THE PHYSICS MAJOR

Department of Physics and Astronomy

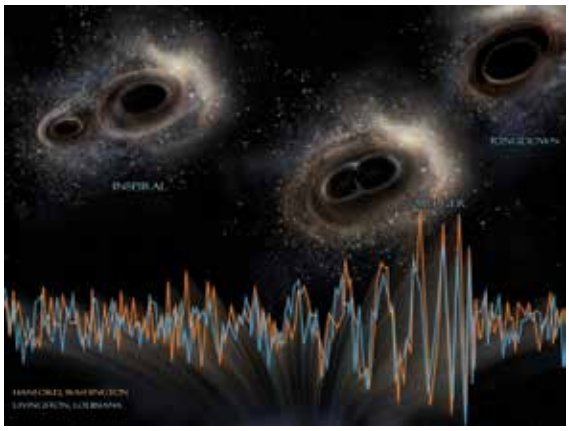
Direct Detection of Gravitational Waves by LIGO

By Prof. Lynn Cominsky

For the first time, scientists have observed ripples in the fabric of spacetime called gravitational waves, arriving at the earth from a cataclysmic event in the distant universe. This confirms a major prediction of Albert Einstein's 1915 general theory of relativity and opens an unprecedented new window onto the cosmos.

Sonoma State University professor Lynn Cominsky is part of the thousand-author team that made the observation, along with SSU alums Ben Owen ('93) and Ryan Quitzow-James ('05). All are co-authors on the discovery paper, which recently appeared in the Physical Review Newsletter.

Lynn Cominsky and Benjamin Owen at the LIGO press conference on 2/11/2016



Gravitational waves carry information about their dramatic origins and about the nature of gravity that cannot otherwise be obtained. Physicists have concluded that the detected gravitational waves were produced during the final fraction of a second of the merger of two black holes to produce a single, more massive spinning black hole. This collision of two black holes had been predicted but never observed until September 14, 2015 at 5:51 a.m. Eastern Daylight Time (9:51 UTC). The merger event created a new black hole with a total mass 62 times that of our Sun. Three solar masses were radiated away as energy in the gravitational wave that signified the merger.

Members of Cominsky's Education and Public Outreach group produced a short Educator's Guide for classroom use to explain the exciting discovery and EPO group Scientific Aurore Simonnet produced the now iconic image that was used for the Feb. 11, 2016 Astronomy Picture of the Day and that is reproduced in the figure above.

"I am thrilled to be a small part of the LIGO outreach effort. Studying black holes has been most of my life's work, and the discovery of gravitational waves using LIGO detectors will open an entirely new branch of astronomy," said Cominsky.

Cominsky Hat Trick: Three awards in one year!

It's been quite an amazing year for Prof. Lynn Cominsky, who was honored with the $20,000 Wang Family Excellence Award from the California State University system, as well as the 2015 Sally Ride Excellence in Education award from the American Astronautical Society and the 2016 Education Prize from the American Astronomical Society. The Wang award was presented at a special ceremony at the CSU Chancellor's Office in January that included a photo shoot and a video session. "Receiving the Wang award is the highlight of my career," said Cominsky. "It is wonderful to know that my dedication to the CSU is so widely appreciated and that my efforts to improve STEM learning nation-wide are being recognized." Cominsky received the award in the area of Natural Sciences, Mathematical and Computer Sciences and Engineering.

In February, Cominsky traveled to Greenbelt, Maryland to attend the annual Robert Goddard Symposium, and to receive the Sally Ride Excellence in Education Award from the American Astronautical Society. She is only the second recipient of this award, for which the citation reads: "For excellence in space-based STEM education by conceiving and accomplishing the S4 (Small Satellites for Secondary Students) program and for inspiring women and under-represented students to participate in spaceflight opportunities." She will receive the Education Prize from the "other AAS" (American Astronomical Society) at the winter meeting in January 2017.

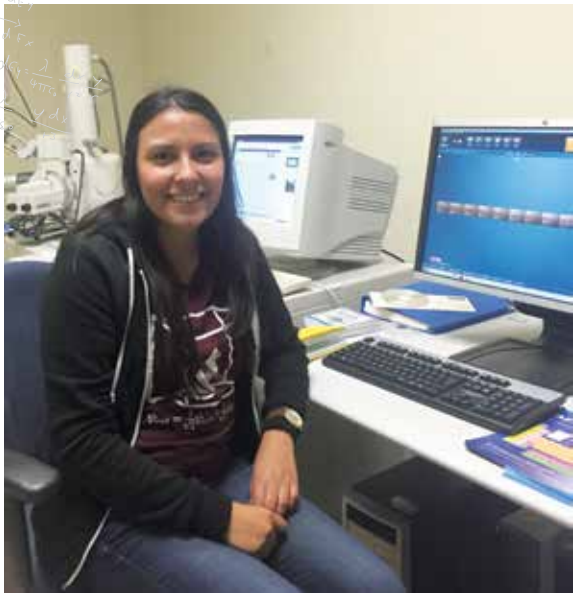
CSU Chancellor Timothy White, left, and Chair of the Board of Trustees, Lou Monville, right, present Lynn Cominsky with the Wang Family Excellence Award.

SONOMA STATE UNIVERSITY

Hichwa Award 2015 and Capstone Research: Fabrication and Characterization of ZnO Thin Films Doped with Mg and In

By Nicola Peyko

My capstone research project has continued to strengthen the knowledge that I have learned in class as well as to improve my critical thinking skills. By doing research I have learned how to operate independently in a laboratory setting. The purpose of my project is to study how the bandgap and electrical conductivity of zinc oxide (ZnO) changes as magnesium (Mg) and indium (In) are added at various concentrations, doped into ZnO. I use a spin coating method to fabricate samples on pure glass substrates with the basic solution containing diluted zinc acetate and diethanolamine in 2-methoxyethanol (MEA). Samples were then annealed in a furnace to bind the solution onto the substrate. I used the facilities in the Keck Microanalysis laboratory to analyze them, such as the scanning electron microscopy (SEM) with energy dispersive x-ray spectroscopy (EDX), UV-Vis spectrometer, and atomic force microscopy (AFM). After working on my project over the summer, supported by the Hichwa Award, I found that Mg-doped samples have a blueshifted bandgap compared to that of pure ZnO. This semester I am able to see how the In-doped samples have a small redshift, depending on the concentration of Indium in the samples. I am currently in the process of trying to make transparent conductive oxides for possible solar applications.



Nicola Peyko analyzing data taken with SSU's Scanning Electron Micorscope

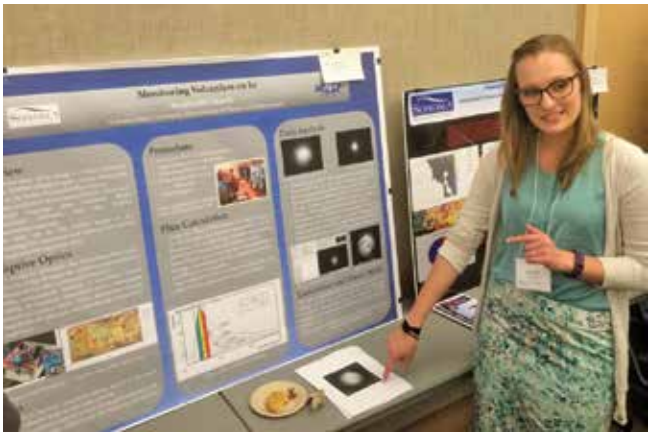
My time here at Sonoma State is coming to a close with only one more semester left. I am grateful to have had such a supportive community here with inspiring faculty, with a special thank you to Dr. Hongtao Shi for his support as my research advisor. I also would like to thank Dr. Bryant and Diane Hichwa for the summer research support in 2015.

This up-coming summer I will be interning through the Department of Energy at the National Energy Technology Laboratory. My goal after college is to continue doing research on energy topics in the industry, for some time. Then I would like to become a high school teacher and teach physics courses.

Capstone Research: Monitoring Volcanism on Io

By Stephanie Church

With my project, I have had the opportunity to apply what I have learned in the classroom to working on astronomy data acquisition and analysis. I have learned about adaptive optics and volcanism on Io. Adaptive optics works to eliminate distortions in our data due to the turbulent atmosphere and Io is an interesting subject because it is the most volcanic body in our solar system. For the data acquisition, we traveled to Table Mountain Observatory in southern California and worked all night with the telescope. Using the analysis program written in Pyraf by a previous student, I was able to process the many hundreds of frames that we collected by figuring out which frames were good. These good frames were shifted and combined to get a median frame that minimizes any camera noise. We enhanced the features of Io and made a map of its surface. I hope that this project is continued and the process for this data analysis is continued on more data in other wavelengths. After graduation, my goal is to get a job to apply the physics that I have learned here at Sonoma State University. I would like to take the GRE in the next year or two and apply for graduate school. I hope that in my future I can work doing something I am passionate about, while furthering my knowledge of physics and astronomy. I am grateful for the support from the Physics and Astronomy Department and my advisor, Dr. Severson, who has been an incredible mentor to me.



Stephanie Church showing the results obtained from the Adaptive Optics system (KAPAO) at the Table Mountain Observatory

A Busy Year for SSU E/PO

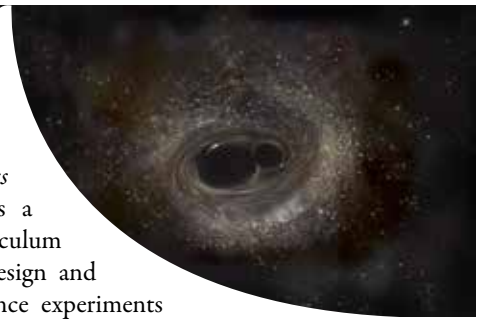
By Dr. Carolyn Peruta

NASA Astrophysics, *LIGO, Learning by Making, and CubeSats* – oh my! What a busy year for the SSU Education and Public Outreach (SSU E/PO) group.

NASA's Universe of Learning: An Integrated Astrophysics STEM Learning and Literacy Program is a new partnership led by the Space Telescope Science Institute (STScI). Over the next five years, the SSU E/PO team will be working with 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.

Want to learn more about the recent gravitational wave discovery with LIGO? Funded by NSF, we are offering a new four-week online course taking place this summer (June 27 –July 21). "LIGO: Detecting Gravitational Waves" focuses on understanding the LIGO interferometer, how the gravitational waves were detected, and how the data are analyzed. Materials from last year's course, "LIGO: Waves and Gravity" are available through our website: *epo.sonoma.edu/ligo/*.

In June 2016, over a dozen teachers from Mendocino County will descend on SSU for the third annual Learning by Making Summer Institute. *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. Students wire electronics, write programs, and construct experiments. This curriculum leverages computational thinking to focus on real world problem solving. Its power comes from interweaving the three pillars of the Next Generation Science Standards: Scientific Practices, Crosscutting Concepts, and Disciplinary Core Ideas. With two full years of hands-on training and one year of in-class pilot testing under their belts, the teachers will now tackle curriculum revisions. This project is a true partnership between scientists, professional educators, and experienced teachers. See what the students at Ukiah High School had to say about the course.

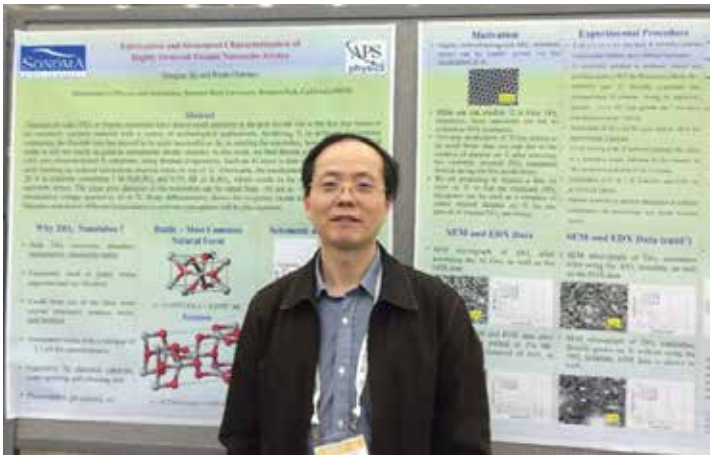


Building on the success of T-LogoQube (launched in 2013), SSU E/PO is partnering with Santa Clara University and Morehead State to build a new teeny tiny satellite – EdgeCube was one of 47 proposals out of 89 to be selected for NASA's Undergraduate Student Instrument Project (USIP). The proposed device, a 1U (10 cm x 10 cm x 10 cm). The proposed device, a 1U CubeSat, is specifically designed to monitor long-term environmental changes in the infrared reflectance of Earth's vegetation. Project EdgeCube will enhance the technical, leadership, and project management skills for an eight-member multi-disciplinary undergraduate student team across all partner institutions. Catch up on all the latest news at *epo.sonoma.edu*

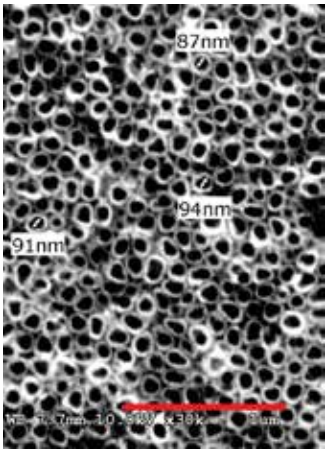
Super Small Things That I Always Care About

By Prof. Hongtao Shi

Why is something only a billionths of a meter in size so important? A quick answer is that it allows us to control and manipulate material at this extremely small scale, and that has a big impact around the world in energy, electronics, and medicine. To get there is not trivial at all, and it certainly takes time. Starting last spring, Rosie Ordonez picked a project to fabricate titanium oxide (titania or TiO_2) nanotubes, which have many technological applications in photo catalysis, photovoltaics, gas sensing, and optical coatings due to its unique properties. Using a self-assembly approach that is fast, easy to control and scale up, we were able to manipulate the nanoarchitectures of such a material. Our work was presented at the 2016 American Physical Society (APS) March Meeting in Baltimore, Maryland, and received much attention from the audience. We will continue to work on this project before starting to make prototyped devices in the laboratory for the detection of hydrogen gas molecules at levels of parts per million.



Dr. Shi presenting his research at the APS March Meeting



TiO_2 nanotubes, scale bar: 1 μm

Capstone Research: Connecting Students' Real-world Experience with Astronomy Laboratory Skills

By Zachariah Miller

Dr. Targett and I have attempted to re-build and distribute several laboratory exercises for the Astronomy 231 course. This course is an introductory lab built to develop mathematical and technical skills, as well as provide a general understanding of astronomy through exposure to several key astronomical phenomenon. It was observed that students taking the course were not always absorbing the correct information and therefore were struggling with later laboratory exercises. It was apparent that certain core concepts, like the proper implementation of significant figures or SI unit conversion, were skills that students may have understood when performing a basic example problem, but when it came time to utilize these concepts in a more real and complicated situation, they would be unable to do so. This is the root of my senior project, an attempt to successfully teach these important and vital concepts in a way so that the student is not just filling in blanks to pass the class, and instead, working with tangible and extensive example problems that require a more comprehensive thought process.

The basic technique behind the project is to provide for the student a very relatable case in which he or she is already using a skill, like significant figure rounding, and then transition into a more problematic situation where the concept is the same, yet what is appropriately significant may be harder for the student to determine. In this particular section of the lab, students are exposed to an example problem in which their peer has asked for the time, but the student's only source of time is from an atomic clock, which gives the time accurately to sixteen decimal places. The example asks for a relevant response: the student should realize that the answer should be rounded to the first couple of digits, which are sufficient to describe an accurate time. By relating the idea of significant figures to an action that is performed daily, like checking the time, we hope to see more and more students realize they already understand significance! By instilling that type of confidence in the students, it is our hope that when transitioned to measuring the distance from the Earth to the Sun, the right significance is now easier to apply to the situation.

Reflections on My First Year as A Tenure-Track Faculty Member

By Prof. Thomas Targett

My first year on the tenure-track was a busy one as I began to integrate into Sonoma State in many ways.

My research in the fields of galaxy evolution and massive black holes has yielded co-authorship on several published research papers, and I am pursuing further work in these fields with Sonoma State students (see article by Demitri Call). Moving forward, 2016/2017 will also see the first results from surveys with the new Atacama Large Millimeter/submillimeter Array (ALMA) facility, on which I have obtained observing time.

At the university, I am serving as the secretary to the SSU faculty senate, delegate at large to the California Faculty Associate (CFA) assembly, as the Physics and Astronomy representative to the School of Science and Technology Curriculum Committee, and as the advisor to the Society of Physics Students (SPS).

This year has seen many successes for SPS, such as the award of "Outstanding SPS Chapter 2014/2015", the award of competitive funding from national SPS to the club, numerous presentations to local schools, and excellent social events. It is great to be working with such an excellent group on campus!

I am also continuing to promote astronomy in the community, speaking at many local K-12 schools in Sonoma Sounty, and to local press and media regarding topical astronomical events.

I am very much looking forward to the future at SSU, and am always willing and eager to contribute to the success of our students and faculty.

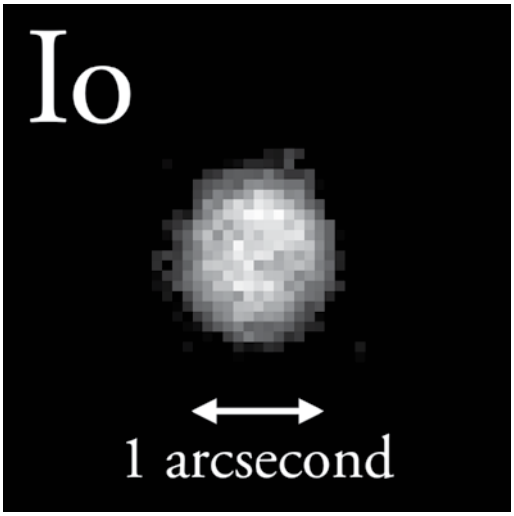
SPS members at a recent meeting together with Dr. Targett

Building the Future

by Prof. Scott Severson

I am happy to announce that during the past year we have made great strides in transforming the SSU campus observatory. Hosting over a thousand visitors from the student body and the public, and integral to both classes and student research, the 40-year-old observatory is in dire need of replacement due to issues with the exterior walls and roof. Rain intrusion damaged equipment and galvanized the Department to replace the structure. With the support of Dean Lynn Stauffer, we were able to persuade Provost Andrew Rogerson to fund the dismantling of the existing structure and its replacement with a new pre-fabricated roll-off roof observatory. This will be assembled on the surviving concrete slab containing our existing telescopes and their mounts. I am working with campus facilities to complete this work in time for a grand opening of the new facility in the Fall.

Other work I am proud of over the last year includes: an observing run at the Table Mountain Telescope with students Stephanie Church and Henry Arbaugh to image the surface of Jupiter's volcanic moon Io with our KAPAO adaptive optics system, the growth of our PhysTEC Physics Teacher Education Coallition efforts to promote physics teaching as a career; hosting another year of the "What Physicists Do" public lecture series, which just completed its ninety-first semester; and the never-ending moments of rewarding classroom instruction and student mentorship that make being at Sonoma State University so worthwhile.



The above image shows a KAPAO adaptive optics image of Jupiter's moon Io. Io is the most volcanic object in the solar system. With sustained observing, the imaging capabilities of the KAPAO instrument will allow us to image and identify specific volcanic activity on Io. A scale of 1 arcsecond is shown. This characteristic angular size of Io is also the limit of resolution for many ground based telescopes. In fact, typical image quality at the campus observatory is many times worse than that, resulting in Io just appearing as a smeared point of light. With AO, and the careful image reduction conducted by physics major Stephanie Church, we are able to see features on the surface of this 3600-km diameter moon located at a distance 700 million km away from the Earth.

Capstone Research: Minority Female Students in the Physics Field

By Angelica Arguelles

My instructional design project introduced physics as a plausible career path for minority female students. In 2011, only 19.1% of physics bachelor's degrees nationwide were awarded to women, and out of those, only 5% were awarded to minorities. In efforts to break these gender and racial inequalities, I hosted a day of outreach for high school female students where they were introduced to the physics field. I designed two different experiments where students engaged in hands-on learning in order to teach them fundamental physics concepts. Students' knowledge of the physics field was evaluated before and after the day's activities and the results showed a positive impact. In the pre-survey, knowledge students should have learned in elementary school was tested, and students averaged a score of 41%. After the day's activities and lessons, students took a post-survey, where the average score rose to 79%. When asked if physics would be a major they'd consider pursuing in the future, all students replied yes.

From my instructional design project I learned many valuable things. Already having the goal of becoming a high school science teacher later in life, I was able to gain experience on how to maneuver a proper lesson plan, in addition to learning to conduct an effective classroom. This project also taught me the importance

Angelica presenting her capstone research at SSU's Research Symposium

of introducing science concepts to students at a young age and more so, that the format in which science concepts are introduced, greatly effects how students learn. By introducing students to the physics field through fun experiments and allowing them to feel confident with their skills at hand, they were able to thrive during the outreach day's activities and tests. The Physics and Astronomy department at SSU has taught me many valuable things and enhanced my passion for the physics field, which I hope to pass down to future generations as a high school science teacher.

An Outstanding Year for SSU SPS

By Stephanie Church, Michael Dobbs, and Nicola Peyko

Sonoma State's Society of Physics Students (SPS) Chapter is continuing to live up to its legacy, from conferences to outreach, to social outings. This past year the SPS has continued to grow due to new member retention. The Skills Labs that were implemented in Fall of 2013 have continued as well as tutoring hours for our peers to help prepare them for the classroom and to develop laboratory skills.

During the Fall 2015 semester, SPS hosted many activities, including fun events for our members and outreach events for others. Five of our members attended the GRE bootcamp in August at UC Santa Cruz, where we took multiple practice tests and learned test-taking techniques from undergraduate school alumni and professors in order to improve performance on the standardized test to be admitted to graduate school. Our recreational events included a bowling night in the beginning of September, which was so much fun that we held a second one in November. The week before Halloween, many members travelled to the Petaluma Pumpkin Patch to get lost in the corn maze. Luckily, we all made it out alive and celebrated at a local restaurant! These were great opportunities for new club members to get involved in the physics community.

In December, we had a movie night in Darwin where we watched the original Star Wars and ate popcorn. Our Fall semester ended with a trip to the theater in Santa Rosa on the Friday after finals to see The Martian. This was the perfect movie to see as a club because earlier in the semester we had a "What Physicists Do" lecture given by the author of the novel, Andy Weir. Mr. Weir talked about how he was influenced by laws of physics and how he made certain parts accurately reflect what really happens on Mars.

As science lovers, we love to get others excited about science, whether it be other students at SSU or younger kids in the community. During the Spring 2016 semester the club performed multiple demonstrations at local schools to spark an interest in physics in the minds of future generations. Piner High School, Taylor Mountain Elementary and La Tercera Elementary have been able to benefit from our dedicated members that enjoy outreach. A few of our members went to Piner High School along with Dr. Qualls, to provide the students with some interactive physics demos that incorporated how physics relates to the real world, and how they can use it in everyday life. Michael Dobbs and Cody Lynch went to Taylor Mountain Elementary to give the kids demonstrations about mechanics, light and waves, and electricity and magnetism. At Code Night, many club members went to La Tercera Elementary School and helped students write programs in an online development environment. At Salute to STEM, club members set up a variety of tables at La Tercera with varying optics, sound waves, and magnetic demonstrations where we taught students the physical concepts behind each of them.

Special visit from Sean Bentley of SPS: Left to Right, Wes Watson, Nicola Peyko, Sean Bentley, Demitri Call, Stephanie Church

During the month of February, the club had its first social of the year to get to know some of our new members with a game/movie night. We played a fun board game provided by Dr. Targett while watching a classic movie, The Incredibles.

Erich at the Molecular Foundry Clean Room

Q-Zar Night: Left to Right, Courtney McNatt, Erich Diel, Trent Rhodes-Ousley, Dr. Hongtao

Ceilidh Event

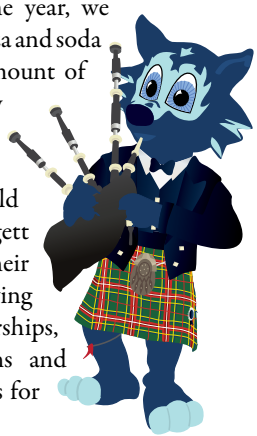
March was one of the busiest months for our chapter: while some of our members were helping judge an exciting competition for 6th-12th graders at the Sonoma County Science Fair, others were competing in an engineering challenge at the Make-A-Thon. Our club members designed a jewelry box which only opened when knocked on in a specific sequence. This was an incredible event to test our skills and see what it takes to work on a team when starting a project from the ground up. Our SPS Chapter has continued to be actively involved with the national physics organizations. We were fortunate enough to have the SPS Zone Meeting nearby in Fresno to hear about physics research conducted by other SPS members. Five members attended and three presented at the APS Far West Regional Meeting in Long Beach. We had a recent visit from the Director of SPS, Sean Bentley, at a club meeting, where he talked about national SPS events and congratulated us on winning Outstanding Chapter. Stephanie Church went to the Undergraduate Women in Physics Conference, where she learned about exciting research conducted and triumphs obtained by women in physics. Towards the end of the month Physics club participated in Geek Week, where all the science clubs on campus competed for the Darwin Cup by undergoing various mind-bending and physically-straining activities throughout the week. Our club also toured several local scientific labs and businesses such as the Molecular Foundry at the Lawrence Berkeley National Lab and Griffo Distillery in Petaluma, which is run by a physicist.

April seemed to be one of our most fun months this spring semester: we decided to change it up and go to Q-ZAR for laser tag instead of our usual bowling nights. Two of our professors, Dr. Targett and Dr. Shi, joined us in a couple games of laser tag. Our members found this to be a very exciting event and would like to do it again before the school year ends. Many of our club members helped reach out to parents and incoming freshmen by tabling at Seawolf Decision Day. Our SPS Advisor, Dr. Targett, has also put on fun events not only for the club but for the entire campus community, including his Ceilidh event which taught many how to dance to Scottish/Irish traditional folk music.

Andrew Baldwin with his secret knock jewelry box

This has been a great year for internships and many of our members have worked hard to receive these opportunities. Congratulations to Cody Lynch (McQuillen Summer Research Award), Demitri Call (SPS Summer Internship), Nicola Peyko (Department of Energy Internship at NETL), Michael Dobbs, (NSF Summer Internship at ATLAS-CERN) Ryan De Leuze (NSF STEM Project Award), Carmen Stepek & Ernest Ongaro (Hichwa Summer Research Assistantship).

Our club prides itself on carpooling to all off campus events and creating an inclusive environment where people from all backgrounds can come and bond over an enthusiasm for physics and astronomy! During the year, we continued to have meetings with pizza and soda every other week with a greater amount of attendance than usual. We are happy to have so many new members this year to help build the community in our department and club. We would like to thank our advisor, Dr. Targett and the entire department for their continued support. With the growing club attendance and memberships, we hope to expand our horizons and accomplish bigger and better things for semesters to come!



McQuillen Award 2016:
Helping Students to Become Makers
By Erich Diel

This past semester, I had the amazing opportunity to work as an assistant to Prof. Jeremy Qualls in a brand new class: *SCI 220: Dream, Make and Innovate*, and that is exactly what the course is all about! The main focus of the course was to teach students how to use modern design and fabrication technology to turn their ideas into reality. I was really excited to be able to be a part of this course because I have always liked tinkering, building, and small-scale fabrication, and I really enjoy helping others to do the same!

My role in the course was primarily to give individualized instruction and assistance to students with regards to some of the more technical aspects of their projects, such as 3D-printing and microcontroller use. My favorite aspect of the class was being able to work with 3D printers. 3D printers are devices that layer, (or "print"), very thin sheets of material (usually plastic) on top of each other to create a three-dimensional object. 3D printers are a relatively new technology that has become significantly more accessible in recent years due to the creation of cheaper, more user-friendly printers. The combination of 3D printers and powerful 3D modelling software (Fusion 360 by Autodesk) allowed students to rapidly design and prototype ideas. This allowed students to experiment with different ideas and to gain experience using 3D design and printing, which is sure to only grow in popularity as the technology gets more advanced.

My involvement in this class was made possible by the wonderful McQuillen Award. I am very grateful that an award like this exists, because it allows undergraduate students, uch as myself, to participate in programs that we may have never been involved in otherwise. Such programs serve to diversify our studies and make our route to a degree a unique one.

Erich Diel helps a Sci220 student with an electronics project

A Kaleidoscope of Possibilities

by Prof. Jeremy Qualls

I wear many hats at SSU. This year I expanded my contributions to SSU by assuming the role of Director of Academic Planning and Resources for the School of Science and Technology (SST). My position, similar to an associate dean at other universities, allows me to facilitate change and resources within the school as well as to assist with the development of new programs. Outside of this position, prototype engineering and STEM education have characterized my research during the past year.

Dr Qualls with the Science 120 2015-2016 cohort

I continued my efforts to investigate high impact practices in STEM education through the NSF-supported work *S3: STEPping up STEM* at SSU and the freshman year experience Science 120. The techniques introduced in the course *Science 120: A Watershed Year* has delivered gains in graduation rates, likelihood to declare a STEM major, and retention rates for students in the class. This interactive first-year experience continues to expand its curricular arsenal. This year saw the addition of an overnight camping experience at the SSU Galbreath Preserve and inclusion of advanced technical field skills.

Following on the success of the Science 120 freshman program, I began developing a class to empower students and to expand their horizons. The Spring 2016 semester saw the creation of the course *Science 220: Dream, Make and Innovate* and a Makerspace in the library. This sophomore-targeted class brings a new level of rapid design and product development to SSU. Students in the Science 220 course utilized 3D-printers, Arduino microcontrollers and modeling software to create solutions to problems with which they personally identified. Prototypes built so far include: smart water bottles, magnetic sketch boards and methods to harvest plastic into 3D printer reels. The course is a partnership between SST, the School of Business and Economics, the Library and community experts. Department alumni are encouraged to contact me if they are interested in being part of the experience.

Science 220 Students Celina Gines and Blaze Carter are using an Arduino microcontroller to create a smarter water bottle

In addition to the SCI 220 curriculum development, I am also working with philosophy professor Dr. John Sullins on a signature physics course that focuses on the philosophy and physics of martial arts. This "learn-by-doing" physics laboratory will be piloted during the Fall 2016 semester.

My laboratory research continues down a number of diverse avenues. The last year saw advances in three areas including 1) next generation air to water harvesters, 2) novel organic charge transfer salts, and 3) device applications. The water harvesting reached the next level by coupling the sustainability of solar adsorption refrigeration with the water retention capabilities of montmorillonite clay desiccant in a single design structure. The next stage of construction will occur during early summer of 2016. My research into organic conductors was expanded beyond the thiocyanate families of mercury, potassium, and copper to include silver and sodium. This has the potential to create novel semiconductor devices tunable under uniaxial strain. Finally, I have been able to continue my work into applied physics by beginning preliminary investigations into low-cost medical infrared sensors and tactile feedback systems for the blind.

AlumNotes

Clyde Underwood ('74) *retired in 2015 as a firmware test engineer after a 38 year career with Keysight Technologies (formerly Agilent, formerly Hewlett-Packard) in Santa Rosa.*

Michael McBride ('75) *is now business development manager for the McBride Group, concentrating on offering "Remembrance and Reflections" video services for those who wish to recount their life in a professional video format. He had a long career in sales with such companies as Optical Coating Laboratory, Inc. and Oerlikon (formerly Balzars). A past president of the SSU Alumni Association, he earned his M.A. at the American Graduate School of International Management in 1977.*

Mary Silber ('81) *accepted a position as professor in the Department of Statistics at the University of Chicago in 2016 after 22 years on the faculty of Northwestern University's Department of Engineering Sciences and Applied Mathematics. Working on the boundary between physics and mathematics, she is applying bifurcation theory to dynamical systems, including the Earth's climate and ecosystems. She was elected a Fellow of the American Physical Society in 2015 and a Fellow of the Society for Industrial and Applied Mathematics in 2012. She earned her Ph.D. in physics at the University of California at Berkeley in 1989.*

Jim Pisano ('82) *passed away in January 2016. He was for many years a software engineer at the National Radio Astronomy Observatory in Charlottesville, VA, where he developed software for the Atacama Large Millimeter Array.*

Brenton White ('84) *is a quality engineer at Volt Engineering Services in Colorado. He is also the principal of Brenton White Company. He was formerly a product manager in measurement and automation software technology for Agilent Technologies in Loveland.*

Dan Nottingham ('89) *is the vice president of product management for MedAptus. He was formerly director of product management for ABILITY Network's innovation office in Boston. He has done similar work for several companies after participating in rocket-launching experiments for the Boston University Center for Space Physics*

Imme Staeffler ('91) *is working in the East Bay. She earned a doctorate in clinical psychology at Meridian University.*

Art Onwan ('93) *is teaching mathematics at the Assumption College English Program in Bangkok, Thailand. Formerly a nuclear medical science officer in the health physics department at Walter Reed Army Medical Center in Washington, D.C., he earned an M.S. in physics at the University of North Dakota.*

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 Rosita Ordoñez

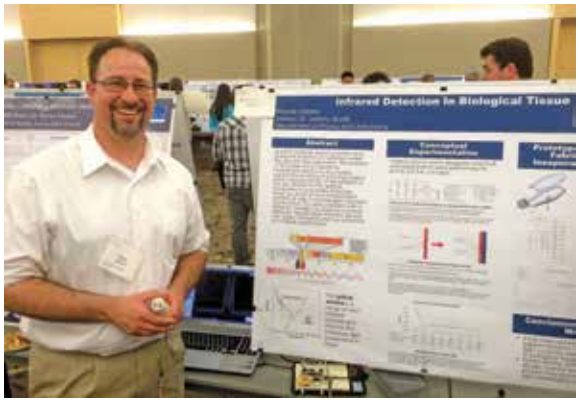
Over the past five decades, the world has changed drastically due to advancements in physics and technology. For example, the first personal computers were made less than fifty years ago and just look how quickly they have evolved. In the next fifty years, I can see computers becoming integrated into all aspects of life and with advancements in quantum computing, new areas of parameter space will be opened. I also see 3D printers, not only in every home, but also printing new homes around the world. Finally, with the recent detection of gravitational waves, I can see scientists not only uncovering new evidence for the nature of dark matter and energy, but also providing clues leading us ever closer to understanding the Big Bang theory. My fellow physicists and I are looking forward to being a part of these upcoming advancements in the world of science.

Capstone Research: Infrared Detection in Biological Tissue

By Wayde Jaskela

The purpose of my project was to create an inexpensive device to accurately resolve the location of a foreign object in biological tissue. Based on the optical transparency properties of human tissue, an array of near-infrared light emitters at select wavelengths was built. This array coupled with a detector creates the basis for a cheap detector, and has potential for multiple applications.

In this project I learned about reflection, absorption, and transmission of near-infrared light as it interacts with different materials. I also learned how to control LEDs and gather data using a microcontroller board and some simple programming skills. The knowledge gained by working on this project provides problem-solving skills that I can take with me to continue the enhancement of my career as a mechanical engineer.



Wayde Jaskela demonstrates the biomedical imaging circuitry that he built for his capstone project

AlumNotes

Daniel R. Hale ('96) *is the chair of the physical sciences department at Folsom Lake College, where he teaches physics and astronomy. He earned an M.S. in physics at Michigan State University.*

Rodney Lee ('97) *is a full-time physics and astronomy instructor at Portland Community College. He earned a master's degree in chemical and life sciences at the University of Maryland in 2014. He earned his teaching credential at SSU in 1999 and an M.S. in astronomy at Swinburne University of Technology in 2003.*

Chris Piazzo ('97) *is the coating process engineering manager at Viavi Solutions (formerly JDSU, OCLI) in Santa Rosa.*

Michael Grzesik ('00) *develops infrared sensors at Teledyne Scientific & Imaging in Camarillo. He formerly worked on focal plane arrays capable of single photon detection at MIT Lincoln Laboratory. He earned a Ph.D. in physics at the University of Massachusetts, Lowell in 2009.*

Sarah Silva ('02) *produces pasture-raised meat and eggs as the manager of Green Star Farm in Sebastopol. She was formerly the program manager in the NASA Education and Public Outreach group at Sonoma State University.*

Jerilynn Schisser ('03) *is a laboratory analyst for the city of Santa Rosa at the Laguna Wastewater Treatment Plant. She has been a chemist at Analytical Sciences in Petaluma and a quality engineer at Triformix. She has also taught physics and chemistry at Jesse Bethel High School in Vallejo and worked as an optical engineer developing three-dimensional graphics systems with Real D in Beverly Hills.*

Ryan Quitzow-James ('05) *earned a Ph.D. in physics at the University of Oregon in 2016. He is a member of the team that recently published the first direct detection of gravitational radiation with the Laser Interferometer Gravitational-Wave Observatory (LIGO).*

Dakota Decker ('08) *is the chief technology officer of GeoOrbital in the Boston area. His company produces an electric bicycle wheel that has attracted media attention. He formerly worked in the propulsion department at SpaceX in Hawthorne, CA. He earned an M.S. in mechanical engineering at UCLA in 2009.*

Bill Garcia ('10) *is the production manager at California Cider Company, the maker of Ace Cider, in Sebastopol.*

Brooks Hanley ('12) *is a solutions marketing engineer at Keysight Technologies in Santa Rosa. He is working on both an MS in electrical engineering and an MBA at California Polytechnic State University, San Luis Obispo.*

Jarod Fahle ('12) *is an audio and test engineer at Audience, Inc in Mountain View. He was formerly an acoustic test engineer at SGS in Lenexa, KS.*

Kalie Miller ('12) *is a structural analyst working on the 777X wing with the Boeing company in Everett, Washington.*

Felix Desperrier ('15) *is a geological consultant with BESST, Inc. in San Rafael.*

Sustainability in the Classroom

By Dr. So Young Han

Introductory physics curricula across the United States are fairly homogeneous. Through a SSU Sustainability in the Classroom Award, the Department of Physics and Astronomy is reevaluating how introductory conceptual physics is taught. The course Physics 100: Conceptual Physics was redesigned to infuse sustainability topics to engage students in creative new ways. This successful approach to bridge physics concepts allowed the class to be more accessible and integrated with students' daily lives. The course was developed and offered during both the fall 2015 and spring 2016 semesters. The efforts have been personified by the logo Seeds of MiRaTree For Sustainable Future. "MiRa", which is based on Asian characters for the future, was paired with "tree" to reflect both an organic experience and hope.

The starting point of the class is awareness. Students closely monitor their trash and waste production in their personal 5 Steps to Awareness journals to bring recognition to waste issues. The journal naturally brings about discussions of materials, physical processes, and underlying physics. Unlike traditional courses, students write and gather information on personally relevant sustainability and physics issues throughout the semester. This helps to develop a lifelong habit of observing surroundings, making sustainable choices and evaluating ideas. Students are encouraged to make active positive steps toward a better future by developing and sharing personal changes in their lives as a result of the class.

The curriculum is broken into broad areas of Land, Water, and Air. Within these broad areas the classical physics topics are interwoven. Some examples of how physics is made personal include students examining why they create so much waste and why cardboard and plastic are cheap and strong. The basics such as tensile strength, force, pressure, weight, and density are critical in understanding the issues. Student learn physics and problem solving skills to understand and address local issues and environmental problems.

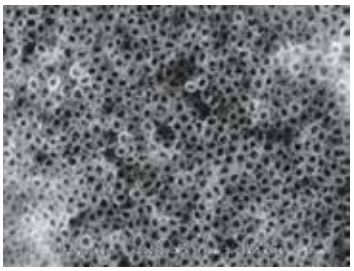
An additional aspect of the course includes students self-identifying and predicting possible future problems. As they explore these problems, the physics necessary to address them becomes evident. This creates a natural learning environment that is self-supporting as well as student empowering.

In response to needs of the class, a web based blog communication was developed to bridge ideas from one semester to another and encourage a community of environmental physics. To learn more go to the blog *www.MiRaTree.com* or email Dr. Han at: *HanSo@sonoma.edu*.

Capstone Research: Fabrication and Characterization of Highly Ordered Titania Nanotube Arrays

By Rosita Ordoñez

For my capstone project, I had the pleasure of working with Dr. Hongtao Shi on the fabrication of a highly ordered titania nanotube array grown on a titanium substrate. Due to its inherent nanostructures, this material has the potential to improve many technologies including gas sensing devices and photovoltaic cells. In this research, a titanium substrate was subjected to a two-step electrochemical anodization process with a fluoride-containing electrolyte. The first anodization resulted in the growth of a disordered array of titania nanotubes, which was then removed by chemical etching with hot, concentrated sulfuric acid. The etching process left behind a template of ordered dimples on the surface of the titanium substrate. This template forced the ordered formation of titania nanotubes during the second anodization. The morphology of the anodized titanium sample was measured using a scanning electron microscope (SEM) in the Keck lab and the elemental presence of titania was confirmed using the energy-dispersive X-ray spectrometer (EDS). This project has taught me how to work independently on research with the guidance of my mentor, Dr. Shi. This experience has also allowed me to apply what I have learned in my chemistry and physics courses to real life situations. In the future, I plan on attending graduate school to study materials science after a one-year break in which I plan to travel to different countries including Australia.



Titania nanotube sample

Newkirk Award 2016: Sustainability and History

By Carmen Stepek

The Horace L. Newkirk assistantship gave me real-world experience in a career field. At first, I worked with Dr. So Young Han in revising laboratory manuals for Physics 209B. This helped me gain a better understanding of how labs are designed and instructed, as well as knowledge on how to write better lab reports in the future. Dr. Han also allowed me to contribute my own ecological articles to her blog on sustainability. Later in the semester, I helped Dr. Lynn Cominsky update the Physics & Astronomy Department's historical archive, that dates back to the 1970s. Newspaper articles, commencement photos, the Physics Major newsletter, and other important documents relating to the department have been catalogued by year. The historical archive is now easily accessible and well-preserved. The Newkirk Assistantship was a significant opportunity to participate in different fields to diversify my background and I sincerely want to thank Nadenia Newkirk for her support. As I move forward, I have learned that it is crucial to take advantage when doors are open to further my success as a physics major.

Article written by Carmen Stepek for Dr. Han's Sustainability Blog

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.

AlumNotes

Amandeep Gill ('15) *will begin graduate study in physics at the University of Nevada, Reno in Fall 2016. She spent the summer of 2015 as an Outreach Intern with the American Physical Society after winning one of the twelve national internships sponsored by the Society of Physics Students.*

Thomas Kohlmeyer ('15) *is an engineer and assistant project manager at Bayside Insulation, Inc. in Concord. He is currently overseeing the installation of the insulation for the heating/cooling system at the new Apple campus.*

Max Torke ('15) *is a junior test engineer at Pacific Light Technologies in Portland, OR. He was a summer intern at the NASA Goddard Space Flight Center in 2015. He won one of the twelve national internships sponsored by the Society of Physics Students.*

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), Mr. and Mrs. Ken S. Zschach

#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.
Dr. Richard K. DeFreez ('80) and Ms. Toni Kristensen

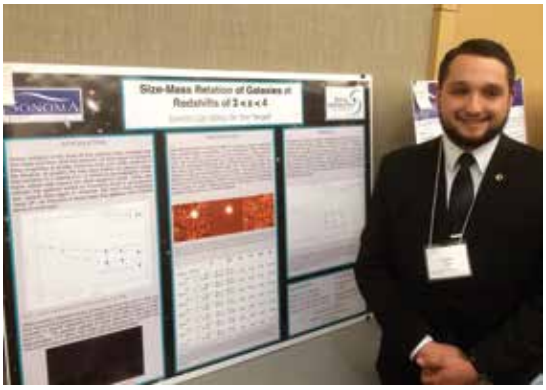
Gifts In Kind:

Dr. Bryant Hichwa donated many cameras, lenses and other photographic equipment to the Department, with an estimated value of over $14,000.

Capstone Research:
Size-Mass Relations of Galaxies at Redshifts 3-4

By Demitri Call

The Fall of 2014 was my first foray into research. I began working with Dr. Targett learning how to characterize high redshift galaxies and model their sizes, shapes, and masses. I worked with a large data set in the beginning and over a couple semesters I was able to whittle down the set into approximately 70 images with central galaxies that were bright enough to use as a final image set. This semester consisted of working rigorously with this final image set in order to find one final data set worthy of publication. We have pushed the boundary for galaxy evolution to look at galaxies from a time shortly before the universe was only 2 billion years into its 13.7 billion year lifetime. Previous data at later times showed a trend in compactness of massive galaxies. This trend is not one that can continue indefinitely and we have been able to look into a time period as yet unstudied for galaxy evolution. It is exciting to know that we are likely to see how the trend will change as we finish analyzing these new data. Beginning a research project during the fall of my junior year was something I had done out of interest but not something I had known would impact the rest of my time at Sonoma nor my future outside of SSU so greatly. My efforts early on in the research led to Dr. Targett suggesting my work on a separate project from the department. The chance to start research early and eagerly led to several opportunities for work on campus, leadership in the physics club, a council position in a national organization, a summer internship on Capitol Hill, and it also led directly to my acceptance into a funded graduate program in the University of Reno, Nevada Physics Department.



Demitri Call at the SSU Research Symposium with his capstone research poster

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