culture across the United States. The Maker movement itself is much more than just making or building things. It includes a fresh mindset of sharing, creativity and problem solving. The National Science Foundation (NSF) has awarded SSU over half a million dollars to evaluate the impact of Makerspace courses on increasing the retention and success of STEM majors. The proposed work includes creating a centralized Makerspace, making course, and a systematic evaluation of the impact on student learning.



Last year, with support from School of Science and Technology Dean Lynn Stauffer, Dr. Jeremy Qualls partnered up with the Library and the School of Business and Economics to create a Maker experience. The idea was to create and pilot a sophomore year experience course and a new Makerspace. The result of last year's efforts was Science 220: Dream, Make, and Innovate and a 400 sq. foot pop-up Library Innovation Lab. During the last year, those seed efforts paid off through our successful NSF proposal, the approval of Sci 220 as an Area E ("Integrated Person") General Education Course, and the creation of a new 1800 square foot Makerspace in a new location in the Library. The efforts were featured in the latest SSU Insights magazine *http://sonoma.edu/insights/* and the school newsletter: *http://www.sonoma.edu/scitech/newsletter/newsletter_fa16.pdf*



The NSF grant was written by Prof. Qualls (PI) and Prof. Lynn Cominsky (Co-PI) and includes other SSU faculty as Senior Personnel. The three-year NSF funding covers everything from equipment to staffing and training. Science 220 is designed to introduce students to methods and technologies needed to create as well as engage in self-reflection and a consideration of societal needs. Students begin with a four-week boot camp including digital fabrication, informational resources, electronics, materials, and rapid prototyping. During this time students begin to develop real world skills, engage in self-examination, and identify and investigate problems in the world that are personally relevant. After the boot camp is over and students have identified a problem, they begin to work with community partners and experts to develop a solution.



The rapid development of SSU's Making facility during the past year is due in part to the strong support from the SSU Library Dean Karen Schneider and Director of Library Technology Jonathan Smith. The SSU Library has embraced the maker movement. They are looking to lead the Makerspace efforts on campus and are examining ways to make this a signature resource. On April 20, 2017, the new SSU Library Makerspace had a "ground-making" opening event as part of President Sakaki's investiture celebration. The Makerspace will be equipped with 3D printers, laser cutters, CNC mills, a vinyl cutter, a sublimation printer, scanners, VR systems, sewing and leather, and a huge arrangement of tools and supplies. Regular workshops and open hours begin Fall 2017. Workshops include 3D modeling to board game creation to cosplay costumes.

If you would like to be part of the Maker efforts at SSU please contact Professor Jeremy Qualls at quallsj@sonoma.edu. We are also taking donation of arts, crafts, and tools for use in the space. If you have old equipment or hobby supplies you are no longer interested in, please let us know.

Capstone Research: Speckle Interferometry

By Christopher Watkins

Over the past year I have been working with Dr. Sanyoung Gee to create a functioning electronic speckle pattern interferometer to be used for the vibrational analysis of various surfaces. When laser light is shined onto the surface of a rough object, a speckle pattern is obtained which can be combined with a reference beam to create an interference pattern. When this interference pattern is imaged, both while the surface is still and when it is vibrating near one of its normal modes, a correlation fringe pattern can then be obtained through the subtraction of the two images. This fringe pattern allows for the detection of surface displacements with a sensitivity of one half the wavelength of light used.

The first fringe patterns that I was able to obtain came from a round drum made of paper driven by a loud speaker that was vibrating near one of its fundamental modes. The lessons I have learned conducting this research have taught me how to trouble-shoot complex problems as well as how to work independently in a research environment. These will be valuable lessons for me in the future as I plan to attend graduate school after taking a year off.

Capstone Research:

The Physics of Guitar Tuning

By Michael Schwartz

Every guitar has an inherent issue with intonation–being properly in tune with itself. Electric guitars, in particular, need to be adjustable to accommodate the various gauges of strings and wide diversity of tunings that musicians use. Because of modern recording techniques, any improper intonation is noticeable, and unpleasant, even to untrained listeners. For my project, an adjustable guitar was built to measure how sharp or flat each note on the guitar becomes as you move along the fret board. The adjustable guitar in conjunction with Mathematica software helped determine the correct string-adjustments for proper intonation of a guitar using standard tuning (EADGBE) and 25-inch scale-length.

This project put into perspective how hard it is to build a properly working guitar. Every time it seemed like I was finished with the adjustable guitar, something needed to be changed or removed. I always thought of an electric guitar as an instrument with strings that were adjusted to fit the body, but now I realize that the adjustments are tailored to make the guitar fit the string to produce proper intonation.

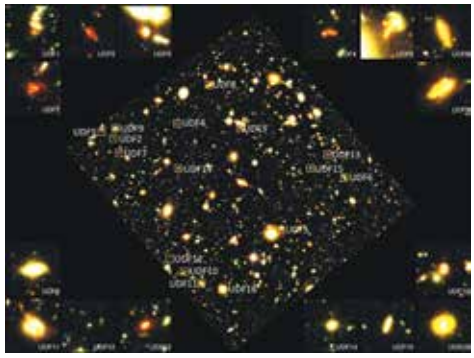
After graduation, I plan on continuing the project to gain an understanding of intonation with different string types and tunings. I want to be able to build an adjustable nut (the upper string termination) for electric guitars so musicians are able to achieve proper intonation easier and more effectively. Current electric guitars lack such an adjustment.

Galaxies and Whisky Do Mix!

By Prof. Tom Targett

My research this year has focused on new results from the Atacama Large Millimeter Array (ALMA). Using this radio interferometer, we obtained images covering the full 4.5-arcmin^2 of the Hubble Ultra Deep Field. Sources detected at these wavelengths (1.3-mm) possess massive dust-enshrouded star-formation rates (SFR > 200M solar masses/yr), and likely play a significant role in development of the most massive galaxies known today. I hope to develop this research with future generations of students at Sonoma State.

In addition, I will be launching the department of Physics and Astronomy's first ever course in Scottish whisky during the summer of 2017. This course focuses on the distilling and production of Scotch Whisky from grain to glass, and I'm sure will have a certain appeal to many.



This year's senior student with the highest GPA giving thoughts on:

1) What will be the hot topics in physics in 50 years from now?

2) What do you think the world will be like in 100 years?

Predictions for the Future

***By** Michael Dobbs*

Predicting the future is a dangerous game! Physics has taken our comprehension of the world to great heights throughout history: Rutherford's gold foil experiment gave us the experimental evidence to theorize about the existence of a nucleus, Bohr's model of the atom revolutionized our understanding of how the atom operates on the quantum level, and Einstein's General Theory of Relativity describes how the gravitational field acts on objects in our universe. What more does physics have to offer in our near future?

Physicists hope to discover the underlying reasons for the existence of dark matter, dark energy, and the expansion of the universe. They aspire to explain the physical connection between the strong, weak, and electromagnetic forces and the gravitational force, which under the current theory do not converge at high energy. I imagine the most influential advances in physics in the next few decades will be the creation of a refined theory of gravity that coincides with our current quantum theory, the innovation of a natural near-room-temperature superconductor, and the discovery of a new elementary particle in a collider. The creation of a Grand Unified Theory would consequently alter our ideas of how nature itself works and reveal underlying truths regarding our cosmological origin. Fabrication of a near-room-temperature superconductor will revolutionize the concept of power consumption and allow us to create much more energy efficient products. The unveiling of another elementary particle would transform our notion of quantum physics and allow for further theory regarding additional quarks, leptons, and bosons in the particle zoo we call the Standard Model.

While physics has explained much of what we currently know about the world around us, it has yet to give us all the answers; in due time, the scientific theory and application of mathematics to understanding nature will disclose a plethora of new and useful information that will aid humanity in discovering our origin and improving our lives.

Cominsky Wins More Awards

Prof. Lynn Cominsky has received the 2017 Frank J. Malina Educational award from the International Aeronautics Foundation. This award has been presented annually since 1986 to educators who have demonstrated excellence in taking the fullest advantage of the resources available to them to promote the study of astronautics and related space sciences. Cominsky will travel to Australia in September 2017 to receive the award at the 68th meeting of the International Aeronautical Congress. She will give a keynote lecture to the IAC and receive her medal at the end of the week-long meeting. The Malina award has a special significance to Prof. Cominsky, as prior to coming to SSU, she used to work with Frank Malina's son, Roger, who was the PI for the Extreme Ultraviolet Explorer satellite project at UC Berkeley. Frank Malina was an early aerospace pioneer who was also extremely interested in education and helped to found San Francisco's Exploratorium science museum.

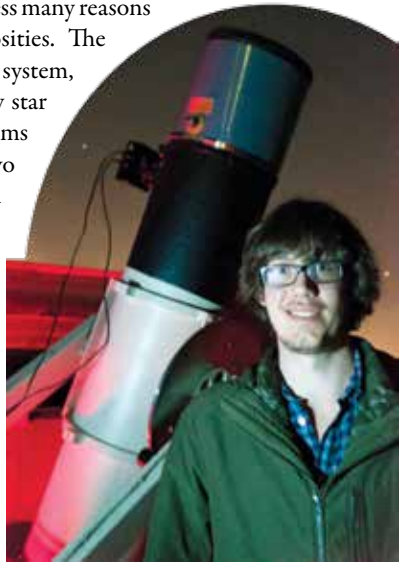
As part of the LIGO authorship team, Cominsky also received a portion of the "Breakthrough Prize" bestowed by Russian entrepreneur Yuri Milner. Other prize-winners with SSU roots include Texas Tech Prof. Ben Owen ('93) and Dr. Ryan Quitzow-James ('03). The $2 million award was shared by the 1000+ authors of the paper that announced the discovery of gravitational waves (*https://dcc.ligo.org/LIGO-P150914/public/main*), with an additional $1 million shared by the "troika" that founded LIGO: MIT Prof. Rai Weiss, Caltech Prof. Kip Thorne (who was Owen's Ph. D. thesis supervisor) and Scottish physicist Ron Drever.

Artist's illustration of merging black holes.
Credit: A. Simonnet

Capstone Research:
Variable Stars at SSUO

By Henry Arbaugh

My capstone project is based on the time-lapse observing of a variable star system. In other words, I take a series of images of a star system whose apparent brightness changes over time. These variable star systems can possess many reasons for their change in luminosities. The target of my study, the i Boo system, is an eclipsing contact binary star system. These are star systems which are composed of two stars which orbit a common point between them, and which orbit very closely together. The changing brightness of an eclipsing binary system occurs when one star passes between the second star and Earth, blocking some of the light and decreasing the system's apparent luminosity. The goal of the project is to observe the system over multiple cycles, and analyze the resulting data in order to determine if there are any changes in brightness between cycles.



During the course of this project I had the opportunity to spend several late nights by myself at the Sonoma State Observatory taking my images. I really enjoyed the opportunity to use the telescopes and tools available to me at Sonoma State. Last spring, I also had the opportunity to go to the Table Mountain Observatory, in Southern California, for a related project. These experiences really gave me a taste of what a future in astrophysics could entail, which is very valuable as I plan to go to graduate school for astrophysics in the future.

AlumNotes

Sharon Morganelli [formerly Gilkison] ('76) *retired in 2015 after 24 years as a disclosure analyst with Jones Hall, a municipal bond law firm in San Francisco.*

William Tomlinson ('83) *is a technical application specialist for the city of Santa Rosa in charge of administrating the city's main transaction system. He earned a second B.A., in management, at SSU in 1992, and an MBA, with a specialization in MIS, at the University of Arizona in 1994.*

Brenton White ('84) *is a software research and development engineer at Keysight Technologies in Colorado. He is also the principal of Brenton White Panoramas, Printing and Web Services.*

Tom McMahon ('85) *is the manager of the engineering group at the Large Binocular Telescope Observatory in Arizona. He worked for many years at the University of Arizona, where he held such positions as program manager for the Center for Astronomical Adaptive Optics, project manager for the Large Binocular Telescope Interferometer, and deputy project manager for the OCAMS suite of cameras for the OSIRIS-REx Asteroid Sample Return Mission.*

Peter Rooney ('86), *a member of the Fratelli Group, a public affairs firm in Washington, D.C., and a colleague were recently hired to handle media coverage for the government of Japan. He was formerly the deputy staff director of the House of Representatives Committee on Science. As the American Physical Society's Congressional Fellow for 1998 he worked in the office of Senator Joe Lieberman of Connecticut. He earned his Ph.D. in physics at the University of California, San Diego, where he was an IBM fellow.*

Eric Mueller ('93) *is safety, health and environmental/PSM Lead at DuPont in Martinez. He earned a master's degree in engineering at North Carolina State University in 2001.*

Robert Lahaderne ('94) *is the director of quality assurance at Fresca Medical in San Clemente. Formerly an engineering manager with the Design Assurance team at Medtronic Endovascular in Santa Rosa and a senior process engineer at SpectraSwitch, Inc., he earned an M.B.A. at the University of San Francisco in 2007.*

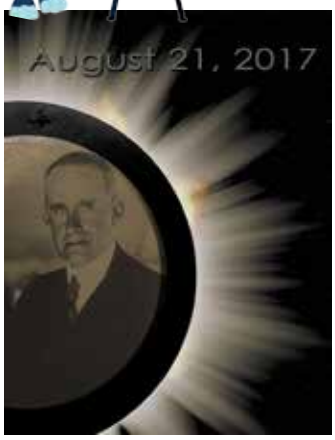
Tim Graves ('01) *is director of special projects and data management at Telecare Corp. in Alameda. He was formerly a business analyst with Pacific Pulmonary Services in Novato. For ten years he was an educational developer and information technology consultant in the NASA Education and Public Outreach group at Sonoma State University.*

E/PO – Champions of Science

By Dr. Carolyn Peruta

Science is awesome!

Care to disagree? Well, the SSU Education and Public Outreach (SSU E/PO) group will fix that for you! We've got rockets. We've got drones. We've got electronics and software and satellites and even electrifyingly powerful mud. Over this past year, the SSU E/PO team has continued to expand and enrich the world of STEM education.



As a member of the NASA's Universe of Learning partnership *http://universe-of-learning.org/*, the SSU E/PO group has been working with Space Telescope Science Institute (STScI), the Chandra X-ray Center (CXC), the Infrared Processing and Analysis Center (IPAC), and the Jet Propulsion Laboratory (JPL) to deliver a unified suite of education products, programs, and professional development that spans the full spectrum of NASA Astrophysics. The first big campaign centers on the Great American Eclipse taking place August 21, 2017. Join citizen scientists across the country as they repeat Sir Arthur Eddington's experiment to confirm gravitational lensing *https://eclipse2017.nasa.gov/*. SSU is responsible for developing a training program for pre-service teachers in the California State University (CSU) system. SSU's other main role is to provide authentic research experiences for students using the Global Telescope Network (GTN). This was originally part of NASA's Fermi Gamma-ray Space Telescope E/PO program. Rachel Freed has joined the E/PO group to develop the activities that can be carried out using GORT and other GTN telescopes and is developing several different activities as entry points to doing ground-based astronomical observations that can be linked to NASA's space-based observatories.

As part of the LIGO education program, Prof. Cominsky, Dr. Kevin McLin and Aurore Simonnet have developed a poster for the Contemporary Physics Education Project (CPEP) highlighting last year's big discoveries of gravitational waves. CPEP has also added a new area of emphasis in gravitation, that is led by Prof. Cominsky. To order the poster, see *http://cpepphysics.org/gravitation.html*

We are gearing up for the fourth annual Learning by Making Summer Institute with teachers from six Mendocino County high schools. *Learning by Making: STEM Success for Mendocino County* is a novel high school curriculum that trains students to design and construct their own science experiments using microcontrollers and the Logo programming language. Over this past year, the Learning by Making team revamped the year-one curriculum covering Biology and Environmental Science. In this course, students explore the geological record of climate change with models of the Sun-Earth system and build mud-based fuel cells that use bacteria to generate electricity. Our team has also kicked off development of Chemistry and Physics experiments. Preliminary activities include optimizing the efficiency of solar cells and using light and temperature to probe properties of matter. If you're interested in experiencing the Learning by Making curriculum for yourself, consider registering for our upcoming half-day hands-on workshop at the 16th Interaction Design and Children Conference in June. Find more information here: *http://lbym.sonoma.edu/idc2017/*

The NASA funded EdgeCube project is now up and running. The student team is hard at work and on schedule to deliver the completed satellite by early 2018, to accommodate a launch from the International Space Station. The small satellite team includes science and business students from SSU, Santa Clara University, and Morehead State. EdgeCube is a 1U (10 cm x 10 cm x 10 cm cube) satellite that will perform global measurements of the "red edge," a near-infrared transition in the spectrum of chlorophyll that can be used to assess the health of vegetation. Someday, EdgeCube could be replicated to provide a constellation of nano-satellites that monitor the effects of climate change on Earth's surface. EdgeCube greatly benefits from additional support from Moog/CSA, an aerospace company in Silicon Valley, SSU's Koret Foundation Scholarship program, and the California Space Grant Consortium. Dr. Garrett Jernigan is the principal mentor for the project, and recently accompanied SSU students who presented their work at the annual CubeSat conference at Cal Poly San Luis Obispo.

Another big project underway by the SSU E/PO group is *Rising Data* – a flight project for undergraduate students that flies payloads on rockets and unmanned aerial vehicles (drones) to introduce students at California Community Colleges to the excitement of aerospace-related experimentation. Instructors from four Hispanic-serving Community Colleges came to SSU last summer to learn how to build the payloads, rockets and drones, and to fly the payloads (see related article by Casey Lewiston on page 10). This past academic year, the Rising Data curriculum was taught at five institutions throughout the state, and this program will expand to 10 colleges by next fall, following a summer training that will be held at Fresno State in July 2017. Kevin John ('07) has led the effort to develop Rising Data's payload hardware and software.

Catch up on all the latest news from SSU's Education and Public Outreach group at *http://epo.sonoma.edu.*

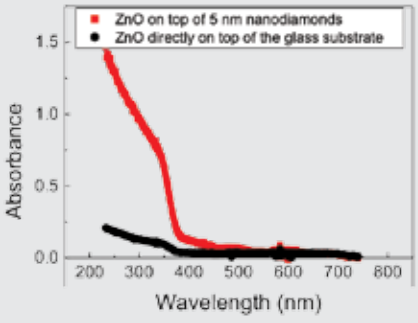
Nanodiamonds are Forever Too

By Prof. Hongtao Shi

Nanodiamonds (size ranging from a few nanometers (nm) to ~100 nm) are indeed diamonds from the structural perspective. They can be synthesized nowadays in a lab at extreme temperatures and under pressure, or in explosion. The recent emergence of fluorescent nanodiamonds has sparked a new era in cell labeling, imaging, and drug delivery, to name a few. One of the projects we are working on is to study the folding and unfolding of proteins, such as Myoglobin and Cytochrome, in a solution containing nanodiamonds, in collaboration with the Department of Chemistry at Sonoma State. Our goal is to better understand the nature of protein-surface and protein-protein interactions, and possible competitions between the two different types of interactions. Our work certainly drew attention at this spring's American Chemical Society conference in San Francisco.

Since the surfaces of nanodiamonds can be either positively or negatively charged, we have taken advantage of this property to spin-coat zinc oxide (ZnO, a wide bandgap semiconductor) thin films, on top of the glass substrates which is covered by nanodiamonds. To our surprise, the addition of this extremely thin nanodiamond layer has dramatically improved the adhesion of ZnO with good optical characteristics. Such a technique may be used to create ordered ZnO nanorods for possible solar applications with better performance than ITO (indium-doped tin oxide).

The figure to the right shows the UV-Vis absorption spectra of two ZnO samples, one with and one without the nanodiamonds as a seeding layer on top of the glass substrates.



Physcon: the National SPS Quadrennial Meeting

By Society of Physics Students: Sonoma State Chapter

Members of our SPS chapter were able to attend Physcon in November of 2016 in Burlingame. Physcon is a multi-day Physics conference that brings together Physics students, professors, and guest speakers from near and far away places. Physcon offered great food, innovative workshops, amazing guest speakers such as Dr. Jocelyn Bell Burnell who discovered pulsar stars, and a nacho bar (not everyone gets to say they got to eat nachos with Astrophysicist Dr. Jocelyn Bell Burnell). Our officers assisted Dr. Lynn Cominsky at her LIGO presentation table at the event sharing the groundbreaking discovery of gravitational waves that are thought to have been produced by the collision of two black holes. There were many colleges and companies that tabled with information about different opportunities and programs for STEM majors.

Though our SPS chapter is small, we have been recognized as an outstanding chapter for the second year in a row, which is a huge accomplishment. Attending Physcon allowed our SPS chapter to network with other physicists and other chapters about what their club is doing and what we could learn from their ideas to make our club stronger.

Being a small club on campus we have been working with Hutchins students and other STEM club members at our outreach events. Our main outreach event each year is at La Fiesta elementary school.

Each fall semester we are invited to engage first graders about light. Our club has received a SOCK, (Science Outreach Catalyst Kit), box from SPS that includes materials and instructions for demonstrations about light but we also incorporate a lot of materials from our stock room run by Steve Anderson who always helps us put together an amazing assortment of Physics demos. Some of our demos include light diffraction glasses, invisible UV ink pens, and everyone's absolute favorite: the hologram pig. This is a very fun outreach event that the kids really love.

This Spring 2017 semester La Fiesta teachers Ryan Kurada and Jessica Hayes asked our officers to come and engage their students about sound. Our club has also received a SOCK box from SPS on sound; some of our demos included plastic cups and string telephones and plastic tube Boom-whackers. Our main goal with the younger students is to get them to use the new vocabulary words they are learning to explain what something is or how it works. Outreach is a great experience for the elementary students and for our club as well.

Dear SSU students,
Thank you for coming to our classroom and doing cool things...
Love, Derek

Our Physics club also tours local science and technology companies such as Keysight Technologies in Santa Rosa. Touring these facilities really helps our students who are getting ready to graduate gain insight on what it is like to work at companies and if it interests them. Our chapter of SPS is very focused on connecting the students with the faculty and each other. It is a great resource for experience and guidance for every student in the Physics major.

McQuillen Award and Capstone:
Harvesting Water from Thin Air

By Cody Lynch

The basis of my project started a few years ago at SSU as a way to provide new sources of water to help with the drought as well as the challenges of obtaining clean water around the world. The premise of this project is to harvest and store clean potable water. The idea for the design is for it to be completely passively solar and relatively inexpensive. I began working on this project in the summer of 2016 with support from the McQuillen award, with the design premise to pull water out of the surrounding air and store it. By the end of the summer I had achieved a functioning prototype. Over the course of this spring semester, I have taken my prototype to the next level. I began scaling up my original design in an attempt to increase the yield of water using affordable and easily obtainable materials. My current design should theoretically be able to collect seven times as much water as before.

I learned many things over the course of this project, including how to run a lab on my own and how to conduct proper research. Next semester my plans are to attend grad school, I chose to go to Cedars Sinai Medical Center In Los Angeles for their Masters of Science in Magnetic Resonance in Medicine program. Once there I plan on using the knowledge I gain to help others and try to make a difference in the field of MRI.

Geof Syphers is SSU Distinguished Alum

by Professor Emeritus Joe Tenn

Geoffrey Syphers ('93) has been selected as Sonoma State University's Distinguished Alumnus for 2017. As chief executive officer of Sonoma Clean Power, Geof has managed the public power agency since it began almost four years ago. In June SCP will expand to become the electricity provider to almost 600,000 people in Sonoma and Mendocino counties, at lower cost and with a higher percentage of renewable power than the privately-owned utility it has largely replaced.

From SSU Geof went to the University of Massachusetts, Lowell, where he earned a master's degree in energy engineering. Returning to Sonoma County, he served as an energy consultant to several companies, most recently Codding Enterprises, for whom he worked to make Sonoma Mountain Village sustainable.

Asked how his B.S. in physics helped prepare him for his position, which involves a lot of engineering, managing, and dealing with other government agencies, Geof replied:

"It's obvious that the physics curriculum helps prepare one to be organized and able to tackle tough problems. What has served me really well is the concept of learning to build tools—to write code, for example. That kind of thinking has served us well in the wholesale power market. We have written routines that optimize trading so as to buy at lowest cost. It helps in understanding which problems we should try to solve, in assessing risk, and in determining which areas to focus on. We have identified seventeen key sources of risk and determined which to put emphasis on. It's more about how to think about problems and reduce them to components and then build them back up. I also need to know how to explain technical concepts to a board of directors made up of elected officials. My background as a teaching assistant in graduate school is especially helpful here."

Geof finds that his chief challenge is the ever-changing set of rules and regulations that come from the state government in Sacramento. Currently there are 15 bills pending in the legislature that would have a major impact on SCP. Two of them, if passed, would abolish it.

As Geof explained in his March 6 lecture in the "What Physicists Do" series, the electric grid has turned upside down. The problem of utilities used to be how to adjust supply to meet demand. Sources of power are turned up or down every three seconds to do so. This worked well when the sources were burning natural gas or coal, but now more and more of the electricity used in California is coming from solar and wind power, and these supplies are not easily adjusted. There are times during the day when power generators actually pay utilities to take power off their hands, as this is cheaper than dumping it. The problem is now to find ways to adjust demand to meet supply. SCP and others are working on a plan to have a huge number of electric vehicles and to adjust their charging so as to take the peak supply. Those interested in this novel concept can watch his lecture at *https://youtu.be/l3GFv4NalTE*.

Geof Syphers is the fifth physics graduate to be honored with a Distinguished Alumni Award by the SSU Alumni Association. He follows physicist Rick DeFreez ('80) in 1995, high school teacher Roberto Ramirez ('72) in 2002, pharmaceuticals executive Donald Herriott ('72) in 2003, and telecommunications executive Zeynep "Zee" Hakimoglu ('75) in 2011. In addition, wine grower and philanthropist Jacques Schlumberger ('82), together with his wife Barbara, received an Alumni Community Achievement Award in 2007.

AlumNotes

Brooke Haag ('01) *is the STEM evangelist for Worldwide Education at Microsoft. She earned an M.Ed. at Harvard University in 2016. Before that she taught physics at American River College and Hartnell College. She earned her Ph.D. in nuclear physics at the University of California, Davis in 2009.*

John Collins ('03) *retired in 2015 as equipment technician for the School of Science and Technology and the Department of Chemistry at Sonoma State University. He is now working on his art and music career in Port Angeles, WA.*

Mark Loguillo ('03) *is a high pressure team lead for sample environment within the Neutron Sciences Directorate at the Oak Ridge National Laboratory. He was formerly a systems engineer with United Space Alliance working with hazardous gas detection systems in and around the space shuttle at the Kennedy Space Center. He earned an M.S. in industrial engineering at the University of Tennessee, Knoxville in 2015.*

Julia Maisen ('03) *is an illustrator and writer. She is currently studying for a master's degree in children's book illustration at Anglia Ruskin University in Cambridge, England.*

Tiffany Davis [formerly Borders] ('04) *is a health coach in Emeryville. She worked as a research and instrument analyst at the Space Telescope Science Institute from 2008 to 2013. She earned her M.S. in astronomy at San Diego State University in 2008. Formerly a telescope operator at the Very Large Array of the National Radio Astronomy Observatory in Socorro, NM, she worked at NRAO and also at the Hubble Space Telescope during summers while a student at SSU.*

Michael May ('04) *is a senior design engineer for Kollmorgen in Radford, VA, where he designs electric motors. He also works for the Missile Defense Agency.*

Tedman Torres ('04) *is a lieutenant and surface warfare officer in the U.S. Navy. He has completed tours of duty on several ships and is a certified nuclear engineering officer. He was formerly a postdoctoral researcher at the H. Lee Moffitt Cancer Center & Research Institute in Tampa, FL. He earned his Ph.D. in biological physics at Arizona State University in 2009.*

Andrew Clawson ('05) *is a senior coating engineer at II-VI Optical Systems, Inc. in Murrieta, CA.*

Roman Hewette ('05) *is an officer in the Coast Guard Reserves and is also working as a hospital administrator for the Department of Veterans Affairs. He earned an M.S. in aeronautical science at Embry-Riddle Aeronautical University in 2014.*

Timothy McKernan ('05) *is a member of the quality management team of the Hilti Group in Austria. He was formerly a lifecycle support engineer working on solar electric inverters for Fronius International GmbH in Wels, Austria.*

Physics in the Kitchen

By So Young Han

What can you make with flour, water, and salt? You could bake breads, muffins, cake, cookies, or pancakes. You could make different types of pizzas including hand-tossed, thin crust, or Chicago style. You could even satisfy your hunger for Udon noodles, German spaetzle, or pasta. How can you make so many different dishes with the same ingredients? How does it all work? What makes the Udon noodle chewy, bread soft and fluffy, or tempura crunch?

We can apply basic science concepts and critical thinking skills used in physics to understand and enhance our daily cooking. It's true that physics is the study of how things work in the physical universe. During the Spring 2017 semester, I piloted a new GE physics lab course: *P102 Physics in the Kitchen*. It is a descriptive physics laboratory course offered in conjunction with SSU University Culinary Services. I co-taught the course with SSU Head Chef Alexandre Purroy. The course was very engaging and satisfying. Students learned science and cooking. It is a new way to introduce the fun side of Physics to students who have been thinking that it is too hard or not relevant for them. The course also addresses sustainability and health issues such as dealing with plastic and disposable wastes, petroleum-based products used in cooking, sugar substitutes, fat and free radicals, and gluten vs. gluten free diet. Students were pulled away from the textbook and virtual world to develop life skills and mindsets.

What can you make with flour, water, and salt? An engaging physics experience.

Capstone Research: The Physics of Ski Design

By Patrick Lukas

Ski technology is rapidly changing, and manufacturers are always looking for the next way to tweak their products in order to create skis with particular uses. One aspect that manufacturers are exploring is the influence of the moment of inertia which would affect a ski's turning ability as well as its ability to spin in the air (for park skis). My experiment measures and compares the moment of inertia for seven different types of skis. The results are compared to the geometrical and construction information found through research and reported measurements in order to see if or how the moment of inertia actually affects ski performance. Through this experiment I've learned how quickly seemingly simple plans can become complicated as well as the fact that reliable results can be hard to come by. After graduation, I plan on following whatever I can find that interests me.

AlumNotes

Kris Tyson ('05) *is a research and development program manager accountable for semiconductor and industrial new product development at Advanced Energy in Fort Collins, CO. He formerly worked at 3M's Optical Systems Division in St. Paul, MN. He earned a master's degree in management of technology at the University of Minnesota in 2012.*

Danielle Del Vecchio [formerly Beddow] ('07) *is a quality engineer at Alluxa in Santa Rosa. She spent a year teaching English in Taipei, Taiwan, where she was also an engineering consultant to East-Tender Optoelectronics Corp.*

Alexander Sevilla ('07) *is a program engineer at Grauling Research Inc. in Santa Rosa. He was formerly at Deposition Sciences, Inc. in Santa Rosa.*

Patrick Brown ('08) *is a manufacturing engineer at Alluxa, Inc. in Santa Rosa. He previously worked at Deposition Sciences, Inc. in Santa Rosa.*

Chris Johnson ('09) *teaches physics and next year will chair the science department at the Army and Navy Academy in the San Diego area.*

Eric Lundy ('09) *is a product design engineer at II-VI Inc. He earned an M.Sc. in mechanical engineering at Manchester Metropolitan University in 2012.*

Katherine "Katy" Wyman ('09) *is a web developer in southern California. She also teaches with the Women's Coding Collective. Formerly a technical assistant in the Director's Office for the Chandra X-Ray Observatory at the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA, she earned a master's degree in astronomy at Wesleyan University in 2011. A poster based on her thesis research won a Chambliss Astronomy Achievement Student Award at the June 2012 meeting of the American Astronomical Society.*

Blaine Gilbreth ('10) *is a software engineer at Pandora. He earned a master's degree in computer and information technology at the University of Pennsylvania in 2014.*

Ryan Young ('10) *works in desktop support at Trusource Labs in Austin, TX.*

Katie Badham ('13) *is an electro-optical engineer at Lockheed Martin Space Systems in Palo Alto. She earned an M.S. in physics at San Diego State University. She has also worked at Cymer in San Diego and Raydiance in Petaluma.*

Safura Baporia ('14) *is a business process analyst at Autodesk, Inc. in Mill Valley.*

Collin Crites ('14) *will be a graduate student and teaching assistant in physics at Montana State University starting in August 2017.*

Dobbs Inducted into Phi Beta Delta International Honor Society

By Prof. Lynn Cominsky

Graduating senior Michael Dobbs has been inducted into SSU's chapter of Phi Beta Delta, the international honor society, in recognition of the work that he did last summer at CERN, the European particle physics laboratory in Switzerland (see related article). The society seeks to increase the visibility and support for international education by SSU students and faculty. Prof. Cominsky nominated Dobbs and commented "We are very proud of all the work that Michael has accomplished at CERN and are thrilled that Fresno State's Prof. Yongsheng Gao selected Michael as one of the NSF interns for last summer!" This summer, SSU student Zachary Kurland will be participating in CERN research. Both Dobbs and Kurland were students in Gao's online particle physics class prior to their selection for the internships.

Newkirk Award 2017:
A New Observatory & Collimating the Mathis

By Daniel Smith

This semester, I had the amazing experience to work with Prof. Severson on a couple of Astronomy projects. The first part of the semester was focused on preparing for the new observatory building. I created an inventory of all the equipment to help organize the move and made technical drawings of both the old building and new building for comparison. Then in March, Prof. Severson, Prof. Targett, myself and several students came together to help officially move out of the old building. The old observatory was demolished over spring break and the new building is getting ready for a grand reopening this coming Fall!

After the move, I began working on building a setup to help collimate our 14" Celestron Schmidt–Cassegrain telescope dubbed the "Mathis." The collimator will work by sending parallel beams into the telescope where they are reflected by a retroreflector in the eyepiece back out onto a target. If collimated well, the laser source and reflected images will be aligned. Creating this rig has posed many challenges including aligning the telescope and target properly as well as ensuring the laser sources are parallel to each other. I am confident however that when the project is complete, we will be able to collimate the Mathis with reasonable accuracy.

Setup to collimate the 14" Celestron Schmidt–Cassegrain telescope

I want to thank Prof. Severson and Steve Anderson for their help and guidance with these projects. I am very thankful to have had this opportunity as part of receiving the Newkirk Assistantship. I'm excited to follow the projects of future recipients of the assistantship.

Capstone Research:
Rising Data Curriculum Development

By Casey Lewiston

Rising Data is a classroom curriculum development project designed to increase interest in engineering and science programs, as well as NASA-related career pathways. Students gain hands on experience building sensors that are carried on small unmanned aircraft and rockets, as well as experience in data analysis and scientific reporting. The Rising Data class is being offered at select Hispanic-serving California community colleges, providing under-served students the opportunity to see practical applications of engineering and science. Some students are further provided the opportunity for internships on NASA projects at SSU, Fresno State and at NASA facilities. The SSU portion of this program included training teachers in the use of unmanned aircraft, designing a processor board that can interface with a wide range of sensors, and putting together curriculum to be used in the classroom. Rising Data is part of the broader Education and Public Outreach Group at SSU.

Last summer we hosted the Rising Data teachers at SSU, where we took them through the process of building unmanned aircraft, rockets and sensors. We launched and flew their work at the end of the training. Seeing the teachers learn how to use the flight systems, and leveraging my past experience to help with that process, it was a great experience.

I don't know specifically where a physics degree will take me, but I'm excited to find out. My hope is to pursue ongoing interests in aerospace engineering, space exploration and to offer support to students who, like me, didn't have the advantage of seeing the possibilities a science education could bring to their lives. I'll be happy with anything that provides a problem to solve.

http://www.sonoma.edu/newscenter/2016/07/ssu-program-trains-teachers-on-drones-and-rockets.html

Thank You for Your Support!

This year marks a turning point for the Department, which is replacing the long-used and well-loved campus Observatory. We are especially interested in receiving contributions to the Observatory fund (C0143) to support our classroom and research work (see article by Dr. Severson). Our academic programs rely heavily on the generous support of donors and your contributions help advance science and learning in all our facilities.

The "What Physicists Do" lecture series is partially supported through donations and grants from SSU's Instructional Related Activities Fund. Prof. Scott Severson hosted the series again this academic year. At 91 semesters, WPD remains the longest-lived public lecture series on campus.

We also have three ongoing student research assistantships: The Horace L. Newkirk Endowed Assistantship (spring semester) and the Mike & Sheila McQuillen and Bryant & Diane Hichwa Summer Research Awards. Research is thriving within the Department, and funded research experiences have provided our students with a great boost, helping them get into selective graduate programs and to begin successful careers in science. Other scholarship funds, such as the Duncan E. Poland Physics and Astronomy Scholarship, the Sol and Edith Tenn Scholarship, and the Joseph S. Tenn Scholarship, also support and provide students with opportunities they would not have if not for the generosity of donors.

If you would like to support our program and students please see:

http://www.phys-astro.sonoma.edu/publicSupport.shtml,

or contact the SSU Development Office at (707) 664-2712 or contact the Department.

Current Funds:

#C0141 Public Programs
Dr. and Mrs. Joseph S. Tenn, Alan Friedman

#C0142 Physics & Astronomy Equipment and Supplies
Mr. and Mrs. William L. Kramer ('77), Lauren Novatne ('89), Sitka E. Halaweh, Charles A. Bullen ('75) and JoAnne Etheridge, Tony Fields.

#C0143 SSU Observatory
No donations this past year.

#C0144 Student Development Program
Bryant P. and Diane Hichwa, Michael T. and Sheila McQuillen

Endowment Funds:

#E0185 Charles and Norma McKinney Fund
The Charles and Norma McKinney fund supports public programs.

#E0208 Horace L. Newkirk Memorial Student Assistanship
Established by Nadenia Newkirk in memory of her father to support student research.

#E0231 Duncan E. Poland Physics & Astronomy Scholarship
Lynn Cominsky and Garrett Jernigan

#E0269 Science at Work Fund
Established by John Max to support What Physicists Do.

#E0304 Sol and Edith Tenn Scholarship
Established by Joe Tenn to honor his parents.

#E0305 Joseph S. Tenn Scholarship
Established by relatives of Joe Tenn to honor his service to the Department.

AlumNotes

Stephan Jackowski ('14) *is a graduate student and teaching associate in materials engineering at San José State University and a materials engineering intern at BAE Systems in Santa Clara.*

Jacob Lewis ('14) *is a graduate student in materials science and engineering at the University of California, Riverside.*

Cody Johnson ('16) *is a photolithography technician at Deposition Sciences Inc. in Santa Rosa.*

Anna McCowan ('16) *is a technician at Keysight Technologies in Santa Rosa.*

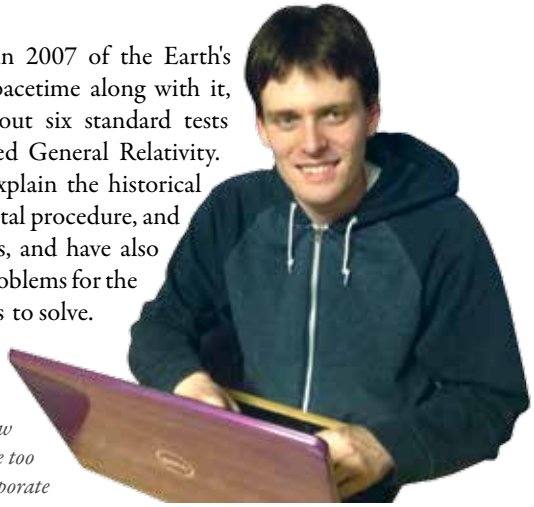
Rosita Ordoñez ('16) *is a contract chemist in the analytical sciences department of Dow Pharmaceutical Sciences in Petaluma.*

Stephanie Winningham [formerly Church] ('16) *is a manufacturing technician at Keysight Technologies in Santa Rosa.*

Capstone Research:
Classical Tests of General Relativity
By Sean Wayland

LIGO, the Laser Interferometer Gravitational-wave Observatory, has achieved a watershed moment in the history of physics. It is the first observatory to detect gravitational waves, as predicted by Einstein's General Theory of Relativity. This discovery and how it was accomplished are too important to not incorporate into physics education, especially as the technology improves and more discoveries are made. I am assisting in the creation of an online course specifically for undergraduate professors to learn about LIGO and teach the information to their students.

The component of the course I am helping to develop is an overview of the Classical Tests of General Relativity. Many of Einstein's predictions had been confirmed before LIGO, which was why scientists were confident enough to build the specialized observatory. From Eddington's measurement of how the Sun bends light from stars behind it during the 1919 solar eclipse to the observations of Gravity Probe B in 2007 of the Earth's rotation pulling spacetime along with it, I have written about six standard tests that have supported General Relativity. For each test, I explain the historical context, experimental procedure, and final measurements, and have also written example problems for the course participants to solve.



"This discovery and how it was accomplished are too important to not incorporate into physics education"

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The Physics Major - No. 42 May 2017
Published by:
Department of Physics and Astronomy
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Edited by: Thomas Targett and Lynn Cominsky.
Written by: Lynn Cominsky, So Young Han, Carolyn Peruta, Jeremy Qualls, Scott Severson, Hongtao Shi, Thomas Targett, Joe Tenn, Henry Arbaugh, Michael Dobbs, Casey Lewiston, Patrick Lukas, Cody Lynch, Michael Schwartz, Daniel Smith, KB Smith, Adam Smithson, Christopher Watkins, Sean Wayland.
Photos by: Steve Anderson, Lynn Cominsky, Jeremy Qualls, Scott Severson, Hongtao Shi, Tom Targett.
Layout and design by: Aurore Simonnet.