# DEPARTMENT OF PHYSICS NEWSLETTER

## FOR ALUMNI AND FRIENDS

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## SANTA CLARA UNIVERSITY

**Inside this issue:**



## LETTER FROM THE CHAIR, BETTY A. YOUNG

Your new SCU Physics newsletter has finally arrived! (You may blame the tardiness of this missive on the new SCU Physics Chair, as I do.) First, let me give a big "thanks!" to **John Birmingham** for his stellar job as Chair for six years. Yes, John, it *was* only six years – we just made it seem longer. (You're welcome.) When John announced he wanted to get out of the Chair's chair in 2015 I got the nod, so I'll be keeping the chair warm for the next few years. I'll do my best to keep the department thriving!

Inside we highlight some recent achievements of SCU Physics faculty, students and recent graduates. **Guy Ramon's** NSF-funded theoretical work on spin qubits was the topic of his most recent and comprehensive *Phys. Rev. B* article. One of his current projects focuses on spectral properties of noise in solid-state quantum devices. Guy recently added two students to his research team and also initiated a new collaboration with colleagues in Poland. Laser physicist **Chris Weber** received a new NSF grant to work on photo-excited states in his lab at SCU. Chris also recently brought three SCU physics majors with him overseas to perform experiments at Okinawa Institute of Science and Technology. Their initial results will be presented this Fall in a set of conference talks. **Rich Barber's** polymer solar cell research with SCU chemist Brian McNelis led to an article that included work by nine undergraduates from both departments. Rich and his students are also beginning a new collaboration to study material properties of embiid (webspinning insects) silk. One of **Phil Kesten's** textbooks, *University Physics for the Physical and Life Sciences*, was translated into Portuguese and published as a four-volume set in Brazil last year. Phil also contributed a chapter to *The Star Trek Universe: Readings on the Films and Franchise* (Scarecrow Press), and gave a talk on the physics of Star Trek as part of the Talks at Google series (broadcast to Google offices worldwide; now available on Google's YouTube channel). **John Birmingham** published a 2016 paper on neural coding that appeared in the *Journal of Neurophysiology*. The paper was written with three SCU undergraduate co-authors and combines physiological data with mathematical modeling. I continue to work on cryogenic detectors for SuperCDMS, while collaborating on new projects with Kent Irwin's superconducting sensor group at Stanford. My recent SCU co-authors include Max Silva (UCSD), John Mark Kreikebaum (UC Berkeley), Carl Dawson (Stanford), Dick Mule ('16), and Zach Steffen ('18). Our newest addition to the department is **Dr. Roxana Flacau** [see inside], a strong experimentalist who teaches updated versions of our introductory labs.

There's been a lot of facilities work on campus recently, including the creation of a beautiful, brick-lined promenade that leads from the main gate of campus to the church, and the construction of several new buildings. Alas, our physics building is still the original… but there's hope! Design of a SCU "STEM" complex is underway. The planned new construction will include faculty and student spaces, modern classrooms, and brand-new faculty research labs. The complex will house Physics and other departments, including those in Engineering. We're excited about the new space that's coming our way. And who knows? The complex may even lead to some exciting new collaborations.

We continue to update the curriculum, recently adding a third quarter of upper-division quantum mechanics (with lab) and a seminar course that connects fundamental physics to timely issues in science, technology and society. Our "biophysics track" [see inside] in the major is gaining traction, and Engineering Physics (EP) remains healthy. Updated course offerings for EP are planned for next year. Lastly, the *Society of Physics Students* at SCU is thriving, enrollments are up, and department events are plentiful.

This year, we seek to identify new internship and early career opportunities for our physics and EP majors. Please share with us any potential leads for interesting positions. Information about department events, including our annual *SCU Physics Undergraduate Research Symposium* (Nov. 12th this year), can be found at http://scu.edu/physics/. If you have any questions about the department or just want to say "hi" please contact me directly at byoung@scu.edu, or reach me by phone through Diane Idemoto in the Physics office (408-554-4314). (Diane is far better than I am at checking voicemail!)

Best wishes to you all, Betty Young

## Faculty Update - Dr. Kristin Kulas

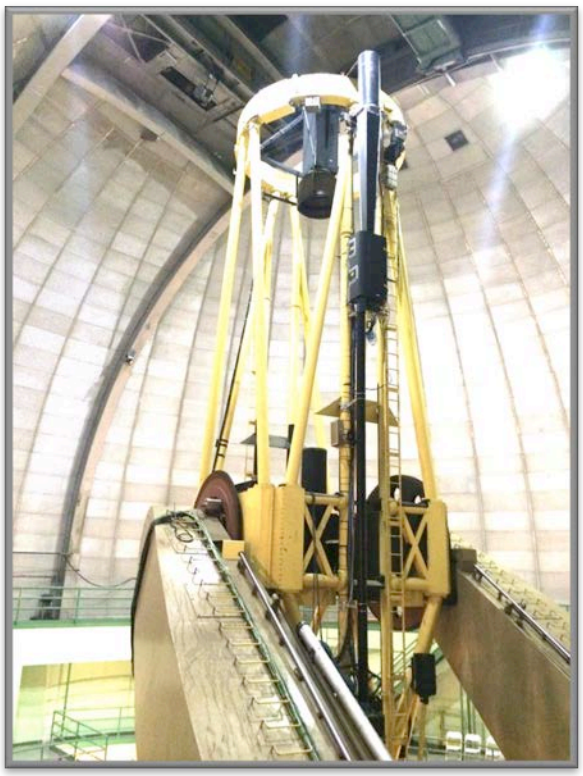
Dr. Kristin Kulas, a Lecturer in Physics at SCU since 2013, recently started a program that enables SCU physics students to work at NASA Ames on research aimed at understanding the physics of dust grain alignment with astrophysical magnetic fields. This research program, led by Dr. Kulas's colleague Dr. B-G Andersson, allows students to use spectroscopic and photometric multi-wavelength datasets to examine and test current theories about grain alignment in magnetic fields. In addition, Dr. Kulas's students are able to participate in observational astronomy on world-class telescopes near the SCU campus and beyond. This new program exposes select undergraduates to a complete view of astronomical research, from observation to analysis.

It is well known that dust grains in the interstellar medium (ISM) align themselves along magnetic field lines. This alignment causes the observed light from the ISM to become polarized. The polarization effect provides an important tool for probing the geometry and strength of cosmic magnetic fields. Detailed models of these fields can be carefully tested, particularly if variations in the grain alignment efficiencies can be well understood. And while quantifiable effects of astronomical grain alignment are abundantly evident, the exact physics associated with the alignment is not yet fully understood. This makes the subject area ripe for student research projects!

Recently, two SCU physics students got to work with Dr. Kulas and her NASA Ames colleagues on studies related to astrophysical grain alignment. In 2015, Sarah Youlton used near-infrared data to classify stars in the L183 cloud and determine the extinction of light passing through specific regions of the cloud. The extinction data were used to quantify the amount and size of dust grains in the cloud. During her internship, Sarah also got to participate in astronomical observations using the Shane 3-meter telescope at nearby Mount Hamilton's Lick Observatory. She contributed to observations of the L183 cloud using the Kast instrument in the spectro-polarimeter mode to obtain additional data for future studies.

In 2016, SCU student Ilija Medan worked with the NASA team on research to carefully examine the "Local Bubble", an area surrounding the Sun that is dominated by a low density, ionized structure. The origin of this structure is usually attributed to a combination of strong stellar winds and local supernovae**.** Using archival polarimetry, photometry, and spectral data, Ilija found evidence for a bimodal distribution in the magnetic field strength at the wall of the Local Bubble. This result is postulated to be due to counter-interactions at the wall; the stellar winds originating from the inside of the Local Bubble compete with effects from ongoing star formation taking place outside the Local Bubble. Ilija and colleagues plan to publish their exciting results soon in Astrophysical Journal. ~~Ψ

*Physics major Sarah Youlton ('16) on the catwalk of the Shane 3-meter telescope at Lick Observatory before a night of observing in 2015. Sarah is currently pursuing a M.S. degree in Applied Mathematics.*

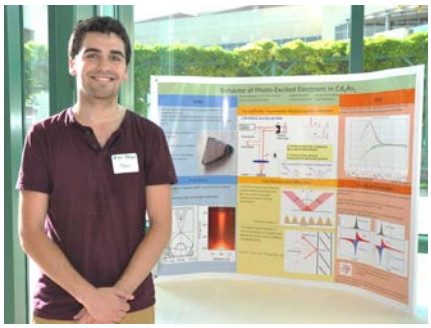


*The Shane 3-meter telescope, commissioned in 1959, is a reflecting telescope located on nearby Mount Hamilton.*

## A New Face In Physics

We are pleased to announce a wonderful new addition to Physics! **Dr. Roxana Flacau**, an experimentalist, received her B.S. degree in Physics from the University of Bucharest, Romania, in 1997. In 2007, she received a Ph.D. in Physics from the University of Ottawa, Canada, where she studied pressure-induced structural phase transitions using powder X-ray diffraction and Raman spectroscopy. After graduate school, she spent three years as a post-doctoral fellow at the National Research Council of Canada, where she studied structural stability conditions for hydrogen-rich compounds with applications to hydrogen storage. Dr. Flacau later joined the Canadian Neutron Beam Center, Chalk River Laboratories, as an Instrument Scientist at the High-Resolution Neutron Powder Diffractometer beamline. There, she continued her work in the field of crystallography and phase transitions, with a focus on systems applicable to the nuclear industry and energy storage technologies. We were able to hire Dr. Flacau as a Senior Staff Lecturer in 2016 and could not be happier. Dr. Flacau's primary roles in the Department are to teach modernized versions of our introductory physics laboratories for majors, and help develop new and exciting experiments for next-generation labs. Rumor has it, though, that a lucky few physics or EP majors may also get a chance to do some exciting research with Dr. Flacau in the near future! ~~Ψ

*(Left-Right): SCU Physics/EP majors Mandy Caputo ('18), Sarah Youlton ('16), Grace Chesmore ('17), Matti Masten ('19) at Oregon State University's 2016 Conference for Undergraduate Women in Physics (WiP).*



*Physics major Bryan Berggren ('17) with his 2016 Sigma Xi research poster presenting work done in Dr. Chris Weber's group at SCU. Sigma Xi is a national honor society for scientific research. Bryan later spent much of 2016 at Okinawa Institute of Science and Technology (OIST), working with collaborators of Dr. Weber. Bryan will return to SCU in January and complete his coursework in time to graduate, on-time, in June of 2017.*

## New Biophysics Track Option in the Physics Major

Thanks to Dr. John Birmingham, the department now offers a Biophysics Track option within the physics major. This new B.S. track is an excellent option for pre-health students with a desire to understand science at a fundamental level. The degree option is also appropriate for a conventional physics major who wants to pursue medicine or a M.D./PhD program in physics or biophysics, or who wants to work in the biotech industry. Students in the Biophysics Track complete the bulk of a traditional physics major along with standard pre-med courses in biology and chemistry. Elective courses within the degree are offered in physics, chemistry, biology, bioengineering and computer science. For more details about the program please see the Physics section of the SCU Undergraduate Course Bulletin. ~~Ψ

## A Special Thanks to the Lynch Family!

The Physics Department recently made some important upgrades to our teaching laboratories, thanks in large part to the generosity of Aaron Lynch ('13) and family. One particularly notable upgrade was made to our laser optics lab for majors. We now have a research-grade set of single-photon counting modules with fiber optic couplers that form the backbone of quantum-optics experiments on photon correlations and Bell's Inequality. We are excited to be able to offer these challenging experiments to our students, and are happy to share the news that additional lab upgrades are well underway! ~~Ψ

# Catching up with alumni: Updates from some of our former students

## John R. Taylor
## B.S. Engineering Physics, 2001

*Dr. Taylor, framed by a centuries old obelisk. John joined the Applied Mathematics and Theoretical Physics faculty at the University of Cambridge in 2011.*

After graduating from SCU with a degree in Engineering Physics in 2001, I moved to Monterey, CA and spent a year working with the Navy at the Fleet Numerical Meteorology and Oceanography Center. Here, the Navy develops and runs weather forecast models that they send out to their ships around the world. I worked in a group developing new ocean models, which are an important component in weather forecasts. While working with the Navy, I realized that there are fascinating and rich applications of physics in oceanography and fluid dynamics. I wanted to learn much more about these areas, so in 2002 I enrolled in the Mechanical and Aerospace Engineering PhD program at the University of California, San Diego (UCSD). During my PhD, I developed a computer model to study turbulent currents in the ocean. I finished my PhD at the beginning of 2008 and moved to MIT to work as a postdoctoral researcher in the Department of Earth, Atmosphere, and Planetary Sciences. Here, I interacted directly with oceanographers and applied the tools and skills I had learned at SCU and UCSD to problems in oceanography.

In 2011, I moved even farther away from home and started a faculty position at the University of Cambridge, in the Department of Applied Mathematics and Theoretical Physics (DAMTP). My current role is the equivalent of assistant professor in the United States system. I teach students in math and the natural sciences (which here, includes physics) and manage a research group that currently has three PhD students and three postdoctoral researchers.

I love my job! I get to spend my days thinking about fascinating problems in physics with important applications to the natural world. Some of the topics that I am working on include the dynamics of ocean fronts such as the Gulf Stream, studying the influence of ocean physics on biology including in phytoplankton (small algal cells) and bacteria, and melting of Antarctic ice shelves by warm ocean waters. In my view there is an urgent need in earth and climate science for talented people with strong training in physics and math to work on problems with big societal impacts. ~~Ψ

### Updates from the Class of '86

After graduating from SCU, **Martin Bodo** (B.S. Physics, '86) started a hard disk drive repair company. That business morphed into an electronics manufacturing operation known as Digital Loggers (http://www.digital-loggers.com) Martin now designs and builds a variety of electronic products for the communications recording, power control, and "Internet of Things" markets. Martin's son Joseph is studying Mechanical Engineering at SCU. It was great to meet Martin when he stopped by the department recently and shared some of his memories of working with Fr. Hayn and Dr. Duffy while a student.

~~Ψ ~~

When **Al Lorenz** finished his Santa Clara U. degree (B.S. Physics, '86) he joined Lockheed, where he enjoyed an intellectually stimulating career. Over the years, Al has worked on many interesting projects, including a few he can talk about! (Check-out the anti-projectile defense system called the ADAM High Energy Laser on YouTube.) Al commutes between the Reno/Tahoe area and Santa Cruz, and after 30 years he's ready to enjoy an early retirement. Want free career advice? Challenge Al to a game of chess!

## Sean Wells-Rutherford
## B.S. Physics, 2011


*Professional digital-signal-processing engineer Sean Wells-Rutherford enjoying his work!*

I arrived at SCU in 2007 with a slight inclination towards pursuing a physics degree, but I was also attracted to numerous other majors offered at SCU. However, after a brief impromptu meeting with Dr. Phil Kesten at summer freshman orientation, I knew I would end up with my B.S. in Physics. (I also completed a minor in Philosophy to keep a good balance with the humanities.) During my time as a physics student, I had the opportunity to work with Dr. Guy Ramon on research into spin qubits in quantum dots. That work gave me a new appreciation for the grueling pace of basic research, but I also discovered the thrill of applying mathematics and mastering new analytical skills to solve practical problems. It was toward the end of my college career that I discovered a deep fascination with synthesizers and music production and was introduced to the field where I discovered I truly belong.

Following graduation in 2011, I worked at a few startups in the Bay Area, but ultimately decided to continue my education at Arizona State University, near my home. At ASU, I completed a Master's in Electrical Engineering, with a focus in Signal Processing and a personal interest in audio. Though I was behind in some of the more basic EE courses when I started at ASU, I was uniquely ready for the more advanced topics encountered in Digital Signal Processing (DSP), as the mathematics strongly resembles that used in physics, particularly in quantum mechanics and statistical mechanics. The computer modeling skills I learned in Computational Physics at SCU gave me an edge in almost all of my graduate courses. During my graduate studies I worked as an intern at Fender, where I began by designing analog guitar pedals. I later worked in a digital communications research lab within the EE department at ASU. There, I analyzed experimental data and studied Doppler effects in Multiple-Input Multiple-Output wireless systems.

I was awarded my Master's of Science in Engineering from ASU in 2014, and have since joined the DSP engineering team at one of the premier audio companies in the world - Shure, Incorporated (near Chicago, IL). Most of my work now revolves around speech processing for conferencing and telecommunication, including the development of linear and non-linear DSP blocks for embedded targets. I also work on microphone array processing and in advanced research and development on Acoustic Echo Cancellation techniques. ~~Ψ

### Physics 192 – Modern Topics in Physics

Varian Medical Systems physicist **Isaias Job** (SCU B.S. Engineering Physics, 1997), was one of six dynamic speakers we hosted in the spring of 2016 as part of a ten-week seminar course focused on applying fundamental physics to timely world-wide issues in Science, Technology and Society. More than two-dozen SCU students and faculty participated in the seminar series. Speakers from industry, two National labs, and two leading research universities presented their recent work on fission sources and nuclear reactor physics, advanced medical imaging in the x-ray regime, precision cryogenic detectors for monitoring nuclear non-proliferation treaties, magnetism-based spintronics and spin-based logic, engineered materials for soft–robotics, and more.

*Physics alum Isaias Job ('97, at board) speaking with physics majors after his Spring 2016 seminar on the physics and technology of advanced x-ray imagers.*

# Department News

## 2015 and 2016 Physics Awards

The Physics Department is pleased to be able to present three very special student awards each year. The *Blockus Award*, in memory of Dr. David L. Blockus, Ph.D., is presented each year to the outstanding senior in physics or engineering physics. The *Drahmann Prize* is presented to the graduating senior who best exemplifies the hardworking and earnest values of Dr. John Drahmann, long time Dean of Sciences and Professor of Physics. The *Carl H. Hayn Prize,* is awarded each year to the most outstanding student in the introductory course sequence *Physics for Scientists and Engineers I, II, III.*

**2015 Award Recipients**

David L. Blockus Award - Max Silva-Feaver, Conor Zellmer

John Drahmann Prize - Garrett Huening

Carl H. Hayn Physics Prize - Shiloh Curtis

**2016 Award Recipients**

David L. Blockus Award – Richard Mule

John Drahmann Prize – Carl Dawson

Carl H. Hayn Physics Prize - Nicholas Schnabel

*Chris Weber, Bill DeHart, Phil Kesten at Bill's retirement party in the Adobe Lodge (July 2016).*

Theoretical physicist **William DeHart** retired in 2016 after *four decades(!)* of service to SCU. The department will not be the same without him! Bill's notable sense of humor and camaraderie will never be replaced. While we hate to see Bill go, we're happy for him; after teaching dozens of lab sections for decades, Bill now gets to enjoy gazing at the stars in the comfort of his impressive, self-built mountain observatory. Bill, we'll miss you – but congratulations to you on your well-earned retirement!

## Congratulations, Class of 2015!

*(L-R): Stephen Cisneros, Conor Zellmer, Caitlin Smith, Garrett Huening, Joseph Landry, Max Silva-Feaver, Brian Lu*

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## Congratulations, Class of 2016!

*(L-R): Daniel Call, Sarah Youlton, Pavel Klier, Connor Gafner, Carl Dawson, Richard Mule (N/S: Hugh Eisenman, Hunter Varnum)*

On a sad note, we recently had to say goodbye to longtime colleague **Stanley Thoreau** (1927 - 2016), who passed-away with family members at his side. Many of you may remember working with Stanley in the physics machine shop. Those of us who attended Stanley's crowded memorial service heard many wonderful stories about Stanley's rich and wonderful life outside of work. Stanley was buried with full military honors in recognition of his service to the United States during World War II. Stanley will remain in our memories forever.

## More Student Events

The SCU *Society of Physics Students* (SPS) has been quite active this year. SPS events have included a weekend trek to the *S.F. Exploratorium*, "Meet-the-Speaker" dinners after colloquia, Make-a-Sno-Cone meet-and-greets, barbeques and volleyball socials, and more. Many SPS members tutor introductory physics students and earn their fair share of pizza. Next month, 22 students will attend *PhysCon 2016, a* national conference for undergraduate physics majors held only once every four years. We're lucky that *PhysCon 2016* will be held in the Silicon Valley area, very near our campus.

And thanks to sponsorship by the *American Institute of Physics (AIP)*, SCU recently established a *Women in Physics (WiP)* group - open to all. In its inaugural year, SCU WiP, led by physics major Grace Chesmore ('17), has already hosted coffee and tea respites for new majors, and organized WiP Movie Nights, student dinners, elementary school demonstrations, and much more. A WiP / SPS Halloween pumpkin carving party is on the books for next week. Most excitingly, *WiP* members are currently planning their upcoming trip to UCLA where they will participate in a physics conference in early 2017.


*[**Photo at right**: A few of the SPS students enjoying an afternoon at the S.F. Exploratorium. (L-R) Shivam Desai, Thomas Ogloza, Mandy Caputo, Connor Gafner (SPS President), Zach Steffen.]*

### *Department of Physics Student Research Symposia*

*Each year many of our majors report on their undergraduate research projects. Here are some of the 2015 titles:*

***Effects of Dye Additives on Polymer Solar Cells*** *Mitchel Bugaj (Faculty advisor: Rich Barber)*

***Evaluation of Perovskite Solar Cell Stability and Fabrication Methods*** *Kyle Bandaccari (Faculty advisors: Brian McNelis and Rich Barber)*

***Characterization of Carbon Nanotube Tips for Atomic Force Microscopy*** *Grace Chesmore (Faculty advisor: Rich Barber)*

***The Classification of MOSFIRE Data to Determine the Role of Dust Grains in the Interstellar Cloud L183*** *Sarah Youlton (Faculty advisor: Kristin Kulas)*

***Velocity Dispersion of Galaxies Forming in the Early Universe*** *Richard Mule (Faculty advisor: Kristin Kulas)*

***Sub-picosecond Optical Response and Coherent Phonons in Two-Dimensional Semiconductor Black Phosphorus*** *Bryan Berggren (Faculty advisor: Chris Weber)*

***The Effects of Charge Noise on Qubit Decoherence*** *Matt Russell (Faculty advisor: Guy Ramon)*

***Characterizing Time-Domain Squid Multiplexers for Superconducting Detectors*** *Zach Steffen (Faculty advisor: Betty Young)*

***Exploring Anomalous Behavior of Superconducting Quantum Interference Device (SQUID) Multiplexing Chips*** *Carl Dawson (Faculty advisor: Betty Young)*

***Microwave Superconducting Quantum Interference Device (SQUID) Based Multiplexer Readout for X-Ray Science*** *Max Silva (Faculty advisor: Betty Young)*

## A Special Request from the Department

We take great pride in the quality of SCU physics and engineering physics majors, and we treat our students as individuals while they prepare for exciting careers within a wide range of scientific fields. One important way you can help our majors truly thrive is to send us leads for student internships or job opportunities. We have a wealth of talented students ready to apply themselves to challenging extra-curricular, summer, or post-bac work. We would love to work with you to identify additional opportunities for our majors. Know of someone looking to hire? Please send the information to byoung@scu.edu. Thank you! ~~Ψ

## Geoff ('62) and Josie Fox Summer Research Fellowships

We deeply appreciate the generosity of Physics alum Dr. Geoff Fox ('62) and his wife Josie for providing several SCU physics and EP majors undergraduate summer research fellowships. For the past two summers, the Fox family's generosity enabled ten additional SCU physics students to work under the guidance of Physics faculty research mentors. Student research areas included quantum computation, superconducting films and devices, biophysics, astrophysics, optics, photon science, and more. We hope to continue this tradition well into the future. To Geoff and Josie we say: "THANK YOU!"

*SCU Summer 2015: Undergraduate researchers (including five Fox Summer Research Fellowship recipients) and their Physics faculty mentors. (L-R): Profs. Ramon, Weber, Young, Zach Steffen, Dick Mule, Grace Chesmore, Bryan Berggren, Kyle Bandacarri, Matt Russell, Mitch Bugaj, Carl Dawson, Sarah Youlton, Max Silva-Feaver, Geoff (Jeff) Fox, Prof. Barber.*

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