THE PHYSICS MAJOR

Department of Physics and Astronomy

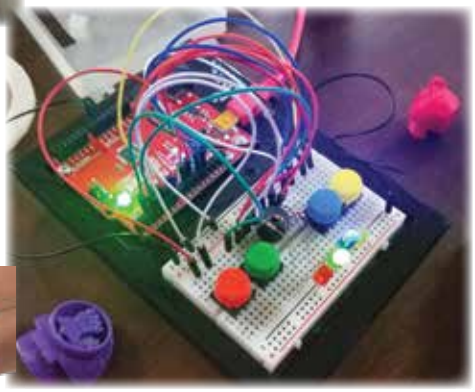
Physics & Astronomy Leads Efforts to Create SSU Makerspace

By Prof. Jeremy Qualls

The SSU Makerspace opened on October 4, 2017. Techies, hobbyists, do-it-yourselfers, crafters, and gamers have two thousand square feet of paradise to enjoy. Housed in the Library, the SSU Makerspace serves as a campus melting pot and a digital fabrication center. A laser cutter, CNC-mills, 3D printers, VR systems, vinyl cutters, a 3D scanner, sewing machines, digital embroidery stations, a circuit board printer, and a sublimation printer are just some of the equipment available. The SSU Makerspace merges traditional arts and crafts with modern empowering digital technology. For the Fall 2018 semester, the Makerspace will have open hours from noon-8pm, Monday through Thursday and noon-5pm on Fridays. These operational hours will expand in sequential semesters. In addition to open hours for the campus, the space supports academic efforts such as the maker course Science 220: Dream, Make, and Innovate and the Maker Certificate Program for Educators.

For the last three years, Professor Jeremy Qualls worked on a vision to create a shared campus Makerspace available to all students, faculty, and staff regardless of major or background. Students needed a casual place to develop technical skills and faculty needed resources to develop classroom and research efforts.

Supported by major funding from the National Science Foundation to enhance STEM education and a strong partnership with the Library, that vison is finally coming to fruition. Student technicians staff the SSU Makerspace with help and technical expertise from SST faculty. The Director of Library Technology, Jonathan Smith, manages the space and ensures smooth integration into the Library infrastructure and mission.



The SSU Makerspace will continue to evolve and grow, providing new resources to SSU and the community. It is part of a larger Make@SSU initiative to increase innovation and experiential learning. Future efforts include collaborating with other Schools across campus, local Makerspaces, and eventually with other campuses in the CSU system.

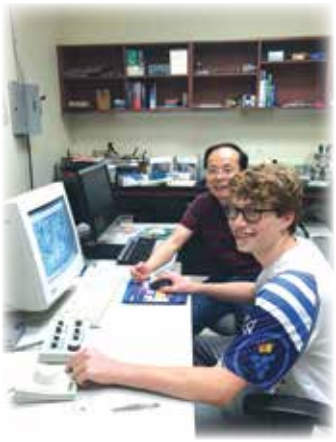
For more information, please contact Prof. Lynn Cominsky at *lynnc@universe.sonoma.edu.* The SSU Makerspace also welcomes donations of unwanted arts and crafts supplies and board games.

Prof. Jeremy Qualls Leaves SSU for University of Southern Maine

In July 2018, Prof. Jeremy Qualls accepted a position as Dean of Science, Technology and Health at the University of Southern Maine in Portland. He and his wife, Dr. So Young Han, had been teaching at SSU since Fall 2007. While at SSU, Prof. Qualls was the recipient of the 2017 Excellence in Teaching Award, as well as serving as Director of Academic Resources and Planning for the School of Science and Technology, Faculty Fellow for the Center for Community Engagement and founding Director of the STEM Freshman Year Experience (Science 120: A Watershed Year). Prof. Qualls also created the SSU Makerspace (see accompanying article) and originated the Science 220, Dream, Make and Innovate class, working with Dr. Han as the founding instructors. The Qualls and Han family will be greatly missed!

SONOMA STATE UNIVERSITY

Capstone Research:
Fabrication and Characterization of Titania Nanotubes
By Ryan de Leuze



This research is focused on the synthesis of highly ordered titanium dioxide (titania) nanotubes made on titanium. The sought after nanostructure has become increasingly popular in recent years due to its potential application in a multitude of fields such as medicine, solar energy, harmful gas detection, and solid state physics. The application of titania nanotube devices for each of these fields is largely dependent on the geometry of the underlying nanostructure. Highly ordered arrays of nanotubes offer maximum utility and efficiency for each device. It is therefore the goal of this research to bring forth a recipe for this fabrication process. In recent years, elegant work has been conducted at Sonoma State under Dr. Shi's direction on the fabrication of highly ordered alumina nanopores. However, the process of fabricating ordered titania nanotubes has proven to be a highly interesting challenge that is both complex and delicate due to titanium's flimsy nature.

The underlying electrochemical processes for fabrication and techniques of characterization have kept this research interesting. Study of the necessary electrochemical process has taught me not only electrochemistry but methods of self-teaching and research. These lessons are invaluable. One technique for characterization that has excited me tremendously is the use of the scanning electron microscope (SEM). This device uses electrons to image beyond the microscopic levels that can be achieved via optical devices. The utility of the SEM allows for magnification levels greater than 150,000. Observation of samples on such a scale is eye opening and incredibly informative. The machine is an absolute privilege to work with and a necessity to conduct research on nanoscales. After graduation, I hope to attend a graduate school where I can continue to pursue rigorous mathematics in pursuit of knowledge.

Capstone Research:
Condensed Magnetic Memory
By Shane Sylvester

Research into the subject of condensed magnetic memory is becoming more and more prevalent in today's society, as most electronic devices such as computers and phones would highly benefit from condensed magnetic storage or memory. The process of fabricating highly ordered aluminum oxide (AlOx) nanopores on aluminum substrates via a multistep anodization is the first step in this research under Dr. Shi's supervision, as one can then fill magnetic materials into these nanopores to form ordered magnetic arrays for data recording. To achieve this goal, one has to reduce the thickness of the AlOx barrier layer inside the nanopores significantly. Our work indicates that anodization at 40 V can create the most ordered nanopore arrays with an average nanopore diameters of around 55-65 nm (roughly 2,000 times smaller than the thickness of a piece of paper). We are in the process of inserting nickel into these nanopores using a pulsed alternating current, after which we can use a vibrating sample magnetometer to generate a hysteresis loop for the sample. Such a loop can then in turn tell us various magnetic properties about our sample such as the saturation magnetization, as well as the coercivity of the material. I plan to take the knowledge I have gained working on my capstone to the private sector, and pursue a career where I can apply these skills to further study solid state physics.

Nobel Prize Winners come to SSU for LIGO-Virgo Collaboration Meeting
By Zack Tweedy

In the middle of March, scientists from all over the world descended upon SSU to discuss the latest data and physics derived from observations of gravitational waves. These observations were taken by scientists using LIGO and Virgo to study merging black holes and neutron star binaries.

Welcome to the LVC (LIGO-Virgo Collaboration). This bi-annual team meeting gathers about 350 scientists for the purposes of data analysis and discussion of the future.

Students at SSU had the privilege of attending these meetings. Mostly physics majors in pursuit of graduate level degrees, we helped facilitate the meetings by running the remote communications systems in the meeting rooms so that those who could not attend in person could participate virtually.

At the end, the LVC held a banquet for those in attendance. Notable scientists included Nobel Laureates Dr. Kip Thorne and Dr. Rainer Weiss. After the usual rounds of drinks and celebration, they gave small, celebratory speeches, congratulating the entire team for their hard work and consistent effort over decades.

LIGO, or the Laser Interferometer and Gravitational Wave Observatory, uses interferometry to measure slight ripples in space-time. These ripples were first predicted by Albert Einstein, as a consequence of his General Theory of Relativity, and were first discovered in September 2015, from the collision of two massive Black Holes. Nearly 100 years after Einstein's prophetic work, we finally had the technology to confirm Einstein's predictions!

SSU Observatory's New Home

By Profs. Scott Seversen and Tom Targett

Sonoma State University has a new home to view the cosmos. After first opening 41 years ago, the Sonoma State Observatory officially reopened with a ribbon cutting ceremony and public viewing night on September 8, 2017. A crowd of between 250 and 300 gathered to hear the remarks of President Judy K. Sakaki, Provost Lisa Vollendorf, Dean Lynn Stauffer and Physics and Astronomy Professor Scott Severson. Once the ribbon was cut, the observatory roof rolled open and the new facility was opened to the public. Despite the clouds rolling in, the crowd enjoyed the evening of photos, cocoa, cookies, a tour of the facility, music and good conversation! There was even an inflatable planetarium set up on the nearby track, generously provided by Physics & Astronomy Chair Lynn Cominsky's Education and Public Outreach group.

Prof. Severson, President Sakaki, Provost Vollendorf and Dean Stauffer cut the ribbon

Roughly 1,000 students in astronomy courses use the facility throughout the year, and students and faculty will be able to use the new observatory for research projects. These projects are a defining part of the Department of Physics & Astronomy's degree programs. The observatory holds several free public viewing nights each semester. The new space will continue to host the American Association of University Women's (AAUW) Tech Trek program, where young girls interested in math and science are encouraged and empowered to study astronomy.

Crowd eagerly awaits the reopening

Upgrades to the facility include a brand new building with a powered slide-off roof, updated computers and digital presentation tools to complement what is viewable through the telescopes. The observatory contains two main, pier-mounted telescopes with computer control, as well as other small telescopes for use outside on public viewing nights. The venerable 14-inch Schmidt-Cassegrain Celestron telescope rests on the east pier and is used for visual observing and spectroscopy. The west pier now hosts a Celestron 11-inch telescope, an upgrade over the previous 10-inch telescope. The observatory instrumentation consists of a spectrometer and sensitive digital cameras with astronomical filters.

Students helping with the 14" telescope observations

Observatory Director Scott Severson, who oversaw the reconstruction project, said there are many people to thank, "If not for finding champions for authentic science experiences on campus, Dean Stauffer and Chair Cominsky chief among them, we wouldn't have this brand new facility." Dr. Thomas Targett, an astronomy professor involved in the project, hopes that students from all walks of life come check out the new space. "One of the reasons I feel lucky to be an astronomer is that almost everyone has some innate interest in the sky," says Targett. "Even if you are not a STEM student, who wouldn't want to learn about the Universe they live in?"

Capstone Research:

False Color Imaging for High School Students

By Claire Shudde

Most science fields are male dominated, with women and racial minorities disproportionately underrepresented. This can be for multiple reasons. For instance, they may be pushed by society, their peers, or their family into studying different subjects. Maybe they don't see themselves reflected in scientific fields, or they are told that girls aren't good at math. The aim of my capstone project is to foster interest in the sciences and encourage students to pursue a major or career in science and engineering if they wish. Since almost all kids and a large portion of the general public are at least casually interested in astronomy, I decided to create an astronomy activity to get students excited about science. Astronomy is closely connected with other science fields, so it can act as an introduction to other topics such as biology and geology.

I created a lesson plan as part of the Global Telescope Network (GTN), part of NASA's Universe of Learning program that aims to create authentic research experiences for high school students and beyond. The GTN develops interactive activities to engage students and encourage deeper learning experiences. In the lesson, students learn to create their own unique astronomical image. The process they use is similar to the one used to create almost every beautiful astronomical image the public enjoys. Making their own images gives students a more personal experience than other lab exercises. The lesson and required materials are available online to make it as accessible as possible for students. To test the lesson, I went to Piner High school and worked with four students, two boys and two girls. The students went through the activity and gave feedback on what they liked and what could use improvement.

Overall, the students greatly enjoyed the exercise and only had a few small suggestions for improvement.

Capstone Research:

Adaptive Virtual Reality

By Erich Diel

I have created a device that can dynamically adjust its own center of gravity. It is designed to be easily integrated with external control systems. Adjustments can be made automatically and continuously, and is entirely adaptable to suit different purposes and experiments. This component allows for fast adjustment to balance through a remote interface. The next issue is to expand this to equipment that requires constant balance or adjustment, which could possibly include mobility devices for disabled and injured.

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 Zachary Kurland

In the next few decades, I predict that physics will become more important than it ever has been in the history of our species. As the clock continues to tick, we are faced with mounting threats of self-extinction-- the likes of which become more serious with each step into the future. From global climate disasters to nuclear war, it seems that our work is cut out for us! Luckily, though, I think all is not yet lost. With the ever-increasing capabilities of our technology, and the growing commitment to overcoming these worst-case scenarios, I believe that the worldwide collaboration between scientists in all disciplines will prove victorious.

The only caveat, though, is that we are going to need more physicists than ever before! This is a problem, because I think that to the majority of society, physics is like the air: it's there, but it's not really thought about in any serious capacity unless you're told what life would be like without it. From the smartphone, to airplanes, to medicine and global communication, physics has played such an important role in creating life as we know it, that it would be shocking to see what it would be like without it. In order to grow more physicists, I believe that a large push from primary educators is needed to promote physics and destigmatize it as one of the hardest subjects ever (even if it may be!). Nonetheless, physicists will continue to be born, and our understanding of the universe will continue to grow as long as we are around to study it. In the next 100 years, I predict major advancements in physics that will fundamentally change the way our species interacts with the universe. I am excited to be alive in this age of discovery, and have the opportunity to be a physicist who can help make the world a better place for generations to come!

GORT Survives Sonoma County wildfires

By Prof. Lynn Cominsky

GORT (GLAST Optical Robotic Telescope), the SSU E/PO group's robotic telescope is located off campus, at the Pepperwood Preserve in northern Santa Rosa. This is an area that burned during the October Sonoma County wildfires. Amazingly enough, GORT survived the fire with the dome and telescope intact, and very little ash inside the dome. The external weather station, the power lines and internet were not so fortunate, and will need to be replaced. This panoramic photograph was taken about a month after the fires, when a crew of E/PO staff and Emeritus faculty Gordon Spear went up to look around. The burned building is GORT's former neighbor, the Hume Observatory. Also lost inside Hume was at least one rare Clark 18 inch refractor, which seems to have vaporized. The Dwight Education Center at Pepperwood also survived, but the barn and home of the caretaker were additional losses at the site. We are grateful to the AstroHaven company who made our dome! Although it was not intended to be fireproof, the white high-tech material seems to have encouraged the fire to flash over GORT so quickly that no damage occurred.

EPO staff member K. Considine and Emeritus Prof. G. Spear at GORT. The ruined building on the left is the Hume Observatory.

Capstone Research:
Black Hole Growth

By Daniel Smith

For my capstone project, I worked with Prof. Scott Severson to explore how black holes grow and to code a simulation to better understand one mechanism of growth. We explored five different ways or mechanisms that black holes can change mass: formation, secular growth, feeding from the accretion disk, mergers, and evaporation. The LIGO conference hosted at Sonoma State this year was a great opportunity and immensely helpful to this project because I was able to speak with current leading experts from all over the world about my own work and about the fascinating recent developments in multi-messenger astrophysics. My main contribution to this project is in the form of a simulation coded in MATLAB to better understand secular growth (matter captured by a BH). This was a particularly interesting and satisfying part of my project which took many hours of coding and debugging. The final product can successfully simulate the behavior of particles as they are consumed by the black hole. In addition, the code also records the effects of general relativity which illuminates some of the more unintuitive properties of extremely massive and fast-moving objects. In conclusion, my project gives a better understanding of the dynamic nature of black holes and their important role in the universe. This is in contrast to the image of the ruthless cosmic vacuum cleaner sometimes portrayed in popular science.

AlumNotes

Scott C. Anderson ('78) *is a science writer and programmer. His latest book is The Psychobiotic Revolution, and his latest website is http://psycho-biotic-revolution.com/.*

Roy W. Harthorn ('78) *performs expert witness investigations and testimony for attorneys and insurance companies related to building codes, construction defects, personal injury, and ADA in Santa Barbara. He is a former chief of building and safety for the city of Santa Barbara and is currently a member of the California State Historic Building Safety Board.*

Brett Morgan ('82) *is a global developer at Autoliv in Ventura.*

Paul LeFebvre ('85) *is manager at MKS Instruments in Medford, OR. He worked as an engineer at JDSU in Santa Rosa for more than thirty years and then as an engineering manager at Deposition Sciences, Inc. for two. He holds nine patents in the field of thin film technology.*

Tom McMahon ('85) *is the project manager responsible for the primary mirror generation of the Giant Magellan Telescope Observatory (GMTO). He has 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 OCAMS suite of cameras for the OSIRIS-REx Asteroid Sample Return Mission.*

Iad Mirshad ('89) *is a senior print application engineer at Kateeva, a leader in inkjet printing of OLED materials, in Newark. He formerly worked at Qcept Technologies, a developer of non-visual defects detector technology in Fremont. He earned a Ph.D. in experimental nuclear physics at the University of California, Davis in 1995.*

Dan Nottingham ('89) *is the vice president of product management for MedAptus in Boston, MA. He was formerly director of product management for ABILITY Network's innovation office in Boston. He started his career participating in rocket-launching experiments for the Boston University Center for Space Physics.*

Frank Moraes ('90) *is an author and website editor. He earned a Ph.D. in atmospheric physics at the Oregon Graduate Institute of Science & Technology in 1995.*

Scott McWilliams ('91) *is director of PVMC Technology Programs at SEMATECH in Albany, NY. He earned an M.S.E. in electronic materials and devices at San José State University in 1996 and an M.B.A. at the State University of New York Oswego in 2016.*

The SSU Education and Public Outreach Group does it again!

By Dr. Laura Peticolas

What an active year it has been for the EPO Group! After an uneventful start of the year, the fire hit and impacted many team members and students. We were grateful for the community of support while recovering, as well as finding out that the EPO group's remote telescope, GORT, was saved while fire raged all around it. What luck! Since then, the EPO group has been engaging learners of all ages in science, technology, engineering, and mathematics.

Laura Peticolas, Juanita Tenorio, Aurore Simonnet, Carolyn Peruta, Kevin Considine, Lynn Cominsky.

All year long, SSU students supported staff and Mendocino County teachers in the "Learning by Making" final year. Students and staff built and tested experiments for the 9th and 10th grade classrooms, which included not only the experiment setups, but also the electronics boards (AppBoards) and Logo computer code. In teacher training workshops, SSU staff modeled the experiment setups and the process by which high school students explore practices of science and engineering. In this curriculum, high school students create a model of the science in the experiment. They then develop appropriate scientific questions to answer with modifications to the experiment. After planning how to make these modifications, they run a new experiment. With the data they have collected using sensors and the electronics, displayed on their computers, they determine if their claims, questions and models can be supported by evidence. Science education researchers found that students in the Learning by Making program increased both their math and science test scores compared with a control group. The EPO group is now working hard to land the next round of funding to enhance the program in Mendocino County schools and new schools in neighboring counties.

Eclipse Megamovie Comes to Sonoma State University

By Dr. Laura Peticolas

In 2011, an "Eclipse Megamovie" was envisioned for the 2017 total solar eclipse that would be created using the public's photographs of the Sun's corona as frames in a movie illuminating dynamic changes in the chromosphere and corona. On August 21, 2017 during and shortly after the total solar eclipse, our team collected photographs from thousands of volunteers with telescopes, DSLR (Digital Single Lens Reflex) cameras, and mobile device cameras setup across the path of totality. Our efforts resulted in 1,190 photographers contributing 50,016 DSLR photographs in a final open-source, public archive that is 766 GB. All photographs in this archive are Creative Commons Zero (CC0), making them freely available for public use. From mobile devices, we obtained an archive of 60,000 images (211 GB). The first Eclipse Megamovie video was compiled and made available to the public a few hours after the moon's shadow left the U.S. East Coast. For two weeks, additional images were added to this video, as volunteers uploaded them to the project server.

Meanwhile, at several local community colleges, the EPO group was supporting more rocket launches. Who doesn't love a good rocket launch? They are especially satisfying when real data get collected as the payload drops from high in the sky, gathering information about the spin, air density, or magnetism. These innovative community college students did just that!

Of course, the EPO group wouldn't be the EPO group without some good old fashioned outreach to families and young children or pre-teens with the time-tested pulsar activity. With a battery, two LEDs, modeling clay, tape, and a string, LEDs can glow while the pulsar model spins, representing pulsars far out in space. Over 400 people participated in these pulsar outreach activities in over 5 events throughout the school year.

The highlight of the year may have been getting to meet two of the three newest Nobel Prize winners in Physics (see LIGO article for more information.) The bitter sweet moments were watching the physics students graduate having completed their capstone projects, many of whom worked with the SSU EPO group, and watching two long standing EPO team members get jobs in the real world and saying goodbye to them: Kevin John ('07) and Hunter Mills ('14). We miss you both! Please come back to visit!

All-in-all, it was a productive, inspiring, exhausting, and celebratory year. We thank all of you who participated in or supported these and other efforts run by our group from federal grants and contracts. Catch up on all the latest news from SSU's Education and Public Outreach group at *http://epo.sonoma.edu.*

The project also resulted in a comprehensive website with profiles created by 12,749 users, several short documentaries, 190 articles and press releases, open-source code for use in future related efforts, and hundreds of public presentations across the country prior to the eclipse.

Dr. Peticolas, who joined the SSU Education and Public Outreach Group as the Associate Director on Oct 31, 2017, led the Eclipse Megamovie project. To truly learn something new about the Sun's atmosphere using this dataset, multiple steps of analysis with the images are required. Dr. Peticolas has begun to work with SSU students, staff and a Summer HS Internship Program (SHIP) student, Emily Cline, alongside a University of California, Berkeley (UCB) researchers and UCB student interns on this data analysis project. Developing and modifying a variety of open-source python code, our data analysis team plans to use the California State University (CSU) Cloud Services both for storage and as a computational platform for complex image analysis on thousands of photographs. Dr. Peticolas aims to get quantitative information on the dynamic brightness of the chromosphere and corona during the 90 minutes when the moons shadow traversed the US from coast to coast. For more information on the Eclipse Megamovie Project, please visit the website: *http://epo.sonoma.edu/megamovies.*

A photograph taken by one of the 1,190 volunteers during totality, (Creative Commons)

A New Beginning for SSU's SPS Club

By Zack Tweedy

The Fall of 2017 was a very impactful semester for SPS. As per usual, each year the Physics Club has an outreach event at La Fiesta elementary school, where we engage first graders about light. Using various demos we teach first graders about the wonders of light and science. Some of these demos include using diffraction glasses to see things in a different and a "holographic" pig. The pig itself is simply a little plastic toy pig, though with some concave mirrors and using physics, it is possible to make the image of the pig seem as though it is floating. It's always a party when we work with La Fiesta!

Hot on the heels of the Fall semester, in the Spring we focused on revamping the Physics Club. With a lot of members having left the club at the end of the Fall semester, a few Physics majors took it upon themselves to rebuild the club. In an effort to make the club known around campus, we tabled at diverse events and opportunities, hoping to draw new Physics majors to our club. Some of these events, such as Big Night, were mildly successful. In addition, we reached out to some of the physics courses and implored those who were studying physics to come check us out and join us for an assorted series of games, events, and competitions.

With little in the way of outreach, our club turned inward, hoping to make the club as fun as possible for members who were in it. We played trivia games, planned fundraisers, and held competitions for our members. These small things each week helped solidify our group's relationship, and by keeping things simple, we managed to keep SPS going. During Spring Break, a few of us had the wonderful opportunity of volunteering at the LIGO-Virgo Conference, or the LVC. This conference brought in scientists all over the world, from nearly every continent, to Sonoma State for a multi-day discussion on the science and progress of these groups and their research into gravitational waves. We had the opportunity to meet some Nobel laureates, among these scientists Dr. Thorne and Dr. Weiss, both whom envisioned the LIGO project over 40 years ago.

Towards the end of the Spring Semester, the physics club hosted a senior send off for those who were graduating this semester. Faculty and members alike showed up for a day of fun barbecue, games, and celebration. Overall, it was a decent year for SPS, and we hope to continue to grow and develop!

McQuillen Award and Capstone:

Einstein and the Classical Tests for General Relativity

By Ryan Brown

The Laser Interferometer Gravitational-Wave Observatory (LIGO) team and their detection of gravitational waves (GW) from the merging of compact binaries, confirmed a long-standing prediction of Einstein's General Theory of Relativity (GR). This has opened up a new frontier to observe the universe. It is possible that with improved detection techniques, GWs can 'illuminate' that which was previously unobservable; such as dark matter, the mechanics of black holes, and more. Prior to these detections, GR went through a number of rigorous tests to determine its validity. In my capstone work, I explored the six most prominent of these tests, manifested this work into a course about the history of the classical tests for GR, to post on the Educational Public Outreach (EPO) section of the official LIGO website.

While these six tests are extremely foundational to GR and very compelling, there was still no direct detection of GWs until 2015. This is why LIGO's detection of GWs was so important. It was the first direct observation of Einstein's GR and postulated GWs. These classical tests were able to infer the existence of GR, GWs, and space-time curvature, but LIGO witnessed it firsthand. The result of my work will be made available on the official LIGO website pending completion.

These six tests for GR, along with the two courses already available on the LIGO-EPO website will provide a background for professors to explore in order to teach the physics of LIGO at university classes and to the public. After I graduate, I will attempt to find a local job in the area while I study for the GRE for a year. I will then apply to graduate school for a PhD in astrophysics. I eventually want to work for LIGO or in theoretical physics.

Jorge Bautista, Zack Tweedy, Prof. Lynn Cominsky, Nobel Laureate Kip Thorne and Ryan Brown at the LVC banquet.

International Travels with Prof. Cominsky

Being part of large international collaborations is a lot of work, but also a lot of fun, and this year was no exception. As part of the LIGO-Virgo Collaboration (LVC), Cominsky's E/PO group together with the Physics & Astronomy Department hosted the LVC at SSU during March 2018 spring break. Over 350 scientists from all over the world attended, and were very impressed with our hospitality, SSU and Sonoma County in general (see article by Zack Tweedy for a student perspective). However, the fall meeting of the LVC takes place in Europe, so in September 2017, Dr. Cominsky traveled to CERN, the European particle physics laboratory in Geneva, Switzerland. While at this meeting, she helped train about 30 Italian teachers in an educator's workshop that was conducted in Italian (with the help of a translator). And of course, she took part in LIGO EPO meetings, to ensure that the latest discoveries were properly publicized and explained (see article by Ryan Brown).

This was a year with extra international travel for Cominsky, as she went to Adelaide, Australia in August 2017 to receive the Frank J. Malina Education Medal from the International Astronautics Federation. The award included a keynote speech about Cominsky's work developing rocketry and CubeSat projects with high school and college students.

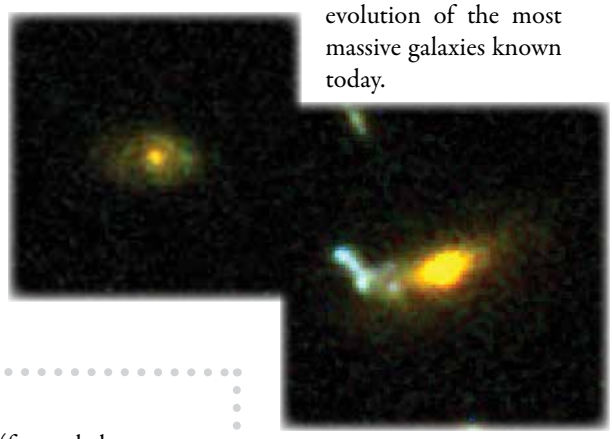
Additionally, in May 2018, Cominsky was invited to give a series of lectures in Taiwan, including the education keynote talk "High Energy Visions of the Universe" at the ASROC (Astronomy Society of the Republic of China) annual meeting. ASROC took place on the Taiwanese island of Kinmen (formerly known as Quemoy), which is a location that most local Taiwanese have never visited. The trip was hosted by ASIAA (Academia Sinica Institute for Astronomy and Astrophysics) in Taipei, which she also visited. And while in Taipei, Cominsky gave a public lecture entitled "Learning by Making: Rockets, CubeSats and more!) to an audience of about 100 local enthusiasts, while promoting SSU's International Education programs.

Prof. Cominsky in Australia

Studying Distant Galaxies

By Prof. Tom Targett

During the 17/18 academic year, my research has focused on the analysis of new astronomical imaging data from the SCUBA-2 instrument. SCUBA-2 is a submillimeter camera, sensitive to light generated by the warm dust around newly forming stars in distant galaxies. While our Milky Way galaxy is only (on average) forming several new stars a year, these new data have revealed a population of galaxies forming ~1000 stars-per-year! Specifically, I will determine the morphology and properties of these rapidly star-forming galaxies, in order to better understand their role in the formation and evolution of the most massive galaxies known today.



AlumNotes

Elizabeth "Libby" Flower [formerly Hays] ('93) *is an emergency room physician at Frank Howard Memorial Hospital in Willits. She earned her M.D. at the University of California, San Francisco in 1997 and did her residency in Santa Rosa.*

Eric Mueller ('93) *leads a team that provides cross-site collaboration and operational support for Monsanto in Hawaii. 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 JenaValve Technology, Inc.. He earned an M.B.A. at the University of San Francisco in 2007.*

Victor Hipkiss ('96) *is the global sales and operations planning leader at GE Healthcare in Wisconsin.*

Justin Wolfe ('01) *is a subsystem manager for the LSST camera optics at the Lawrence Livermore National Laboratory. Formerly an engineer at Optical Coating Laboratory, Inc., Santa Rosa, he earned an M.S. in optical sciences at the University of Arizona.*

Kevin Thomas ('02) *is an IC test technician at Keysight Technologies in Santa Rosa.*

Julia Maisen ('03) *is an illustrator and writer, currently working with Wonder Workshop and Paperwheel, both in the Bay Area. She earned a master's degree in children's book illustration at Anglia Ruskin University in Cambridge, England in 2017.*

Marta Fuentes-Filp [or Marta Fuentes]('05) *is a science teacher at the Jewish Community High School of the Bay in San Francisco. She formerly taught at Westmoor High School in Daly City. She earned her teaching credential at San Francisco State University in 2012.*

Sean Greenwalt ('05) *is a paratransit driver in Chico.*

Elizabeth Harmony ('05) *is a technician with Broadcom Inc.*

Mark Wollam ('06) *is a control systems engineer at 3D Systems in the San Diego area. He previously worked at Control Technology Inc.*

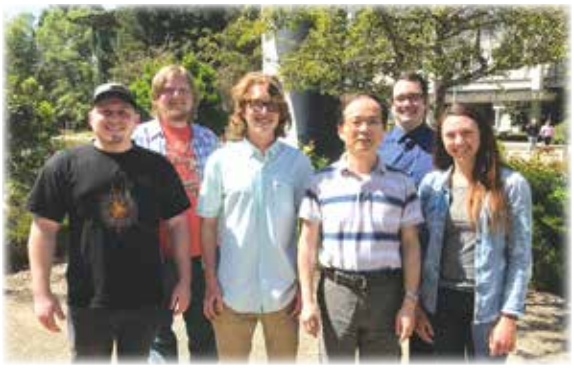
Michael Dobbs ('07) *is an associate at Sage Renewable Energy Counsulting in San Rafael. He previously conducted research at the Wolfram Summer School and at CERN.*

Ryan Olson ('07) *is a naturopathic doctor in Sebastopol. He received his Doctor of Naturopathic Medicine degree in 2017 from Bastyr University in San Diego. He formerly worked as a youth camp coordinator for Cal Adventures.*

Five Is a Big Crowd

By Prof. Hongtao Shi

2017-18 was a busy year! I received the Koret Scholars Award last fall, which is a grant the Koret Foundation provides to support student research. Such an award allowed me to work with four Koret Scholars, Ryan de Leuze, Marissa Mullins (Chemistry major), Trent Rhodes-Ousley, and Shane Sylvester on a few projects in the field of Materials Science. In January 2018, Zachary Kurland also joined the group to collaborate with Trent to design, build and test a home-made vibrating sample magnetometer (VSM) to facilitate the measurements of magnetic samples in a fully automated way. Thanks to Dr. Qualls and MakerSpace, Zach's 3D printing and design skills immediately made a difference, which allowed us to move the project forward quickly. We can now study magnetic samples by measuring their responses to an external magnetic field and plot the data in real time on the computer screen. Our results are very reproducible! On the other hand, Ryan and Shane had to put a lot of time into trouble shooting and trying different electrochemical parameters in order to fabricate honeycomb-like nanometer scaled pores or tubes for different applications. By using a method called multistep anodization, we were able to improve the ordering of our nanoarchitectures significantly. We are now in the process of filling in these nanopores with different metals to form magnetic nanowires. It will be very interesting to see what the VSM will reveal with regard to the property of these magnetic nanowires. Last but not least, Marissa has also made progress in fabricating zinc oxide (ZnO) nanowires on ITO (indium doped tin oxide) substrates. By spin-coating the surface of ITO with nanodiamond particles (average size 3.5 nm), we were able to dramatically enhance the adhesion of ZnO to the ITO surface. Room temperature light emission from these nanowires has been clearly demonstrated, which can find applications in optoelectronics.



Left to right: Zach Kurland, Trent Rhodes-Ousley, Ryan de Leuze, Prof. Shi, Shane Sylvester, Marissa Mullins

Capstone Research:
Reduction in Thin Film Curvature Post Deposition

By Chance Hawkins

The development of refined techniques to generate thin films with controlled surface parameters is a critical aspect of device construction. During the thin film deposition process, there can be undesired variation in the curvature of the coating surface. For this work, thin film substrate samples were created. The samples were then characterized by using a Zygo laser interferometer to map sample thickness and curvature. This provided surface values to propose adjustments to the growth process to reduce the curvature.

My research focuses on our measuring parameters and using the Zygo interferometer to gather data points and determine processes to help flatten the surface of the thin film coating. Using a theoretical calculator I was able to propose two processes using an averaging method and a maximum deviation method to reduce curvature. For both of my substrates curvature was reduced, but the averaging method resulted in a closer to "flat" value.

AlumNotes

Patrick Brown ('08) *is a product line manager at Alluxa, Inc. in Santa Rosa.*

Adam Dye ('09) *is a mathematician at Grand Vision Gaming in Reno, NV.*

Farzaneh Rasti ('10) *is a program engineer at Grauling Research Inc. in Santa Rosa. She was formerly at Deposition Sciences, Inc. in Santa Rosa.*

Ryan Young ('10) *is a network engineer at Cisco in Austin, TX.*

Luke Haley ('11) *is an acquisition project manager at Keysight Technologies in Santa Rosa. He is also pursuing an MBA at California Southern University.*

Austin Powell ('11) *has been promoted to data scientist with Kaiser Permanente in the Bay Area. He earned a master's degree in statistics at San Jose State University in 2016.*

Cristhyan Alfaro ('12) *is a semiconductor equipment supervisor at Keysight Technologies in Santa Rosa.*

Matthew Fontana ('12) *is a graduate student and teaching assistant in chemistry at UCLA. He received his M.S. in 2013. As a UCLA Collegium of University Teaching Fellow he developed and taught his own general education class, "Communicating Science: Chemistry in the World Around Us." In 2017 he was one of just five UCLA teaching assistants to receive a Distinguished Teaching Award.*

Chuck Neely ('13) *is a calibration and measurement technician at US Conec in North Carolina. He was previously an associate materials engineer at Deposition Sciences, Inc., in Santa Rosa.*

Jude Rowe ('13) *is a locksmith in Santa Rosa.*

Stephan R. Jackowski ('14) *is a materials engineer at BAE Systems in San Jose. He earned an M.S. in materials engineering at San José State University in 2017.*

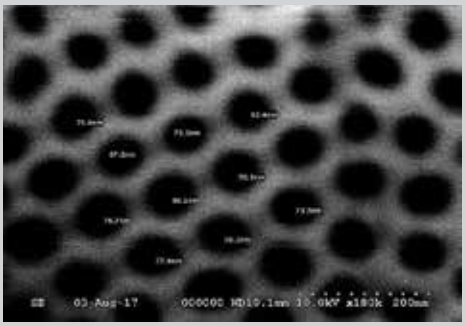
Peter Hiep A ('15) *is a teaching fellow at KIPP Prize Preparatory Academy in San Jose.*

Max Torke ('15) *is an optical test engineer at OSRAM Opto Semiconductors GmbH in Portland, OR. He was a summer intern at the NASA Goddard Space Flight Center in 2015, winning one of the twelve national internships sponsored by the Society of Physics Students.*

Hichwa Award:
Creating Aluminum Nanowires
By Shane Sylvester

My research for the summer of 2017 with Dr. Shi required that I carry out a variety of tasks, with the goal of fabricating ordered Anodized Aluminum Oxide (AAO) templates with large enough pores (about 60 nanometers (nm)), so that we may insert nickel into these pores to form nanowires for possible data recording applications. With the nickel nanowires in place, we then plan to place the samples into a vibrating sample magnetometer to study their magnetic properties. A large majority of the summer research was spent on figuring out a way to lower the barrier resistance of each anodized alumina template on top of the aluminum substrate. Creating an ordered array of nanopores with large pore size, thin AAO walls, and a reduced barrier layer proved more difficult than first expected. A two-step anodization process involving a voltage drop at the end of the anodization, followed by acid etching after the anodization, proved to create samples that are close to meeting the criteria for us to insert nickel nanowires.

An interesting experience I had during the research was using LabView, a graphical programming language to create a program which enabled a user to remotely control and communicate with the electronics to accomplish a specific task, such as electropolishing and anodization. All the data points that are graphed are saved to a spreadsheet as well, so that the user may generate graphs on other computers as well as look at the numbers.



The Hichwa summer research award provided me with the opportunity to learn and practice many skills that I plan to take to the private sector. More specifically I was able to work with various disciplines of STEM, such as electro-chemistry, vacuum technology, circuit analysis, troubleshooting, as well as thin film deposition. The Hichwa award has provided me with knowledge and confidence that will carry over into my work outside of Sonoma State University, for which I am forever thankful.

Capstone Research:
Constructing and Testing a Homemade Vibrating Sample Magnetometer
By Zachary Kurland

A Vibrating Sample Magnetometer (VSM) is an instrument that is capable of measuring the magnetic properties of materials. When a magnetic sample vibrates in an external magnetic field, the changing magnetic flux induces an electric potential in a pickup coil which is proportional to the magnetic moment in the sample, governed by Faraday's Law. The homemade VSM is remotely controlled by the graphical programming language LabView, which facilitates magnetic field sweeping and data acquisition. The data acquired from sweeping the magnetic field as the sample vibrates in it produces a graph called a hysteresis loop. The hysteresis loop is constructed in real time on a computer screen as the measurement proceeds, and the final product reveals the sample's magnetic properties. In order to make this experiment very reproducible, I utilized 3D modelling and printing techniques, and machined aluminum parts to allow for micro-meter precision in the positioning of the sample.

The most fun part of this project, under Dr. Shi's direction, was designing a sample holder with 3D modelling techniques. Using such techniques, I was able to take my mental image of the system and bring it to life in a matter of hours by 3D printing the components and assembling them after. The most difficult part of this project was designing the extremely rigid mechanical system that provides micro-meter adjustment precision in the x, y and z directions, while ensuring that their individual adjustments remain independent of one another.

In the fall of 2018, I will be moving to the Boston area to pursue a PhD in Physics at UMass Lowell. As of now, I am most interested in the application of physics in medicine, but have interests in every branch of physics. I hope to explore the field within the first year of my graduate studies before I begin working on a particular project.

Thank You for Your Support!

The Department has led the campus efforts to create the Makerspace and build an new 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. Tom Targett hosted the series this academic year. At 95 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. & Mrs. Joseph S. Tenn, Alan Friedman. Lynn Cominsky & Garrett Jernigan, Demitri D. Call ('16), J. Robert Dobbson, Carl Farriss, Robert A. Fisher, Winston S. Fisher ('09), Amandeep K. Gill ('15), Mr. & Mrs. Harvey B. Hecht ('92), Hunter J. Mills ('14), Johannes R. Raab ('79), Jerilynn Schisser ('03).

#C0142 Physics & Astronomy Equipment and Supplies
Charles A. Bullen ('75) & JoAnne Etheridge, David K. Hawk ('77), Mr. & Mrs. William L. Kramer

#C0143 SSU Observatory
No donations this past year.

#C0144 Student Development Program
Dr. Bryant P. and Diane Hichwa, Michael T. & Sheila McQuillen, Lauren Novatne ('89)

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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
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#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
Dr. Richard De Freez ('80) and Ms. Toni Kristensen

AlumNotes

Cody Johnson ('16) *has been promoted to materials and process engineer associate at Deposition Sciences Inc. in Santa Rosa, where he heads the photolithography department.*

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

Wesley Watson ('16) *is a mechanical engineer and product designer with Sonoma Coast Designs.*

Stephanie Winningham [formerly Church] ('16) *is an institutional research associate at Stanford University. She formerly worked at Keysight Technologies in Santa Rosa.*

Michael Schwartz ('17) *operates scanning electron microscopes and focused ion beam devices for Keysight Technologies in Santa Rosa.*

Great American Eclipse

By Profs. Tom Targett and Lynn Cominsky

The 2017 solar eclipse put on a spectacular show for much of North America. While eclipses are not at all uncommon (there is one every 18 months or so), it was very rare to have one which so many people could see (as statistically they often occur over the oceans or in remote areas).

In Sonoma County, SSU did not get see totality (the moon seeming to obscure the entire surface of the sun). On campus, the approximately 80% partial coverage resulted in a dimming affect similar to the darkening seen when wearing 3D glasses at the cinema.

Not wanting to miss such an amazing event, several SSU faculty traveled into the zone of totality. Dr. Thomas Targett traveled north to town of Albany in Oregon. The remote town proved a bustling hub of eclipse viewers, and Dr. Targett was able to meet many members of the public curious for scientific details. Thankfully, the skies remained clear, and all present got a wonderful view.

Dr. Lynn Cominsky decided to splurge for a vacation at the same time as the eclipse, and joined a group of over 200 astronomers, families and friends in Jackson Hole, Wyoming. The trip was organized by Eureka Scientific, Inc., who also provided parties before and after the event, as well as music, and great food at the Spring Creek Ranch. The viewing site was situated above a horse corral, which offered the opportunity to observe equine reactions to the eclipse. And at the 6000+ foot elevation, the temperature dropped rapidly, by about 25 degrees Fahrenheit. The horses were calmly eating breakfast until the light went out and it became very cold. Then they started chasing each other around for the 2.5 minutes of totality, but went back to eating when the Sun reappeared. It was an amazing experience, which definitely lived up to the hype!

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