THE PHYSICS MAJOR

Department of Physics and Astronomy

A New Star Joins the SSU Department of Physics and Astronomy:

By Prof. Jeremy Qualls

The Department of Physics and Astronomy is proud to announce a new addition to the team, Dr. Thomas Targett. Dr. Targett arrived at Sonoma State University as a visiting professor in 2013, and now joins the faculty of the Physics and Astronomy department as a tenure track professor. Dr. Targett's colorful personality and enthusiasm for science has been a natural fit. Since being at Sonoma State University he has taught classes in Descriptive Astronomy, an Introduction to Observational Astronomy, Frontiers in Astronomy, and Cosmology. He has offered several classes in "flipped" and fully online formats, and served as a research supervisor to numerous SSU students. Dr. Targett has also been very active with California Faculty Association (CFA), the Society of Physics Students (SPS), and department outreach. In the short amount of time he has been here, not only has Dr. Targett established himself as a scholar but he also has brought much character to the campus. He is the faculty advisor for the eSports club which has quickly become one of the largest clubs on campus with over 150 member. His lecture for the *What Physicists Do* series *"A Citizen Science Colonization Model For The Koprulu Sector in Starcraft 2"* has the highest view count in the history of the series with over 10,000 views: ***https://www.youtube.com/watch?v=h-APhVy0-Q8***

United Kingdom Infrared Telescope

Dr. Targett obtained his undergraduate and masters degrees from Cardiff University in 2003, with a research focus on 21-cm emission from neutral hydrogen. He obtained his Ph.D. from the University of Edinburgh under the supervision of Prof. James Dunlop, in the fields of sub-millimeter galaxy evolution and the coupled growth of galaxies and black holes. In 2007 he began his first research postdoc at the California Institute of Technology (Caltech), followed by similar appointments at the University of Birmingham (UK), the University of British Colombia, and the University of Edinburgh.

As a member of several large international astronomical collaborations, Dr. Targett has contributed to the data reduction, processing, and scientific analysis of astronomical imaging in the field of "Big Data". These surveys include the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDELS), the Hawk-I UDS and GOODS Survey (HUGS), and the Hubble Ultra Deep Field 2012 (UDF12). His research now focuses on galaxy evolution, sub-millimeter galaxies, and the high-redshift universe. Dr. Targett has significant experience in observational astronomy, with over a month spent at the United Kingdom Infrared Telescope on Mauna Kea in Hawaii, and additional time at the James Clerk Maxwell Telescope, the W. M. Keck Observatory, the William Herschel Telescope in La Palma, and the Palomar Observatory in California. He has also served on the telescope time-allocation committee of several major facilities, and as a referee for peer-reviewed publications, including the *Monthly Notices of the Royal Astronomical Society* and the *Astrophysical Journal.*

As an expert on the various whisky-producing regions in Scotland, Targett, ably assisted by his wife Karen, hosted SSU's first-ever faculty Scotch tasting in April. Five of Targett's favorites were enjoyed by about 60 attendees, who were also entertained by a slide show explaining the differences in flavors and distilling methods that characterized each region. When asked why he was generously treating so many of his colleagues to free drinks, Targett remarked that it was his "way of getting to know the colleagues with whom he expected to be spending the next 30-35 years of his career."

The department looks forward to a bright future with Dr. Targett.

SONOMA STATE UNIVERSITY

Hichwa Award 2014: Taking the Twinkle Out of Stars

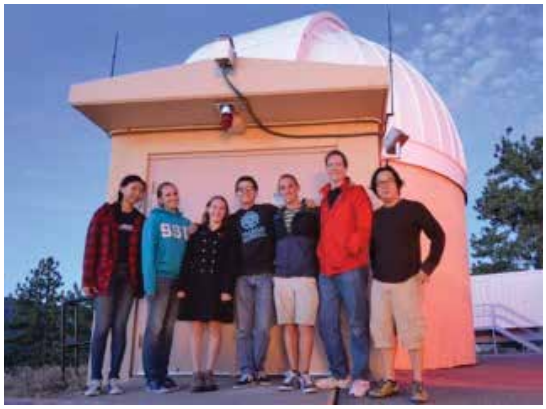
By Stephanie Church

During the summer of 2014, I was granted the opportunity to do research with Dr. Severson through the department's Hichwa Research Award. I learned how to do data analysis for images taken with the KAPAO adaptive optics system that is installed on the telescope at the Pomona College Table Mountain Observatory in Southern California. The KAPAO project is a collaboration between

Undergraduate students Stephanie Church (front) of Sonoma State University (SSU) and Greta Zhong (back) of Pomona College (PC) operating the KAPAO instrument at Table Mountain Observatory.

Pomona College, SSU, Caltech, and Harvey Mudd College and it uses adaptive optics to take the twinkle out of stars, which is caused by the turbulent atmosphere. This is a great alternative to pricy space telescopes, and it is excellent for undergraduate research.

The KAPAO system was installed in the summer of 2013 and data were already obtained and ready to analyze. Therefore, for the summer, while Pomona students were working to realign the system, I was learning how to operate and improve the analysis program written in Pyraf by a previous student. After that, I was prepared to analyze and run the program for new data. At the end of July, Dr. Severson and I went to Pomona. We spent a week with Dr. Philip Choi and his students, where we spent long, cold hours, filled with caffeine and many snacks, to get new images of various astronomical objects. We also pushed the limits of the KAPAO system to correct for dimmer objects. In the end, I found that the previous ideas for how well the system was correcting for the aberrations was an overestimate. Luckily, after the adjustments and realignment over the summer, the system was performing as well as originally believed! Though data analysis is very important, I learned that it can be a bit tedious and once completed, a great feeling of accomplishment is experienced. I am grateful to the Hichwas for the support that enabled me to have such a great summer experience!



Following a successful night at the telescope, the KAPAO team poses for a dawn photograph outside the dome. Left to Right: Greta Zhong (PC), Stephanie Church (SSU), Kelli Rockwell (PC), Franklin Marsh (PC), Henry Steiner (SSU SHIP Intern), Dr. Scott Severson (SSU), and Dr. Phil Choi (PC).

Multimedia on canvas by Hunter Mills ('14)

In this year's Physics Major we are introducing a new article to be continued through the years. The idea is to identify the senior student with the highest GPA and ask him or her to give thoughts on two questions:

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?

- Jeremy Qualls

Predictions for the Future

***By** Adam Smithson*

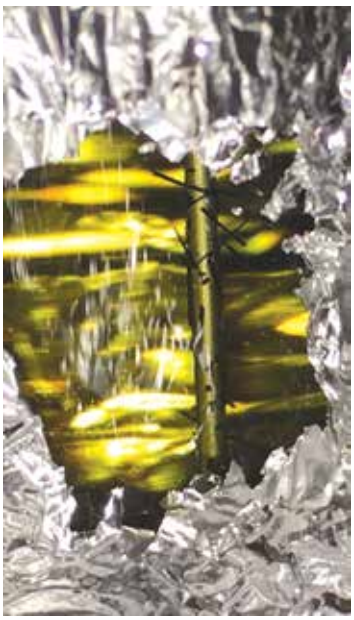
Fifty years from now, what I expect to be one of the hottest topics in physics is quantum computing. Though the topic of computing may be huge in computer science, as one would expect, the understanding of quantum mechanical phenomena will be pivotal in the development of mainstream quantum computers. There are currently massive limitations on quantum computing, such as temperature, system size, and exposure to outside conditions. The system must consist of a small number of relatively isolated particles, at a very low temperature. This is highly impractical for a mainstream computer for individuals, or company use. Fifty years from now I expect great advances in these issues, but understand that taking advantage of quantum mechanical properties of these systems will be a huge topic in physics.

In 100 years I expect the world to have made improvements for human (and hopefully other) life. I suspect that the average lifespan will be around mid-90s, possibly 95. This prediction is based on the trend in lifespan, beginning in the late 1800s. Along with this, I have seen reasonable arguments from experts in the field of robotics that Star Trek-like robots, with very humanistic appearance and 'personality' will come within the next 30-35 years. I do not believe that they will attain consciousness; I do believe it is possible, but improbable within the next 100 years. I suspect they will be highly advanced androids whose purpose is to provide the assistance of a robot with the programmed intellect of a helpful friend. The last advance I expect for humanity within the next 100 years is nuclear fusion. Though my knowledge of the topic of fusion is limited, the articles I have read have hinted at a possible rise in progress. Considering the benefits of nuclear fusion over fission, I am very hopeful for energy advances in this area.

Newkirk Award 2014:
Electrical Characterization and Fermi Surface Reconstruction of Organic Metals

By Michael Dobbs

For this year's Newkirk assistantship project, I have worked alongside Dr. Jeremy Qualls in synthesizing a tetra-methyl-tetra-selena-fulvalene (TMTSF) based organic crystalline metal that exhibits semiconductive properties. To conduct the synthesis, electrochemical H-cells were set up so that by applying ~1V and a 1 micro-amp to the system, a chemical reaction was started that initialized growth of these crystals on the anode. Due to the chemical environment established by the solvents (Trichloroethylene (TCE), Ethyl Alcohol (EtOH), and Perchlorate/Hexafluorophosphate) the crystals formed in flat planes that were tightly stacked on top of each other. The material exhibits conductive properties because of the overlapping p and d-orbitals on adjacent selenium ions.



TMTSF crystals growing inside an H-cell.,Their long, thin, spiky structure is due to their one dimensional nature.

In order to characterize these properties, the impedance and Fermi surface of the crystal were measured. A four-terminal transport measurement was set up to measure the electrical conductivity and magnetoresistance. This system applies a voltage to the crystal with an ammeter in parallel to measure the induced current and calculate the directional

impedance of the sample using Ohm's Law. Dr. Qualls' high-powered magnet was used to reconstruct the Fermi surface of the crystal, which signifies the magnetic, electrical, and thermal properties of the metal. The magnet system allows the sample to cool down to liquid helium temperatures and apply a high-powered magnetic field through it. Under these circumstances, the free electrons in the conduction band of the metal act like simple harmonic oscillators, producing oscillations in the conductivity of the material (Shubnikov-de Haas effect). The period of these oscillations is inversely proportional to the cross-sectional area of the Fermi surface in a plane normal to the applied magnetic field. Three-dimensional mapping of the Fermi surface is possible by rotating the applied field direction and taking measurements at the various angles.

Continuation of this project requires further characterization of the crystals by measuring the quantum oscillations of their magnetic moment (de Haas-van Alphen effect), specific heat, and sound attenuation. This project has given me the opportunity to learn about solid state and condensed matter physics, the engineering behind various machines used to characterize properties of metals, and the chemical synthesis of crystals. I would like to thank the Newkirk family for their generous funding to make this project possible.

Thermodynamics Through Dance

By Peter A

When I entered as a Physics Major in junior year, I had little to no chemistry background. By the time I entered my upper-division classes such as Statistical Physics, Modern Physics, and Intermediate Lab, one of the foundations of quantum mechanics I needed to know was Thermodynamics. As a visual learner, I searched for Thermodynamics tutorials on YouTube. From what I've noticed in most of the videos, they're usually set up as 1 person talking for over 10 minutes, and drawing equations and pictures on a whiteboard. Even though these videos were very informative, I still had a hard time in seeing "the big picture" for each law in Thermodynamics. After seeing these videos, what came to mind was, "I wish there was an instructional video that's artsy, entertaining, and informative at the same time." With the help of Dr. Severson as my advisor, I constructed this idea, turned it into a senior research project, and created a video tutorial of the Laws of Thermodynamics through Dance.

Even though the idea of teaching a subject through dance is creative, making the video itself was very difficult. Throughout the process, I had to find dancers that were available at certain times, create a choreography that represents each law, teach the choreography to the dancers, explain to the dancers what each law is about, edit all the video clips taken and construct them in an orderly fashion. Despite the long process, finalizing the video was extremely rewarding. Not only did this project help me become a better teacher and leader, it also made me feel more comfortable in terms of talking in front of others.

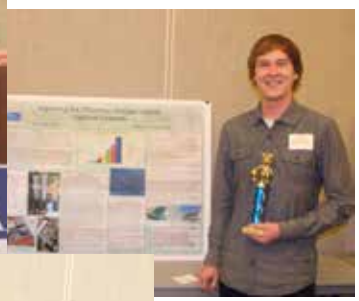
https://www.youtube.com/watch?v=AkxbWHKMyjg

Physics Major Wins Best Poster at SST STEM Symposium for Second Year in a Row

By Prof. Lynn Cominsky

The Physics & Astronomy Department distinguished itself once again this year, as 14 physics majors presented posters – the most of any department within the School of Science and Technology. And for the second year in a row, a physics major won Best Poster. This year's winner was Clayton Piatt, for his capstone project with Prof. Qualls, entitled *Improving the Efficiency of Algae Based Carbon Capture*. For his award, Clayton received a trophy that was custom-created by Prof. Qualls, featuring a golden version of Dr. Lobo with spiky fur, due to his hand being placed on an adjacent Van de Graaff generator. (The original artwork featuring "spiky haired Dr. Lobo" was created by SSU E/PO Scientific Illustrator Aurore Simonnet, and also graced the STEM Symposium poster and program.) Prof. Qualls was also one of the main Symposium organizers, and helped in the judging. Last year's winner, Hunter Mills, was one of the 8 judges who participated.

The other posters by physics majors included six that presented various aspects of CubeSat development (mentored by Dr. J. Garrett Jernigan and Prof. Cominsky), including three by the all-female A3Sat team: *Compact Antenna Testing for SSU's Next Cubesat* (Alyssa Afa'ese, who is actually an EE major), *Design and Testing of A3 PocketQube Prototype* (Amandeep Gill), and *A Balloon Borne Experiment for Measuring CO_2 in the Stratosphere* (Anna McCowan, also mentored by Dr. Tom Targett); plus *Torquing SSU's Spin-LCube Satellite* (Max Torke), and *Aerospace power system for a 1U CubeSat built by SSU Students* (Wes Watson). A related poster *Ground Station for Small Satellites* describing the new CubeSat ground station on the roof of the student center was presented by Aaron Owen. Prof. Severson mentored posters by Julian Mariano: *A Spectroscopic Study of Io* and perhaps the most unusual physics-themed "poster" that described the YouTube video by Peter A: *The Laws of Thermodynamics...Through Dance!* (See related article on page 3). Besides Clayton Piatt's winning poster, Prof. Jeremy Qualls also mentored Dylan Brubaker: *Single Phase Solar Refrigeration*, and Max Maurer: *Atmospheric Water Harvesting*. Prof. Hongtao Shi's student projects included C*athodoluminescence with Spectroscopy Instrument* by Felix Desperrier, and *Exploring Objects with Electronic Speckle Pattern Interferometry* by Michael Nolan (also mentored by Dr. Sangyoun Gee from Raydiance). Dr. Targett's astronomy research was represented by Demetri Call's poster *High Redshift Galaxy Size-Mass Relation*. The Green Music Center continued to be the site of acoustic research – this year's project was *Acoustic Analysis of Schroeder Hall* by Thomas Kohlmeyer (mentored by Dr. Mike Jones). We are very proud of all of our student participants!



Clayton Piatt shows off his "Dr. Lobo" trophy for best poster

Physics majors attending the 2015 STEM Symposium (L to R): Michael Nolan, Cody Johnson, Julian Mariano, Dylan Brubaker, Anna McCowan, Peter A, Aaron Owen (in front), Clayton Piatt, Aman Gill, Rosie Ordoñez, Demetri Call, Karina Smith, Stephanie Church, Max Torke.

AlumNotes

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

Frederick Arioli, Jr. ('75) *retired in 2014 after many years as an engineer at Lockheed Martin Space Systems in Palo Alto. He worked on software for several space missions, including the Spitzer Space Telescope and the forthcoming James Webb Space Telescope.*

John C. Nelson ('76) *is director of research at 10x Technology in Libertyville, IL. He was formerly a senior research specialist with the 3M Display and Graphics Business Laboratory in Petaluma.*

Dan O'Donnell ('83) *works in information security at Boeing in El Segundo. He was formerly the Information Systems Security Officer for the RAND Corporation in Santa Monica. He heads the MacIT Advisory Board.*

James A. Patrick ('83) *is an airway transportation systems specialist with DataPath in Hawaii. He was formerly a military pilot.*

William C. Tomlinson ('83) *is data warehouse architect for ITT BIW Connector Systems in Santa Rosa. He formerly worked for Royce Instruments, Inc., a producer of test instruments used in the research and development of new silicon chips. He earned a second B.A., in management, at SSU in 1992, and an MBA, with a specialization in MIS, at the University of Arizona in 1994.*

Kim Powers ('84) *is a senior software engineer with Rockwell Collins in the Bay Area. He earned an M.S. in physics at the University of Arizona.*

Michael Rogen ('84) *is now studying Chinese in Taiwan. He retired after many years with Maxon Precision Motors, Inc., Burlingame, where he was vice president of electronics sales and marketing.*

Jon M. Jurgovan ('85) *is an Administrative Patent Judge in the Dallas area. He was formerly a senior patent attorney with BlackBerry in Texas and with Alston & Bird LLP in Atlanta. He earned an M.S. in electronic engineering at California State University, Fullerton and a J.D. at Washington & Lee University in Virginia.*

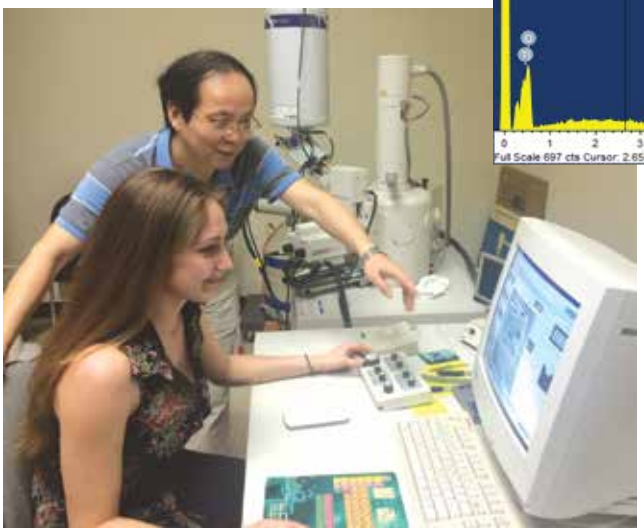
Small is Big, Really!

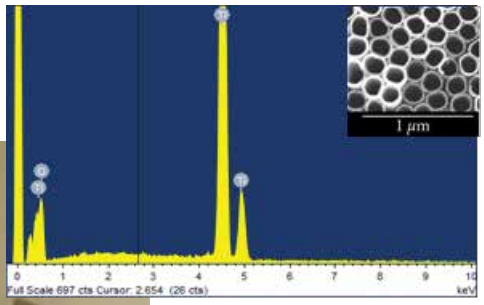
By Prof. Hongtao Shi

Nanometer scaled materials have been the subject of enormous interest in the past two decades. Their defining characteristic is a very small feature size in the range of 1-100 nanometers (1 nm = 10^{-9} m). At such a small scale, material properties are significantly affected by the laws of atomic physics. These materials have the potential for wide-ranging industrial, biomedical, and electronic applications.

Inspired by the fact that titanium dioxide (TiO_2 or titania) is a particularly versatile material with many technological applications in photo catalysis, photovoltaics, gas sensing, and optical coating, we started a new project this spring. We focused on the fabrication of vertically oriented titania nanotubes, using the so-called bottom-up approach via anodization of pure Ti foils (an electrochemical surface treatment process), which has promise to achieve unique properties and superior performance due to titania's self-assembled nano-architectures. The ability to control such architectures can be expected to positively impact many technologies. Currently, Rosita Ordoñez is working on this project. A Summer High School Internship Program (SHIP) student will continue to work on this project in the summer.

Dr. Shi and Rosie Ordoñez are using the Scanning Electron Microscope (SEM) in the Keck laboratory to analyze samples.





Energy dispersive X-ray spectrum of our samples, confirming the formation of TiO_2. Inset shows the SEM micrograph of titania nanotubes. Photo credit: T. Hashishin, Ritsumeikan University, Japan.

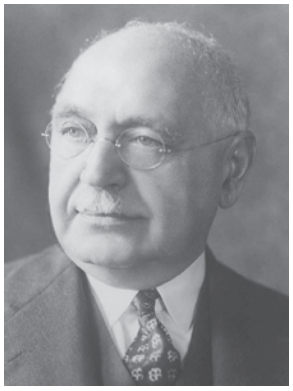
Tenn Essay Wins Prize

Professor Emeritus Joe Tenn has won second prize in the 2015 Griffith Observer science writing contest. His article, "From Ukiah to Yale: Frank Schlesinger and the Measurement of Stellar Positions," will be published in the magazine, and he will receive a cash prize. The magazine is published monthly by the Griffith Observatory in Los Angeles.

Schlesinger, who lived from 1871 to 1943, was one of the noted scientists awarded the Catherine Wolfe Bruce gold medal of the Astronomical Society of the Pacific for his lifetime contributions to astronomy. He led the way in measuring stellar parallaxes (distances) by means of photography and he was one of the most respected American astronomers from about 1910 until his death, during which he directed the Allegheny and Yale observatories.

As the longtime chronicler of all the Bruce medalists (see *http://phys-astro.sonoma.edu/brucemedalists/*), Dr. Tenn had written a very brief biography of Schlesinger long before he received an invitation to speak in a lecture series associated with the recently restored Ukiah Latitude Observatory (ULO) last October. Choosing to speak on Schlesinger was easy, as supervising the construction of the ULO and serving as its first astronomer was Schlesinger's first job after getting his Ph.D. at Columbia University in 1898.

Frank Schlesinger



credit: 1937, Yale University Astronomy Department Archives, courtesy Dr. Dorrit Hoffleit

"After I gave the talk, I decided I had invested too much time preparing it not to do something else with the material," Tenn reports. So he wrote it up and submitted it to the essay contest. He had entered the contest four times in the 1970s and '80s, winning a fourth prize and three honorable mentions, but this was his first entry since 1986. He is especially proud that his students won four honorable mentions, some with papers originally written for his classes.

Dr. Tenn's major activity now is preparing the Astronomy Genealogy Project, which he founded and directs. It will eventually post a great deal of information about the world's astronomers and their educations. He also continues to collect and post the achievements of the Department's graduates at:

http://www.phys-astro.sonoma.edu/gradsAchievements.shtml

SSU Education and Public Outreach is Re-*Making* Education, One Experiment at a Time

By Dr. Carolyn Peruta

Mix one part 21st century global economy, one part accelerating scientific advancements, and one part understaffed science, technology, engineering, and math (STEM) workforce and what do you get? A striking need to train the future STEM leaders of our country. Science education needs an update!

Enter the Next Generation Science Standards (NGSS) and the SSU's Education and Public Outreach (SSU E/PO) Group project, "Learning by Making: STEM Success for Mendocino County". NGSS demands modern high school curricula focusing on the critical thinking and communication skills that students need for postsecondary success and citizenship in a world fueled by innovations in science and technology. Learning by Making is here to make that a reality. Our curriculum uses computational thinking to focus on real world problem solving while interweaving the three pillars of NGSS: (1) Scientific Practices, (2) Crosscutting Concepts, and (3) Disciplinary Core Ideas.

Learning by Making trains students to design and construct their own experiments using microcontrollers powered by the simple, yet flexible and powerful, Logo computer language. Students will literally design and construct their own systems of sensors. They will wire; they will code; they will make. This project is not about creating the perfect lab setup with step-by-step instructions. Here the students and teachers will learn through exploration.

Laura Herman looks on while Susana Ramirez and Roger Little construct their group's experiment.

Last June, SSU E/PO descended on the Mendocino County Office of Education in Ukiah, CA for an intensive week of programming, circuitry, and experimenting. Our team met with 12 teachers from six schools across Mendocino County and a myriad of professional evaluators and county staff.

During the weeklong training, teachers posed scientific questions then designed simple experiments with our software and hardware. One such question "How much light is reflected from leaves rather than absorbed?" led to a fancy apparatus complete with zip ties, foil, and (of course) plenty of tape. High school teachers Susana Ramirez Fuentes, Laura Herman, and Roger Little explored the reflective properties of 8 leaves, three swatches of paper, and a mirror. Their light sensors sent electrical signals whizzing through a specially made circuit board powered by a microcontroller and into their computer for analysis. The result? Well, you'll just have to try making your own experiment to find out!

The Learning by Making Summer Institute group, June 2014. (from L-R) Susan Wandling (SSU), Allison Baldwin (Ukiah HS), Anna McCowan (SSU),Patty Halpin (Ukiah HS), Megan Schmitt (Fort Bragg HS), Laura Herman (Willits HS), Carolyn Peruta (SSU), Susana Ramirez Fuentes (Willits HS), Kai Hamblin (Point Arena HS),Amanda Derby (Round Valley HS), Jim Snyder (Anderson Valley HS), Kayla Davis (Fort Bragg HS), Kim Jenderseck (Anderson Valley HS), Roger Little (Point Arena HS), Laura Chase (SSU), Kevin McLin (SSU), Ann Marie Bauer (Round Valley HS), Garrett Jernigan (SSU), Lynn Cominsky (SSU), Marina Varfolomeeva (WestEd), Linlin Li (WestEd)

New Honors for Cominsky

Department Chair and Professor Lynn Cominsky has been awarded the Aerospace Awareness Award by Women in Aerospace (WIA). She is one of six women in the nation selected for their devotion to the advancement of women in aerospace and for their significant contributions to the field. Cominsky was nominated by Dr. Hashima Hasan of NASA Headquarters and was chosen for her "excellent leadership and sustained dedication to aerospace education and for her tenacious advocacy for girls and young women in aerospace." She was honored along with other award recipients in Arlington, VA at the Ritz Carton Pentagon City Hotel at a reception dinner and ceremony on Oct. 29, 2014. In February, Cominsky was elected to the position of member-at-large for the executive committee of the Physics Division of the American Association for the Advancement of Society. She was named a Fellow of the AAAS in 2013 and is featured on the AAAS Member Spotlight website with an article entitled "Five Things About Me: Astronomer Lynn Cominsky." At the Provost's Research Symposium on April 15, 2015, Cominsky received the Presidential Award for Excellence in Scholarship, formerly known as the Bernard and Estelle Goldstein award. Cominsky was awarded $1500. Formerly known as the Bernard and Estelle Goldstein award, Cominsky received $1500 to be used for professional development. She used the award to support the travel of four SSU students to the annual CubeSat development conference at Cal Poly SLO. Physics majors Aman Gill, Wes Watson and Max Torke and EE major Alyssa Afa'ese attended the conference to share their experiences working in the Department's CubeSat lab with Cominsky and mentor Garrett Jernigan, as well as networking with other CubeSat aficionados from academia and industry.

Cominsky with the WIA award, which was presented by NASA Deputy Associate Administrator Lesa Rowe. Credit: WIA.

McQuillen Award 2014:
Development of Aluminum Nanopores

By Adam Smithson

During the summer of 2014, I began my research with Dr. Hongtao Shi on anodized aluminum nanopores, and their practical application through generous support of the McQuillen award. Anodization is an electrochemical process that converts the outer layer of a metal into a corrosion-resistant anodic oxide finish. The most common example of anodization is its use in creating the smooth, shiny surface on electronics such as smartphones. For my research with Dr. Shi, we begin by cutting out a 2cm by 2cm piece of aluminum and hand polished one side. Next we put the hand polished side through an electrical polishing process, specifically by driving a current through the sample while it is bathed in an electropolishing solution. This process ensures that a portion of the aluminum is extremely smooth, so that the nanopores we wish to form are uniformly distributed, and have constant diameter. We proceed by doing a similar process, but this time with the same portion of aluminum bathed in oxalic acid. This is the anodization. The anodization turns the surface aluminum into aluminum oxide, and from this process, extremely tiny pores are formed in the newly grown surface. Figure 1 shows one of our early samples, with the outer gray section being the hand polished aluminum, the silver ring being the remaining section of the electropolished aluminum, and the central yellow-gold region being the aluminum oxide from anodizating the sample. By anodizing the sample for 2 hours and then again overnight (normally 14 hours) we expect to find nanopores in a uniform, hexagonal structure, as shown in Figure 2. To observe this pattern Dr. Shi and I used Sonoma State's Scanning Electron Microscope (SEM, Figure 3) to see this extremely small structure. So far we have been able to create micropores with a reasonably uniform structure (Figure 4), but not in a hexagonal pattern as desired. We have a few issues to work out to regulate the structure, but when we can consistently create the desired nanopores, there are interesting practical applications. We can fill those nanopores with a ferromagnetic material such as iron, nickel, or cobalt. This then creates a very compact array of magnetic rods, each of which can have their own magnetic field pointing either up or down. This extremely tiny chip of aluminum oxide becomes an information storage unit with a very large storage capacity to surface area ratio (varying with pore size). This chip works similarly to how a solid state hard drive stores information, but in a much smaller area. Though reaching this point is quite a ways away for me and Dr. Shi, we hope to make great progress within the upcoming academic year.

I would like to thank the McQuillens for this opportunity.

Fig.1: Early sample

Fig.2: Desired hexagonal pores

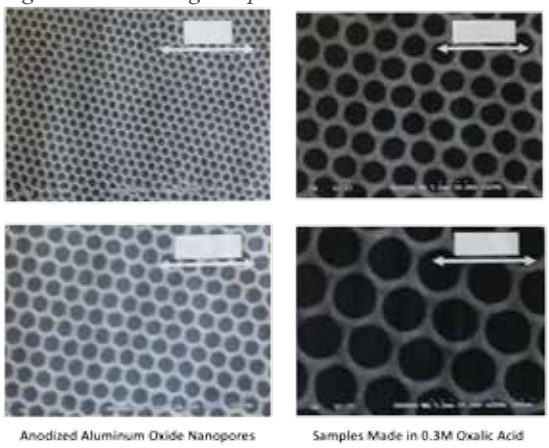


Fig.3: SEM

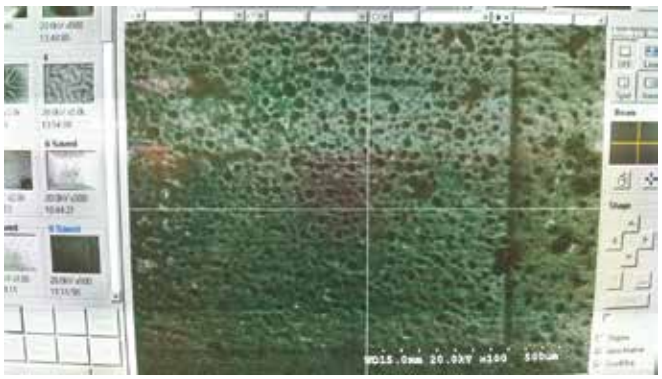


Fig.4: Actual micropores made at SSU

What Physicists Do

by Karina Smith

This year gave us the 88th and 89th semesters of SSU's renowned What Physicists Do public lecture series, with speakers addressing a wide range of topics. The timely discussion of environmental matters manifested itself in separate talks both from visitors from the Lawrence Berkeley National Laboratory: Dr. Robert Van Buskirk's discussion of Moore's Law in relation to the development of green technology and Dr. Marc Fischer's talk about how physics knowledge can be used to solve problems related to anthropogenic changes in Earth's climate. The ever-popular astronomy talks included Dr. Ann-Marie Madigan of UC Berkeley on the subject of objects at the center of the Milky Way and Dr. Kenneth Freeman all the way from the Australian National University discussing dark matter. Dr. Andreas Heinrich of IBM joined us to talk about the use of a scanning probe microscope to study and control atoms. Dr. Claire Poppett ended the fall semester talks with her discussion on the use of the DESI fiber optic spectrograph to learn about dark energy.

The spring semester started off with one of our most unique speakers, but also one of our most famous outside of the world of physics, Andy Weir, a software engineer and bestselling author. Weir's talk revolved around his novel (soon to be made into a film) and science fiction survival story, *The Martian*. Dr. Amir Huda of CSU Fresno provided a lecture on biomedical physics, specifically how physics technology can be used for the improved diagnosis and treatment of human diseases. Celebrated physicist Dr. Vera Lüth gave a particle physics talk on symmetries and violations in weak interactions. Right on time for the upcoming centennial of Einstein's Theory of General Relativity, Dr. Norna Robertson of Caltech and the University of Glasgow discussed the search for gravitational waves with a special focus on the development of the Advanced LIGO detectors. Dr. Frances Houle of the Lawrence Berkeley National Lab addressed the development of artificial photosynthesis as a source for energy. And eminent astrophysicist Dr. Frank Shu, who has turned his attention to the impact of climate change, presented his work in the field of carbon sequestration by the production of biochar.

We are very glad to have had the honor of being joined by such an accomplished array of speakers and deeply anticipate the 90th series next semester. The lectures are recorded and are available via YouTube links at the WPD website:

http://www.phys-astro.sonoma.edu/wpd

Dr. Norna Robertson (Caltech and the University of Glasgow) reviewed the search for gravitational waves, and in particular discussed the Advanced LIGO detectors which are expected to carry out their first observational run during 2015.

Best-selling Author Andy Weir speaks with Dr. Scott Severson (inset) via a videoconference interview during a recent "What Physicists Do.

AlumNotes

Jay Noceto ('85) *is an area director at T-Mobile.*

John Palmerlee ('85) *is a production engineer with The Switch Lab in Sebastopol. He has been a senior software engineer and web developer with several companies, and he is working on a novel. A pilot, he is on the board of the CAFE Foundation.*

Lee Steele ('85) *is a technical writer currently working at the naval warfare center in Indiana. He is has worked for Northrop Grumman and on NASA's Fermi Gamma-ray Space Telescope.*

Victoria Hewitt [formely Moore] ('87) *and her husband own and operate a thoroughbred horse farm in Paris, Kentucky. They are authors, whose first novel won the Pinnacle Book Achievement Award for fantasy and romance. She and her son have published a juvenile novel about Minecraft and are working on another. She was formerly the principal of Lawrence Cook Middle School in Santa Rosa.*

Christopher Cook ('88) *is principal engineer at Edmund Optics in New Jersey. 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.*

Kenneth Ritley ('88) *is Head of Global IT Transformation for Swissport, the world's largest ground handling company in the aviation industry. He is responsible for transforming their distributed IT departments and IT systems into a single department with standards and processes. Until recently he was the head of the global IT delivery center for Sulzer in Winterthur, Switzerland. He earned a Ph.D. in physics at the University of Illinois in 1998 and afterward was a postdoctoral researcher at the Max Planck Institute for Metals Research in Stuttgart, Germany.*

Phil Cullen ('89) *passed away on 3 May 2015. He was a senior consultant with Manex, a non-profit NIST affiliate, helping small to mid-sized manufacturers to be more competitive. He had previously worked at the Lawrence Berkeley National Laboratory and at Read Write systems. He earned an M.B.A. degree at Santa Clara University in 2008.*

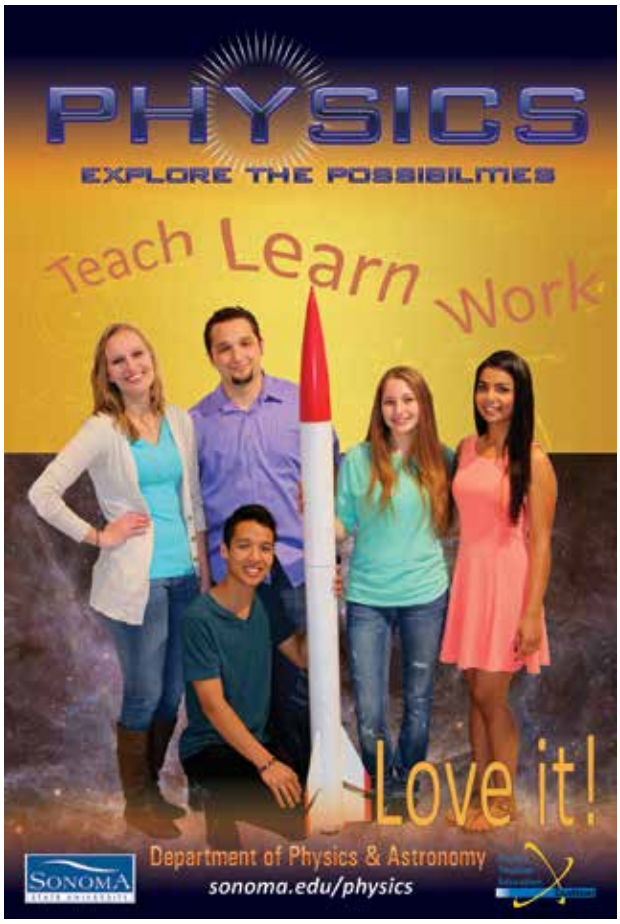
Iad Mirshad ('89) *is a senior applications engineer with Qcept Technologies, a developer of non-visual defects detector technology in Fremont. He earned a Ph.D. in experimental nuclear physics at the University of California, Davis in 1995.*

Department of Physics & Astronomy Awarded Teacher Recruitment Grant

By Prof. Scott Severson

Dr. Scott Severson and Dr. Lynn Cominsky were awarded a $30,000 recruitment grant from PhysTEC, the Physics Teacher Education Coalition. The 2013 National Task Force on Teacher Education reported "the need for qualified physics teachers is greater now than at any previous time in U.S. history." Entitled "Building the Sonoma State University Physics Teacher Pipeline", the awarded grant responds to this need. The grant centers on two major components: the recruitment of interested high school students; and the development of a supportive structure for undergraduate students as they gain teaching experiences within the department. The grant-supported work includes: building closer connections with instructors at area high schools and community colleges; the development of recruiting materials and classroom presentations; and meetings with Physics & Astronomy students that present innovative teaching pedagogy in a fun and inspiring atmosphere. This recruiting effort strives to build and assess a sustainable model of preparing more physics teachers at Sonoma State University.

This year's activities included the selection of a "teacher-in-residence" - Petaluma High School physics instructor Victor Brazil - as well as several meetings that brought together SSU physics majors with local instructors. We also sponsored a meeting to revive PION (Physics in Our Neighborhood) and shared the new program's goals with other local high school instructors.



Poster: PhysTEC grant funding supported the production of this recruiting poster for our department. The photo features current students (clockwise from left: Stephanie Church, Demitri Call, Rosita Ordoñez, Amandeep Gill, and Peter A). The poster was designed by Aurore Simonnet and Scott Severson with photography by Steve Anderson.

AlumNotes

Dan Nottingham ('89) *is director of product management for ABILITY Network's Innovation Office in Boston. He has done similar work for several companies, most recently Imprivata, after participating in rocket-launching experiments for the Boston University Center for Space Physics.*

Jon C. Davis ('89) *is a services capture manager at Hewlett Packard, where he has worked for 35 years.*

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.*

Eric Weiss ('91) *is vice president of customer success at Uplogix, a software company in Texas. He earned his Ph.D. in physics at the University of Washington in 1998 with research in experimental particle physics at the Stanford Linear Accelerator Center.*

Jason I. Alexander ('92) *is the business development manager at IMRA America, Inc. He has worked at several companies in the laser field since earning an M.S. in physics in 1995 at Indiana University-Purdue University at Indianapolis.*

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

Eric Mueller ('93) *is the plant operations manager at DuPont Pioneer, a biotechnology firm in Hawaii. He earned a master's degree in engineering at North Carolina State University in 2001.*

Charles Rogers ('94) *is a compliance advisor at CoreLogic Flood Services.*

Jorge Polanco ('95) *is the manager for radio frequency optimization at Autoconsa, a Central American contractor for the cell phone industry. He earned an M.S. in reliability engineering at Galileo University after returning from SSU to his native Guatemala.*

Ian Holland ('95) *is a licensed Marriage and Family Therapist practicing in Santa Barbara. He intends to relocate to Marin County soon. He was formerly a counselor with the Academy of Healing Arts for Teens, running groups to raise social and emotional intelligence. He earned an M.A. in Clinical Psychology from Antioch University Los Angeles.*

Cherie Copeland [formerly Montague] ('95) *is a manager at Winsoft in Santa Ana.*

Bill Oakes ('96) *is an engineering manager at TriVascular Technologies, Inc. in Santa Rosa. He formerly worked at Medtronic and JDSU, both in Santa Rosa.*

Adolfo Duarte ('97) *is a network engineer with Hewlett Packard in the Sacramento area.*

Barnell Hampton ('98) *is a program analyst with E & J Winery.*

Christopher Crosher ('01) *is a staff engineer with Schafer Corporation in Albuquerque, NM.*

Tom Bittancourt ('03) *is a test engineer at EchoStar Corporation in Colorado.*

Michelle Curtis ('04) *is a reliability technician currently on assignment at Keysight Technologies in Santa Rosa.*

Marta Fuentes-Filp ('05) *is teaching physical science at Westmoor High School in Daly City. She earned her teaching credential at San Francisco State University in 2012.*

Getting Involved with Physics & Astronomy through the SPS Club!

By SPS President Stephanie Church

The Society of Physics Students (SPS) has had another exciting year. We have continued our series of Skills Labs for a second year to provide students with important skills that can only develop outside of the classroom. These Skills Labs are presented by students in order to help solidify their knowledge of what they have learned during their own research. Students focus on teaching a variety of topics, such as soldering, Arduinos, scanning electron microscopes and even building a LinkedIn profile. We intend to expand our Skills labs by inviting other STEM majors to join as well.

During the Fall semester, our club applied for two grants through National SPS and we won both of them. Aman Gill was the lead on a proposal to SPS Future Faces to develop a series of skills labs with MESA on micro-controllers and soldering. For the Marsh W. White Outreach award, we proposed to host a camping trip with the Santa Rosa Junior College. This was the third year in a row for our SPS chapter to win! We wanted to host this trip to connect with the other physics students in our own community and we thought camping at Sugarloaf with the Robert Ferguson Observatory would be a fun way to do so. Our camping trip occurred in April so we had a lot of time for planning but it still made for a busy spring semester.

Michael Dobbs volunteering at Code.org Night with a local elementary school

March was a busy month for the club. We participated in the 5th annual Geek Week competition and received 3rd place. This is a fun event that works to bring the clubs within the School of Science and Technology together through games, such as dodgeball, limbo, egg drop, catapult building, and relay races. During spring break, club members volunteered at an elementary school's code.org event, where we helped kids learn how to code. The next day, many of us went on a tour of Planet Labs in San Francisco to see where they build small CubeSats for taking images of the Earth's surface. From San Francisco, we went straight to the SPS Zone Meeting held at UC Berkeley and toured the Advanced Light Source Lab at Lawrence Berkeley National Lab. At the conference, we were able to build connections with other physics students throughout California and learn about the projects they work on for research.

April was even busier than March and filled with many fun activities. A couple of us participated in the Integration Bee that was hosted by the Math & Stats Club and we were very proud when physics major Wes Watson actually won the competition! One Friday evening, we had a bowling night at the nearby alley and almost 20 members attended and Professor Targett joined us, as well! Other activities included the Marsh White camping trip, the annual end of the year BBQ, and a tour to the local satellite communications company, X2nSat. Lastly, after the semester ended, we toured the SLAC National Accelerator Laboratory at Stanford.

Stephanie Church, Rosie Ordoñez, and Aman Gill with Lobo at Seawolf Decision Day

Rosie showing off the SPS 2014 T-shirt!

Anna McCowan was president in the Fall 2014 semester and I became president in Spring 2015. I am excited to continue this experience and all the fun activities during the fall. When you come to Sonoma State, there are always conversations about getting involved; SPS Club is the perfect way to do so! If you're interested in physics and astronomy, then come get in contact with us!

We would love to thank our advisor, Dr. Shi and the entire department for their continued support in all our exciting ventures.
Students interested in joining SPS should go to:
http://www.students.sonoma.edu/clubs/sps

Prospective and current physics majors are encouraged to view our Facebook page or the web site for any news and upcoming events.

SPS BBQ with chefs Demetri Call and Aaron Owen

Thank You for Your Support!

We are truly grateful to those who continue to support the Department as we try to maintain our traditions and offer our students new opportunities for research and personal growth. Private donations have been crucial in the growth and continuation of excellence in the Department of Physics and Astronomy, especially important as state contributions continue to decline. Our academic programs rely heavily on the generous support of donors and your contributions help advance science and learning, making the world and our Department a better place for our students.

The "What Physicists Do" lecture series is supported through donations and grants from SSU's Instructional Related Activities Fund. Prof. Scott Severson hosted the series again this academic year. At 89 semesters, WPD remains the longest-lived public lecture series on campus.

We now 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*, contact the SSU Development Office at (707) 664-2712 or contact the Department.

AlumNotes

Mark Wollam ('06) *is a senior systems analyst at PLC's PLUS in Bakersfield.*

Ryan McDaniel ('07) *is an engineer at Deposition Sciences, Inc., a wholly owned subsidiary of Lockheed Martin Corporation in Santa Rosa.*

Alexander McMahon ('07) *is a senior security information and event management engineer at Leidos in Portland, OR. He is also working on a master's degree in system engineering at Johns Hopkins University.*

Josh Rose ('07) *is a test engineer at Microsemi Corporation in Santa Rosa.*

Current Funds:

#C0141 Public Programs
Lynn Cominsky and Garrett Jernigan, Joe Tenn, Alan Friedman

#C0142 Physics & Astronomy Equipment and Supplies
Mr. ('75) and Mrs. Charles A. Bullen, Mr. and Mrs. Ken S. Zschach, David Hawk ('77), Lauren Novatne ('89)

#C0143 SSU Observatory
No donations this past year.

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

Endowment Funds:

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

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

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

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

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

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

Gifts In Kind:

The family of Hartley L. Bond donated a vast treasure trove of books that spanned a wide range of topics in physics, astronomy, mathematics and engineering.

AlumNotes

Orion Leland ('08) *is an electrical engineer at RETECH Systems LLC in Ukiah. He earned a master's degree in electrical and electronic engineering at California State University, Sacramento in 2014.*

Winston Fisher ('09) *is an intern engineer at Zeiss XRM in Okaland.*

Farzaneh Rasti ('10) *is an engineer with Illumina in the San Diego area.*

Austin Powell ('11) *is an analyst intern with Kaiser Permanente in the Bay Area. He is also completing a master's degree in statistics at San Jose State University.*

Luke Haley ('11) *is a software developer at Keysight Technologies [formerly Agilent Technologies] in Santa Rosa.*

Crystal Ewen ('12) *is an engineer at Raytheon in Arizona. She earned a master's degree in applied physics at Northern Arizona University in 2014.*

Bryce Terrell ('12) *works for Clear Capital in Truckee.*

Katie Badham ('13) *is a graduate student at San Diego State University, where she is studying for an M.S. in physics with an electro-optics concentration.*

Brandon Baker ('13) *is a distributed antenna system technician with Ridge Communications in San Ramon.*

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

Antonio Cazarez ('14) *is a dealer at Graton Resort & Casino in Rohnert Park.*

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