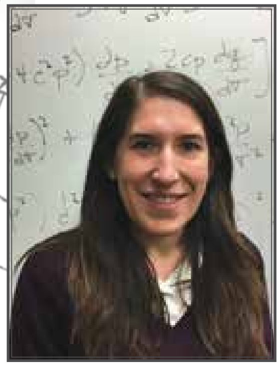
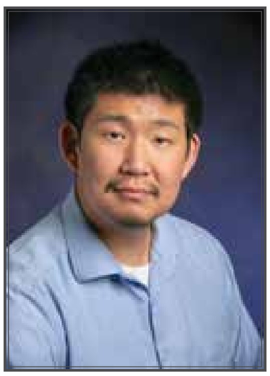
New Physics Faculty Members



Dr. Alexandra Miller

Alexandra Miller is thrilled to be joining the physics team at Sonoma State University! A Northern California native, Dr. Miller received her Bachelors of Science from San Francisco State University, just across the bay, before pursuing her PhD down south at the University of California, Santa Barbara. After earning her degree, she worked as a Visiting Lecturer at Wellesley College. She's now ready to return to her roots, with hopes of inspiring the next generation of physicists, both in and out of the classroom.

Dr. Miller works in the field of theoretical Quantum Gravity and can't wait to share her passion with the fantastic SSU students. Her research aims to answer one of the biggest open questions in physics today: How can one consistently unite Einstein's theory of General Relativity with Quantum Mechanics? This is imperative to our understanding of the universe at its most fundamental level and is especially important in finding a complete description of black holes and of the universe right after the big bang. Dr. Miller has several projects she hopes to push forward with the help of SSU students. These experiences will not only expose students to the forefront of Quantum Gravity research, but will also build their skills in theoretical modeling, mathematics, and computer programming.



Dr. James Lee

James Lee is one of two new faculty joining the Department of Physics and Astronomy. James earned his Ph.D. from the University of Illinois at Urbana-Champaign in 2013. His doctoral work revealed how subtle changes in the shape and orientation of electron orbitals in transition metal salts can profoundly affect their magnetic ordering. He also studied the many different electronic phases in competition with superconductivity in copper oxide superconductors. As a postdoctoral research fellow at Lawrence Berkeley National Laboratory, James helped develop new methods of using coherent x-ray light, generated by synchrotron and free electron x-ray laser sources, to probe the magnetic properties of matter. Prior to joining Sonoma State University, James ran the x-ray and high magnetic field facilities in the University of Illinois Materials Research Laboratory. There, he instructed students on how to use scientific instruments in a wide range of research (e.g., DNA packing in viruses, chemical composition of Roman artifacts, high temperature phase transitions in perovskites), and how to interpret their data.

James' current research concentrates on the properties of magnetic materials whose electron spins form topologically twisted swirling patterns called skyrmions. He is eager to guide students in research on this topic, as well as to incorporate his broader knowledge of condensed matter physics into classroom instruction.

Cominsky Steps Down as Department Chair

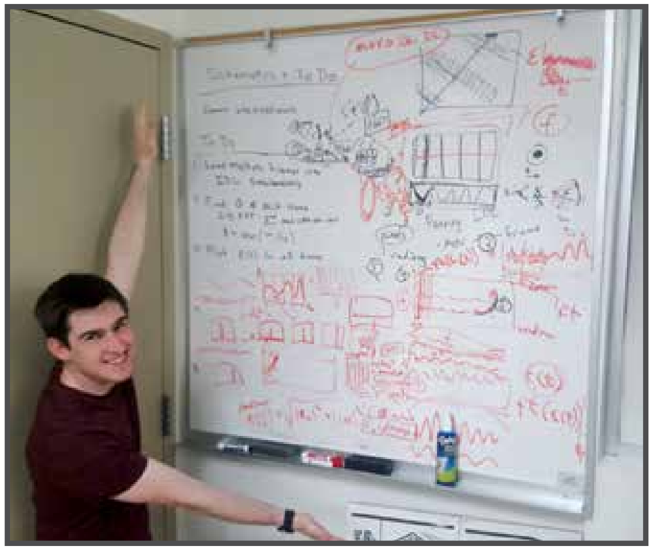
After a record setting five three-year terms, Prof. Lynn Cominsky has stepped down as Physics & Astronomy Department chair. The new Department Chair will be Prof. Scott Severson, beginning in Summer 2019. "I am very proud of the growth of the Department, including the creation of the new Makerspace in the Schulz Library as well as our new campus Observatory building, both of which were opened last year. But more important than facilities are the wonderful faculty that we have hired during my 15 years as chair, which includes all of the currently tenured and tenure-track faculty, as well as our two new hires that will begin in Fall 2019." Other highlights include the remodeling (over a decade ago) of the Physics & Astronomy Department space as part of the Darwin renovations, creating what is still fondly referred to as "New Darwin." Cominsky will be using the extra time to work on grant-funded projects, including the further development of the Learning by Making integrated ninth-grade STEM curriculum that was recently awarded another $4 million from the US Department of Education, as well as NASA's Universe of Learning Astrophysics Learning and Literacy program (see the accompanying article about SSU's Education and Public Outreach group.)

Capstone Research:
Simulating LIGO: Wavefront Sensing using Interferometry

By Zack Tweedy

This project is a continuation from my Fall 2018 project, Constructing LIGO, where I built, calibrated, and tested my own interferometer. This portion of the project was primarily software-based, as I developed code to take a video, split that video into several thousand frames, and then run calculations based on those frames to measure a signal that simulated LIGO's historic detection.

The computer language I used is called IDL, or Interactive Data Language. This computer language is primarily built for astronomers, who take images and manipulate them into different forms of data. Due to the nature of IDL, I was able to generate a similar process for my work.



Zack Tweedy explains LIGO signals

LIGO's chirp has two primary components, an exponential frequency change over time, coupled with an amplitude increase over that same timeframe. The data suggests that as the frequency increases, the amplitude of that wave also increases. With this in mind, I needed to insert a signal into my interferometer that would generate that same data set.

In order to insert a specific signal, I needed to make adjustments to my interferometric setup. First, I changed out a gear system for a speaker, which would insert a sound wave through a wooden block and into the mirror. With the speaker in place, I tested a variety of function generators. I eventually came upon an online frequency generator and sweep generator capable of adjusting the frequency and the amplitude of a wave simultaneously. Once I found the sweep generator, I knew I could generate a signal similar to that LIGO detected.

At the end of the semester, I was able to run my experiment, and measure a simulated LIGO chirp. This project now can serve as a foundational testbed for other students. Students in the future can take the research I conducted and manipulate the project for other means, while still keeping to the core product. This experiment can be taught to students in an optics lab, where the students could learn valuable lessons in interferometry and its use to make measurements. The greater community could view this experiment to understand how LIGO works, from start to finish.

Now that the project is finished, I can move on to bigger and better things. I will be pursuing work in the greater Santa Rosa area, and eventually be moving onwards to graduate school.

Capstone Research:
Dual Wavelength Laser Photometry of Particulate Matter

By Jacob Davidson

Analysis of smoke particulate size in a contained air sample with a dual wavelength laser apparatus leads to better air quality sensors. I built and operated a dual laser system to analyze the scattering of light due to different sized particulates in an air sample. Measuring the difference in intensity of scattered light at two wavelengths allows me to calculate the size of particulates from different sources such as cigarettes, toilet paper, and cornstarch baby powder. Particulates smaller than 10 microns are extremely harmful to human lungs and can increase the risk of lung cancer. Further development of air quality sensors using dual laser systems to efficiently analyze particulates in air will improve the utility of smoke detectors and make air quality sensors more accurate.

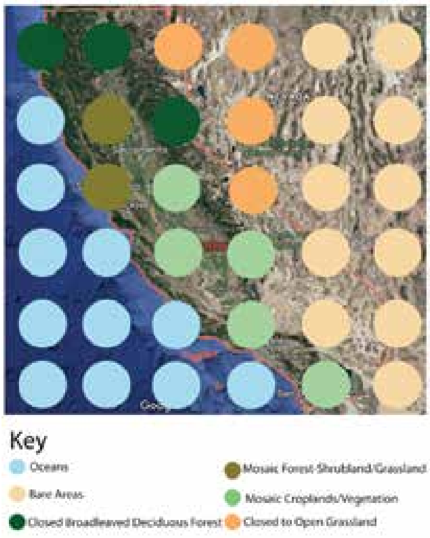
This was a wonderful experience getting to develop, design, and execute my own project in which I could gather meaningful data. Typically, throughout my academic career, the experiments in labs were straight-forward and didn't allow for any personal development of ideas, but this project let me develop and execute my own experiment. The biggest highlight of my Capstone project was the freedom that I was given to develop my own project that not only employs lessons I've learned from physics, but also gives me the confidence to conduct my own research. I currently work for a start-up company out of Petaluma that is using the same blue laser diode that I used in this experiment. After I graduate on May 18^{th}, I will start my full time job working as an engineer for this company.

Jacob Davidson works with laser optics

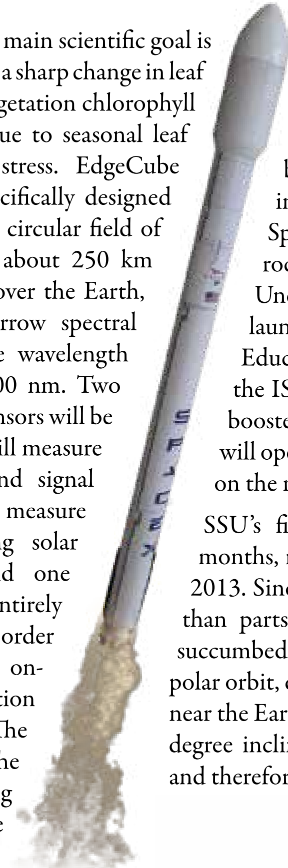
EdgeCube is Almost Ready for Delivery!

By Prof. Lynn Cominsky

SSU's second small satellite is called EdgeCube, because its main scientific goal is to make a global measurement of the red edge that monitors a sharp change in leaf reflectance in the range 680 to 750 nm from changes in vegetation chlorophyll absorption due to seasonal leaf changes or stress. EdgeCube has been specifically designed to monitor a circular field of view that is about 250 km in diameter over the Earth, using 10 narrow spectral bands in the wavelength range 630-800 nm. Two additional sensors will be flown: one will measure the broadband signal in order to measure the incoming solar radiance, and one will be entirely blocked in order to provide on-board calibration with respect to thermal drifts, dark noise signals, etc. The incoming solar radiance is needed in order to calculate the top-of-atmosphere reflectance (at-sensor radiance/incoming solar radiance), thus normalizing the data through the seasons and by latitude. Although EdgeCube's ground spatial resolution is substantially less than conventional multispectral satellites, its design will test the red-edge monitoring concept within the limitations of a 1U CubeSat (10 cm per side).



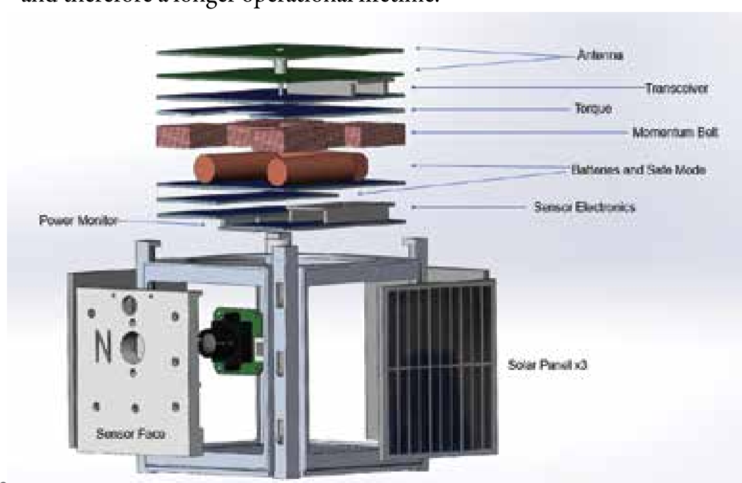
Simulation of EdgeCube results



At SSU, EdgeCube has involved over 30 students to date, including students majoring in physics, electrical engineering, computer science, and geography. Students have presented the status of EdgeCube during the past three years at the annual CubeSat conference at Cal Poly SLO. Dr. Garrett Jernigan, the team's technical mentor, has accompanied the students to the conference, as well as providing invaluable advice about all aspects of building small satellites.

During the past year, EdgeCube has undergone extensive end-to-end testing, to better simulate flight conditions. Environmental testing is the last major task to be performed in order to increase the chances of successful operations on orbit. These tests, including vacuum operations and moderate vibrational testing (up to 2 g) will take place this summer. We are on track to deliver the flight-qualified satellite to NASA by October 2, 2019. After that, the satellite will be integrated into a dispenser which will be carried to the International Space Station on December 4, 2019 by a Space-X Falcon-9 rocket. The development of EdgeCube was funded by NASA's Undergraduate Student Instrumentation Project, and it is being launched through NASA's CubeSat Launch Initiative (CSLI) Educational Launch of Nanosatellites (ELaNa) 28 Mission. From the ISS, on January 20, 2020, EdgeCube will be lifted by a special booster to its final orbit of ~500 km. After launch, SSU students will operate EdgeCube from the radio antenna that was built in 2015 on the roof of the Student Center.

SSU's first satellite, T-LogoQube, successfully operated for two months, returning magnetic field data, following launch in November 2013. Since CubeSats are made of commercially available parts (rather than parts that are hardened for radiation exposure), T-LogoQube succumbed to radiation in January 2014. However T-LogoQube was in a polar orbit, directly passing through areas of high charged particle density near the Earth's poles. We hope that EdgeCube's ISS-aligned orbit (~51.5 degree inclination) will provide a more benign radiation environment, and therefore a longer operational lifetime.



Expanded view of EdgeCube payload

Capstone Research: Synthesis of Nanopore Templates for Nickel Nanowires

By Scott Allred

The challenges our world will face in the next century are those that will test the limits of human ingenuity. With more people on earth each year the globe increasingly looks to science to find solutions to problems like: How do we sustainably generate energy and how do we increase data storage density? To tackle these challenges we turn to the smallest little wire you've ever seen, or rather can't see. Using nanowires we are able to create solar panels that are much more efficient and create data storage devices a fraction of the size they are currently.

Scott Allred demonstrates an oversized nanopore template

Over the course of our research we have created nanopore arrays on the surface of ultra pure aluminum. The fabrication and characterization of nanopores requires a multistep anodization process and careful imaging with a scanning electron microscope. If your finger was a 1 cm diameter circle, we could grow 15 billion of our nanopores on it. One huge challenge of this scale of work is understanding what is happening on the sample and how to create these ordered nanopore templates in a reproducible way when you can't simply see them. The goal of our research project is to deposit wires in our templates and study their magnetic properties.

I plan to use my experience from research and studies at Sonoma State to work in engineering for a local thin film or semiconductor company. Over the next 10 years I plan to pursue a graduate degree either in an engineering field or in business.

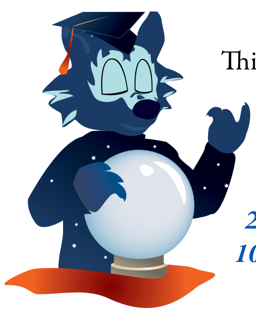
Capstone Research:
Analyzing the Properties of Solid-state Refrigeration Technology: Thermoelectric Coolers (TEC)
By Ernest Ongaro

For my capstone project, I chose to study Solid-state Refrigeration Technology and analyze the properties of a commercially available device, commonly called a Thermoelectric Cooler (TEC). Conventional refrigeration technology is a mechanical system that uses high pressure gases, typically a type of hydrochlorofluorocarbon (HCFC), which is an aggressive greenhouse gas. TECs, on the other hand, have no moving parts that require maintenance or emit noise and use no high-pressure gases or liquids, which makes them extremely reliable. They are comprised of a series of p-type and n-type semiconductor pairs between two ceramic plates as these semiconductors have different charge carrying capabilities. I wanted to create a system to measure a typical TEC's Cooling Capacity and Efficiency. In short--how much thermal energy can the TEC draw from an enclosed system per unit time and how much electricity did it take to perform the task? I designed and built a test apparatus to create as close to an ideal operating environment as possible so that my measurements could be as accurate as possible.

As an experience, I believe this project stood as a great representation of what our Physics and Astronomy Department strives to provide to every student as they complete the degree program. First, the project touched on many different disciplines of physics: electronics, thermodynamics, statistical mechanics and even quantum mechanics. Second, a long-term project like the capstone, in general, required near-constant problem solving, endurance and a proactive nature to complete. Last, this project seemed to require just as much applied, practical skill and knowledge as it did theoretical. The ability to make a thought, like my test apparatus, come to fruition as a tangible object in a laboratory is not only useful to the individual, but a skill extremely sought after by employers. Giving physics students the opportunity to spend a generous amount of time putting their theoretical knowledge and lab experience to the test in situations where there may not be just one "right answer" or even any "right answers" is a fantastic gift that will give them a leg-up whether they choose to continue their education or go straight to industry.

I am lucky enough to already have a career coming out of school. I am a local, small business owner alongside my father, uncle and cousins. Lovingly nicknamed "the shop" by my family for 87 years, our company provides the Bay Area with residential HVAC and Plumbing services.

Ernest Ongaro demonstrates his cooling system to Milla, his dog.



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 Ernest Ongaro

As a befitting representation of our discipline's vast scope, I believe the next breakthroughs in physics will be in expanding our current limits on both the micro and macro scale. More specifically, what I hope to witness is development in our ability to garner further understanding and significance from currently available data sources. We are able to collect far more information than we are able to process, analyze and store.

One example is the data collection from the Large Hadron Collider (LHC) at CERN. So much data comes from a single collision that parsing out the relevant information is truly analogical to finding a needle in a haystack. This arduous task requires algorithms that can efficiently and effectively identify what to keep and what to throw away. At the moment only a fraction of the total information can even be analyzed by the algorithms. I believe that the next series of breakthroughs will find better use of the information we already collect, rather than new technology or techniques to dig "deeper" or "farther".

First off, there are many new prospective methods of storing our data. New materials are being created and some of their properties have potential in replacing conventional transistors. One example would be metamaterials using graphene, properties which have been observed that could be used to create transistors on a scale much smaller than what is currently produced commercially.

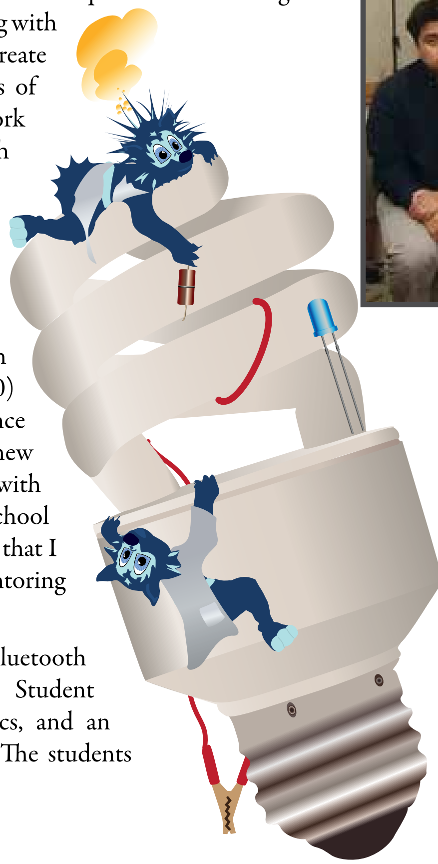
How the data are processed after collection is just as important. Some of the more promising new ways of processing data include quantum computing, machine learning, and analog computing. Quantum computing and machine learning use probabilities to crunch numbers more efficiently, while analog computing utilizes changes within a well-known relationship of parameters, such as the voltage, current, resistance to calculate an algorithm near-instantaneously.

I should mentioned that I found out about all these exciting new advancements from a wonderful resource provided by Sonoma State's Physics and Astronomy Department called What Physicists Do (WPD). Every semester a weekly colloquium is scheduled to bring in a speaker working on the frontier of the newest developments in the field of physics. When you spend most of your time in a classroom, a seminar like WPD helps give some perspective as to where all the foundations of theory we're learning leads to. I'm excited to see where physics leads us and the ways in which Sonoma State cultivates the minds that will drive that future.

Capstone Research: Innovative Thinking

By Shannon Lessard

Being a Physics major at Sonoma State, I always knew that I had a love for teaching science to older students. Thanks to the help and mentorship of Dr. Cominsky, I was able to spend an entire year creating a new club at Petaluma High School called "Dream, Make, Innovate." Our goal in starting this project was to allow students, such as myself, that have a passion for teaching to have hands-on experience working with students in which we are allowed to create new things and explore limitations of designs in a project. Being able to work with the students at Petaluma High School has greatly opened my eyes to the potential students have in creating and designing projects that have previously have been thought to be too complex.



From the classes offered here such as The Watershed Year (Science 120) and Dream, Make, Innovate (Science 220), I was inspired to take my new knowledge of making and couple it with teaching. Once I was in the high school setting, all of the science techniques that I had been taught were used while mentoring the students.

Together, we have created a Bluetooth chicken coop door, Associated Student Body dance lights using all physics, and an Augmented Reality 3-D Sandbox. The students and I have learned so much from each other and we have been able to see others grow. With all the highs and lows that we have encountered, everyone has persisted and been dedicated to making the projects the best they can be. Once it was all completed, Mr. Brazil and the students that worked alongside me were invited to Sonoma State's Science Symposium. I believe that they had successfully achieved college level work and earned the right to brag about the 3-D sandbox with me. I now know that I truly want to teach at a high school level and love to see young minds grow in the way that they think.

Victor Brazil, Shannon Lessard and 4 PHS students with the 3D sandbox at SSU's Science Research Symposium

AlumNotes

Jim Hill ('71) *retired in 1999 from teaching physics at Piner High School in Santa Rosa. He is a past president of the Northern California/Nevada section of the American Association of Physics Teachers. Active in ham radio, he helps teach electricity to Sonoma Valley High School students.*

Arnie Christiansen ('74) *retired in 2019 as the principal of Computerized Data Systems, Inc, a consultant firm in Houston.*

Richard K. DeFreez ('80) *retired in 2018 as a senior scientist for Met One Instruments, Inc. in Grants Pass, OR. He formerly held similar posts at MesoSystem Technology and Hach Homeland Security Technologies in Grants Pass. He has also been on the faculty of Linfield Research Institute and the Oregon Graduate Institute of Science and Technology, where he earned his Ph.D. in applied physics in 1985. He was honored as one of Sonoma State University's Distinguished Alumni in 1995.*

John R. Johnson ('80) *passed away sometime between 2013 and 2019. He had retired after working as an engineer at Ford Aerospace, Rockwell Avionics, Lockheed Space Operations Company, Daden Engineering and KW Microwave in southern California. He designed hardware and software components and systems.*

Richard Montgomery ('81) *is a professor and past chair of the Department of Mathematics at the University of California, Santa Cruz, where he works on the N-body problem of classical mechanics. He earned his Ph.D. in mathematics at the University of California, Berkeley. He has been a Sigma Xi Distinguished Lecturer and (in 2018) an Eisenbud Professor at the Mathematical Sciences Research Institute in Berkeley.*

Joanne Del Corral ('83) *retired in 2018 after thirty-five years as a lecturer in the SSU Department of Physics and Astronomy. She taught several introductory laboratory courses.*

Dan O'Donnell ('83) *is the director of information security for Viking Cruises. He has held similar posiitons at Millennium Space Systems, Boeing, and the RAND Corporation.*

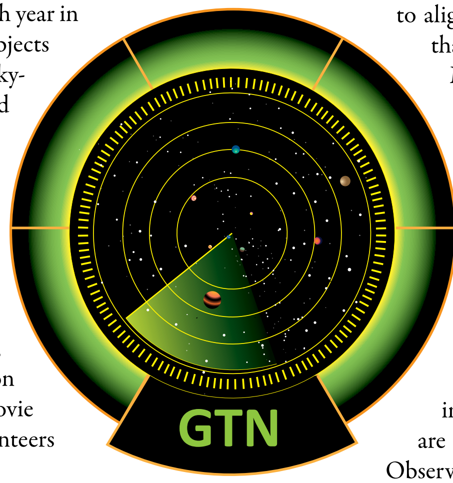
Christopher Cook ('88) *was promoted to technical fellow at Edmund Optics in New Jersey in 2018. Formerly director of thin films development at Axsun Technologies, he previously built a thin film laboratory while simultaneously working at MIT's Lincoln Laboratory and earning an M.S. in electro-optics engineering at Tufts University.*

Andrew Peri ('91) *is a consultant on environmental and transportation issues in Marin County. He is currently working on exposure to magnetic radiation. He has taught part-time in the department of geography and human environment at San Francisco State University, where he earned an M.A. in 2005.*

The SSU Education and Public Outreach Group Report

By Dr. Laura Peticolas

The Education and Public Outreach group has had another busy year. We were awarded $4 million over 5 years from the Department of Education for STEM + C (Science, Technology, Engineering, Mathematics + Computer Science) 9th grade Learning by Making curriculum in rural and high needs high schools. We brought back to life our 14" remotely-operated telescope that sits at Pepperwood Preserve, after the fire burned out the electrical and network cables. We revised our Global Telescope Network website and program, funded by NASA. We celebrated NASA's Fermi tenth year in space gathering data from high-energy gamma-ray objects in our Universe with anniversary graphics, a new sky-map, and beautiful posters in the likeness of stained glass windows celebrating Fermi's discoveries. We have also contributed science and science education expertise to another NASA project, the National Informal STEM Education Network, run in part out of the San Francisco Children's Discovery Center. We were delighted when Google granted us a $5K gift to support our involvement of students in the Eclipse Megamovie Project data analysis. Then, we obtained a grant from the CSU for use of Amazon Web Services to analyze these Eclipse Megamovie photographs. SSU students and several volunteers supported all of these efforts.



Graphic from new GTN website

New Learning by Making logo

For the past five years, Sonoma State University's Education and Public Outreach Group has been working to create and fine-tune a ninth grade curriculum that rethinks the way STEM courses engage students. The result has been a *Learning by Making (LbyM)* curriculum that trains students to design and construct their own experiments. Piloted in six Mendocino County high schools during the past four years, the curriculum will now expand to Sonoma and Lake counties thanks to the $3.93 million grant from the U.S. Department of Education. *LbyM* has been our group's most challenging project, but it also has the potential to transform STEM education nationally. The *LbyM* project was specifically designed to benefit rural schools which are typically underserved in STEM education. With many rural schools not having credentialed teachers in each science discipline, teaching an integrated STEM curriculum allows flexibility. The curriculum design also provides advanced students the opportunity to take on more challenging activities, which is important in rural schools where small student populations preclude the ability to offer AP classes. We have the opportunity to rethink the way that STEM subjects are taught, so that students are more actively engaged in doing science, and not just memorizing facts. During the 2016-17 school year, external evaluators at WestEd conducted an impact study that compared student learning outcomes using the *LbyM* curriculum to other 9th grade students who were enrolled in traditional courses. Their initial evaluation demonstrated significant gains in science learning and improvements in mathematics skills. See *http://lbym.sonoma.edu* for more information. SSU students Courtney McNatt (physics), Anthony Aboumrad (engineering), Corbin Shatto (engineering), and Ana Tongilava (math) have all contributed to building and testing the new Arduino-based curriculum.

The *Global Telescope Network (GTN)* is a NASA-funded program to advance STEM learning and literacy by using Internet-controllable telescopes to engage learners in authentic research experiences. The *GTN* is developed and maintained by scientists, engineers, and educators at Sonoma State University (SSU), in partnership with remote telescope networks around the world. The *GTN* provides opportunities for participants to learn astrophysics content and skills on their own timelines and in their own environments. This past year, we have worked on revamping the *GTN* website to align it with other NASA-funded telescope programs that connect to the *GTN* program: PANOPTES and MicroObservatory. Coming soon will be interactives that teach about exoplanet and Cepheid light curves in the context of astrophysics themes "Other solar systems; Other Earths" and "History and Origin of the Universe." In addition, we are working on authentic research guides for the public to use our own 14-inch Schmidt-Cassegrain robotic telescope, nicknamed *GORT* (Gamma-ray Optical Robotic Telescope.) *GORT* has been in operation since 2004. *GORT* can be remotely operated, and has a selection of filters that provide images in different visible wavelength bands. We are also in conversations with the Robert Ferguson Observatory to build a stronger, more robust Sonoma County astronomical collaboration. Already, community college and community volunteers are working to benefit both *GORT* activity development and *RFO* community engagement. For example, Lillian Santos, Robin Maila, and Veronica Ruiz have supported light curve analysis education from *GORT* and *RFO*, edited *GTN* website pages, and presented at *RFO* events.

GORT survived the 2017 fires and is now taking data again like the above image of M65

The Fermi telescope celebrated its tenth birthday this past summer and fall. Our group supported press releases from its discoveries, creating articles and graphics too. The Fermi team members, including those from SSU, created a set of constellations made from the brightest gamma-ray sources. Working with the Fermi team, our EPO team member, Aurore Simonnet, developed inspiring posters and 10th year anniversary graphics, as well as a revised sky map that illustrates Fermi's major discoveries over the past 10 years.

Stained-glass style posters show-casing the Fermi project on its 10 year anniversary

The National Informal STEM Education Network provides STEM toolkits and exhibits to museums across the country in all fifty states. We support their Earth & Space toolkit development and professional development offerings, and provide science advice and input into their Sun, Earth, Universe Exhibition. Biology student Mackenzie Hunt increased her physics knowledge as she supported a stellar activity development process.

Analyzing over 50,000 photographs taken by photographers, engineers, and scientists during the 2017 total solar eclipse to add to our understanding of the solar corona is a daunting task. Very few of the images are calibrated to determine the effects of the camera optics or the CCD background noise. In addition to this lack of generalized calibration of the data, the star Regulus is located only in a subset of the images. This makes rotating the images to align solar features over the 90 minutes of the shadow crossing the United States an extremely challenging task. Running image analysis python code at SSU in collaboration with colleagues at UC Berkeley has been a resource-intensive task involving SSU students and EPO group members. In order to make the computational analysis more feasible, the EPO group was granted a CSU Amazon Web Services (AWS) award of $10,000 in computational resources on AWS servers.

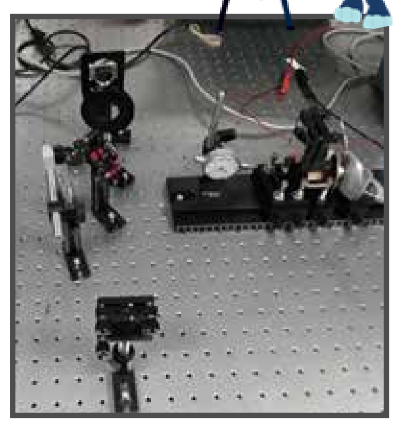
In addition to these computational resources, we also were gifted $5,000 by Google Making & Science to support student data analysis and solar research on this project. Physics major Andre Bernard has delved into the many components of this research. Engineering major David Story has supported software development to support future students using Jupyter Notebooks to access AWS resources from SSU computers.

For more information about all of our projects, see: *http://epo.sonoma.edu.*

Hichwa Award:
Constructing LIGO: Building, calibrating, and testing my own Interferometer

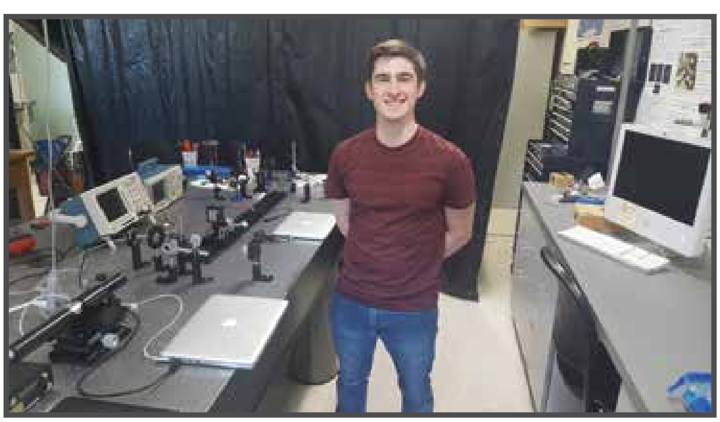
By Zack Tweedy

During the Fall of 2018, I received the Hichwa Research award, and began my journey to simulating LIGO, the Laser Interferometer and Gravitational-Wave Observatory. LIGO is one of the largest scientific collaborations in the world, making measurements so fine they can detect ripples in spacetime billions of light years away. These ripples are mainly caused by two black holes colliding. The feats of engineering and physics involved are truly remarkable, and three leaders of the LIGO team were awarded the Nobel Prize in 2017 for their work. It was my goal in the Fall to construct a miniature version of LIGO, calibrated to the highest degree possible. To do this, I needed to make an interferometer.



Detail of optics setup

An interferometer is a tool used by physicists to make very fine positional measurements using light. The laser system is comprised of a laser, a beam splitter, two mirrors, and a camera. The resulting pattern resembles a bullseye, with alternating light and dark circular bands surrounding a center. These bands are called "fringes," and together a light and dark band make up one wavelength of light.



Zack Tweedy with his LIGO simulator

There were several challenges in building an interferometer, primarily in testing and fine-tuning the equipment, reducing the noise, and ultimately calibrating the interferometer. Due to the very fine measurements taking place, there is a lot of systemic noise in the system, ranging from the AC turning on all the way to people opening and closing doors down the hall from the lab, where the interferometer was built. With these challenges in mind, I managed to calibrate this interferometer to the best of my ability.

I calibrated my interferometer to approximately 2% of the laser's actual wavelength. This means that there is approximately 2% error in my system. Once the interferometer was built and tested, I could continue to the next step in my Simulating LIGO project, completed as my senior capstone (see accompanying article).

Capstone Research: Scanning Electron and Atomic Force Microscopies for Imaging Protein and RNA Complexes

By Tanner Kimberly

For my capstone project this semester, I have been working on imaging a particular protein and RNA complex using scanning electron microscopy (SEM) and atomic force microscopy (AFM). These methods, SEM and AFM, are utilized in order to visualize extremely small structures all the way from the microscale down to the molecular level. The protein, B-cell activating factor receptor (BAFF-R), and a particular RNA molecule bind to act as a drug delivery system for the treatment of Non-Hodgkin's Lymphoma. The images collected with these microscopes allow the elucidation of the binding mechanism between the protein and RNA molecules. What's very exciting about this study, is that this methodology may prove to be a viable means for further studies of protein and RNA drug delivery systems.

This project has been very rewarding because it has allowed me to learn how to operate these very sophisticated scientific instruments and how to analyze the data that they produce. Another aspect that has been particularly valuable is that I am a double-major in physics and chemistry. I have had many struggles with the project throughout the semester, but the knowledge I was able to obtain is extremely valuable. After graduation, I will be starting graduate school at UC Davis for my PhD in chemistry and am very excited to see what unfolds on my next academic journey!

Tanner Kimberly inspects SEM images

AlumNotes

Imme Staeffler ('91) *is a psychologist practicisng adult individual psychotherapy in San Francisco, where she opened a new office in 2018. She earned a doctorate in clinical psychology at Meridian University.*

Raymond Ubelhart ('91) *is a consulting software architect at Auris Health, Inc. in Carlsbad. He earned an M.S. in computer and engineering science at SSU in 2004.*

Marie-Chrisine Raude ('91) *is a mechanical designer at Ventek International in Petaluma.*

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

Holly Jessop ('93) *is a research scientist (epidemiology/biostatistics) at the California Department of Public Health. She completed her Ph.D. in epidemiology at the University of Hawai'i at Manoa in 2018. She earned an M.S. in tropical conservation biology at the University of Hawai'i at Hilo in 2008 and a second M.S., in public health, at the University of Hawai'i at Manoa in 2011. She formerly worked in the Education and Public Outreach program of the Chandra X-ray Observatory at the Smithsonian Astrophysical Observatory.*

Nickolas Melville ('93) *is an HV Battery Project Leader at Byton. He was formerly a senior engineer building batteries for satellites with SSL in Palo Alto. He earned an M.S. in mechanical engineering at UC Davis in 1995.*

Eric Mueller ('93) *is Hawaii Enablement Site Lead for Bayer Crop Science in Hawaii. He earned a master's degree in engineering at North Carolina State University in 2001.*

Paul Somerville ('93) *is a manager with Skip, an e-scooter ride-sharing company in San Francisco. He has been a partner in MotoJava, a cafe/motorcycle shop in San Francisco, and a project manager for Coherent, Inc. in Santa Clara.*

Greg Sprehn ('93) *founded and directs Rivendell Heights, Inc., a provider of contract research for medical device development and testing. Specialties include electroretinography, psychophysical eye tracking, infrared, visible and x-ray imaging systems, and instrument design. The holder of three patents in image processing and fiber-optics, he is now based in Middletown and working on the design and test of infrared illumination systems for primate gaze tracking and vision performance tests useful in translational drug development.*

Siana Alcorn [formerly Hurwitt] ('97) *is maker relations manager with the Maker Faire organization in San Francisco. She was for many years a group manager, managing software to access validate, analyze, visualize, and report aerometric data, at Sonoma Technology, Inc. in Petaluma.*

Shawna Baskin ('02) *is the CFO at DeepNet Computer Consulting. She was formerly Diagnostic Test Engineer with Alcatel-Lucent.*

Tyana Stiegler ('03) *is a postdoctoral researcher at the Lawrence Livermore National Laboratory, where she works on the nEXO detector. which will be searching for neutrinoless double beta decays in liquid xenon. She earned a Ph.D. in experimental particle physics at Texas A&M University in 2013 with research on the LUX (Large Underground Xenon Detector) Project, a dark matter direct detection experiment in South Dakota. She earned her M.S. in physics at the University of California, Davis.*

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

Tedman Torres ('04) *is a lieutenant and surface warfare officer (nuclear) in the U.S. Navy. He is currently the main propulsion assistant on the USS La Jolla at the Norfolk Naval Shipyard in Norfolk, VA. He was formerly a postdoctoral researcher at the H. Lee Moffitt Cancer Center & Research Institute in Tampa, FL. He earned his Ph.D. in biological physics at Arizona State University in 2009 with a dissertation on fluorescence correlation spectroscopy.*

Capstone Research:

Fabrication and Characterization of Zinc Oxide Nanorods

By James Garner

Zinc oxide (ZnO) is a wide bandgap semiconductor that has outstanding material properties. ZnO nanorods are advantageous because they can be used in various optoelectronic applications due to their extremely large surface area. The synthesis of these nanorods can be achieved through several different thin film deposition techniques. This spring semester, I worked on a project which used a process called electrochemical deposition (ECD) to create these nanorods on indium tin oxide (ITO) coated glass substrates. Such a process is cost-effective, easy to operate and scale up. After the fabrication process, I analyzed the dimensions and population density of the nanorods using a scanning electron microscope (SEM) in the Keck Microanalysis Laboratory and a UV-Vis spectrometer in the laser lab. The purpose of my research was to measure the change in the physical properties of zinc oxide nanorods caused by varying parameters, such as the molarity of the solution used, during the ECD process.

James Garner prepares a ZnO sample

I had several opportunities to utilize problem solving and critical thinking during my research. The first several samples I made using the ECD process were not suitable for measurements. They either broke while being mounted into the deposition cell or they cracked during the deposition due to the fragile nature of these thin glass substrates. It wasn't until the sixth sample that I was actually able to do a deposition correctly, and the main difference here was the size of the indium wires I used as electrical contact points while mounting the sample into the cell properly. It may seem trivial, but it turns out the electrical connection component of the deposition cell was critical in creating a quality deposition. I became very familiar with operating the SEM and got a lot of experience with imaging the samples.

After graduation, I intend to gain employment at one of the local material science institutions here in Santa Rosa, whether that is in the field of thin film optics, like my research project, or in some other subcategory of that discipline.

AlumNotes

Ashley Janny [formerly Wiren] ('04) *is a systems engineer at Raytheon in Huntsville, AL. She previously workeed at Boeing in Kent, WA. She earned an M.S. in aerospace engineering sciences at the University of Colorado at Boulder in 2005.*

Kevin John ('07) *is a senior test engineer at Sensys Networks in Berkeley. He was for several years an education resource developer in SSU's Education and Public Outreach Group.*

Michael Youmans ('07) *is a manufacturing engineer at Joby Aviation, a transportation VTOL aircraft startup in Santa Cruz. He formerly worked at Kespry in Menlo Park, and Spectra-Physics in Sunnyvale.*

Michael Duncan ('09) *is a hazardous materials specialist for the Contra Costa County Health Services Hazardous Materials Programs. He earned an M.S. in physics at California State University, Fresno in 2012. He did research in experimental particle physics at CERN.*

Kenneth Martinelli ('09) *is the quality systems manager at Photop Advanced Coating Center (II-VI) in Santa Rosa. He was formerly a quality engineer with Sonoma Photonics, a subsidiary of Northrop Grumman Corp., in Santa Rosa.*

Katherine "Katy" Wyman ('09) *is a software engineer for the family calendar app Cozi . For two years she taught with the Women's Coding Collective. Formerly a technical assistant in the Director's Office for the Chandra X-Ray Observatory at the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA, she earned a master's degree in astronomy at Wesleyan University in 2011. A poster based on her thesis research won a Chambliss Astronomy Achievement Student Award at the June 2012 meeting of the American Astronomical Society. She did research in radio astronomy at the National Radio Astronomy Observatory in summer 2009.*

Bradley Yearwood ('09) *is a software engineer working on embedded systems development for Roku.*

Timothy Hessong ('09) *is a metrology engineer at Zygo Extreme Precision Optics in Richmond.*

Luke Haley ('11) *is now global transformation manager at Keysight Technologies in Santa Rosa. He earned an MBA at California Southern University in 2018.*

Jarod Fahle ('12) *is an audio software quality assurance engineer at Amazon Lab 126. He previously worked at Knowles Intelligent Audio in Mountain View and SGS in Lenexa, KS.*

Matthew Fontana ('12) *is a chemistry instructor at Santa Rosa Jr. College. He earned his Ph.D. in chemistry at UCLA in 2018. 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 was one of just five UCLA teaching assistants to receive a Distinguished Teaching award.*

Anna Wojtowicz ('13) *is a process development engineer at MiaSole, a thin-film solar manufacturer in Santa Clara. She earned an M.S. in physics at Colorado State University in 2017. She was formerly a research associate at Oak Ridge National Laboratory, where she developed software for enhancing nuclear reactor simulation modeling and data analysis.*

Hunter Mills ('14) *is a data scientist working on clinical informatics at the University of California, San Francisco. He earned a master's degree in computational and mathematical engineering at Stanford University in 2018.*

Rosita Ordoñez ('16) *is a quality control chemist at Pharmacyclics, an AbbVie Company, in Sunnyvale. She formerly worked at Dow Pharmaceutical Sciences in Petaluma.*

Cody Johnson ('16) *is working as a materials and process engineer at Sonoma Photonics, a subsidiary of Northrop Grumman, in Santa Rosa. He was formerly a materials and process engineer associate at Deposition Sciences Inc. in Santa Rosa, where he headed the photolithography department.*

Jake Nichols ('17) *is a metrology engineer at Viavi Solutions in Santa Rosa.*

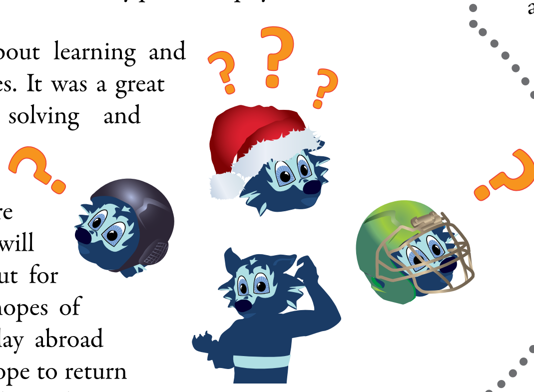
Capstone Research:
The Effectiveness of Headgear in Soccer

By Isabella Amyx

Isabella Amyx tests her experimental setup

Over the past 9 months, I have been researching the physics behind heading a soccer ball and how it can lead to concussions. A concussion is a type of traumatic brain injury which occurs from a large impact to the head. They are very common in sports such as football and soccer. As a member of the Sonoma State women's soccer team, this is a risk I face every day and have experienced first-hand. I wanted to learn about the factors that can increase the possibility of a concussion and if there are any preventions that really are effective. I am very excited about my research and it has been amazing to focus on something that involves both of my passions: physics and soccer.

This project has been all about learning and adapting to new circumstances. It was a great opportunity for problem solving and research exposure that will help me in the future as I begin searching for a job. Before entering the research field, I will be going to Europe to try out for some professional teams in hopes of having the opportunity to play abroad for a year or so. After that I hope to return to California and work in mechanical engineering or optics.

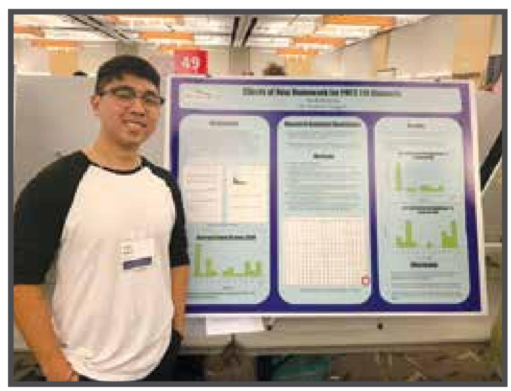


Capstone Research:
Creating Better Worksheets for PHYS 114: Intro to Physics

By Cody Kojima

For my capstone project, I created new worksheets to assign as homework to the students of SSU's spring 2019 PHYS 114 class. The original goal of the project was to determine if these new worksheets were superior to that of the old online worksheets, through analysis of the past and current grades of students. However, I found this not to be feasible as there was a large difference in the classes' grade distributions. So instead, I tried to determine whether completion of the new homework had any effect on current students' average exam scores. The idea behind this is that any good homework should help supplement students' understandings which will be reflected in their exams.

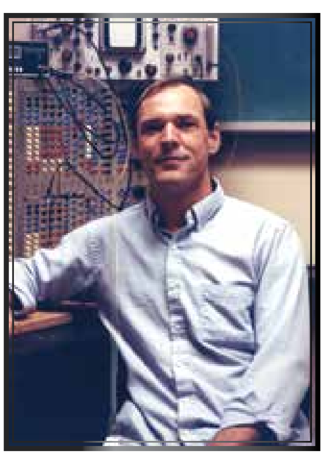
The most interesting experience during my capstone journey was the fact that I had a plan that didn't fall through and had to readjust my way of thinking to come up with an effective way to show the results of the new worksheets that I created. Not only was this a challenge, but a great life lesson. As an aspiring pilot after graduation, this capstone gave me the opportunity to adapt to a problem and demonstrate some critical thinking as this is an important quality to have as an aviator. After I graduate, I plan to travel back to Hawaii and apply to serve as a pilot in Hawaii's Air National Guard.



(Right) Cody Kojima with his poster at SSU's Science Research Symposium

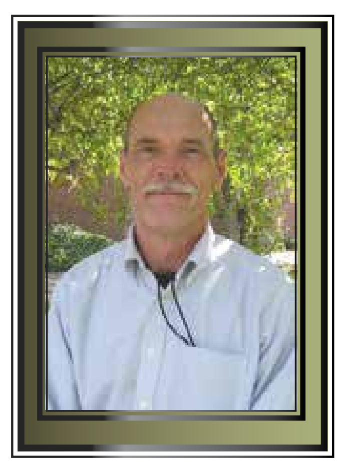
Steve Anderson Retires

By Prof. Lynn Cominsky



1990

The Physics & Astronomy stockroom will never be the same, now that long time Instructional Equipment Technician, Steve Anderson, has retired. Steve's last day was December 21, 2018, after serving the Department for 37 years. Steve was a true mainstay of the Department, whose outstanding service to our students and faculty earned him SSU's Staff Excellence Award in 2014. Our favorite description of Steve's work ethic is that if you asked him for a classroom demo, you got an entire cart filled with at least 10! Steve's deep and broad technical knowledge was invaluable to generations of seniors trying to finish capstone projects, as well as helping us to stretch our lean equipment budgets by constantly fixing things, including the SEM. Another notable accomplishment was Steve's role in helping to acquire and install the liquid nitrogen plant outside of Darwin Hall. He will be missed!



2014

Thank You for Your Support!

Our academic programs rely heavily on the generous support of donors, and your contributions help advance science and learning in all our facilities.

This year, we are especially interested in raising funds to support student research, as hourly rates have increased and we have annual deficits in our three assistantship programs: The Horace L. Newkirk Endowed Assistantship 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.

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 this academic year. At 97 semesters, WPD remains the longest-lived public lecture series on campus.

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.

We also now have a new donation fund to support the Education and Public Outreach group. The group gets many requests for community support and donations will greatly improve our ability to more broadly support under-served populations.

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
Joe & Eileen Tenn, Alan Friedman, Lynn Cominsky & Garrett Jernigan, Robert A. Fisher

#C0142 Physics & Astronomy Equipment and Supplies
Charles A. Bullen ('75) & JoAnne Etheridge

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

#C0486 Education and Public Outreach
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Endowment Funds:

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

#E0208 Horace L. Newkirk Memorial Student Assistantship
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, Paul Shaffer, Anonymous

#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 DeFreez ('80) and Ms. Toni Kristensen

Capstone Research:

Determining Galaxy Size through Photometry

By Erik Castellanos-Vasquez

The basis of my project focused on implementing modifications to preexisting code in an effort to provide a more accurate estimate on the size of a galaxy. This process is performed by measuring the amount of light that the galaxy gives off at increasing radii from the center by collecting the value of individual pixels within each radius.

The main problem that I attempted to resolve, which due to the pixels and the nature of the code that is used to gather data, is that any given pixel will either be considered completely inside or outside a particular radius. This means that even if only half of the pixel is technically inside a certain radius, the entire value of the pixel will be considered inside that same radius.

Erik Castellanos-Vasquez analyzes a galaxy image

In order to reduce the significance of this issue, the main focus of my work was to subdivide each image pixel into "sub-pixels" which would each contain a fraction of the value of the original pixel. This would allow for a smoother distribution of pixel values across the entire image.

During the duration of this project I had to learn to code in python since it had the ability to work with the particular type of images that I was going to be analyzing for the project. It was interesting to learn as I was able to develop my knowledge of python, which I could still use at a later date.

After graduation, I am planning on working locally until I apply to graduate school at a later date. My main interest for graduate school has been astronomy however, I have also found an interest in aerospace engineering but I will have time to think things over and decide on which path I would like take. I can say for sure that I would like to continue my education in one field or another.

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