

New Faculty

We now have two faculty members who specialize in Physics Education Research. Meet Dr. Benedikt Harrer, the newest addition to the department (p.2).

SJSU Physics Alumni In Their Own Words

Four Physics graduates discuss life after SJSU (p.3).

Supporting the Department

The State provides funding for teaching our classes, but it does not come close to covering the costs of student scholarships and research, modern facilities, conference travel or 21st century equipment. Any amount helps. Find out how you can support the department by visiting www.physics.sjsu.edu and clicking on the "Give Now" link, or contact the department chair to hear about our greatest needs:
Michael.Kaufman@sjsu.edu

Dear Alumni and Friends,

For years, the department has had a computational physics course, but several years ago we began serious discussions about its usefulness. Most students took the class as an elective late in their undergraduate program, and there was no obvious connection to other course work. We redesigned our computational curriculum: all physics students now take an introductory computing class their first year, followed by computational physics early in their upper division work, so they can use their computational skills throughout their undergraduate program. No physicist, in industry, academia or education, can succeed without these skills. When I visited an advanced lab class last week, I was thrilled to see students using their computational skills to program circuits, run simulations, and report results. Our redesign efforts are starting to pay off. Similar intentional redesigns are taking hold in our introductory physics and advanced courses, where collaborative learning and problem solving are replacing passive lectures.



SJSU Physics graduates go on to a variety of careers in the sciences, technology, engineering, computing, service industries, entrepreneurship, teaching, and law, to name but a few. In this edition of the newsletter, four graduates tell us about their careers in their own words. **We want to hear from you.** Please fill out our alumni survey at <http://tinyurl.com/SJSUphysalum>

We have an exciting year ahead. We are conducting searches for two new faculty members: one in computational astrophysics and one in experimental optics. Faculty and students are busy creating new knowledge and inventing new ways to teach. Let me know if you'd like to visit the department or have any other questions.

Sincerely,

Michael Kaufman, Chair

Michael.Kaufman@sjsu.edu

Meet our new Faculty



Assistant Prof. Benedikt Harrer earned his Ph.D. in physics, specializing in physics education research, at the University of Maine in 2013,

where he analyzed classroom video to identify disciplinary progenitors in middle school students' ideas about the concept of energy. He also holds a graduate degree in physics and mathematics, with a concentration in teaching and education from the Ludwig-Maximilians-University in Munich, Germany. Before joining SJSU, he taught pre-service math/science teachers in the Cal Teach program at UC Berkeley, where he also directed the Cal Teach Summer Research Institute and co-directed the Berkeley Engineering Research Experiences for Teachers (BERET) program.

Dr. Harrer has established the **Productive Interactions and Ideas in Physics Laboratory** (PI/IP Lab) to study the ways in which students construct an understanding of physics concepts. Beginning this

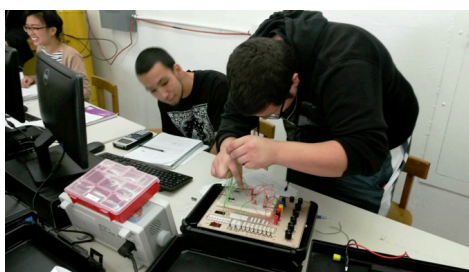


spring, he will use his new video analysis studio (left) to study

interactions between students during collaborative problem solving.

Updated Facilities and New Capabilities

Under the direction of Assistant Prof. Ranko Heindl, the **Physics 120A and 120B classes have been fully updated** with new curriculum and experiments and modern instrumentation, including new PCs with LabVIEW



programming language and National Instruments data acquisition boards (DAQs). These classes are offered every Spring (120A) and Fall (120B) semesters. Many topics in applied physics are covered including analog & digital electronics,

data acquisition, data analysis using Python, modern physics experiments, and advanced instrumentation. Students report that they regularly use the programming and presentation skills learned in the redesigned, required computational physics course, Physics 140.

Assistant Prof. Ehsan Khatami purchased parts and assembled two compute servers (below) for his research group. Each server has 16 cores (32 threads), 256GB of memory, and more than 2TB of storage space. These were combined with another server with the same specifications acquired by the Department, and an older server, into a small **high-performance**

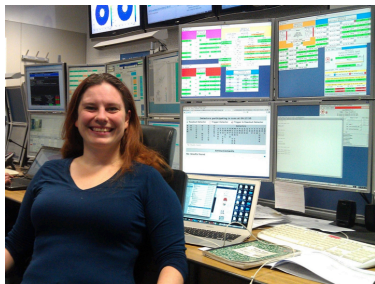


computer cluster for the Department's research and instructional needs. The cluster is housed in a College of Science climate-controlled server room but can be accessed by students working in our Astro/Physics Computation and Visualization Lab.

SJSU Physics and Astronomy graduates in their own words

Dr. Rosi Reed, Lehigh University (BS '05, Masters student '08)

"After graduating SJSU, I worked as an engineer for [L-3 Communications](#) in Redwood City, California, on Klystrons, large vacuum tubes used in variety of applications from particle accelerators to airport radar. After three years, I briefly returned to SJSU to brush up on my physics before heading to [UC Davis](#) where I received my Ph.D. in high-energy experimental nuclear physics in 2011, using the STAR experiment at the [Relativistic Heavy Ion Collider \(RHIC\)](#) accelerator, located at Brookhaven National Labs (BNL) on Long Island, New York. I then had a postdoctoral position at [Yale University](#) followed by a Research Professorship at [Wayne State University](#) in Detroit, Michigan. For both positions I used the [ALICE](#) experiment at the Large Hadron Collider (LHC; see photo, right) at [CERN](#) for my research. Recently I



took a tenure-track faculty position at Lehigh University, where I am starting an experimental nuclear physics group. My current research is at the [STAR experiment](#) at BNL, where I am investigating Quantum Chromodynamics (QCD), one of the fundamental forces of nature. The heavy-ion collisions at BNL create a new form of matter called a Quark Gluon Plasma (QGP), where the nucleons have melted into quarks and gluons, forming a nearly ideal strongly interacting fluid. I use what we call hard probes, particles produced in high-

energy nucleon-nucleon collisions in the initial stages of a heavy-ion collision. In particular I use jets, which are formed when the high-energy quarks or gluons produced in these initial stages fragment and hadronize into a collimated spray of hadrons, to address the important fundamental questions of how and why quarks and gluons lose energy in the QGP. If we understand the answers to these questions, including the energy dependence (which is why it is important to perform measurements at the lower energy collisions at RHIC) we will be able to understand the key features and structures of QCD."

Tin Tran (BS '13)

"I started at SJSU in 2009 as a Physics major. During my time as an undergrad, I had the opportunity to work several tutoring jobs on campus, primarily in the Physics department tutoring center and the Engineering department tutoring center. In my senior year, I was lucky to join the NASA-funded [Astrobiology research internship](#) at the [SETI institute](#), where I spent 2 years doing research on Infrared spectroscopy of star-forming regions.

After graduation, I worked as a contract Support Engineer for a research project at [Google](#). The project used cameras, projectors, turntables, lighting, and complicated software processing in

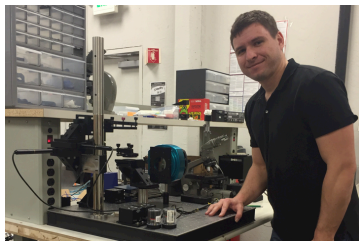


a close environment to produce highly-detailed 3D renderings of arbitrarily sized/shaped objects. This experience led to a job at [IBM-Silicon Valley](#) lab where I now

work as a software engineer for IBM's DB2 on z/OS product, a mainframe database management system. It's mainly used by big businesses (e.g. Verizon, ExxonMobil, Target, Allstate, BlueCross, Wells Fargo, The Bank of China). Revenue for DB2 alone is about \$2B per year."

Andrew Reid (MS '14)

"I am working as a systems engineer at a start-up called Silicon Valley X-Ray.



We develop and build high speed, high resolution X-ray microscopes for the semiconductor industry. Having a background in physics has been invaluable, enabling me to make decisions for new prototypes and to improve upon existing systems. I am glad to have found a career in which I can use my knowledge of physics!"

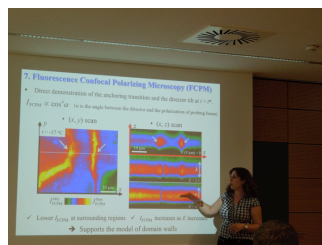
Greta Cukrov (BS '14)

"I am a Ph.D. candidate in the Chemical Physics Interdisciplinary Program (CPIP) at the Glenn H. Brown Liquid Crystal Institute (LCI) at Kent State University. LCI is the birthplace of liquid crystal displays, a ubiquitous technology that now generates more than \$100B in annual sales. The CPIP is small in the sense that fewer than ten students are admitted each fall, but is big in the sense that the opportunities for learning and future careers at the cutting edge of science and technology for human interfaces are limitless. Alumni of the program are in high demand -both in industry and in academia.

The science and technology of LCD's and

electro-optics of organic materials are among our hottest research areas. Many new applications are being pursued, each of which could have the potential to create the same economic impact as LCD's. Liquid crystal rubber flexes and twists like an artificial muscle when exposed to light, heat, or electric fields. Biosensors made with liquid crystals provide exquisite sensitivity to the presence of harmful bacteria. Liquid crystal organic photovoltaic materials promise to improve the efficiency of solar energy conversion. Many of the CPIP graduate students earn not only diplomas, but also patents for their work in developing these innovative technologies.

I work in Dr. Oleg Lavrentovich's research group where I explore twist-bend nematic liquid crystals, materials in which the crystals are aligned in the same direction but have no particular positional order.



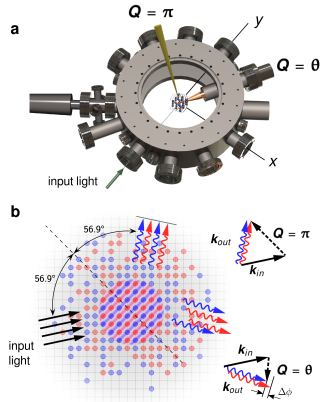
The first year of graduate school has been busy: I co-authored a paper in the journal Soft Matter, received

Honorable Mention for a graduate student poster at the ACS March meeting, was chosen for Best Research Presentation at the OSA conference in May, and travelled to Germany to collaborate with scientists at Universitat Magdeburg and to present my work at a conference (see photo)."

Tell us your story:

<http://tinyurl.com/SJSUphysalum>

Assistant Prof. Ehsan Khatami was part of a team,



led by Dr. Randy Hulet at Rice University, that compared experimental results with computational simulations to understand the physics of high-temperature superconductivity. In the experiment they trapped a collection

of 100,000 to 250,000 lithium-6 ions in an optical lattice and, using lasers, caused the ions to settle into an antiferromagnetic state—that is, a pattern in which neighboring spins alternate between up and down (see the figure). The feat is significant because high-temperature superconductivity emerges from an antiferromagnetic state. What's more, Hulet's lattice is a physical embodiment of the Fermi-Hubbard model, a physically simple, mathematically intractable description of electron-electron interactions. The temperature of the atoms in the lattice was deduced by comparing light scattering data to two state-of-the-art numerical simulations, one of which (the numerical linked-cluster expansion) has been developed for this model by Dr. Khatami. The results are published in *Nature* and are summarized in *Science*. Khatami has given four recent talks on his work, and is collaborating with undergraduate students **Mike Mulanix** and **Carlos Morante** and graduate student **Kelvin Chng**. He was awarded more than 433K CPU hours on Xsede Supercomputers for "Studying quantum lattice models of strongly-correlated electrons using numerical linked-cluster expansions", time valued at more than \$30,000.

Assistant Prof. Ranko Heindl is working with undergraduate **Eric Freda** and graduate students **Justin Slater** and **Karl Muster** on synthesis and characterization of magnetic nanostructures. His lab in SCI 250 became fully operational in the

past year (see below). His students have successfully synthesized templates for nanowires with diameters of $\sim 50\text{nm}$, and are further improving the synthesis process. The group is also working on static and dynamic characterization of these nanostructures using a vibrating sample



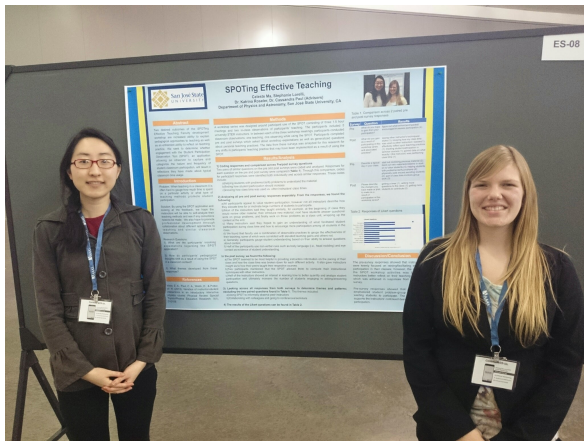
magnetometer and ferromagnetic resonance spectrometer. Students are also using an X-ray diffractometer and scanning electron microscope in the Engineering Building for their research. Prof. Heindl's work on magnetic tunnel junction devices, "[Time-domain analysis of spin-torque-induced switching paths in nanoscale CoFeB/MgO/CoFeB magnetic tunnel junction devices](#)", was published in the *Journal of Applied Physics*.

Assistant Prof. Aaron Romanowsky's was awarded the [SJSU Research Foundation Early Career Investigator Award for 2015](#). The award goes to a tenure-track faculty member that has "excelled in areas of research..... at an early or beginning point in their careers at SJSU." Romanowsky's discoveries with students **Richard Vo** and **Michael Sandoval**, continue to [make headlines](#). Another student, **Bradley Thompson**, discovered a rare compact elliptical galaxy in the process of formation, a result that will appear in a forthcoming publication. Romanowsky is busy following up on the discoveries using the [Gemini Observatory](#) and the [Hubble Space Telescope](#). He



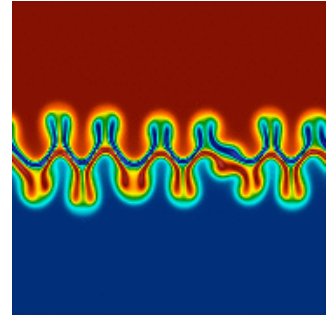
is also part of teams using the [Keck Observatory](#) to study [the fluffiest galaxies](#) in the universe and the [dark matter content](#) of elliptical galaxies. He was awarded an [NSF grant](#) to support his work on the evolution of globular clusters. In October, he led students on a behind-the-scenes tour of [Lick Observatory](#) (image on previous page).

Assistant Prof. Cassandra Paul has completed the conversion of Physics 2A from a traditional lecture-based course into one where students spend more than 80% of their time on collaborative problem solving. The “discussion-labs” that form the centerpiece of the course are less structured than previous cookbook labs and allow students to confront their understanding of physics concepts head-on. Paul is also busy carrying out Physics Education Research with her team: undergraduates **Stephanie Lorelli**, **Celeste Ma** and **Zairac Smith**, graduate students **Erick Hickok** and **Annie Chase**, and lecturer **Paul Houck** (MS '12). Paul and her group presented their work this year at [AAAS](#), [AAPT](#) and [PERC](#) meetings. In the photo below, Ma and Lorelli present their analysis of classroom interactions studied using the Real-Time Instructor Observation Tool (RIOT).



Prof. Alejandro Garcia's research on mesoscale flows was featured in the Lawrence Berkeley Laboratory Newsletter in March. With collaborators from LBL's [Center for Computational Sciences and Engineering](#) and the [Courant Institute](#), Garcia studies physical regimes between the discrete and the continuous. He was the

keynote speaker at the Discrete Simulation Monte Carlo conference in Kauai in September. The image at right shows a calculation of instability formation at the



interface of two fluids. He also gave talks at [DreamWorks](#) and [Pixar](#) on the physics of scale and taught a free, self-paced MOOC, "[Basic Physics for Animators](#)." He was also Acting Department Chair in Spring/Summer of 2015.

Associate Prof. Peter Beyersdorf took his graduate optics lab students on a factory tour of the facilities at [Coherent](#). This trip provided the students a chance to see first hand how the laser sources that they have been studying and working with in lab are manufactured and tested. From the assembly of solid state laser systems, to the ongoing maintenance of various gas-ion laser systems, we saw a broad range of technologies that are being developed and/or serviced. This



demonstrated that a broad understanding of various technologies is invaluable in industry, and provides motivation for learning about a range of technologies in the lab and the classroom. It also served as a recruitment opportunity for Coherent, as it lead to one of our graduate students, **Razieh Mahzoon**, applying for and earning an internship.

Prof. Ramen Bahuguna and SJSU physics students **Brianna Conroy, Robert Norris, John Kam** and **Richie Nagi** will attend the Optics and Photonics Winter School and Workshop at the University of Arizona in January.

Monika Kress was promoted to the rank of Professor in Fall 2015. As part of her work on introductory course transformation, she gave presentations at CSU conferences in Long Beach and Pomona. A web page summarizing Physics 50 course transformations can be seen on the CSU's Merlot website.

Prof. Lui Lam presented an invited talk "Humanities, Science, Scimat: A New General-Education Course" at the 5th International Science Matters Conference, "Interdisciplinary Education and Teaching in the 21st Century," held in Cascais, Portugal, Oct. 28-30, 2015. Scimat is the new multidiscipline initiated by Lam in 2007/2008 that treats all human-dependent matters as part of science. It encourages collaboration between humanists and natural scientists. The biennial conference series was cofounded by Lam in 2008. The conference featured reviews by top experts from around the world, such as Harvard's Deirdre Barrett.

Prof. Emeritus Patrick Hamill, has a new paper in press for the Bulletin of the American Meteorological Society, "A New Instrumented Airborne Platform for Atmospheric Research," about science carried out with the NASA Ames Alpha Jet (below). An instrument pod hangs under the jet's wing and measures water, CO₂ and other atmospheric gasses as the plane flies over urban, suburban and agricultural locations.



Prof. Brian Holmes gave a talk on the physics of the horn at the May meetings of the Acoustical Society of America in Salt Lake City, and a talk on the physics of brass musical instruments at the medical school of Louisiana State University in New Orleans on November 12. William Thorpe published his work "4 e e cummings songs" in October.

Holmes wrote these songs in 2009 when he was composer in residence of the San Francisco Choral Artists. A new composition, *Twilight in the Alps*, premiered in October in Los Altos;

this piece is for women's chorus, alphorn (see photo), and cowbells. Several of his Christmas works will receive professional performances by the Dayton Symphony in Ohio, and by VocalEssence, a chorus in Minneapolis.



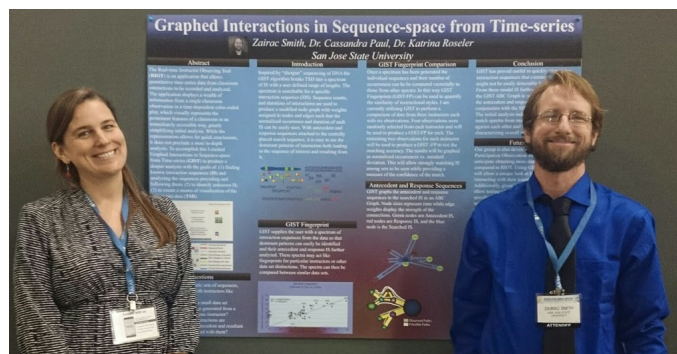
Prof. Carel Boekema's invited conference paper from New3-SC10 has been published in the Int J Modern Physics B, with SJSU student co-authors **Franchesca Owens** (BioChem), **Ashley Love** (Software Eng), **Zhengzheng Li** (Chem) and **Perry Sakkaris** (Physics). This perspective on the (magnetic?) origin of cuprate superconductivity was presented in Chongqing, October 2014. At the end of August at the Int M2S Superconductivity conference in Genève, Switzerland, he and his students presented a poster on positive hole effects in MgO, RbCO & Fe₃O₄. Student co-authors **Carlos Morante, Maria Stone** and **Hannah Johnson** (all Physics) focused on the chemical and physical similarities between these unusual oxides. Presently, Professor Boekema is on leave, and is guest scientist at the CNRS Institute Charles Gerhardt, Montpellier, France, as well as at SETI, Mountain View CA. He collaborates with Professors ML Doublet (CNRS)

and F Freund (NASA) on the rare O⁻¹ state in MgO in a search for earthquake precursor effects. On the latter, he has given an invited CNRS seminar. Muon experiments are planned for the next cycle at [ISIS UK](#) to continue MgO & Li-based oxide studies. Boekema continues to work on his graduate text on Magnetism & Superconductivity. His book proposal at Cambridge University Press was well received.

Prof. Kenneth Wharton reports that two SJSU student-authored papers have been accepted for publication this year: "[Unit Quaternions and the Bloch Sphere](#)", by Wharton and **Daniel Koch** (BS '14), and "[Are Retrocausal Accounts of Entanglement Unnaturally Fine-Tuned?](#)", authored by **Demetrius Almada** (BS '14) and graduate students **Kelvin Chng, Shane Kintner** and **Brandon Morrison**. Wharton won 3rd Prize (and \$2000) in the 2015 FQXi.org essay contest concerning the "[Mysterious Connection Between Physics and Mathematics](#)." This is his fourth consecutive essay to win the \$2k prize. The essay, entitled "Mathematics: Intuition's Consistency Check" will be published in a Springer volume next year.

Prof. and Chair Michael Kaufman was on sabbatical for spring and summer of 2015, and is eternally grateful to Alej Garcia for serving as Chair in his absence. He made research visits to colleagues at [Harvard-Smithsonian Center for Astrophysics](#) and the [University of Maryland](#), presented an invited talk at the meeting "[30 Years of Photodissociation Regions](#)," in Asilomar, CA, and co-authored four research papers on topics in interstellar chemistry: [O₂ formation in protostellar outflows](#), [water emission from supernova shock waves](#), [turbulence in molecular clouds](#), the [binding energy of O-atoms on dust grains](#). In October, he gave the SJSU [University Scholars seminar](#).

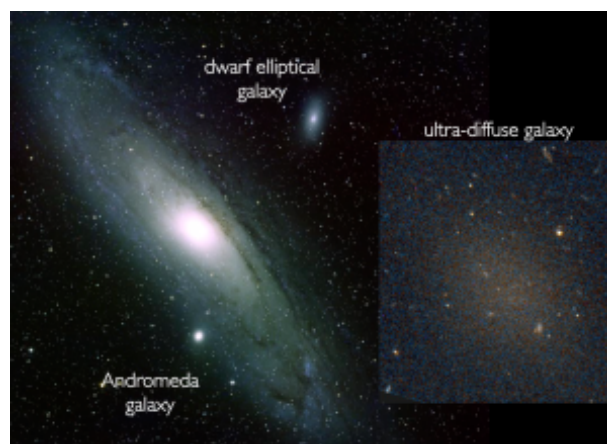
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Assistant Prof. Cassandra Paul and student Zairac Smith present their work at the 2015 AAAS Conference

Help support student research

Scholarships, student travel, conference participation, and facilities upgrades are made possible by generous support from donors. Contributions **in any amount** help ensure that SJSU Physics & Astronomy students continue to have access to world-class research experiences. To find out how to make a tax-deductible contribution in support of SJSU Physics & Astronomy, visit www.physics.sjsu.edu and click on the "Give Now" button, or contact the Department Chair at Michael.Kaufman@sjsu.edu.



Ultra-diffuse galaxy discovered by Assistant Prof. Aaron Romanowsky and collaborators