2019 Summer Undergraduate and Graduate Research Colloquium

Abstracts

Thursday, August 15, 2019
9:00 – 11:00 am

Bren School Courtyard

University of California, Santa Barbara

The California Alliance for Minority Participation (CAMP)

www.mrl.ucsb.edu/CAMP

The Summer Research Program provides a 10-week intensive research experience for CAMP eligible students interested in a career in science, engineering, technology, or mathematics. CAMP participants work in a UCSB laboratory with a graduate student or postdoctoral researcher mentor. Mentors provide one-on-one training and support for the research project. In addition to research, the interns also participate in weekly group meetings to develop oral presentation skills, attend special seminars and present their results at an end-of-summer poster session. Students also present their research at the statewide CAMP symposium the year after completing their internship.

Mapping the Hydrophilic Channels of a Nafion-like Anion Exchange Membrane

Alejandra Acosta-Hernandez, Chemistry, University of California Santa Barbara
Austin Barnes, Steven K. Buratto, Department of Chemistry and Biochemistry

Fuel cells are an efficient high power alternative energy source with zero carbon emissions. The proton exchange membrane (PEM) fuel cell converts hydrogen fuel into electricity. As the name implies, the most important component of the fuel cell is the membrane itself. The PEM conducts protons through randomly distributed aqueous channels that are 5-10 nm in diameter. The morphology of the channel network is linked to the conductivity. Nafion, which is the current state-of-the-art PEM, is composed of a perfluorinated (PF) Teflon-like backbone and a sulfonic acid side-chain. However, PEM fuel cells require expensive platinum catalysts to facilitate the electrochemical reaction, which has impeded commercialization. Anion exchange membranes (AEM)s, which conduct hydroxide, present the possibility for implementing inexpensive Earth metal catalysts, which would significantly reduce the cost of production. Currently, the AEM performance is limited by poor conductivity. Understanding the nano-scale morphology of the channels could provide insight toward its conductive properties and overall performance. In this work, we investigated the surface morphology of an AEM analog to Nafion (PF AEM) using atomic force microscopy (AFM) and tapping-mode phase images. Given the chemical structure similarities between Nafion and the PF AEM, we hypothesize that the surface morphologies are similar, which could give rise to high conductivity. The morphology of the membrane was compared at dry, humidified, and ambient conditions using a closed imaging cell in both its chloride (PF AEM-Cl^-) and hydroxide (PF AEM-OH^-) form. Preliminary data of the PF AEM-Cl^- shows hydrophilic domain diameter of ~16 nm, which is larger compared to Nafion (~8 nm) at ambient conditions. We plan to implement conductive-probe AFM, which maps the channels that are connected completely through the membrane. This study provides insight toward the future design of higher conducting AEMs.

Analysis of Microbial Community Change in Anaerobic Bacteria on Degrading Kelp

Joshua Burgos-Ponce, CCS Biology, University of California Santa Barbara
Na Liu, David Valentine, Earth Science

Anaerobic degradation of kelp in the ocean is poorly understood relative to aerobic degradation. While there have been several studies on aerobic degradation of kelp, there have only been a few long-term studies of anaerobic degradation of kelp. Anaerobic degradation of ocean plan life can be used in industrial applications such as possible creation of fertilizers and biofuels. This project aims to identify bacteria that could be responsible for the anaerobic degradation of kelp. In order to accomplish this goal, the giant kelp (*Macrocystis pyrifera*), along with several other species of kelp, were placed in anaerobic serum bottles with in-situ seawater and allowed to incubate in the dark over several weeks. Microbial DNA samples will be extracted weekly for 16s rRNA gene sequencing. Analyzing at different time points will allow us to study the overall change in microbial community over time. Currently, the

acquired samples are still incubating, however by the end of the experiment we should see varying degrees of higher amounts of anaerobic bacteria as well as sulfate-reducing microbes.

Viscoelastic Properties of Byssal Threads of the Californio Mussel
Ismael A. Carvajal, Mechanical Engineering, University of California Santa Barbara
Marcela Areyano, Eric Valois, Herbert J. Waite, Molecular, Cellular, and Developmental Biology

Mytilus *californianus* readily adhere to many types of materials such as rocks, metals, and wood despite hostile environmental conditions in the intertidal zone. The mussel can achieve this through the byssus, a collection of energy dissipative threads and adhesive plaques. In this work we focus in the byssal threads distal region where we seek to understand their viscoelastic properties. The distal region exhibits the unique combination of being stiff and yet extensible, making it capable of dissipating large amounts of mechanical energy. Initial findings demonstrate the distal region of the byssus stress relaxes under constant strain, but it is unclear what components permit this energy dissipation. Understanding the relaxation properties will further our understanding of the byssal self-repair process, which may lead to better design principles for synthetic materials. Tensile testing was performed in order to characterize mechanical properties such as elastic modulus and stress relaxation. Our results indicate that byssal threads experience treatment dependent relaxation. For example, a native thread relaxes at approximately 40% while a thread that has been treated with pH 5.5 relaxes approximately 60%. In order to connect bulk material properties, such relaxation %, to the molecular level, small-angle X-ray scattering (SAXS) was implemented. From the SAXS experiments it was observed that when byssal threads are strained to 10%, the molecular strain is equivalent. This result demonstrates the non-crystaline components in the thread must deform at the same length as the bulk and that the crystalline components do not experience deformation. These results have helped understand the healing process in the distal region as well characterize viscoelastic properties that could be implemented into synthetic materials.

Exploring Fundamental Properties of Tau in its LLPS State
Jorge Jacinto, Biochemistry & Molecular Biology, University of California Santa Barbara
Bretton Fletcher, Cyrus Safinya, Materials

The microtubule-associated protein, tau, has previously been found to be one of the major components of neurofibrillary tangles, a hallmark of Alzheimer's disease; however, the exact mechanism through which tau dissociates from microtubules (MTs) and forms these neurotoxic aggregates is not fully understood. Previous studies have shown that tau can undergo liquid-liquid phase separation (LLPS) *in vitro* in the presence of polyanionic biomolecules found in cells, such as RNA, suggesting a possible intermediate between MT-bound tau in health and aggregated tau in the disease state. Due to the complexity of interactions and forces driving coacervation, the Safinya group is interested in developing fundamental knowledge of this phenomena as it pertains to tau functionality. We have provided evidence that tau coacervation may also be induced under various other conditions, such as in the presence of GTP and even by itself in solution. This has been done by recombinantly expressing and purifying certain isoforms of tau protein and using it to perform microscopy experiments which have helped us learn about the physical properties of LLPS tau. Here we present results from purifying and labeling our protein as well as preliminary data from DIC and fluorescence microscopy. By building off of these results, we hope to use this experimental platform to bring us closer to understanding the exact mechanisms through which neurofibrillary tangles develop in individuals with Alzheimer's disease.

Determination of Thermal Properties for Thin GaAs Semiconductor Devices
Alejandro Murillo, Mechanical Engineering, University of California Santa Barbara
Usama Choudry, Bolin Liao, Mechanical Engineering

In the field of silicon photonics, previous studies have shown that ordered multilayered structures of gallium arsenide have interesting and advantageous properties. These GaAs semiconductor devices are employed in promising applications for photonic devices like quantum dot lasers. Other applications include the development of optoelectronic devices that have an improved performance in high-speed telecommunications and information processing. However, there has not been direct experimental evaluation on the effect of threading dislocations on the thermal conductivity of GaAs devices. It is important that this analysis is done to better understand how the heat dissipation affects the efficiency of the photonic devices and their lifetime cycle. In this work, we execute a noncontact laser-induced transient thermal grating (TTG) technique to investigate properties like thermal diffusivity and thermal conductivity of GaAs-based buffers on Si. We studied samples with different threading dislocation densities (TDD) which were generated during the growth process. Samples with a higher TDD are expected to have a lower thermal conductivity than the samples with lower TDD due to increased phonon scattering. These results indicate the importance of growing GaAs with a significant reduction of TDD through rational design of devices structures, to obtain high thermal conductivity and improve heat dissipation.

The Mutual Exclusion of Grooming Behaviors in *Drosophila melanogaster*

Angel Okoro, Cellular and Developmental Biology, University of California Santa Barbara
Li Guo, Julie Simpson, Molecular Cellular and Developmental Biology

Although animals receive various sensory stimuli, they typically only execute one behavior at a time. However, the neural circuit behind behavior selection is unknown. Here we use *Drosophila* fly grooming to address this question. When flies are fully immersed in dust, they follow a stereotypical cleaning sequence from anterior to posterior grooming, but they cannot execute multiple cleaning behaviors simultaneously. This mutual exclusivity is necessary to prevent them from losing balance or getting injured. We used optogenetic screening to identify a group of neurons titled R81C11 that when activated induce front leg rubbing in undusted flies. In contrast, when these neurons are activated in decapitated flies they simultaneously induce front leg rubbing and back leg rubbing, overriding mutual exclusion. Anatomical image shows R81C11 contains neurons in both the brain and the ventral nerve cord (VNC). After comparing behavior data from intact and decapitated flies, we hypothesized that the subset of R81C11 neurons in VNC are able to simultaneously activate both behaviors, but signals from the brain regulate mutual exclusion. Furthermore, anatomical data shows that the neurites of VNC R81C11 neurons and axon terminals of mechanosensory bristle neurons overlap. This implies that VNC R81C11 neurons might communicate with mechanosensory bristle neurons which are the main sensilla for dust sensitivity. We intend to use genetic tools to extract a smaller subset of neurons that can induce simultaneous grooming, and to map upstream and downstream targets of these neurons. We aim to use these results to elucidate the neural mechanism of mutual exclusion.

Garnet Phase Formation during interactions between Thermal Barrier Oxides and Molten Silicates

Rodrigo Rodriguez, Chemistry, University of California, Santa Barbara
Collin S. Holgate, Carlos G. Levi, Materials Department

Thermal barrier coatings (TBCs) are thermally insulating ceramic layers added to the surfaces of actively cooled superalloy gas turbine components that enable them to operate more efficiently at high temperatures. Durability of TBCs depends on their tolerance to thermal cycling, which results from a porous microstructure that induces a low in-plane elastic modulus. However, siliceous debris ingested with the intake air deposit on the coating surfaces, melt at peak temperatures in the engine cycle and penetrate the porosity, stiffening the coating and degrading their strain tolerance. The infiltration can be arrested by selecting a TBC composition that reacts rapidly with the penetrating melt, forming solid phases that fill the near-surface porosity precluding further flow into the coating. This investigation explores the stability of the garnet phase in reactions between yttrium-aluminum/iron garnets in systems consisting of Ca, Mg, Fe, Al silicate melts. Reactants were produced by precipitation from precursor solutions, pyrolyzed into powder, pressed and heat treated in the range 1200-1400°C. The equilibrated microstructures were analyzed utilizing scanning electron microscopy, energy dispersive X-ray spectroscopy, and X-ray diffraction to determine the extent of garnet formation and phase compositions. The results are incorporated into a larger effort aimed at developing a thermodynamic database on garnet formation to inform novel TBC development.

Detecting Low-Density Nanoscale Spin Arrangement with Shallow Nitrogen-Vacancy Center Ensembles

Nicolas Williams, Physics, University of California Santa Barbara
Zhiran Zhang, Ania Jayich, Physics

Detecting magnetic spins on the nanoscale is useful as a step toward individually resolving such spins in magnetic imaging. The development of a single-spin resolution imaging technology poises itself on the brink of an age of new

scientific advancement. Here we investigate using shallow nitrogen-vacancy (NV) center ensembles in diamond to detect nanoscale arrangements of gadolinium spins. We employ spin relaxometry techniques to determine if and where Gd^{3+} spins are present. Upon polarization, the characteristic time in which the NV returns to a thermal mixture of spin states is called T_1. Spin relaxometry operates on the principle that the T_1 measured on NVs goes down in the presence of strongly fluctuating magnetic fields. Gd^{3+} spins are chosen since they have a large spin $S = 7/2$ and thus produce such strongly fluctuating magnetic fields. We expect to detect T_1's that are reduced by about an order of magnitude and demonstrate consistency with the regions of gadolinium deposition on the diamond surface. Informed by these results, we can move from ensemble measurement to measurement with a single NV, thus decreasing the spatial region over which Gd^{3+} spins can be detected and greatly improving the spatial resolution for imaging.

Role of Antibiotics in Shaping Kelp Microbiome

Faeben Wossenseged, Biological Sciences, University of California, Santa Barbara
Anna James, Elizabeth Wilbanks, Ecology, Evolution, and Marine Biology

Host-microbe interactions play a critical role in host development and health. The symbiotic relationship between a host and the collection of microbes that constitute the 'host microbiome' can be studied in kelp in order to better understand the function of these tiny organisms in relation to kelp's physiological state. Antibiotics are influential in shaping the kelp microbiome and can be produced by the kelp itself, or by specific bacterial populations in an attempt to minimize competition for space and resources on the kelp surface. The aim of this project is to develop antibiotic resistance profiles of different kelp bacteria strains to better understand how antibiotics are utilized to keep kelp blades healthy. Antibiotic sensitivity tests were performed on six different kelp bacteria strains using five different antibiotics: chloramphenicol, gentamicin, ampicillin, kanamycin, and neomycin. The chosen kelp bacteria showed high levels of susceptibility to chloramphenicol and high levels of resistance to gentamicin, indicating that future studies are required to understand these potentially critical antibiotics in shaping kelp-microbe interactions.

Cooperative International Science and Engineering Internships (CISEI)

http://www.mrl.ucsb.edu/CISEI

The Cooperative International Science and Engineering Internships program, sponsored by the Materials Research Laboratory, helps undergraduate students develop a global network at an early stage of their scientific careers. CISEI exchanges undergraduate interns between UCSB and partner universities in Eindhoven-Netherlands; Tokyo-Japan; Saarbruecken-Germany; Goethenburg-Sweden and Dublin-Ireland to participate in summer research experiences.

The development and optimization of 3D printed dynamically bonded materials

Alexander Deen Fusi, Polymer Technology, Kungliga Tekniska Högskolan, Sweden
Caitlin Sample, Christopher Bates, Craig J. Hawker, Materials Research Laboratory

The ever-increasing problem of petrochemically derived plastic pollution and the inefficiency of recycling polymers constitute some of the significant technological problems of polymeric materials. Such issues have led to the development of advanced self-healing materials called vitrimers that, despite being cross-linked, can exchange bonds upon heating. Vitrimers can be reprocessed with ease and have comparable mechanical properties to pristine, undamaged polymers. This work aims to design a vitrimeric system that can be shaped and polymerized through stereolithographic 3D printing techniques, such as Solution-Mask Liquid Lithography (SMaLL), thus obtaining an object of interest. To render such technology available to the public and commercially competitive, we have developed and optimized the synthesis of acrylate and epoxy monomer systems containing dynamically bonded dioxaborolane cross-links. Tri-functional molecules were reacted with arylboronic acids to produce boronic esters and reacted further to add an epoxy or acrylic terminus to be polymerized in situ cationically or through free-radical polymerization through SMaLL to create materials with isotropic and self-healing properties. Resin formulations, which include the dioxaborolane cross-linkers, acrylic or epoxy monomers, and a photochromic initiating system, will be optimized to produce materials with appropriate mechanical properties and self-healing character given by the dioxaborolanes connections. The resulting material will be analyzed through Dynamic Mechanical Analysis to determine the bond exchange kinetics, and the mechanical properties will be investigated through tensile and rheology tests.

Synthesis of light-responsive polymeric ionic liquids using an azobenzene photoswitch

Rengaraj Gopal, Materials Chemistry, Chalmers University of Technology, Sweden
Angelique Scheuermann, Christopher Bates, Javier Read de Alaniz, Materials, Chemistry and Biochemistry

The growing energy demands have made the need for efficient energy storage and conductive materials very crucial. Polymeric ionic liquids (PILs) display great potential as solid electrolytes in batteries and fuel cells, due to their ability to combine advantageous attributes of both ionic liquids (low vapor pressure, thermal and chemical stability, broad electrochemical window) and synthetically tunable physical properties of polymers. A reversible azobenzene photoswitch was incorporated into the PIL, to affect its mechanical and electrical properties with light. The change in volume of azobenzene during light-stimulated trans-to-cis isomerization was utilized to alter the mobility of ions in the PILs. Light has better temporal and spatial control than heat and was preferred for the isomerization of the azobenzene photoswitch. Monomers were synthesized using air and water-free Schlenk line techniques, purified using column chromatography, and analyzed using nuclear magnetic resonance spectroscopy (NMR). Reversible Addition-Fragmentation chain-Transfer (RAFT) technique was used to polymerize the monomers and to achieve low polydispersity. Future work includes light-based studies of the PILs to determine the effects of the azobenzene photoswitch on PIL mechanical and electrical properties.

Computational Approach Towards the Design of Complex Morphologies in Triblock Copolymer Melts

Mizuki Kamata, Chemical Science and Engineering, Tokyo Institute of Technology
Joshua Lequieu, Glenn Fredrickson, Chemical Engineering

Block copolymers are all around us. Since self-assembling block copolymers form well-ordered nanostructures, they have been applied to a wide variety of products such as adhesive tape, asphalt additives and coatings. Simple diblock copolymers (AB-type materials) have been researched extensively, yet only a handful of relatively simple morphologies have been found. Multiblock copolymers exhibit much more complicated phase behavior and are much less understood. Here, I focus on triblock terpolymer melts (ABC- type materials) and find globally stable morphologies by using Self Consistent Field Theory (SCFT). Using SCFT, we have found several new phases such as cylinder packings with the p3m1 and p4gm space groups and the CsCl and NaCl phases. The complex morphologies associated with triblock copolymers can lead to new and exciting further applications such as photonic crystals or advanced membranes. These predictions will be used to guide future experiments performed in research groups here at UCSB. This combination of experiments and field-theoretic simulations will also provide further understanding of unique morphologies of self-assembling block copolymers.

In Situ High-Temperature Oxidation of Titanium in Low Oxygen Environment

Sarah Lößlein, Materials Science and Engineering, Saarland University (Germany)
Mayela R. Aldaz-Cervantes, Carlos G. Levi, Materials Department, UC Santa Barbara

Titanium alloys are attractive for structural applications, particularly in aerospace engineering, owing to their outstanding balance of mechanical properties with relatively low density. However, their application is limited to moderate temperatures because of their poor oxidation behavior above 500°C. Due to the high oxygen solubility in titanium, its oxidation process is complex and only partially understood. To elucidate the oxidation mechanism of titanium, pure titanium samples have been oxidized for four hours at 800°C. A lower temperature of 600°C was also tested. In situ oxidation experiments were performed using a heating stage under an argon environment which enabled a real-time observation of the oxidation process and identification of the resulting oxide products through Raman spectroscopy. Further analysis by scanning electron microscopy allowed the characterization of the surface oxide morphology. A continuous growth of a rutile oxide layer on pure titanium was observed after oxidation at 800°C followed by slow cooling rates. A notable observation is that the oxide evolves primarily during cooling rather than at the hold temperature, which reveals that all the oxygen incorporated at temperature is dissolved into the metal as interstitials. The oxidation process of titanium and the complexity of its products are found to depend strongly on the oxidation parameters as well as the exact composition of the material.

Aqueous Gel Thin Film Adhesion for Biomedicine

Lisa Månsson, Engineering Physics, Chalmers University of Technology, Sweden
George Degen, Department of Chemical Engineering, University of California Santa Barbara
Angela Pitenis, Materials Department, University of California Santa Barbara

Lubricious interfaces are ubiquitous in biology and are often on the order of micrometers or less in thickness. One example is the tear film in the eye, which protects the sensitive, highly innervated cornea. Biomedical implants in contact with the eye, including contact lenses, must be designed to interface with the natural lubrication mechanisms of the ocular environment to prevent irritation or inflammatory responses. Hydrogels, common contact lens materials, consist of highly hydrophilic crosslinked polymer chains and thus absorb large amounts of water, which imparts high lubricity, or very low friction, to their surfaces. In some cases, hydrogels can be extremely slippery, with friction coefficients on the order of 10^{-3} measured between contacting swollen gels. Despite their widespread use, the mechanical properties of thin hydrogel films remain poorly understood. In this work, a casting method for creating thin hydrogel films was used to study their mechanical properties. Gel thickness was measured using confocal microscopy, and adhesion between a glass probe and a hydrogel film was measured using a Surface Forces Apparatus. The results suggest that the contact mechanics, including adhesion, of thin hydrogel films to rigid glass surfaces depend on hydrogel water content as well as indentation depth. This work and further investigation of other properties of thin hydrogel films, such as friction, are of great interest to better understand and control these materials for use in biomedicine.

Surface Functionalization and Capping of Diamond NV Centers by Molecular Beam Epitaxy

Marie Niederlaender, Physics, Saarland University, Germany
Brian Haidet, Kunal Mukherjee, Materials Department

In recent years nitrogen vacancy (NV) centers in diamond have drawn much attention as a two-state quantum system, which is of high interest for quantum technology. These defects in the crystal lattice of diamond have potential to act as solid state qubits which have comparably long coherence times and can be read out and controlled optically. A major drawback however, is frequent unwanted interaction between the NV centers and surface spins, which results in loss of coherence. In collaboration with the Jayich group our novel approach to this outstanding problem utilizes the interaction between near-surface NV centers and single atoms, controllably placed on and bound to the diamond surface (adatoms). As a first step we deposited indium adatoms on diamond substrates containing shallow NVs, using molecular-beam epitaxy (MBE). Utilizing ion scattering spectroscopy (ISS) and X-ray photoelectron spectroscopy (XPS), the atomic coverage and composition of partial monolayers of indium are quantified with calibration samples of 100% and 0% indium coverage. The MBE growth rate is calibrated using a thick layer of deposited indium. Additional capping of the surface with inert atoms serves to minimize the decohering effects due to surface contaminants. The interactions of the adatoms with the NVs, as inferred through changes in coherence times, will be measured using confocal and wide field microscopy. Developing and measuring ultra-sparse adatom layers enables the fabrication of structures where individual NV centers can be observed interacting with individual adatoms. With this method, we hope to build interacting hybrid quantum systems with long coherence times, an important component for next generation quantum devices.

Synthesis and Characterization of Polymers with Well-Defined End Groups in the Study of Biomineral Crystallization

Job J.C. Struijs, Chemical Engineering and Chemistry, Eindhoven University of Technology
Yvonne J. Diaz, Craig J. Hawker, UCSB Materials Research Laboratory and Javier Read de Alaniz, UCSB Department of Chemistry and Biochemistry

Hydroxyapatite (HA) crystals are ubiquitous in biological systems. Therefore, these HA crystals are promising for health care applications, such as dentistry, and general material applications. Studies into the size and morphology of HA crystals have shown that these properties significantly influence their utility. Previous research shows that the formation of HA crystals are affected by the presence and characteristics of polyacrylic acid (PAA). For example, the molecular weight and architecture of PAAs, acting as a matrix, have been found to play an important role in the size, morphology and formation of HA crystals. However, the influence of end group functionalization of the polymer, especially for low molecular weight PAA, is unknown. In order to investigate the effect of the polymer end group, low molecular weight PAAs (ca. 2 kg/mol) were first prepared by light mediated atomic transfer radical polymerization. Then, the facile and scalable procedure presented in this work was used to access a library of PAAs with efficient control over the end groups by taking advantage of mild conditions and cheap reagents. The chain ends of these polymers were confirmed by ^{1}H NMR and their low dispersities were observed by size exclusion chromatography. Secondly, the polymers with the different end groups were assessed for their influence, on both size and morphology, in the formation of hydroxyapatite crystals. It is imagined that this could be a starting point towards biomaterials that mimic, for example, bone and teeth crystals.

Microwave-Assisted Synthesis of the Antiperovskite Carbides Mn_3ZnC and Ni_3GeC

Ida Svenningsson, Applied Physics, Chalmers University of Technology, Sweden
Sam Teicher, Ram Seshadri, Materials Research Laboratory

Antiperovskite carbides have a long history in metallurgical research, and members of the family exhibit unusual properties such as superconductivity and giant magnetoresistance. They are cubic structures with the formula X_3AC_δ, in which the X site hosts the element with the lowest electronegativity. Recent computational work suggests that both Mn_3ZnC and Ni_3GeC might be topological semimetals—3D analogs of graphene with interesting electronic properties. Conventional synthesis of antiperovskite carbides can be a complicated task: Mn_3ZnC is conventionally produced through several heating and mixing cycles over multiple weeks and Ni_3GeC_δ has never been successfully produced with carbon filling, δ, close to 1. Microwave-assisted synthesis addresses both issues by reducing synthesis time and locally heating the carbon, which is a strong microwave susceptor, and also offers a pathway towards isolating metastable antiperovskite carbide family members due to the fast reaction time. In this work, we synthesize the antiperovskite carbides Mn_3ZnC and Ni_3GeC via microwave-assisted synthesis. Mixed precursors are vacuum sealed in fused silica tubes and then heated up in a conventional microwave for several minutes. X-ray diffraction is used to characterize the reaction product. Preliminary results suggest that microwave-assisted synthesis performance is comparable to conventional synthesis.

Improvements on Background Correction of DEER Measurements on Aggregates of Tau
Robin Vermathen, Medical Sciences and Technology, Technical University of Eindhoven
Yann Fichou, Song-I Han, Department of Chemical Engineering, Chemistry and Biochemistry

Double Electron-Electron Resonance (DEER) is a technique that uses electron paramagnetic resonance to measure the distance between two unpaired electrons. When these electrons are site-specifically introduced in a protein in the form of spin labels, intramolecular distance measurements can provide information on the three-dimensional structure of a protein. In this research, improvements were made on the quality of DEER measurements on aggregates of the intrinsically disordered protein Tau, which are associated with neurodegenerative diseases such as Alzheimer's and Parkinson's. Background measurements with singly spin-labelled Tau proteins were performed to analyze the effects of interprotein spin-spin interactions on the signal. Results showed a background signal that deviates significantly from the background model commonly used for data correction. This has led to the description of a new background model that can be used to make data correction more reliable in the future. Additionally, steps have been taken towards developing a technique that will allow for the flash freezing samples without the need for a cryoprotectant, which is expected to lower the background signal in DEER, due to the prevention of local spin-label accumulation. Finally, implementation of a Gaussian pulse scheme for DEER set-up was achieved. This will reduce the formation of common artifacts in the data, allowing for more reliable background correction without significant loss of data. These steps aimed at better understanding and decreasing the background signal in DEER measurements can all lead to higher quality data being acquired from DEER, allowing for better understanding of the aggregation pathway of Tau.

Edison Scholars Program (Edison)

http://mcnair.ucsb.edu/edison.html

The Edison Summer Research Program is designed to encourage talented undergraduate students to participate in research under the direction of a faculty mentor in Chemical Engineering, Chemistry, Computer Science, Earth Science, Electrical Engineering, Environmental Studies (BS), Mathematics, Mechanical Engineering, Physics, and Statistics. The Edison Scholars Program is designed to increase the number of women, low-income, first-generation, veterans, and those historically underrepresented in Edison-eligible fields to pursue research and graduate education in those fields. This program was established through funding from Edison International and during the eight-week summer research program students gained professional skills and graduate school preparation in addition to conducting undergraduate research.

Tunable Band Gap in Strained and Twisted Bilayer Phosphorene
Jacob Brooks, Chemical Engineering, University of California, Santa Barbara
Gwen Weng, Vojtech Vlcek, Department of Chemistry and Biochemistry

Phosphorene is a recently discovered 2d semiconductor with unique (opto)electronic properties and it is a prime-candidate material for ultra-thin and flexible electronics. The linear structure of phosphorene is characterized by a puckered honeycomb lattice with high anisotropy of electronic structure, which further depends on the thickness of the system (i.e., the number of monolayers). We investigate the electronic excitations (fundamental band gaps) in strained mono- and bi-layer phosphorene, as well as the response of a bilayer to a twisting angle using first-principles theoretical methods. The fundamental band gap of monolayer phosphorene changes by up to 30% subject to a realistic strain of ± 4%. The character of the gap changes from direct to indirect. In contrast, the response of the bilayer phosphorene to strain is even larger. In response to a uniform strain of ± 4% the band gap in bilayer phosphorene changes can be tuned by ± 50%. In addition, imposing a twisting angle on one of the layers in the bilayer has a large effect on the band gap which is explained through different components of the transformation. Because the twisted structure directly affects the equilibrium interlayer difference, the twisting angle can also tune the band gap. Hence the number of layers and twisting angle in phosphorene represent simple mechanisms of tuning the size of the band gap and its response to external stimuli.

Effect of Endophytes on Nutrient Availability and Litter Decomposition
Yesenia Cardenas, Bachelor of Science Chemistry, University of California Santa Barbara
Austen Apigo, Ryoko Oono, Ecology, Evolution, and Marine Biology

Plant litter decomposition is an important ecological component of the terrestrial carbon cycle; however, the roles of endophytes in this process still remains unclear. In this study, we primarily focused on how variability in endophyte communities influenced plant litter decomposition rates and nutrient availability using microcosms of *Pinus torreyana* needles. We manipulated the presence and duration of non-endophytic microbes across four experimental treatments during a year-long incubation. Soil was added at varying time points (0, 1 and 3 months) to alter the duration of endophyte-only decomposition. We quantified changes in carbon and nitrogen availability with an acid hydrolysis protocol. We expect an inverse relationship between decomposition time and litter mass loss rate due to lower labile carbon resource availability as decomposition advances. We also predict that litter decomposition rate will be slower in treatments where endophytes have had a longer 'head-start' before soil microbe colonization.

Origami hexTrack Optimization

Grace Chang Physics, University of California, Santa Barbara
Deborah Kuchnir Fygenson, Department of Physics

The origami method for creating DNA structures is widespread, however precise knowledge of the underlying thermodynamic mechanisms is lacking. In part due to this, procedures for origami preparation have significant room for exploration and improvement, particularly in the areas of anneal procedure and staple to scaffold ratio. In order to optimize the process for creating tracks, we varied the aforementioned variables between anneal procedures HTM13 (1.5hrs) and NCSLOW (24hrs). We confirmed successful creation of hexTracks through gel electrophoresis and Atomic Force Microscopy (AFM), which we expected to show that longer and slower anneal procedures yield the cleanest formation of hexTracks. The results from our two anneal procedures demonstrated that HTM13 had a higher yield, but the individual tubes had significant structural anomalies. Although less time efficient, the data suggests that NCSLOW is the ideal anneal procedure.

Gas Transport in Methane Pyrolysis: Solubility of Argon, Methane, and Hydrogen in Sodium-Potassium Chloride

Guriqbal Gill, Chemical Engineering, University of California, Santa Barbara
Eric McFarland, Chemical Engineering

Methane pyrolysis can convert natural gas into hydrogen fuel without releasing carbon dioxide. We are reacting the gas in a high-temperature molten salt, and to understand the reaction pathway it is important to determine the solubility of these gases and the reaction kinetics in the melt. This work studies the volume change of single bubbles in molten salt to determine the solubility of methane and hydrogen and investigate the reactivity using a furnace slit setup. Inert argon was also used as a control to provide a baseline. Temperature-dependent gas solubility was determined by recording the diameter of single bubbles over time at different temperatures. The transport rate of gas into the melt and its diffusion coefficient can be determined. The results indicate rapid transport of hydrogen into the melt before reaching an apparent saturation point and cyclic methane transport dependent on reaction and diffusion rates. Further, trials with methane indicated accumulation of a carbon layer on the bubble surface, a phenomenon that directed further research towards carbon aggregation in molten salts. These findings established a foundation for gas behavior in a pyrolysis reactor and can be applied to further optimize methane pyrolysis for potential commercial use.

The Hydrodynamic Performance of Bio-Inspired Hydrofoils: Flexible Surface Roughness

Haolin He, Mechanical Engineering, University of California, Santa Barbara
Dr. Emilie Dressaire, Dr. Alban Sauret, Drew Hallman-Osinski, Mechanical Engineering

From research to entertainment, aquatic robots and other autonomous vehicles are among the most innovative technologies in the market. A major limitation, however, is their short runtime and thus engineers seek to improve their hydrodynamic efficiency. Recent efforts have shown that rigid bio-inspired surface roughness improves swimming efficiency. In nature, however, most animal surface structures, such as shark skin, are flexible. In this study, we aim to determine if the flexibility of the surface roughness further enhances the hydrodynamic efficiency of model surfaces by closely mimicking animal skin. To examine the performance of flexible surface roughness, we use a thin rectangular plate as a primitive flapper or fin. We first perform a validation test for the experimental setup without surface roughness. Then, we add surface roughness and vary the geometry and flexibility of the roughness. We hypothesize that the flexibility of the surface roughness would improve hydrodynamic performance by modifying the fluid flow around the foil, including the generation of vortices. This experiment offers not only an insight into the function of flexible surface roughness in hydrodynamic performance but also a new perspective in creating more efficient technologies in aquatic environments.

Site Saturated Mutagenesis of a cyanobacterial photoreceptor to develop a fluorescent reporter protein for anaerobic imaging

Zoe Imansjah, Nolan Anderson, Rachel Taylor, Dr. Arnab Mukherjee
Department of Chemical Engineering, University of California, Santa Barbara

Anaerobically compatible fluorescent proteins are needed to study biological systems that thrive in anaerobic environments such as the human gut. However, the toolset of such proteins is extremely limited. One promising family of oxygen independent fluorescent reporters are flavin-based fluorescent proteins (FbFPs), which are able to fluoresce without a need for oxygen. However, flavin-based reporters are only available in a single color, which makes multiplexed studies of anaerobic biosystems challenging. Our goal is to overcome this challenge by engineering an algal photoreceptor to emit oxygen-independent fluorescence that is red-shifted from current flavin-based reporters. Our approach is to use directed evolution via site saturation mutagenesis, targeting individual amino acids at preselected regions of interest, and screening for variants that emit brighter red-shifted fluorescence. After completing one round of site saturation mutagenesis project, we will perform additional rounds of directed evolution and screening using random mutagenesis via a technique known as error prone PCR. Preliminary results indicate that mutation of specific amino acid can increase brightness of protein fluorescence, and additional sites of interest are under further development. Future research building on this project aims to develop a range of oxygen independent reporters with spectrally diverse fluorescence able to be integrated into bioimaging in oxygen deficient environments.

The effect of changing blade pitch angle on the power output of a model wind turbine for use in class demonstration

Jorge Jimenez Mejia, Physics, University of California Santa Barbara
Dr. Paolo Luzzatto-Fegiz, Simone Stewart, Mechanical Engineering

The strategies people have used to create energy has damaged the environment. While there are many different ways of creating energy (e.g. coal, natural gas, hydro-power, nuclear fission, oil, wind) wind turbines are one of the best ways to produce energy without further polluting the earth, as they purely use wind flow to create energy. Due to the traditional arrangements of wind farms, the turbines in the first few rows end up harnessing the most power from the wind, while the turbines at the back of the farm hardness less, resulting in decreasing efficiency across the entire farm. This research focuses on measuring the voltage, power and revolutions per minute of a single three-foot tall model wind turbine using a microcontroller. Collecting data by measuring these components at different blade angles (pitch), helps develop a better understanding of the range of angles where the wind turbine is more efficient. The result obtained may identify contributions to increase the efficiency of individual turbines, which could change the way we think about how turbines interact with each other in wind farms.

Fluid-Structure Interaction in a Bed of Deformable Cilia Under Fluid Shear Stress

Nathan Jones, Mechanical Engineering, University of California Santa Barbara
Dr. Emilie Dressaire, Mechanical Engineering

Beds of primary cilia in the epithelial tissue that line the human trachea are submerged in a Newtonian periciliary fluid layer (PCL) and beat to transport the non-Newtonian mucus layer above them upwards and out of the respiratory system. This process is critical in the human respiratory system as foreign particles trapped in a static mucus layer may cause infection or disease in the lungs or trachea. Fluid-structure interaction through rigid micro-hairs has been investigated previously, but few studies have been performed using a bed of deformable hairs, which bears closer resemblance to the biological system. The ultimate goal of this project is to observe the fluid-structure interaction through a bed of flexible hairs in a setup that mimics the epithelial cilia in the trachea. A model bed of cylindrical hairs is cast with a flexible elastomer and a Newtonian fluid similar to the PCL is mixed and pumped through the hairs at a certain flow velocity within a sealed, transparent channel. The experimental parameters such as the flexural rigidity of each hair, the viscosity of the fluid, and the fluid flow velocity are chosen to match the properties of the biological system. The results of this study are critical in understanding the role of the PCL in mucus transport which can provide significant data in the diagnosis and treatment of patients with mucus transport issues in the pharmaceutical sector.

Producing Biomass-Degrading Enzymes in Bacteria
Freda Lababidi, Chemical Engineering, University of California Santa Barbara
Susanna Seppala, Michelle O'Malley, Chemical Engineering

Anaerobic gut fungi (Neocallimastigomycota) are a promising source of enzymes that break down lignocellulosic plant biomass. It is known that these microscopic fungi that live in the digestive tract of herbivorous animals produce a large number of biomass-degrading enzymes (Solomon et al. 2016). Here, we aim to produce some of the enzymes that originate from the anaerobic gut fungi in easily grown Escherichia coli bacteria, to be able to characterize the enzymes and test their functions properly. This is done using a library of 300 identified gene sequences that encode putative biomass-degrading gut fungal enzymes. The genes are cloned and expressed in E.coli, and protein production is detected by SDS-PAGE and Western Blot. Given that the proteins are produced, the proteins can then be purified before characterizing them and assaying their activities. Some activities of these biomass-degrading enzymes of interest may present more environmentally-friendly ways in generating various products.

Carrier Design for Photonic Integrated Circuit
Shannon Lee, Joseph Fridlander, Victoria Rosborough and Jonathan Klamkin
Electrical and Computer Engineering, University of California at Santa Barbara

The cost, efficiency, size and time to build a circuit are most often the deciding factors when choosing between discrete and integrated circuits. A photonic integrated circuit (PIC) is a semiconductor chip with many optical devices and can be very compact. The purpose of this study is to design and fabricate a carrier for a PIC. The carrier has space on a ground plane to mount the PIC along with metal traces for sending electronic signals to individual devices within the PIC. Accessing the PIC also requires a probe card which is a small system of probes that are placed onto the metal traces to control the PIC. Gold wire bonds connect the PIC devices to the metal traces on the carrier. In addition, the carrier material, aluminum nitride (AlN), provides good thermal conduction between the PIC and a thermal sink. To fabricate the carrier, a lithography mask is created according to the design. The fabrication process includes a single lithography layer, a metal deposition and a liftoff, in which the metal is removed wherever there is photoresist from the lithography step. The carrier resulting from this project will inform future carrier designs to efficiently operate the PIC.

Using Methanotrophic Bacteria to Produce Sustainable Aquaculture Feeds
Melanie Leung, Environmental Science, University of California Santa Barbara
Jessica Couture, Dr. Steven Gaines, Bren School of Environmental Science & Management

Aquaculture, or fish farming, serves an increasingly important role in meeting the growing demands for protein sources as global human populations continue to grow. Key issues in aquaculture sustainability center around the feeds used to raise fish. Conventional feed ingredients like fishmeal and soybean meal cause high greenhouse gas emissions and other environmental impacts. This project aims to gain a deeper understanding of the tradeoffs of using methanotrophic bacteria (*methylococcus capsulatus*) as a feed source for aquaculture. Such bacteria use methane as a carbon energy source to produce a protein-rich single-cell meal product that can be fed to fish. Previous research has focused on quantifying the impacts of producing these bacteria-based feeds using newly extracted natural gas, a fossil fuel-based source. This study quantifies the impacts of producing such meals using a mitigated source of methane, landfill gas, which is collected by diverting existing gas from being direct released into the atmosphere. An attributional life-cycle assessment was performed to compare the different production pathways and found that use of diverted methane sources can decrease greenhouse gas emissions for bacteria-based feeds. These results suggest that using bacteria to produce aquaculture feeds can decrease the environmental impacts of fish farming overall. Specifically, using bacteria meals produced by mitigated methane sources can further decrease the climate change impacts of fed aquaculture. Future research on this topic should investigate the costs, energy demands, and pollution reduction potential in methane gas extraction from landfills.

Increasing the Bandwidth and Stability of OPLL Loop Filter
Zhengzhi Lu, Electrical Engineering, UC Santa Barbara
Junqian Liu, Clint Schow, Electrical and Computer Engineering

Today, Phase-locked Loops (PLL) are widely used in electrical communication systems for synchronizing the phase of an output signal with that of a corresponding input signal. An Optical Phase-locked Loop (OPLL) functions similarly to a PLL, except that the input and output signals are photons rather than electric current, so its phase locking design needs to be different from that of a PLL. To incorporate optical phase locking in OPLL, we require a much wider bandwidth while maintaining a stable gain margin and phase margin in its loop filter. We used frequency-domain analysis, analog simulations, and solder board testing to construct and confirm proper functionality of the loop filter. We successfully pushed the loop bandwidth to 150 MHz with a stable phase margin (~60 degrees) and 200 MHz with an unstable phase margin (~45 degrees). This is a promising result as long as we can increase the phase margin in the future.

Increasing the Resolution of CO_2 Produced by Methylotrophic Methanogenesis Using a Phosphate Buffer System
Xiadani Moreno, Earth Science, University of California, Santa Barbara
Qianhui Qin, Dr. David Valentine, Earth Science

Biological methanogenesis, the production of methane by anaerobic archaea, is a vital step in the biogeochemical cycling of carbon. The fractionation of stable carbon isotopes during methanogenesis can be measured by comparing $\delta^{13}C$ values in the organic reactants and products with high accuracy; However, methylotrophic methanogenesis is a reaction involving a "branch point," where $\delta^{13}C$ values are assigned to each organic product. Bicarbonate-buffered media make it difficult to discern how much CO_2 is *metabolically* produced during methylotrophic methanogenesis, and so no previous study has tested the carbon isotope fractionation from methylated compounds to CO_2. Here, we present a cultivation method which reduces the contribution of bicarbonate reactions in the production of CO_2. Two strains of methanogenic archaea were cultivated in bicarbonate-buffered media and subsequently diluted in a phosphate-buffered system. The concentrations of the methanogenesis products were then measured using gas chromatography. Preliminary results show high concentrations of CH_4 gas in the headspace of the cultures. These findings suggest a phosphate buffer system is suitable for the cultivation of methanogens. Later utilizing GC-IRMS to find $\delta^{13}C$ values of every product will assist in forming more exact isotope and mass balance equations, as well as increase our understanding of isotope fractionation at branch points. We suspect $\delta^{13}C$ values will show a depletion in CH_4 and enrichment in CO_2, and intermediate levels for biomass. By establishing more precise measures of biologically produced CO_2, we improve our understanding of biologic contributions of greenhouse gases in the Earth system.

Performance of a Hydrogen Fuel Cell in the Presence of Methane
Ryan Patrick, Chemical Engineering, University of California, Santa Barbara
Eric McFarland, Chemical Engineering

Utilizing hydrogen as a source of energy faces many challenges, one of which is dissemination. Introducing hydrogen gas to the current natural gas infrastructure could be accomplished if a fuel cell was used to electrochemically separate the mixture. The goal of this experiment was to determine the effect that different molar ratios of H_2 to CH_4 have on the fuel cell's power output. Experiments were ran at room temperature and pressure. A mass flow controller was used to control the volumetric flow rates of H_2 and CH_4 gas into a PEM fuel cell. Power was monitored via an ammeter and voltmeter. An increase in H_2 flow rate led to an increase in power output. This research shows that CH_4 does not impede the performance of a fuel cell membrane. Further research is needed but these results indicate that fuel cells can be used to as a means to produce power off of hydrogen gas that has been injected into an existing natural gas infrastructure while separating the mixture, a costly expenditure in any chemical plant.

Reducing Noise in Measurement Devices for Studying Correlated Electron Behavior in 2D Materials
Khari Stinson, Physics and Linguistics, University of California, Santa Barbara
Liam Cohen, Andrea Young, Physics

The material known as graphene, a honeycomb lattice made of carbon atoms, has attracted attention in recent years for unusual properties such as seemingly massless electrons and superconductivity, making it the focus of the Young Lab. To interface with graphene-based devices, the lab uses equipment called DAC ADC boxes (digital-to-analog converter, analog-to-digital converter). These boxes are currently limited in their precision by electromagnetic interference (EMI) caused by electrically connected digital electronics. To reduce this interference, this study is redesigning these DAC ADC boxes using fiber optics to electrically isolate the digital and analog ends. Assessing the successfulness of the redesign will require evaluating the performance of the current boxes. We will test the noise levels of both the existing and forthcoming devices with a spectrum analyzer, measuring output power in the absence of any deliberately created signal. We expect to find that the primary source of noise is EMI from the digital devices, with a magnitude between 10 and 20 $nV/\sqrt{Hz}$; the redesigned boxes should have significantly reduced noise. These findings will give us further information on what the sources of noise are, helping guide and evaluate the redesign. These improvements will help to probe physical phenomena at finer scales that require higher resolution than our current boxes are capable of operating at, advancing our understanding of this unusual 2-dimensional material.

Understanding Histone Lysine Methyltransferase (H3K4MTs) Subunits: WDR5A and WDR5B Protein Interactions
Zohaib Suhail, Biochemistry, University of California Santa Barbara
Dr. Dzwokai Zach Ma, Department of Molecular, Cellular, and Developmental Biology

Understanding the mechanisms by which genetic diseases occur has been one of the biggest focuses in cellular biology. So far, we understand Histone H3 Lysine 4 Methyltransferases are involved in the proliferation of such genetic diseases. It consists of one catalytic subunit and four core regulatory units. Previous research has shown the knockdown of one of these core regulatory units can lead to genetic disorders. Specifically, WD Repeat-Containing Proteins A and B (WDR5A and WDR5B) is vital for the binding of the three other core regulatory proteins to the catalytic subunit MLL1. If the protein is WDR5A, then the three core proteins can bind to MLL1. However, WDR5B prevents this binding to mDPY-30, the core protein that directly binds to WDR5A. Previous research has shown WDR5A and WDR5B differs in three amino acids despite having the same shape. The purpose of this experiment is to mutate the arginine in WDR5A to cystine in WDR5B and vice versa then test the binding or non-binding of each protein. The goal of this project is to obtain a better understanding of the differing functions in WDR5 proteins and their relationship to genetic diseases. Preliminary results indicate because cystine is a larger amino acid, it provides steric hinderance on WDR5B preventing the binding to mDPY-30. With the lack of binding, the MLL1 catalytic subunit has limited gene expression leading to genetic diseases.

Early Undergraduate Research and Knowledge Acquisition (EUREKA!)

http://eureka-csep.cnsi.ucsb.edu/

The Early Undergraduate Research and Knowledge Acquisition (EUREKA!) program is designed to enrich the academic experience of undergraduates at UCSB in science, technology, mathematics and engineering (STEM) disciplines early on in their educational careers. The program is focused on introducing students in their first year to the broader science community on campus and providing exposure to research through academic year internships. Students who have participated in the Summer Institute in Mathematics and Science (SIMS) are especially encouraged to apply. EUREKA is hosted by the Center for Science and Engineering Partnerships (CSEP) at the California Nanosystems Institute (CNSI). We aim to nurture student's academic achievement through financial support and opportunities to actively engage in the science community through early preparation that addresses the academic skills, social networking, and career exploration needed for success in the sciences.

Using Updated Health Care Data to Build Predictive Model on Hospital Readmission Rate

Chloe Wang, Department of Probability and Statistics, University of California, Santa Barbara
Doris Padilla, Ming Yi, Ian Duncan, Department of Probability and Statistics

Hospital readmission being so high has always been a serious problem in the healthcare field. A lot of prior actions was taken either by different hospitals, or directly from the government in order to reduce the readmission rate. While in a lot of intervention programs, there has been a misunderstanding that most high cost patients usually came from high cost in the previous year. In our research project this summer, we used the health care data from 110,000 patients with over 3 million claims in order to analyze the trend for patients cost transitions over the years. Some prior work has been done on similar topic by professor Ian Duncan, but this time we used the latest updated data and specialized in the indicator of diseases. We focused on comparing the different cost level transitions for patients in several common chronic disease groups. In that case, our analysis will be really useful in building a predictive model in the future for reducing readmission rate purpose in general.

Analyzing the Genetic Basis of Dwarfism in an Alpine Plant

Diego Orellana, Pre-Biology, University of California Santa Barbara,
Jason Johns, Scott Hodges, EEMB Department

Plants have been evolving for millions of years to best fit a range of environments. One such extraordinary case is alpine plants, which grow in extremely harsh conditions. To adapt in these conditions alpine plants have adopted several unique traits, one of which is dwarfism. Dwarfism is a highly sought-after trait in agriculture due to its ability to forego common problems such as lodging, and research has been done in several model agricultural species such as rice and corn, revealing candidate genes for its mechanism. However, very little work has been done in alpine adapted ecological systems. The genus Aquilegia has a well-researched and annotated genome, making it an important ecological and evolutionary model. Our focal species for this project is Aquilegia jonesii, the most alpine adapted columbine, holding many of the classic traits seen in alpine plants, including extreme dwarfism. This summer we analyzed second generation (F2) hybrid crosses between A. jonesii and another columbine variety, A. origami, which exhibit a gradient of intermediate phenotypes and genotypes between the two parents. We have measured leaf area (a proxy for dwarfism) on 97 of the F2 plants, giving us an estimate of the distribution of phenotypes for the F2 population, which is representative of the distribution of genotypes. We have prepared genomic DNA libraries for each of these 338 individuals to analyze areas of the genome associated with the dwarf phenotype using a Quantitative Trait Locus (QTL) analysis in the near future.

Single and Multi-Agent Reinforcement Learning in the Classic Snake Game Environment
Misha Obukhov, Computer Engineering, University of California Santa Barbara
Mert Torun, Ramtin Pedarsani, Department of Electrical and Computer Engineering

Reinforcement learning has been previously proven to be capable of achieving human level or superior performance in various tasks within defined environments. Here, we investigate the results of applying Proximal Policy Optimization (PPO 2017) to train a network to be capable of playing the classic Snake game. Additionally, we test the results of modifying the environment to allow for multiple agents to be trained in parallel in zero sum competition. We demonstrate that the algorithm is able to consistently solve the standard single agent case and find that multi-agent convergence in a competitive environment can be achieved on a comparable training timescale. Furthermore, we use our data to reiterate the classic Machine Learning result that less neurons can lead to more effective generalization and better performance in some circumstances.

Modeling Opinion Dynamics Using the Affine Boomerang Model
Emily Lopez, CCS Mathematics, University of California, Santa Barbara
Elizabeth Y. Huang, Francesco Bullo, Center for Control, Dynamical Systems and Computations

Social network analysis is the study of interpersonal behavior that represents group members as nodes and using edges to characterize the relationship between members. The aim of this study is to analyze a recently proposed opinion dynamics model, which is structured under the assumption that if two people have a positive relationship, then their opinions will come closer to agreement, and if they have a negative relationship, their opinions will diverge. We will study the model by simulating it for star graphs, where individual interact with one mutual person and not each other, and cycle graphs, where each individual interacts with two people, to observe how the structure of positive and negative relationships drives the opinions of the members of the network. In the case of a star graph with two opposing factions, we should observe that within each faction, members will agree, but the opinions of the factions will polarize. Simulations show that in the case where there are more than two factions, the opinions of some of the factions may oscillate, unless all edges are negative. Furthermore, in cycle graphs with two factions, it is apparent that there is a direct relationship to increasing an individual's attachment to their opinion and the time it takes for it to reach a polarizing steady state. Understanding how social network structures impact the ability for a group to come to agreement gives us further insight about human interaction, which can be applied toward information dissemination, political science, and economics.

Investigating Differences in Degrees Traveled as a Measure of Path Integration in Spatial Navigation between Age and Sex
Chloe Lopez, Biochemistry, University of California, Santa Barbara
Shuying Yu, Emily Jacobs, Psychological and Brain Sciences

Spatial navigation is the most fundamental behavior carried out by an animal and involves going from one location to another in a given environment. One form of spatial navigation is called path integration, which involves updating one's position and trajectory using proprioceptive cues. Current research studies have shown that the effects of age and sex impact different aspects of spatial navigation such as strategy use, navigation efficiency, and route selection. However, the impact of age and sex differences on path integration is unknown. A replication of a study using a loop closure task, a measure of path integration, was conducted to investigate if the effects of age and sex impact path integration using degrees traveled on a circle as the primary measure. Participants were immersed into a desert landscape using a virtual reality simulation and walk along different circles of varying radii (0.5 - 3.0 meters). The task requires participants to mentally update their position relative to their motion to determine when they have reached their starting location again. 89 participants, aged 18-61(43 males and 46 females), took part in the study. The results revealed that there were no significant main effects or interaction effects of age or sex at the 1.0 m and 3.0 m radius circles. For the 2.0 m radius circle, there was no main effect of age or age and sex interaction, but there

was a statistically significant main effect of sex. It is hypothesized that the 2.0 m radius circle best gauged participants in their environment, whereas the 1.0 and 3.0 m provided for more errors in degrees traveled. Future studies will build on this behavioral data to examine whether age-related changes in spatial navigation, including path integration, are related to neuronal changes in the brain's navigation circuitry.

Investigation of Corrugation Modes as a Mechanism for X-Ray Variability
Jacob Howard, Physics, University of California, Santa Barbara
Omer Blaes, Department of Physics

The study of black hole accretion flows is strongly motivated by evidence that observed X-rays emitted from stellar objects such as active galactic nuclei (AGN) and black hole binaries (BHB) are generated by the accretion of material onto black holes. Despite the wide variety of size and mass among these systems, the intensity of these X-ray emissions consistently exhibit periodic oscillations that are driven by processes that are not well-understood. Systematic study of the dynamical elements in these accretion flows is therefore critical to uncovering the underlying mechanism responsible for this oscillatory behavior. In this project, we use the fully three-dimensional, general relativistic, magnetohydrodynamical simulation code Athena++ to study the spatial and temporal structure of untilted accretion flows around spinning black holes. We compare two simulations with identical initial conditions but two levels of resolution. Our analysis of the lower-resolution data reveals clear variability in the flow structure at multiple radii. However, our analysis of the higher-resolution data in which turbulence develops more realistically lacks the presence of these periodic features. The absence of these structures in high-resolution, fully general relativistic, magnetohydrodynamical simulations suggests that turbulence driven by magnetorotational instabilities may prevent coherent modes from propagating in untilted accretion disks.

Path Planning and Tracking for Autonomous Cars
Danny Hernandez, Electrical Engineering, University of California Santa Barbara
Guillaume Bellegarda, Katie Byl, Electrical and Computer Engineering

Autonomous vehicles have the potential to increase safety, efficiency, and reliability in transportation services. Keeping that goal in mind, this work entails path planning and tracking for a small car model in both simulation and hardware. Specifically, given the starting position and orientation of the car, the objective is to navigate to a target position and orientation. A Dubins path is one way to map out the desired path, which can consist of a maximum of 3 segments, where each segment is either a curve or a straight line. This path can vary depending on how sharp of a turn the car can make, but all Dubins paths can be narrowed down to one of two general paths: a Curve-Curve-Curve path or a Curve-Straight-Curve path. Once the path is planned, simulation trials are run to track the path as closely as possible. A controller is implemented to adjust the steering angle based on the error between the car's current and target locations. Once the error between the desired and actual path is within some satisfactory bound, the trajectory is executed on the real world model by mapping the simulation car's steering angle value at each time step to the real system.

Signaling Dynamics of SMAD Proteins
Ricardo Espinosa Lima, Pre-Biology (Biochemistry), University of California: Santa Barbara
Markus Merk, Max Wilson, Molecular, Cellular and Developmental Biology.

SMAD proteins are found in every mammalian cell and play important roles in stem cell differentiation and embryonic development. These proteins are part of the pivotal Transforming Growth Factor beta (TGF-β) signaling pathway that regulates apoptosis, growth and differentiation. We hope to understand this pathways dynamic and combinatorial encoding strategy to ultimately control over some of these cell behaviors. Little is known about the effects of the dynamics and combinations of these proteins on the transcription of their downstream genes once they enter the nucleus. To probe the information encoding capabilities of the TGF-B pathway we fluorescently tagged a panel of SMAD proteins to visualize their dynamics using confocal microscopy in real time. By tracking SMAD protein dynamics and corelating those dynamics to cellular behaviors we hope to learn how cells interpret and multiplex complex signals, which we may, one day, control using optogenetic tools.

Behavioral Responses of Cultured White Abalone (*Haliotis sorenseni*) to Predatory Sea Stars in a Laboratory Experiment

Nelson Beltran, Aquatic Biology, UCSB
Lindsay Marks, NOAA

The White Abalone (*Haliotis sorenseni*) is a critically endangered species that will likely go extinct without human intervention. Efforts to enhance wild populations are underway by the White Abalone Restoration Program through spawning, raising, and eventually reintroducing juvenile white abalone into the wild. However, the high risk of predation on these captive-bred abalone, which are naïve to predators, threatens our restoration efforts. This summer, I studied the behavioral responses of captive-bred white abalone to a natural predator, the Giant Spined Star (*Pisaster giganteus*), in a laboratory experiment. Specifically, I asked: a) do captive-bred abalone display defensive behaviors in response to the predatory sea star?, and b) can they learn to escape more quickly after multiple encounters with the predator? To answer these questions, I observed the behavioral responses of individual captive-bred juvenile white abalone to tactile stimulus from either a sea star (experimental treatment) or an abiotic sponge (control treatment) over five-minute trial periods. I first touched the abalone with the sponge and 3 days later, I placed the sea star on the abalone. Finally, I exposed the abalone to the sea star two more times, with one day in between each exposure. We found that abalone have innate reflexes to predators which differ in increased variability and extremity of response from a non-predator stimulus. We also found that abalone can learn to escape more quickly from sea stars after just one encounter. With these findings, we can inform methods to introduce captive-bred white abalone into the wild, so that there may be a better chance for them to escape sea stars after release.

Binge-drinking Induced Negative Affect and Molecular Irregularities in C57BL/6J Mice

Eliyana Van Doren, Psychological and Brain Sciences, University of California Santa Barbara
Leo Jimenez Chavez, Karen Szumlinski, Psychological and Brain Sciences

Alcohol binge-drinking behaviors and severity of withdrawal are known to vary in both primates and rodents depending on their age and sex. The region of the brain that mediates behavioral responses to alcohol is called the nucleus accumbens (NA). The NA also plays a significant role in regulating stress and reward-motivated behavior. Glutamate is an excitatory neurotransmitter, and glutamatergic dysfunctions within the NA are linked to alcohol withdrawal-induced anxious behaviors. This study examined the expression of two proteins important for glutamatergic signaling during early and protracted alcohol withdrawal following two-weeks of binge-drinking. These findings will support our behavioral observations and provide biochemical evidence of the observed behaviors. The aim of this project is to better understand how changes within the NA interact with binge-drinking and withdrawal behaviors and the subject factor interactions of sex and age.

Measuring Semiconductor Growth using Image Processing

Aureliano Ceballos, Electrical Engineering, UCSB
Brian Markman, Mark Rodwell, ECE

Efforts to develop confined epitaxial lateral overgrowth as a procedure to enable Tunnel Field Effect Transistors (TFETs) has faced challenges because it is difficult to gather a statistically significant amount of data using a single person to manually record data. It is thus necessary to automate measurements in order to accelerate data collection and analysis to better direct future growth efforts. The code written will measure and record facets of semiconductor material grown in a Metal Organic Chemical Vapor Decomposition (MOCVD) process. The major components of the code can be summarized under two sections: object detection and edge detection. An Aggregate Channel Feature (ACF) object detector was used to find vertically oriented transistors. The next step is to crop the detected transistor and use an image of the semiconductor growth to perform edge detection. The process used for edge detection is the Hough Transform, a widely used algorithm for finding lines in images. Each line detected is rounded to one of the following angles associated with the crystal structure of the semiconductor and its length is recorded. No significant amount data has been gathered but, the current version of this code will allow for a significant improvement to gathering and analyzing data for future TFET device fabrications.

High Transconductance Metal-Oxide-Semiconductor Field-Effect Transistor

Yunxuan Yang, Electrical Engineering, University of California, Santa Barbara
Hsin-Ying Tseng, Mark Rodwell, Department of Electrical and Computer Engineering

Metal-oxide-semiconductor field-effect transistor (MOSFET) is a very crucial component in electronic devices. As the cellular network technology moves toward the sixth generation which targets at speeds of one terabyte per second, there is a dire need to fabricate high transconductance MOSFETs in order to have our electronic devices operate at such high frequencies. We are making planar MOSFETs with different fabrication procedures and techniques to test out factors that will influence the transconductance and overall performance of MOSFETs. Initial analysis is done using optical microscopes and measurements are done using probes. The fabrication process for our current batch of MOSFETs does not yield very good transconductance or other electrical parameters. By redoing the measurements after post-metal annealing, we have excluded the damage done by metal deposition as the cause of our result. We plan to use focused ion beam to do further analysis by looking into the interior of the MOSFETs.

Future Leaders in Advanced Materials (FLAM)

http://www.mrl.ucsb.edu/FLAM

Science and engineering students from UCSB and other universities acquire research experience in a variety of exciting fields through these internships. This program includes students from Jackson State University and the University of Texas at El Paso funded by the NSF Partnerships for Research and Education in Materials (PREM) program. FLAM interns meet regularly to share their experiences and report on their progress. Our research interns often present at conferences such as SACNAS, SHPE, ACS, APS and others.

Microrheology of Static Microtubule Hydrogels

Ibrahim Abu-Hijleh, Physics, University of California Merced
Remi Boros, Zvonimir Dogic, Department of Physics

We study the viscoelasticity of passive microtubule networks over varying microtubule concentrations. Our gels consist of a suspension of microtubules in $MgCl_2$ and PIPES buffer and are doped with fluorescently labeled polystyrene beads. By extracting the mean squared displacement of these beads, we show that viscosity increases as a function of microtubule concentration up to a critical concentration of 0.8 mg/mL. Above this concentration, the gels behave elastically. These data are a control for future experiments that will probe viscoelasticity in microtubule-kinesin-based active gels.

Photo (Re)configurable PILs

Gustavo Alcantara, Organic Chemistry, University of Texas at El Paso
Manuel Sanchez Zayas, Dr. Javier Read de Alaniz, Chemistry and Biochemistry Department

Studies indicate that a transition between a neutral polymer to a polymeric ionic liquid should exhibit a remarkable change in physical and chemical properties, including increased conductivity and flexibility, allowing for a new set of potential applications. In this study, we have synthesized a novel photo acid generator (PAG) for the *in-situ* release of a strong acid upon light exposure, imparting spatial and temporal control over the material properties. Furthermore, this PAG has been strategically designed to allow for facile covalent tethering into the polymer matrix that will allow for direct measurements of the change in glass transition temperatures and ionic conductivity.

Uranium-Carbon Multiple Bonds

Ivan E. Arvizo, Biochemistry, University of Texas at El Paso
Greggory Kent, Trevor W. Hayton, Department of Chemistry and Biochemistry

Separation of the minor actinides from the lanthanides possess a major problem within high-level nuclear waste separation. Traditionally separation of these elements is inefficient and relies on the use of toxic chemicals. The synthesis of new actinide-element bonds that feature a higher degree of covalency may provide the experimental data needed for designing chelators with greater selectivity for the actinides over their 4f congener. Unfortunately, a complete fundamental understanding of uranium-multiple linkages with other main-group elements has been obscured by limited examples of known molecules. The syntheses of actinides motifs featuring higher bond orders would provide varying electronic structures, allowing us to probe covalency by observing changes in 5f and 6d orbital participation. In particular, the synthesis of uranium-carbon multiple bonded molecules is of interest as the π character involved in these bonds is expected to yield a stronger covalent interaction. One of the synthetic routes we propose is the reaction of strained cyclopropenes (3,3-diphenylcyclopropene and bis(diisopropylamino)cyclopropenylidene) with tris((hexamethyldisilyl)amido)uranium(III), where the metal center is expected undergo two-electron oxidation by cleaving the highly strained cyclopropene ring, yielding a U=C bond. Such a case would represent the first "Schrock"-type carbene of the actinides, an interesting motif not yet elucidated, providing insight into covalency of high valent uranium-organic frameworks. The syntheses of these complexes will lay the foundation for using DFT computational studies to understand the degree of *f* and *d* orbital participation in U=C bonds.

Investigating Vapor-mediated Processes for Synthesizing SiC-Based Composite Matrices

Pyper Atkin, Chemical Engineering, University of California, Santa Barbara
Ravit Silverstein, Carlos G. Levi, Materials Department

SiC-based ceramic matrix composites (CMCs) are of interest in many applications due to their high strength, low density, and ability to withstand very high temperatures. This unique set of properties has the potential to enable greater overall engine efficiency in aircraft, rockets, land-based turbines, and hypersonic flight vehicles. An important group of these materials is fabricated by reactive melt infiltration of Si into carbonaceous material filling the spaces between the SiC fibers. However, the operating temperatures are currently limited by the presence of unreacted Si, which has a lower melting point than SiC. The goal of this project is to develop an improved route for the synthesis of SiC-based matrices that are fully dense and minimize the amount of residual silicon. SiC compacts are prepared via spark plasma sintering (SPS), which uses pressure and the heat from an electric current to compress powder into a pellet with variable density. SPS parameters, including the heating rate, temperature, and dwell time, will be optimized to achieve 40-50% relative density. These specimens will then be infiltrated with C precursors to produce a porous network of carbon, which would then be exposed to Si vapor to yield a SiC surface that can be wetted by molten Si, which will be subsequently infiltrated on the vapor-treated preform. These experiments will lead to a better understanding of the kinetics of Si infiltration and the mechanism of reaction. Electron microscopy will be used to measure the reaction layer and characterize defect evolution in the product. Results from this work will support the development of advanced ceramic materials and help meet the demand for more efficient turbine engines.

Epitaxial Growth of Cadmium Arsenide Thin Films on a Lattice Matched Buffer Layer

Elsa Bramasco-Rivera, Mechanical Engineering, University of Texas at El Paso
Manik Goyal, Susanne Stemmer, Materials

A Dirac semimetal is a newly discovered electronic phase in condensed matter physics, which possesses promising properties for electronic applications, by sharing the same properties as a metal and semiconductor. These materials are composed of having a linear electronic band dispersion, high carrier mobility and ultrahigh magnetoresistance. Cadmium arsenide (Cd_3As_2) is a 3D Dirac semimetal which has gained attention in research studies. To study this material for such electronic device applications, high quality thin films are required for analysis. Molecular beam epitaxy (MBE), which is a low energetic deposition technique, is one of the best approaches to grow these thin films. We grew thin films using MBE, resulting in high quality on a lattice matched buffer layer with controlled thickness. An alloy of AlSb and InSb was used as an insulating lattice matched buffer layer between the Cd_3As_2 thin film and a GaSb substrate. X-ray diffraction data shows thin films are closely lattice matched with the $Al_{0.4}In_{0.6}Sb$ buffer layer. Atomic force microscopy data shows a smooth surface morphology. Electron mobility of 8,050 cm^2/V-s with low carrier density of 5×10^{11} cm^{-2} were obtained at 2 K. Ultimately, we grew the Cd_3As_2 thin film on a lattice matched substrate, which has similar mobility and lower carrier density than a previous Cd_3As_2 thin film grown on a lattice mismatched substrate, showing an improved quality of the Cd_3As_2 thin film.

Studying Water Dynamics at Peptoid-Water Interfaces

Kevin Curtis, Chemical Engineering, University of California, Berkeley
Mikayla Barry, Rachel Segalman, Chemical Engineering

To design energy-efficient membranes for water purification, water dynamics at polymer interfaces need to be understood and quantified. In order to better understand these interactions, we investigated the effects of hydrophobicity on water diffusion near polymer surfaces with biomimetic sequence-defined side chains known as peptoids. The Segalman Group has already quantified water diffusivity at short-chain, free floating peptoid surfaces through incorporating a NMR-active “spin label” group into the peptoid chain and examining the solution through ODNP (Overhauser Dynamic Nuclear Polarization) spectroscopy. Now we have decided to investigate the behavior of water near a polymeric membrane-like surface. For this, we used micelles containing a polystyrene core and a poly(ethylene oxide)-like segment with our peptoids anchored for ODNP analysis. By varying the location of spin labels in our peptoid sequences, we will be able to measure water diffusivity at several different distances from hydrophobic groups. We hypothesize that water diffusivity increases near hydrophobic surfaces, due to the fact that water has little attraction to these surfaces. In addition, we believe that this effect will only be present within a few nanometers of the hydrophobic side chains causing them. This will lead us to believe that designing membranes with regions of hydrophobic surfaces could increase water molecules movement through the membranes and will advance our fundamental knowledge of water-polymer interactions.

Magnetocaloric Properties of the Solid Solution $Co_{1-x}Mn_xCr_2O_4$

Gregor Dairaghi, Physics, Carleton College
Joya Cooley, Ram Seshadri, Materials Department

Magnetocaloric materials are a promising subset of magnetic materials with applications in high-efficiency magnetic refrigeration systems and waste heat recovery. These materials undergo a magnetic phase transition at their magnetic ordering temperature, Tc, resulting in a temperature change. Performance is often represented by the magnetic entropy change upon magnetization, ΔS_M. Density functional theory (DFT) calculations have identified several existing compounds that may exhibit large ΔS_M, including the spinels $CoCr_2O_4$ and $MnCr_2O_4$. We synthesized several compounds of the solid solution between these end members, $Co_{1-x}Mn_xCr_2O_4$, to explore how the Co:Mn ratio allows us to fine-tune the magnetic and magnetocaloric properties of the material. We used high-temperature solid-state synthesis methods and characterized each sample using X-ray fluorescence spectrometry to measure elemental composition, and powder X-ray diffraction to determine crystal structure. An MPMS3 equipped with a vibrating sample magnetometer measured the magnetization of each sample at a range of temperatures and applied magnetic fields to determine its magnetic properties. We found ΔS_M to increase with Mn substitution from approximately -1 J kg^{-1} K^{-1} for the $CoCr_2O_4$ to -5.5 J kg^{-1} K^{-1} for the $MnCr_2O_4$. Tc ranged from approximately 100 K to 45 K for the $CoCr_2O_4$ and the $MnCr_2O_4$, respectively. We hope to collect neutron diffraction data to better understand site disorder within the crystal structure of these spinels. Because of the variable properties of $Co_{1-x}Mn_xCr_2O_4$ with different Co:Mn ratios, this system has promise as an effective magnetocaloric material for use at a range of operating temperatures.

Doping of the Organic Semiconductor P3HT with a Lewis Acid Reaction

Melissa Dangler, Metallurgical and Materials Engineering, Colorado School of Mines
Kelly Peterson, Michael Chabinyc, Materials Science Department

Interest in low-cost, solution processable organic electronics has grown in recent years due to the increased demand for flexible, lightweight, thin, and energy efficient devices. In order to create these devices, doping is necessary to increase the natural conductivity of semiconducting polymers. The conjugated polymer poly(3-hexylthiophene-2,5-diyl) (P3HT), has long been established as such an organic semiconductor. On its own, the strong Lewis acid tris(pentafluorophenyl)borane (BCF) has been shown to successfully act as a p-type dopant of P3HT. However, BCF, when used in conjunction with 1,4-benzoquinone (BQ), has been shown to oxidize decamethylferrocene and it is likely to do the same to P3HT, leaving it positively charged. In this study, BCF was mixed in varying ratios with BQ in order to dope the P3HT. The focus of this work is to determine whether the addition of BQ to dopant mixtures effectively increases the doping efficiency of BCF. Changes in electronic and chemical structure associated with the doping of P3HT were studied using FTIR and UV-Vis spectroscopy techniques. Conductivity tests were then performed on thin film samples using a 4-point probe analysis. From the initial UV-Vis results, mixtures with ratios of BQ to BCF that are greater than 1:2 effectively dope P3HT. Such dopant combinations may offer a new avenue for increasing the performance of future P3HT-based organic electronic devices.

Varying the Lattice Parameter Mismatch of $Ti_{1-x}Zr_xCoSb$ with MnCoSb

Kaelin Gates, Chemistry, Jackson State University
Emily Levin, Ram Seshadri, Materials Research Laboratory

Novel magnetic phenomenon can occur when crystallographic symmetry is broken. Symmetry may be broken by adding lattice misfit strain through the incorporation of a second phase. Internal strain gradient effects on magnetic properties are an unexplored subject that can provide fundamental knowledge for magnetic intermetallics. In order to explore the effects of interfacial strain on magnetic Heusler structures, a biphasic Heusler composite was prepared by combining ferromagnetic MnCoSb with nonmagnetic $Ti_{1-x}Zr_xCoSb$, where we can vary the lattice parameter using composition. By controlling the lattice parameter of the nonmagnetic phase, the mismatch between the two phases is changed and affects the interfacial strain. The nonmagnetic phase $Ti_{1-x}Zr_xCoSb$ (where $x = 0, 0.25, 0.5, 0.75, 1.0$) was arc melted and then annealed at several temperatures. The lattice parameter changes by replacing the smaller Ti with the larger isoelectronic Zr. Rietveld refinement of X-ray diffraction shows a single phase for heat treatments over 800°C, and increasing lattice parameter with increasing x. The heat treatment found to provide a solid solution between TiCoSb and ZrCoSb will be used to anneal the composite with MnCoSb such that the magnetic phase is separated from the $Ti_{1-x}Zr_xCoSb$ solid solution. Further characterization will be done by scanning electron microscopy (SEM). We hope to learn how the varied lattice mismatch affects interfacial strain and also how that affects magnetic properties

Studying Decomposition Pathway of DASAs for Development of Catch and Release System for Amines

Michelle Heng, Chemical Engineering, California State University Long Beach
Miranda Sroda, Javier Read de Alaniz, Chemistry and Biochemistry

Donor–acceptor Stenhouse adducts (DASAs) are photochromic molecules that respond to visible light and have a wide range of applications in various fields including drug delivery and chemical sensing. However, photoswitching is highly solvent-dependent and DASAs are prone to decomposition, limiting their application. The mechanism for the formation of DASAs has been heavily studied and is well understood, giving rise to chemical sensing applications and further use as a photoswitch. The mechanism of decomposition upon exposure to light and heat is unknown. In this work, we explore a new possible decomposition pathway of DASAs, which undergoes a retro-DASA reaction, resulting in the reformation of the furan adduct. We employ time ^{1}H NMR solution experiments to study the decomposition kinetics of DASA under different solvent conditions including temperature, solvent polarity, and concentration. The discovery of this novel decomposition pathway of DASAs will aid in better understanding the reactivity of DASA under heat and light, as well as new applications. Further work will be to study this decomposition pathway in polymer matrices. This work will pave the way for the design of DASAs on polymers to develop a catch and release system for amines, thus overcoming the limitations of current chemical sensing applications and possibly further applications in novel synthesis approaches.

Atomistic Calculation of the Peierls Stress in NbTiZr for Aerospace Applications

Emily Hwang, Chemistry, Harvey Mudd College
Yanqing Su, Irene Beyerlein, Materials and Mechanical Engineering

The Peierls stress is defined as the minimum resolved shear stress to move a dislocation at absolute zero. It is an important measure of dislocation mobility, a property that controls the strength and ductility of crystals. The Peierls stress has not been well explored in multi-principal element alloys (MPEAs) and would be a useful quantity in predicting mechanical behavior. MPEAs are novel alloys that consist of three or more elements added in near-equiatomic amounts, in contrast to conventional alloys, which are comprised of a single base element with minor alloying elements. The different elements and atomic ratios in MPEAs can lead to properties that are superior to those of conventional alloys. In this study, we investigated the ternary MPEA NbTiZr, a known refractory alloy with potential for high-temperature and aerospace applications. Atomistic simulations using the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) were used to calculate the generalized stacking fault energy (GSFE) and Peierls stress of edge, screw, and mixed dislocations on each slip plane of the <111>{110}, <111>{112}, and <111>{123} slip systems. Our results have shown that the various Peierls stresses of NbTiZr are considerably higher than that of pure Nb. This shows that NbTiZr is likely stronger than pure Nb and thus can be a more durable alternative to Nb in current refractory and aerospace applications.

High Intensity and Low Etendue Lighting with Phosphor Converted Laser Diodes

Estella Liu, Chemical Engineering, University of California Santa Barbara
Jason Grebenkemper, Kristin Denault, Fluency Lighting Technologies Inc.

Low etendue laser-based light sources, characterized by narrow beam angles and small areas, are more efficient and cost-effective alternatives to energy consuming and high maintenance halogen and xenon bulbs currently used in specialty lighting markets, such as movie projectors, spotlights, and museum lighting. Fluency Lighting Technologies is developing a compact phosphor converted laser diode design that produces bright, long lasting, and low etendue white light which cannot be achieved with diffuse light emitting diodes (LEDs). In previous experiments, we have optimized the composition and encapsulation method for the phosphor powder, and our phosphor-laser design has reached target power densities. To produce brighter and narrower angle white light, we are currently characterizing and investigating the angular distribution of light output through different optics. Using a goniometer for precise angular measurements and a spectrometer to determine power output and color properties, we can calculate the angular power distribution for the blue laser diode, the phosphor chip, and other diverse optics. For total light characterization, an integrating sphere is used to determine light output, efficiency, and color quality. Preliminary angular power and color quality results suggest that light emitted from the phosphor chip is evenly distributed, and the light color is consistent throughout the beam. After completing the angular distribution measurements, we plan to incorporate different optical devices into Fluency's phosphor-laser design to optimize beam transmission, increase homogeneity, and tune beam angle.

Super-Soft Elastomer Electrodes for Dielectric Actuators

Erin Mee, Material Science and Engineering, Everett Community College
Veronica Reynolds, Michael Chabinyc, Materials

The field of soft robotics aims to create robotic systems that can function in diverse and variable environments and can be used in applications including prosthetics, healthcare, or even outer space and deep sea exploration. Dielectric elastomer actuators (DEAs) are an interesting option to drive the movement of soft robots because they directly transform electrical potential into mechanical work and can be easily integrated into existing electronic technologies. The device architecture of a DEA appears similar to a parallel plate capacitor, with a dielectric sandwiched between two electrodes. In a DEA, however, both the dielectric and the electrodes are soft and stretchable. Upon applying a potential across the two electrodes, the collection of charges creates electrostatic forces that attract perpendicular to the electrodes and repulse parallel to the electrodes, causing the actuator to contract and expand. One major challenge for DEAs is the high voltage required for actuation with current materials. Developing lower modulus materials can reduce actuation voltages, as higher strain would be developed under a given stress. My group works with an elastomer architecture that reduces trapped entanglements inherent to typical elastomers, which impose a lower limit to the elastic modulus. In this project, I created an electrode material by dispersing carbon nanotubes in my group's super-soft elastomer architecture through a variety of dispersion techniques. Impedance spectroscopy was used to probe the material's electrical properties. In this work, high conductivity is demonstrated in a carbon nanotube elastomer composite that could ultimately be applied in a better performing DEA.

Synthesizing Sustainable, Green Monomers for 3D Printing

Marializ Nieves Maldonado, Chemical Engineering, University of Puerto Rico at Mayagüez
Eileen Seo, Craig Hawker, Chemistry and Biochemistry Department

Petrochemically derived plastics are known for their chemical inertness, where plastic bags can take up to 500 years to break down. Therefore, there has been a significant interest in the development of green monomer and degradable crosslinker chemistries by using low cost bio-feedstocks. In search of monomers that can be chemically modified for efficient polymerization, we explored different chemical routes for the syntheses of green monomers using feedstocks from lemon and corn that can either undergo radical or cationic polymerizations. For instance, we have synthesized itaconic anhydride via nucleophilic substitution of itaconic acid, which is derived from corns, and tested its capacity for hetero-functionalization and polymerization. The ultimate goal is to use sustainable monomers in combination with degradable crosslinkers to make photocurable resin and apply to light-mediated 3D printing. Light-mediated 3D printing techniques, such as Solution Mask Liquid Lithography (SMaLL) developed in the Hawker group, allow one to create high resolution 3D printed objects with target mechanical and chemical properties. In particular, SMaLL enables the incorporation of more than two monomers in one pot where the polymerization of each monomer can be regulated using different wavelengths of light. This allows orthogonal polymerizations at different regions. By introducing green monomers and degradable crosslinkers to multicomponent 3D printing, high resolution 3D printed biodegradable multimaterials can be achieved.

An Apparatus for Measuring Quantum Capacitance at Cryogenic Temperature

Paola Perez, Electrical Engineering, The University of Texas at El Paso
David Kealhofer, Susanne Stemmer, Materials

In a capacitor whose plates are formed by metal and semiconductor films, the quantum capacitance is a contribution to the total capacitance that is a direct measure of the semiconductor's density of states, a thermodynamic quantity fundamental to the transport characteristics of the semiconductor. Quantum capacitance is most interesting at cryogenic temperatures, where thermal broadening of features in the density of states is suppressed. In a cryostat, the quantum capacitance can be as many as six orders of magnitude smaller than the capacitance of the cables connecting the capacitor to the measurement electronics, making the design of the probe—the apparatus housing the sample platform and cabling—critical to the feasibility of the experiment. Finally, the thermal properties of the probe necessitate compromise with its electronic properties. Here we present the design and fabrication of such a capacitance probe to be used in the Quantum Design Physical Property Measurement System (PPMS) at temperatures down to 2 K. The probe's stainless-steel tubing and cabling provide thermal anchoring to the cold isothermal region at the bottom of the cryostat without conducting a prohibitively large heat load from the top, while the configurability of the probe end allows for different experiments to be built without complete disassembly of the probe. We also present first experiments on capacitors fabricated from a Au/Ti metal top plate, Al_2O_3 dielectric, and Cd_3As_2 bottom plate. Such measurements will give new, quantitative understanding of the density of states in a complicated heterostructure system of current interest.

Improving Copper Adhesion to Polyimide in the Electroless Plating Process

Bailee Rusconi, Chemistry, California Polytechnic State University San Luis Obispo
Dr. Hellen Papananou, Dr. Rachel Segalman, Chemical Engineering

As technology moves toward flexible electronic devices, circuit boards also need to evolve from their current rigid form to a more malleable structure that can be incorporated into a flexible device while still maintaining their ability to carry electricity. The electrically conductive parts of traditional circuit boards are typically made of copper. Usually, the process by which copper is deposited on them is done through electroless plating; therefore, there is a need to apply this existing knowledge of copper deposition to flexible circuit boards. The problem with implementing this knowledge is that copper does not adhere well to the flexible substrate, usually polyimide. Our goal is to synthesize a dual functional water-soluble polymer that can adhere very well to the substrate but also coordinate with copper. Mussel moieties histamine and dopamine are known to promote adhesion under water; therefore, we propose utilizing these moieties on a polymer backbone to create a thin adhesive film between the substrate and the deposited copper. We chose a water-soluble poly (ethylene oxide–allyl glycidyl ether), P(EO-AGE) backbone, that histamine and dopamine can be easily incorporated into, in order to facilitate adhesion with the flexible substrates while enabling the planarization of copper in electroless copper plating. Once synthesized, the polymer was incorporated in the electroless plating process. Adhesion was determined via a scotch-tape test and the quality of plating was characterized through atomic force microscopy. With the implementation of adhesive polymers in the electroless plating process, flexible electronics can be feasible.

The Development of Microfluidics Devices for the Study of Complex Coacervation
Vedika Shenoy, Chemical Engineering, University of California Santa Barbara
Chelsea Edwards, Matt Helgeson, Megan Valentine, Mechanical Engineering and Chemical Engineering

Complex coacervating systems form liquid-liquid phase separated solutions with unique viscosity, wetting, and adhesive properties. To utilize these characteristics, it is important to experimentally determine the phase behavior of specific polymer systems. Currently, separate solutions of varying concentrations must be prepared to investigate coacervate phase diagrams, which is both time- and material-intensive. We present a microfluidic device which enables the investigation of the salt-polymer phase diagram in a single measurement. We propose a gradient generating design to produce a range of salt and polyelectrolyte concentrations. This device allows for the imaging of mixtures of salt and polyelectrolytes at various concentrations to observe the conditions under which coacervation occurs. Thorough mixing is needed for the accurate characterization of output concentrations from the gradient generator to map the location of points on the phase diagram. Channel walls are patterned with a staggered herringbone mixer (SHM) to promote mixing. The mixing of a fluorescein isothiocyanate-dextran solution with a diffusivity representative of that of the polymer solutions on the device will be quantified to experimentally validate the expected steady-state gradient. We use poly(acrylic acid) (PAA) and poly(allylamine) (PAH) as a model polyelectrolyte system to validate the device by comparing on-device results to off-device phase diagrams from literature.

Exploring Structure and Magnetism of Potential Skyrmion Hosts in the Filled *β*-Manganese Structure $Cu_{1.5}M_{0.5}(Pt_{0.7}Cu_{0.3})_3B$ (*M* = Fe, Ni, Zn)
Maryann Valerio, Physics, Mount Holyoke College
Linus Kautzsch, Ram Seshadri, Materials Department

Skyrmions are chiral magnetic nanostructures comprised of electron spins aligned in a topologically protected, vortex-like formation. Skyrmion hosts are a promising materials for low-power, high-information-density spintronic devices such as magnetic racetrack memory. A previous study found room-temperature skyrmions in the $Co_xZn_yMn_z$ system, which crystallizes the *β*-Manganese structure. This noncentrosymmetric structure allows long range Dzyaloshinskii-Moriya (DM) interactions that can enable the formation of skyrmions. Here, we report on the modifications of another recently-discovered compound with the filled *β*-Manganese structure (interstitials occupied by B atoms), $Cu_2(Pt_{0.7}Cu_{0.3})_3B$. We doped the system to form $Cu_{1.5}M_{0.5}(Pt_{0.7}Cu_{0.3})_3B$ (*M* = Fe, Ni, Zn). Fe and Ni were expected to yield a magnetic systems which might host skyrmions. Zn was added to attempt to synthesize a new superconductor in this class. The crystal structure was confirmed as *β*-Manganese for all three samples by x-ray diffraction (XRD); magnetic properties were characterized by vibrating sample magnetometry (VSM/SQUID) and morphology by scanning electron microscopy (SEM); composition of main and secondary phases was determined through energy-dispersive x-ray spectroscopy (EDS). The iron compound is a chiral magnet with a Curie transition temperature at 300 K and may be a low-temperature spin glass. The compound shows a second magnetic transition around 600 K resulting from an iron-rich impurity. The nickel and zinc compounds are paramagnets; the zinc compound had a minority (< 0.1%) superconducting phase. Though no skyrmions could be observed, the results demonstrate that the *β*-Manganese structure is preserved with doping; in addition, a new chiral magnet (*M* = Fe) was discovered.

Characterization of InN Quantum Dots
Micah Webb, Electrical Engineering, Jackson State University
Caroline Reilly, Steven DenBaars, Electrical and Computer Engineering

Epitaxial quantum dots (QDs) can be used in the active regions of light-emitting diodes (LEDs) and laser diodes (LDs). The focus of this study was infrared emitting InN QDs grown on GaN for use in infrared optoelectronic devices. This process was difficult since the two components, InN and GaN, have different growth temperatures and lattice constants. GaN is typically grown at 1200°C and InN is grown at 600°C, with the materials having a lattice mismatch of greater than 10%. This work concentrates on the growth of InN QDs by metalorganic chemical vapor deposition (MOCVD) at low growth temperatures and the subsequent characterization of the QDs. MOCVD was used to grow InN QDs, on top of MOCVD-grown GaN-on-sapphire substrates. The samples had different nominal thickness, which refers to how thick a layer would be if the material were to grow as a planar layer rather than as QDs. We used atomic force microscopy (AFM) to get images of the QDs, then calculated the amount of material deposited (layer thickness) from the AFM images. After that, we compared the calculated layer thickness to the expected values (nominal thickness). For most samples, the calculated values were much larger than the expected values, up to an order of magnitude greater. For example, one sample had a nominal thickness of 0.50 nm, but the layer thickness was 5.41 nm. This difference between the expected value and the calculated value may be due to factors such as, the calibrated growth rate being too low, the AFM not resolving the QDs well, and the assumptions made in calculations. Future studies, such as comparing the size of the QDs by AFM to other more advanced microscopy techniques such as scanning transmission electron microscopy (STEM), may address the discrepancies found here.

Understanding the Reactions Between Thermal Barrier Oxides and Molten Silicates

YiLing Yang, Mechanical Engineering, University of California, Santa Barbara
Collin S. Holgate, Carlos G. Levi, Materials Department

Thermal barrier coatings (TBCs) are ceramic layers that allow gas turbine engines to operate at higher temperatures, with concomitant benefits to their fuel efficiency. However, current TBCs are susceptible to degradation and failure owing to the infiltration of molten silicate (CMAS) into their porosity that is needed to enable coating compliance. Infiltration of the TBC can be stopped when exposure to CMAS causes a rapid reaction forming new solid phases near the TBC surface. Quick dissolution and diffusion rates are necessary to enable prompt saturation, which is required for reaction between the CMAS and the TBC; therefore, understanding the kinetics between the two processes is critical. To quantify these kinetics, dense TBC oxides were placed in a 1D diffusive contact against different compositions of CMAS. The diffusion couples are heated to 1300°C for a prescribed, typically short time, to obtain concentration profiles before crystallization occurs, and rapidly cooled to retain the high-temperature configuration. Quantification of dissolution and diffusion rates is enabled by analyzing the TBC element concentration profiles in the CMAS, using an electron microprobe. Reaction products from the TBC-CMAS interaction were observed using electron microscopy to understand the reaction mechanisms. This research provides knowledge of the kinetic differences between traditional and new TBC materials (e.g., $Gd_2Zr_2O_7$). It is evident that the $Gd_2Zr_2O_7$ reacts faster with CMAS than the traditional TBC material because of enhanced dissolution and crystallization rates. The enriched understanding of dissolution, diffusion, and crystallization behaviors of TBCs, provides insight to guide novel TBC design.

Gorman Scholars Program (Gorman)

http://gorman-csep.cnsi.ucsb.edu/

The Gorman Scholars Program provides UCSB undergraduates across all STEM majors an opportunity to receive invaluable mentoring from faculty, postdoctoral researchers, and graduate students, while pursuing innovative interdisciplinary research projects. The internship begins in the summer and continues through the academic year. Each scholar is mentored by a member of the UCSB faculty, who assists the student in designing a plan of research and enrichment activities fitted to the individual interests and academic goals of the student. Support through the Gorman Scholars Program includes: written and oral communication training, leadership and professional development opportunities, networking with academic and industry professionals, and resources to attend one professional conference. This program is hosted by the Center for Science and Engineering Partnerships (CSEP) at the California NanoSystems Institute (CNSI) and the Office of the Dean, Math, Life & Physical Sciences. The Gorman Scholars program is graciously funded by a gift from the Gorman family.

Optogenetic Tool to Control Kinase Signaling

Erfan Zeyaei Kajbaf, Molecular, Cellular, and Developmental Biology, University of California, Santa Barbara
Ryan Lach, Max Wilson, Department of Molecular, Cellular, and Developmental Biology

Mitogen-Activated Protein Kinases (MAPKs) are fundamental for transmitting information through cellular signaling pathways. The activation of these kinases catalyzes the addition of phosphate groups, a mechanism known as phosphorylation, to the target molecule, and has been observed to occur in elaborate temporal patterns. Currently, there is no tool for reversibly controlling kinases and thus mimicking those endogenous signals. In this research, we sought to create a new optogenetic tool to reversibly control a specific MAPK called ERK. We modified the wild-type ERK protein to contain a light-switchable heterodimer, which upon activation would occlude the active site of the enzyme. This allows us to turn the protein "on" or "off" using different wavelengths of light, giving us full modular control of this node of the MAPK pathway. This novel tool will allow us and others to isolate contribution of a kinase's activity to signal transduction in the pathway that utilizes it. We created this tool and are analyzing the tool in a mammalian cell culture system. The next step for us will be to use this tool on other MAPKs in the same pathway as ERK and in parallel pathways. This will allow us to have a better understanding of the effects that each kinase has on cell behaviors by isolating their activity form the enormously complex cellular signaling network.

Hardware Efficient Image Reconstruction for Two-Photon Microscopy

Abel Semma, Computer Engineering, University of California-Santa Barbara
Alex Nguyen-Le, Luke Theogarajan, Electrical Computer Engineering

Two-photon excitation microscopy is a fluorescence imaging technique that can image deeply through living tissue in a minimally invasive fashion, establishing itself as a mainstay for in-vivo neuroscientific investigation. We aim to miniaturize an entire two-photon microscope to enable experimentation in freely moving organisms, requiring miniaturization of the electronics/optics as well as hardware specific software to control it. Processing the raw data coming from our system is a job poorly suited for a CPU; the associated computations use up very few hardware resources, so we investigate the use of highly parallelized architectures for the potential speedups. We use NVIDIA's CUDA library to design our algorithms, and we process recorded data sets to demonstrate the reduced processing time and corresponding raw throughput rates.

Aggregation Induced Emission in Stereospecific, Photoluminescent Polymers
Victoria Rubio, Chemistry Major, University of California-Santa Barbara
Allison Abdilla, Javier Read de Alaniz, Craig Hawker, Chemistry Department

Aggregation induced emission (AIE) is a rare phenomenon where fluorophores emit light when closely packed together in concentrated solutions or aggregated solid states. As fluorescent properties of AIE fluorophores are highly influenced by their local environment, these dyes act as a unique tool to visualize nanoscale structures such as DNA and proteins. In particular, AIE is used to probe the dynamic helical conformation of these molecules with emission turning "on/off" depending on helix formation. In this work, we sought to explore AIE in stereospecific polymers that are known to form helices and study how changes in chain conformation can influence their fluorescent properties. Our attention was focused on stereospecific tetraphenylethylene (TPE) based polymers made up of bulky AIE pendent fluorophores and flexible methacrylate backbones. To make these polymers, the aggregation induced emission monomer TPE ethyl methacrylate (TPE-EtMA) was synthesized via air-free techniques. The polymerization of TPE-EtMA via anionic and radical polymerization was investigated to prepare stereospecific polymers and their stereo-irregular analogs. Future work will explore the stereochemistry-dependent fluorescent properties of these materials, and the ability to switch AIE activity on/off through external stimuli. We predict that the results from this study will provide valuable insight into the structural design of AIE polymers and their luminescence-based applications.

Determining the Role of Epigenetics in the Variations of Thermal Tolerance and Plasticity Between Populations of *Tigriopus californicus*
Michael Meneses, Aquatic Biology, UC Santa Barbara
Sam Bogan, Dr. Gretchen Hofmann, Department of Ecology, Evolution and Marine Biology

Changing ocean conditions such as increased temperature and pCO_2 will have major consequences on marine ecosystems. These conditions can act as a driving selective pressure and negatively affect the fitness of marine organisms. Phenotypic plasticity, the capacity of a single genotype to exhibit variable phenotypes across different environments, can drive acclimatory response to such pressures. Plasticity can vary between different species and populations. However, how these differences evolve is still poorly understood. Plasticity is partially attributed to epigenetic processes such as DNA methylation, a cellular-level process that regulates the quantity and variability of a gene's expression. Thus, epigenetic pathways may have diverged among populations with differences in plasticity. The intertidal copepod *Tigriopus californicus* displays varying levels of (i) thermal tolerance and (ii) plasticity in thermal tolerance between populations, with both tolerance and plasticity increasing as latitude decreases. We exposed two populations of *T. californicus* collected from different latitudes to acute heat stress and measured their subsequent thermal tolerance, respiration rate, and froze replicates for downstream for measuring DNA methyltransferase activity to determine the correlation between epigenetic activity and changes in plasticity. We found that populations from Pt. Dume (southern) and Santa Cruz (northern) showed significant differences in both body size and thermal tolerance, (2) neither population displayed changes in thermal tolerance after heat stress and (3) respiration rates varied as a function sex, temperature, and population. Analysis of methyltransferase activity within this experiment may provide a better understanding of the role of epigenetics in adaptational plasticity.

Leveraging Microscopy to Characterize the Morphology and Autofluorescence of Lignocellulose Degrading Microbes
Corey Kerdman-Andrade, Chemical Engineering, University of California Santa Barbara
Patrick Leggieri, Dr. Michelle O'Malley, Chemical Engineering

Lignocellulose, the woody complex responsible for the strength of plant cell walls, is the most abundant renewable biomass resource available. Its valorization promises to enable sustainable production of value-added products from biofuels to pharmaceuticals; however, lignocellulose is recalcitrant to chemical and biological degradation. Rumenous anaerobic microbial consortia, found in the primary stomach of ruminants (cows, sheep, etc.), naturally evolved to degrade lignocellulose as an energy source. Within the rumen, anaerobic fungi are the primary lignocellulose degraders. Methanogenic archaea consume byproducts of fungal metabolism and are critical to consortium function. Biomass breakdown is spatially dependent in these systems, as fungi bind to biomass and each other, and methanogens associate within the fungal network. To mechanistically understand lignocellulose degradation in anaerobic consortia, we aim to characterize spatial organizations of the constituent microbes. The morphology of a representative anaerobic fungus, *Neocallimastix sp.* (S3), was characterized via brightfield microscopy; morphology of a representative methanogen, *Methanobacterium bryantii*, is already well characterized. To distinguish between constituent microbes in a mixed culture, non-overlapping fluorescence in both species is necessary. Autofluorescence in the fungus was observed with excitation and emission channels spanning virtually the entire visible light spectrum, with limited UV activity. Autofluorescence in methanogens is well-characterized, with UV excitation and blue light emission. Therefore, we developed methods to resolve fungi and methanogens in co-culture without the use of stains, probes, or dyes. Following optimization of cultivation of imageable consortia, the spatial organization of rumenous consortia will be quantified to further our understanding of consortium function.

Developing sustainable synthetic routes to lithium-ion battery electrodes
Allyson Ee, Chemical Engineering, University of California, Santa Barbara
Howie Nguyen, Raphaële Clément, Materials Department

NMC-type cathodes ($Li_{1+x}Ni_{1-x-y-z}Mn_yCo_zO_2$) have replaced lithium cobalt oxide ($LiCoO_2$) in several commercial battery applications, due to the higher energy density and lower cost of their reduced cobalt (Co) content. Yet, the synthesis of these materials is commonly achieved via a solid-state route, generally involving two high-temperature (~1000°C) calcination steps of about 15 hours each. Microwave (MW) synthesis obviates the need for this high energy and inefficient convective heating route by selectively, uniformly, and rapidly heating the sample. Compared to the conventional solid-state calcination, MW synthesis is reliable, cheap, and energy/time-efficient. As such, this project aims to develop a MW synthesis protocol for NMC-type cathodes, and to investigate differences in the structure and battery performance between electrodes synthesized via MW and conventional routes. Phase purity and composition of the samples will be assessed with X-ray diffraction (XRD) and inductively coupled plasma atomic emission spectroscopy (ICP-AES), respectively. The microstructure and morphology of the electrode particles will be examined using scanning electron microscopy (SEM). Moreover, solid-state nuclear magnetic resonance (ss-NMR) and electron paramagnetic resonance (EPR) experiments will be conducted to identify the effect of MW vs. convective heating on the local structure of the cathodes. Ex-situ and operando ss-NMR and EPR experiments can probe changes in the local structure of these cathodes as a function of state of charge; such changes can be directly related to the specific energy density, voltage and capacity fade, and efficiency. These identified structure-property relationships and synthesis development will conceivably lead to cheaper and more energy-efficient lithium-ion batteries.

Examining the Effects of Varying pH Conditions on the Early Development of the Painted Sea Urchin, *Lytechinus pictus*
Buyanzaya BuyanUrt, Environmental Studies Major, UCSB
Terence Leach, Gretchen Hofmann, EEMB Department

As the concentration of atmospheric carbon dioxide grows, ocean conditions become warmer and more acidic. These environmental consequences of global climate change threaten the survival of marine organisms, particularly those that undergo calcification. As the frequency of extreme heat and acidification events increase, it is likely that these marine organisms will be exposed to multiple environmental stressors at a time. In this study we sought to test how the larvae of a calcifying organism reacted when exposed to subsequent stress events. Our organism of focus was the summer-spawning painted sea urchin, *Lytechinus pictus*, due to its role as both an ecologically important species as well as a developmental model. In our study, gametes were collected by spawning adult urchins and combining the resulting sperm and eggs. Fertilized eggs were then separated into triplicate buckets maintained at either high (1136.4 μatm) or low (586.2μatm) pCO2 treatments throughout early development. Upon reaching their larval stage, individuals were measured for skeletal length, thermal tolerance, and developmental success. Thermal tolerance trials revealed urchins that had developed under high pCO2 conditions had higher tolerance to a thermal stress event than those that developed under low pCO2 conditions. Our results conveyed two major findings: (1) exposure to one stressful event had better prepared *Lytechinus pictus* larvae for another stressful event and (2) *Lytechinus pictus* larvae are extremely resistant to high temperature stress. Analysis of gene expression, lipids, and proteins will provide further understanding of the impacts of environmental stressors on *Lytechinus pictus* physiological performance.

Institute for Collaborative Biotechnologies
Summer Internship in Biotechnology (ICB)

The Institute for Collaborative Biotechnologies (ICB) Summer Internship in Biotechnology is designed to recruit and train a diverse group of students whose interests lie in the STEM (Science, Technology, Engineering, and Mathematics) research areas. The program provides an 8-week, full-time research experience for community college and undergraduate students, who work in teams of two on Army-funded basic research projects. Each team is assigned a graduate student and faculty mentor, and work is conducted in our state-of-the-art ICB labs. In addition to hands-on learning, the program integrates professional development through research seminars, career development workshops, practice talks and presentations, as well as weekly oversight meetings.

Effects of Hoop-Height & Ball-Weight Manipulations on Basketball Accuracy in Experts and Novices

Jeanette Espinosa, Bioengineering, Santa Barbara City College
Amanda McCandless, Biological Sciences, University of California, Santa Barbara
Jordan Garret, Dr. Tom Bullock, Barry Giesbrecht, UCSB Psychological & Brain Sciences Department

Relative to novices, experts typically exude greater flexibility in changing contexts. The neural mechanisms underlying this adaptability is largely unstudied in a naturalistic environment. We recorded 64-channel EEG while collegiate level expert (N= 7) and recreational (recs) level (N=9) basketball players shot free-throws under normal and explicitly manipulated conditions; standard ball-weight vs 10% increased ball-weight, and standard hoop-height vs 10% increased hoop-height, in a factorial design. We expected experts to habituate more quickly to both aforementioned manipulations, relative to recs, and that these adjustments would be tracked by identifiable neural activity. Specifically, fluctuations in theta (4-7 Hz) frequency band activity might track successful shot adjustment, while beta band (14-32 Hz) activity may track force perseveration in situations of maladaptation. Preliminary analyses indicate that experts shot more accurately relative to recs across all conditions. Time-frequency analysis of theta power relative to baseline in experts versus recs revealed more efficient allocation of cognitive resources by experts and a delayed overcompensatory allotment by recs. Experts also displayed significantly lower beta power (~7s to 1s) post shot cue compared to recs, suggesting greater motor control. Taken together, these results reveal the likely mechanisms underlying expertise flexibility that engenders optimum performance.

Building a Photoactive Material That Generates Mechanical Work When Exposed To Light

Geoffrey Hanson, Chemical Engineering, Ventura Community College
Vivian Ross, Chemical Engineering, University of California, Santa Barbara
Kyle Clark, Javier Read de Alaniz, University of California, Santa Barbara Chemistry Department

Current methods of extracting energy from light involve slow, complex processes that store the energy in an intermediate prior to use. The aim of this research is to produce mechanical work directly from light energy by incorporating Donor Acceptor Stenhouse Adducts (DASAs) into materials systems. Currently, the only photoswitches successfully incorporated into materials systems are azobenzenes. However, DASAs offer advantages to azobenzenes because DASAs are negative photochromes and have different absorption wavelengths in the open and closed forms. In spite of these advantages, DASAs are harder to functionalize because current methods of liquid crystal elastomer formation are not amenable to DASA incorporation. We hypothesized that incorporation could be achieved through the use of Diels-Alder reactions. Progress was made in attaching norbornadienes to DASA photoswitches and crosslinkers, as well as attaching maleimides to liquid crystals. Diels-Alder reactions between the

maleimides and norbornadienes will allow for the creation of a cross-linked polymer capable of generating mechanical work.

Genomic and growth characterization of a novel anaerobic gut fungal isolate

Mason Gatz, Chemistry, Allan Hancock College
Nikola Malinov, Chemical Engineering, University of California, Santa Barbara
Candice Swift, Michelle O'Malley, Chemical Engineering Department

The anaerobic gut fungi (AGF) present in large herbivores are excellent degraders of recalcitrant lignocellulosic biomass. These fungi produce an extensive array of enzymes adept at decomposing biomass, such as grasses, into constituent sugars for the herbivores to digest. Leveraging this ability of the AGF would enable the sustainable production of commodity chemicals and products directly from waste biomass. Access to and analysis of the genetic code of these understudied microbes is the first step towards industrial-level applications. This study sought to extract high-quality genomic DNA for sequencing from a novel anaerobic gut fungus isolated from an elephant at the Santa Barbara Zoo. The CTAB extraction protocol modified for AGF yielded a concentration of roughly 38.3 µg of DNA/g of fungal mass; a greater than tenfold improvement over an alternative protocol based on bead beating and silica column purification. The extraction also generated DNA fragments in excess of 60,000 base pairs, providing the high molecular weight DNA desired for sequencing. The novel isolate was further tested for growth using pressure as a proxy on various substrates with a previously sequenced isolate of the same genus, *Piromyces*, serving as a control. The new isolate surpassed the growth of the control on all substrates, indicated by a shorter lag phase and a greater total accumulated pressure. Future work will test the isolate's growth on lignin-rich poplar and in defined media before proceeding to sequencing. DNA sequencing will consequently allow for species-level classification and genomic characterization.

Maximizing Access to Research Careers
Undergraduate Student Training in Academic Research
(MARC U*STAR) Program

http://marc-csep.cnsi.ucsb.edu/

The Maximizing Access to Research Careers - Undergraduate Student Training in Academic Research (MARC U*STAR) Program is funded by the National Institutes of Health (NIH). The program seeks to increase the number of highly-trained biomedical and behavioral scientists, from disadvantaged or underrepresented backgrounds, in leadership positions to significantly affect the nation's health-related research needs. MARC Scholars embark upon a two-year program of scientific research, leadership development and graduate school preparation guided by individual biomedical faculty mentors across UCSB science and engineering departments and staff at the Center for Science and Engineering Partnerships.

Light-tunable Hydrogels
Alanna Stull, CCS Biology, UCSB
Erik Hopkins, Max Wilson, MCDB

Hydrogels are multifunctional, water-filled, three-dimensional structures made up of cross-linked polymer chains. The biomedical utility of hydrogels is limited due to a lack of control over its physical properties. In this research, we sought to address this issue by utilizing photo-switchable proteins known as opto-proteins to control the density of cross-linking throughout the hydrogel. In order to achieve this, constructs containing the opto-protein, mCherry, and SNAP-tag binding enzyme were expressed, purified, and proven to be photo-switchable. Collagen gels were cast and imaged in order to determine a baseline for the strength and number of cross-links in a regular gel. BG-Maleimide will be used to link the SNAP-tag on the opto-protein to cysteines in the collagen ultimately creating a light-tunable hydrogel.

Exploring the role of activating transcription factor 6 in Kaposi's sarcoma-associated herpesvirus infection
Adriana Ramirez Negron, Microbiology Major, University of California, Santa Barbara
Guillermo Najarro, Dr. Carolina Arias, Molecular, Cellular, and Developmental Biology Department

Kaposi's sarcoma-associated herpesvirus (KSHV) is an oncogenic herpesvirus, known to cause malignancies in immunocompromised patients. To gain control of the host protein folding machinery during infection, KSHV modulates the unfolded protein response (UPR), but the precise mechanisms it uses to do so remain unknown. The UPR is a cellular homeostatic mechanism that alleviates stress in the endoplasmic reticulum (ER) when unfolded proteins accumulate. The UPR consists of three protein signal transducers: IRE1, PERK, and ATF6. KSHV inhibits the signaling of IRE1 and PERK in infected cells preventing their normal function, but how it controls ATF6 remains unclear. In this project, we focused on exploring the role of ATF6 in KSHV infection. In our initial approach, we treated KSHV-latently infected cells with Ceapin, a small molecule that inhibits ATF6 function by sequestering this transcription factor in the cytoplasm of the cell. We tested if Ceapin worked in these infected cells by determining the protein levels of the ER-chaperon BiP by immunoblot. BiP is an important chaperone that is transcriptionally regulated by ATF6 in response to ER stress. Our results indicate that Ceapin worked since it prevented the upregulation of BiP in ER stress induced-cells. We are currently testing the effect of ATF6 on KSHV protein expression and virus replication. Our project will help better understand virus-host interactions and uncover potential targets for the development of future therapies.

Coordination between cell proliferation and differentiation using C.elegans germline stem cells.
Earl Hwande, Biological Science, University of California, Santa Barbara
Pradeep Joshi, Joel Rothman, Molecular, Cellular & Developmental Biology

The nematode *Caenorhabditis elegans* (*C. elegans*) has a stereotypical cell lineage, offers powerful tools of genetic manipulation, a fully sequenced genome, and extensive conservation of genetic pathways between humans and *C. elegans*, which makes the nematode a powerful model organism for researchers to probe into the manner in which stem cells differentiate or proliferate. Understanding of the process in which stem cells undergo self-renewal, the regulatory circuitry that sustains their pluripotency, and events that commit progeny cells to particular differentiation states are key aspects of stem cell biology that are extremely critical. Stem cells are strongly associated with maintaining tissue repair, homeostasis, development, aging and cancer, while the soma has a fixed stereotypical lineage, the germline is the only tissue in the nematode that remains proliferative throughout its life and hence supports a pool of proliferative germline stem cells. Maintaining a proper balance between proliferation and differentiation is critical to maintaining homeostasis; too much proliferation would result in tumors and premature differentiation would result in too few gametes. We are investigating the role of miRNAs, small regulatory non-coding RNAs, in maintaining stem cell homeostasis. Specifically, we want to investigate if over-expression of specific miRNAs is sufficient to drive tumor formation by inhibiting tumor suppressors.

Mapping the cellular stress responses that oversee RNA health in Saccharomyces cerevisiae
Diego Reyes, CCS Biology, University of California, Santa Barbara
Carlos Ponce, Diego Acosta-Alvear, Molecular, Cellular and Developmental Biology

Cells must maintain an internal biochemical balance—homeostasis—to survive. Specific molecular mechanisms, globally known as stress responses, enable cells to reinstate homeostasis when facing biochemical imbalances. In my project, I am working in establishing a model system that would allow us to gain insights into the inner workings of a stress response responsible for protecting the RNAs of eukaryotic cells. This model exploits the molecular features of Huntington's disease, a neurodegenerative disorder characterized by neuronal cell death due to the accumulation of toxic protein aggregates. These aggregates result from expression of expanded polyglutamine tracts encoded by CAG nucleotide repeat expansions (NREs) found in the *HTT* gene. Notably, such NREs also causes a profound structural change in the mRNA encoding HTT (hungtintin), which adopts a double-stranded conformation. We hypothesize that such RNA conformation may cause cellular harm. To test this hypothesis, I have introduced constructs encoding chimeric mRNAs consisting of the GFP coding sequence fused to HTT NREs into the baker's yeast *Saccharomyces cerevisiae*. Expressing these constructs in wild type yeast as well as in a collection of candidate mutant strains revealed that deletion of the RNA helicase Ski2 increased the sensitivity to these constructs. This result suggests that Ski2 is part of a dedicated system to combat abnormal RNAs in eukaryotic cells. In the next step of my project, I will perform a focused genetic screen in yeast cells to identify additional genes in charge of protecting the cells from RNA health imbalances.

UCSB Mathematics Summer Research Program for Undergraduates 2019

http://math.ucsb.edu/REU/

The UCSB Summer Research Program for Undergraduates offers upper division undergraduate students with outstanding academic potential the opportunity to work closely with faculty mentors on mathematics research projects for eight weeks during the summer. This program is financially supported by the National Science Foundation.

The program has been designed for students who wish to learn more about the research experience and possibly pursue an academic career in teaching and research. Each student participant works individually or in a small group with a faculty mentor in one of the proposed research projects. The students also attend a weekly colloquium, participate in some workshops for professional development, and develop oral and written skills through weekly talks and reports.

Participating students receive a stipend of $4,000. Housing at the university and an allowance for travel expenses is also provided.

Students participating in this program must be United States citizens or permanent residents. Also, students who have received their bachelor's degree and are no longer enrolled as undergraduates are not eligible to participate.

Three Perspectives on Genus One Curves.

Alexander Bauman; Mathematics, Brown University; **Sunita Bhattacharya**; Mathematics, University of Massachusetts Amherst; **Sriram Gopalakrishnan**, Mathematics, The University of Utah; **Amy Li**, Mathematics, Wellesley College.
Nadir Hajouji, Mathematics Department, UC Santa Barbara.

Let K be a field and $\overline{K}$ be an algebraic closure. A degree 2 genus one curve C is given by the equation

$$w^2 = au^4 + bu^3v + cu^2v^2 + duv^3 + ev^4,$$

where $a, b, c, d, e \in K$. We studied three different perspectives pertaining to such curves.

First, for any pair of integers u, v, we can associate a quadratic extension L/K such that C has a nontrivial point over L. In the case $K = \mathbb{Q}$, a quadratic extension is determined by the unique squarefree integer d such that $L = \mathbb{Q}(\sqrt{d})$. Given random relatively prime u, v we determine the probability that d lies in a given congruence class modulo a prime.

Second, with each such curve we can associate an elliptic curve $\mathrm{Jac}(C)$ such that C and $\mathrm{Jac}(C)$ are isomorphic over $\overline{K}$. In the case $K = \mathbb{Q}$, we can fix a prime $p \in \mathbb{Z}$ and perform Tate's algorithm on $\mathrm{Jac}(C)$ at p, which more precisely classifies the singularity type of our curve modulo p. We adapt Tate's algorithm to work for degree 2 genus one curves in the case $K = \mathbb{Q}$.

Finally, for global function fields $\mathbb{F}_p(t)$, we searched for all equations for all degree 2 genus one curves with a fixed Jacobian and with prescribed bounds on the degree of the coefficients at different primes. We consider conditions on the coefficients of the elliptic curve which guarantee the existence of these genus one curves. We also consider the bound on the number of possibilities of the coefficients for a genus one curve over for the given field.

Studying the spectral theory of Laplace-Beltrami operators on almost Abelian Lie groups.

Marcelo Almora Rios; Mathematics, Harvey Mudd; **Kelley Yang**; Mathematics, University of Southern California.
Zhirayr Avetisyan, Mathematics Department, UC Santa Barbara.

The Hamiltonian of a quantum mechanical system with a Lie group of symmetries can often be described by a partial differential operator (PDO) that is invariant under these symmetries. Thus, the spectral theory of these invariant PDOs gives a mathematical description of energy level problems in symmetric quantum systems.
Arguably, one of the most important PDOs on a Lie group is the Laplace-Beltrami operator associated to a left or right invariant Riemannian metric. We study Laplace-Beltrami operators of invariant Riemannian metrics on connected almost Abelian groups. Because the corresponding Hamiltonian system is integrable, the explicit spectral resolution of the Laplace-Beltrami operators can be found via separation of variables. In this project, we explicitly describe a complete system of generalized eigenfunctions, as well as the spectral measure and resulting eigenfunction expansion. Though this expansion would formally require an introduction to Gelfand triples, the presence of explicit formulae allows for a reduction to the classical Parseval equality for the Fourier transform.

Almost Abelian Lie Groups, Their Quotient Groups and Automorphisms
Katalin Berlow, Mathematics, Carnegie Mellon University; **Isaac Martin**, Mathematics and Physics, University of Utah.
Zhirayr Avetisyan, Mathematics Department, UC Santa Barbara.

Consider a homogeneous anisotropic model of the early universe. Such a system possesses a symmetry group that, for any fixed time, displays the full translational symmetry of Euclidean space, but changes smoothly as t varies.
Mathematically, this system is modeled by taking a fixed homogeneous space of the given Lie group G and letting the group action evolve in time following a path in the automorphism group, $\mathrm{Aut}(G)$. The group $\mathrm{Aut}(G)$ thus encodes the variety of possible dynamics. We limit our study to the class of real almost Abelian Lie groups, i.e., those real non-Abelian Lie groups which contain a codimension one Abelian subgroup. All real solvable 3-dimensional Lie groups are almost Abelian, and they appear in homogeneous cosmological models.
In this project, we first derive matrix representations for all real connected almost Abelian groups. We then prove that the automorphisms of an almost Abelian Lie algebra which lift to Lie group automorphisms are exactly those that fix a normal discrete subgroup of the simply connected Lie group associated to the Lie algebra. Using the aforementioned matrix representations we obtain explicit descriptions of these automorphisms in the real connected almost Abelian case.

Linearizations of Matrix Polynomials Expressed in the Newton and Lagrange Bases and Their Condition Numbers
Anthony Akshar, Mathematics, UC Santa Barbara; **Remy Kassen** , Mathematics, Duke University; **Daria Mileeva**, Mathematics, UC Santa Barbara.
Maribel Bueno, Mathematics Department, UC Santa Barbara.

Consider a nonlinear holomorphic function $f : \Omega \subset \mathbb{R} \to \mathbb{C}^{n\times n}$. The usual way to solve the nonlinear eigenvalue problem $f(\lambda)x = 0$ is to approximate $f(\lambda)$ through interpolation with a matrix polynomial $P(\lambda)$ and solve the polynomial eigenvalue problem $P(\lambda)x = 0$. This requires constructing a degree one matrix polynomial with the same spectrum as $P(\lambda)$, known as a linearization, and then solving the related generalized eigenvalue problem. We consider interpolation matrix polynomials expressed in the Newton and Lagrange bases. Historically, the Newton basis has been used because of its low computational cost for including new interpolation nodes. However, the commonly overlooked Lagrange polynomials allow for the efficient introduction of new interpolation nodes when expressed in the barycentric form. We construct novel families of linearizations of $P(\lambda)$ that can be easily constructed from its coefficients when $P(\lambda)$ is expressed in each basis. We then analyze the eigenvalue condition numbers (a measure of the sensitivity of the eigenvalues to small perturbations in the input data) for each basis and compare them. Lastly, we provide numerical experiments to illustrate our theoretical results.

Chebyshev linearizations of matrix polynomials: are they well-conditioned?

Elise Brod, Mathematics, Grinnell College; **Rebecca Embar**, Mathematics, UC Santa Barbara.
Maribel Bueno, Mathematics Department, UC Santa Barbara.

Many applications (e.g., signal processing, control theory, experiment design) require solving the polynomial eigenvalue problem (PEP), $P(\lambda)\vec{x} = 0$, for a matrix polynomial $P(\lambda)$. It is often necessary to express $P(\lambda)$ in a non-monomial basis. The standard way to solve a PEP is to use a linearization (i.e., a pencil embedding the eigenstructure of P), but not all linearizations are created equal. A family of linearizations of $P(\lambda)$ expressed in the Cheybyshev Type 1 and 2 bases was recently introduced by Lawrence and Perez (2017).
We compare the eigenvalue condition number (measuring the sensitivity of the eigenvalues to small perturbations of the input data) of each of these linearizations with the condition number of $P(\lambda)$ by providing upper and lower bounds on the ratio of these condition numbers. We prove that, when $\lambda \in [-1,1]$, the change in the condition number only depends on a dimensional constant and provide a subfamily of linearizations for which this constant is moderate. We also study the general case when $\lambda \in [a,b]$ and show that, in this case, the bounds depend, among other factors, of the length of the interval $[a,b]$ and the distance of its center from the origin. Finally, we provide numerical experiments to illustrate our results.

McNair Scholars Program

http://mcnair.ucsb.edu

The UCSB McNair Scholars Program prepares qualified undergraduates for entrance to a PhD program in all fields of study. The goals of the program are to increase the number of first-generation, low-income and/or underrepresented students in PhD programs, and ultimately, to diversify the faculty in colleges and universities across the country. This federal program was established in memory of physicist and Challenger astronaut, Dr. Ronald E. McNair. It is one of several TRIO programs funded by the U.S. Department of Education supporting the academic achievement of students from groups traditionally underrepresented in higher education. The UCSB McNair Scholars Program is supported by the U.S. Department of Education, the Office of the Executive Vice Chancellor and the deans of the College of Letters and Sciences and the College of Engineering. Additionally, our science, technology, engineering, and mathematics (STEM) scholars are being funded by Edison International. The UCSB McNair Scholars Program provides undergraduates with opportunities to participate in academic year and summer research activities. McNair Scholars attend courses, seminars and workshops on topics related to graduate school preparation; complete a research project under the guidance of a faculty mentor; and have the opportunity to present their research at local, regional, and national conferences.

To Study or Not to Study: The Educational Attainment of Latinx Youth Formerly in the Informal Economy
Emily Andrade, Sociology, University of California- Santa Barbara
Dr. Denise Segura, Sociology

Unemployment and poverty are among the many reasons why some turn to the informal sector to supplement their household income. The informal sector and adolescent employment are both significantly researched phenomena respectively. This paper examines the motivation of 1.5 and second-generation children of Mexican immigrants in Los Angeles to enter informal employment sectors in street vending, construction, gardening and housekeeping and how these experiences shape their educational attainment and aspirations. These Latinx youths' educational attainment and aspirations are examined through the review of sociological literature on the Latinx experience in various informal sectors, in order to fill in the some of the gaps in the explanations given to the low educational attainment of Latinx youths in Los Angeles. Despite regarding higher education as important for success, many find themselves choosing to find employment to help support their family over pursuing higher education. This paper argues that the socioeconomic status of their family and development of 'economic empathy' are two of the most influential factors in determining whether a Latinx youth will decide to pursue higher education

Tu Eres Mi Otro Yo: Seeing Oneself in Ethnic Studies Curriculum at an HSI
Xochitl Briseño, Political Science, University of California, Santa Barbara
Dr. Rebeca Mireles-Rios, Education

HSIs are defined by the Department of Education as accredited degree-granting public or private nonprofit institutions of higher education with 25% or more total undergraduate Hispanic full-time equivalent student enrollment (Laden, 2004). However, as the number of HSIs continue to increase, as well as the percentage of Latinx/a/o students enrolled at these institutions, educational advocates, researchers, policymakers, institutional leaders, and students have called attention to the need for examining the characterization of "Hispanic Serving." One characteristic of "serving" that has been discussed by scholars is the level to which these institutions provide culturally relevant curriculum and engagement practices (Hurtado, 2003, Garcia, 2012). In an attempt to understand

how policymakers, administrators, and academic institutions can work towards reforming the educational system, these decision makers must critically evaluate what institutions are doing now. To this end, this study focuses on how a newly designated Tier One Research institutes in California serves its Latinx/a/o student population through Ethnic Studies Curriculum and culturally relevant student engagement practices. This study utilizes a qualitative analysis of thirty-two interviews conducted with undergraduate Latinx students at a Hispanic Serving Institution. Through coding of the interviews for thematic analysis, this study is able to help correlate HIPs as a mean of alignment to the institution. This is done by the application of Kuh's educational theory as a lens which I use to analyze thematic codes allows me to assess why lack second year engagement leaves students to feel academically and socially isolated. However, the data presented a lack of exposure to culturally relevant High Impact Practices during the participants second year as well as a lack of a second form of engagement. Implications for educators and policymakers are elucidated and future research will conduct follow up interviews with the participants at the end of their fourth year.

Yüe Ou and the Flower Boats: Literati Identity and Mobility in 18th to 19th century Guangzhou

Zheng Chen, History, University of California, Santa Barbara
Professor Xiaowei Zheng, Department of History & East Asian Studies

This study follows a growing literature on localist activism and identity in Imperial China. It looks at the development of literati identity in 18th to 19th century Guangzhou through examining the city's entertainment culture and the cultural elites who took part in it. It takes place on Guangzhou's flower-boats, where the entertainment scene unfolded and pays attention to literati Zhao Ziyong's lyric poetry Yüe Ou. The popularity of Yüe Ou—sung in the Guangzhou dialect—among flower-boat frequenters is notable. While there were persons from the Guangdong province, many of them were outsiders from other provinces. By exploring the multi-dimensional relationship between new cultural elites of Guangzhou and the localized entertainment culture, we can attempt to weave a narrative that addresses the social mobility and elite identity of Guangzhou. In using a combination of gazetteers, travelogues, poetry anthologies, and diaries, this study seeks to do just that and will contribute to future endeavors on similar topics.

Tailoring properties of lattices through nodal design

Marco Colin, Chemical Engineering B.S., University of California, Santa Barbara,
Amanda Ruschel, Frank Zok, Material Science

Lattice materials are composed of arrays of interconnected struts and are used for their weight-efficient mechanical properties. They have increased in prevalence due to recent advances in additive manufacturing (AM) technologies and are used in applications such as aerospace and force protection systems. Despite the design complexity afforded by AM, conventional methods of node design have been limited to rigid connections. Rigid connections may limit the large-deformation mechanical response of lattice materials. The present research focuses on node designs that allow for articulation of the struts at the nodes. Pertinent design variables in nodal connections are found from analytical mechanical models of nodal response and by exploring the limitations of one specific multi-material AM process. The design concepts are demonstrated by manufacturing prototypical parts and assessing their geometric fidelity and mechanical response. Further research will study the influence of nodal parameters on overall lattice mechanical properties.

The Impact of Genetic Testing on the Racial Categorization of Mismatched Claimed Identities

Zoey Eddy, Psychological and Brain Sciences, University of California Santa Barbara
Diego Padilla-Garcia and Payton Small, Brenda Major, Psychological and Brain Sciences

Psychologists have examined multiple factors that influence how people racially categorize others. This study looks at genetics as a factor of racial categorization, and also looks at a group of individuals that have not been prominently studied before. While many individuals claim a racial identity that matches their parents' racial identities, others have a mismatched claimed identity because their racial identity differs from their parents' identities. The purpose of this study is to understand how genetic testing results influence how people perceive and racially categorize individuals with mismatched claimed identities. 492 White participants examined profiles of a

target with a mismatched claimed identity, and were also provided varying levels of genetic information about the target (no information, 2%, 29%, or 49% DNA match to their claimed identity). The participants then answered a questionnaire with multiple measures assessing how the participants racially identified the target, and their attitudes toward the target. The results of this study will indicate the significance of genetic information to the perception of racial identity in the case of individuals with mismatched claimed identities. As genetic testing becomes more advanced and easily accessible, it is important to understand how genetic information influences the perceptions of racial identities.

Decolonizing Language and Asserting Identity: A two-part analysis of the French language between France and colonized African and Caribbean countries

Alyssa Frick-Jenkins, Black Studies and Linguistics with French emphasis, University of California Santa Barbara
Dr. Butch Ware, History

French imperialism mutes expression of racial identity through language practice. Francophone Blacks and Africans experience linguistic alienation and social subordination based on subjective ability to communicate in French. In response, they have re-appropriated and re-asserted their racial identity through the very medium used to dominate them. This paper takes on the question of language and its function, first by performing a comparative literature analysis between Francophone Black and African writers in hopes to develop a holistic view of sentiments towards the colonial situation. Finally, the prepared legacy of linguistic imperialism is analyzed by novel theoretical frameworks which support the effort by writers to decolonize the French language. The goal is to analyze the opposing sides of French– one devoid of racial or cultural markers and one superimposed with such features– and their measurable linguistic differences and effect of racial identity and cultural transmission. This research seeks to answer Audre Lorde's question: can the colonized utilize "the master's tools" (i.e. the colonial language) to dismantle the "master's house" by commanding their own existence where the language was inherently not made to do so.

High Granularity Upgrades for the Compact Muon Solenoid (CMS) : The 8" Design

Transito Gonzalez, Mathematics, University of California Santa Barbara
Dr. Joseph Incandela, Brunel Ødegard and William Ortez, Department of Physics

It is largely because of facilities such as the European Organization for Nuclear Research (CERN), that encourage mass collaboration, that humanity steps forward in understanding the fundamental characteristics of the universe. CERN is currently working on upgrades for the Compact Muon Solenoid (CMS), which is a general-purpose detector. These upgrades are meant to replace the CMS end caps with the High Granularity Calorimeter (HGCal) in order to improve particle-flow calorimetry. Our studies focus on the 8" particle-detector module design, produced, in part, at the University of California, Santa Barbara. In order to understand module performance, the modules must be thoroughly tested. To this end, our work in the laboratory is devoted to analyzing each module that we produce. One of these tests involves raising and lowering the voltage across a module to observe current responses and another involves data acquisition. Through these tests, we hope to gain an understanding about module performance in order to ensure that the new design can eventually be utilized at CERN.

First to Second Year Transitions for Latino Males at a Research-Intensive Hispanic Serving Institution

Jose Gutierrez, Sociology
Dr. Rebeca Mireles-Rios, Education

Latinas/os are the nation's largest ethnic/racial minority group in the United States. Despite Latina/o student increases in population, the retention and graduation rates of the group remain the lowest of any other ethnic/racial group in the United States. More startling, Latino males lag significantly behind their female peers in terms of both college access and degree attainment. In response, Hispanic serving institutions (HSIs) are creating programs to address the recruitment and retention of Latino male students. However, few researchers have focused on Latino male undergraduates' experiences at research-one HSIs. Instead, many researchers have focused on the community college experience of Latino males. This study provides a qualitative analysis of ten interviews conducted with undergraduate Latino males enrolled at The University of California, Santa Barbara (UCSB), a research-intensive

Hispanic serving institution. Through coding of the interviews for thematic analysis, this study is able to provide insight into the experiences of Latino males at research-intensive HSI.

***Legacies of a Movement:* The Civil Rights Movement and Its Impact on the Environmental Justice Movement**

Juanita Iheanacho, Global Studies, University of California- Santa Barbara
Dr. Paul Spickard, History

The Civil Rights movement set a precedent for non-violent protest and local activism for the many movements that have followed in its footsteps. The environmental justice movements of the 1980s drew direct inspiration from the Civil Rights movement and were able to utilize similar activism strategies using the networks and leadership that had been established during the Civil Rights era. This project analyzes the impact of the Civil Rights movement on the environmental justice movement in four key areas: environmental injustice as a matter of racism, the contributions of Civil Rights activists to the environmental justice movement of the 1980s, the political networks that were established during the Civil Rights Era that carried into the environmental justice movement, and lastly the Civil Rights protest strategies from which environmental justice activists drew inspiration. In order to establish the relationship between the Civil Rights movement and the environmental justice movement, published interviews with Civil Rights and environmental justice activists are analyzed. I analyze newspaper articles covering key environmental justice protests in order to compare the rhetoric that surrounds the political activism of underrepresented communities. Additionally, this project considers research that emerged during the transitional period from the Civil Rights movement into the environmental justice movement which explores the relationship between race and environmental injustice, such as the proximity of communities of color to hazardous waste plants, landfills, or dumps. Ultimately, this study aims to understand how political activism can play a major role in securing the environmental rights of ethnic minority populations in the United States.

Trinidad's Adoption into the Global Economy and Underdevelopment

Taylor Colette Jackson, Sociology, University of California Santa Barbara
William I. Robinson, Sociology
Sharon Tettegah, Education

In the age of globalization, countries who were adopted into the global economy as a means of development now face increasing wealth disparities. This study focuses on the impact of the Inter-Monetary Fund structural adjustment policies to Trinidad after the economic crisis of the 1980s. I aim to investigate whether the introduction of the aforementioned policies had a negative effect on Trinidad's socioeconomic development. This study employs both qualitative and quantitative analysis. First, I conduct a historical analysis to understand how Trinidad's economy and race relations developed from colonization to the modern era. Then, using cross-tabulations, I analyze the social impact of neoliberal policies on certain economic factors such as Trinidad's GDP and unemployment rates.

The Influence of Demographic and Socioeconomic Status on Federal Funding for Wildfire Risk Mitigation

Simran Kaur, Economics, University of California, Santa Barbara
Andrew Plantinga, Bren School of Environmental Science and Management

Fuel reduction projects such as prescribed burns and underbrush removal mitigate the risk wildfires pose to people and property; however, these projects require a large amount of funding. In California, fuel reduction projects receive financial support from both public and private sources, but most of the funding is awarded by federal agencies such as the United States Forest Service. This study examines how demographic and socioeconomic status affects the degree of federal support that different communities in California receive for wildfire risk management via fuel reduction projects. Federal funding is distributed to communities through Fire Safe Councils (FSCs), which are formed on the county and local level through grassroots community participation. The main purpose of FSCs is to establish Community Wildfire Protection Plans (CWPPs). Therefore, we predict that communities with demographic and socioeconomic characteristics associated with smaller rates of civic engagement (i.e. poor, less educated, and non-white) will have fewer FSCs and CWPPs, and less federal funding for wildfire risk management. This study compares the number of FSCs and CWPPs in each county to the median household income, percentage of individuals who have completed a secondary education, and percentage of non-white individuals to reveal whether demographic and socioeconomic characteristics create inequity in how federal spending supports communities facing wildfire risk.

Minimum-Ionization Particle Tracking in the Light Dark Matter eXperiment

Juan Lazaro, CCS Physics, University of California Santa Barbara
Phillip Masterson, Valentina Dutta, Joseph Incandela, Physics

We are developing a minimum-ionizing particle tracking algorithm for use in the proposed Light Dark Matter eXperiment (LDMX). Given event information, it analyzes the pattern of energy depositions, called hits, in the electromagnetic calorimeter (ECal) and returns the number of tracks found. So far, the algorithm has two stages. In one sweep from the back to the front of the ECal, it searches for hits that can not be associated with the recoiling electron but could be due to the photon produced when the beam electron scatters off of a thin Tungsten target. Starting with any isolated hit toward the back of the calorimeter, the algorithm looks for additional hits on the adjacent layer that may overlap, or nearly overlap, with the original cell. It then does another sweep using linear regression that can find tracks at large incident angles that may not have been found previously. Because we only expect to see real photons that may induce tracks in background events, this will help to catch yet un-vetoed background events and thereby augment our current methods of vetoing. “Background,” here, refers to a class of events that might resemble a dark matter process in the detectors but are actually the result of known standard model processes. Currently, the tracking algorithm, on its own, can reject approximately 95% tested sample. LDMX has excellent background rejection to successfully discover or rule out hidden sector particles in the 1 MeV to 1 GeV mass range as a source of particulate dark matter.

Implications of Varying the Objective Probability Distribution Within the Ellsberg Paradox

Fidel D. Lopez, Economics and Mathematics, University of California, Santa Barbara
Emanuel Vespa, Department of Economics

Various decision experiments have been studied which violate the axioms of subjective expected utility theory (SEUT); this study deals with such experiments. In particular, we focus on the Ellsberg paradox. We create two variations on the classical paradox that differ only in the objective probability distribution of the known jar. We do so with the intent of testing our hypothesis: as we move away from the objective probability distribution in the Ellsberg paradox, subjects will behave in a manner that is more consistent with SEUT and, in particular, with the sure-thing principle. We worked with a hypothesis test for proportions and $\alpha = 0.05$. Our results were statistically significant and, thus, we were able to confirm our hypothesis. Our findings suggest that the Ellsberg paradox may not be as detrimental to SEUT as previously thought. Instead, we believe it represents a very specific scenario which SEUT fails to properly explain.

Making Sense of One’s Undocumented Status: The Role of Family Socialization for DACA College Students

Nicole Mendoza, Communication, University of California Santa Barbara
Dr. Jennifer Kam, Department of Communication

Prior research has found that families of color often engage in ethnic/racial socialization--conveying verbal and nonverbal messages that teach children about their ethnic/racial identity and prepare them to navigate bias that they will encounter themselves. Such socialization efforts have been positively linked to children’s academic and psychosocial well-being. Thus, drawing from the work on family ethnic/racial socialization, the present study examined how immigrant families engage in family undocumented-status socialization--conveying verbal and nonverbal messages that help children make sense of what it means to be an undocumented immigrant in the United States. Although extensive work has been done on family ethnic/racial socialization, we know little about what such socialization looks like with respect to undocumented immigration status. Semi-structured interviews were conducted with 40 Latinx and Asian DACA (Deferred Action for Childhood Arrivals) college students. Anumber of themes were coded in regards to family ethnic/racial socialization including family informational and emotional support, family advocating protection, discussing the reality of deportation, etc. Examining the ways in which families talk about being undocumented is important because such messages are likely to contribute to

undocumented children's identity development, and are likely to teach them how to cope with their stress from being undocumented.

The recurrence of high-magnitude debris flows in Santa Barbara and Montecito

Bryant Pahl, Earth Science: Climate & Environment, University of California, Santa Barbara
Chandler Adamaitis, Dr. Ed Keller, Department of Earth Science

The magnitude 6 debris flow event that occurred in Montecito, CA following the 2018 Thomas Wildfire has left increasing concern for the possibility of future high-magnitude events. While evidence for past high-magnitude debris flow events can be found as boulder fields and boulder levees in canyons and stream banks of the area, the recurrence interval of these events is currently unknown. This study uses unconventional methods of examining the mean weathering rind thicknesses (WRTs) measured on sandstone boulders of debris flow deposits throughout Santa Barbara county to determine the geochronology of these events. We made 20 WRT measurements per boulder on a sample set of boulders at 16 sites. We hypothesized that by comparing the mean WRT of each site, we could categorize them into small, intermediate, and large groups. This would allow us to distinguish each site as being the result of a relatively younger or older debris flow event. These findings help predict the ages that can be expected for future study when these measured WRTs are correlated to exact age dates collected from radiocarbon analysis of charcoal found in the fine-grained matrix of the debris flows. If the correlation exists, we will create a calibration curve that will allow WRTs to be used as an independent chronometer to date past debris flows where radiocarbon analysis is not available, creating a more complete recurrence history of Santa Barbara and Montecito debris flow events.

Nematodes: A Possible Disease Reservoir for Amphibian Killing Fungus?

Yanelyn Perez, CCS Biology, University of California Santa Barbara
Tatum Katz, Dr.Cheryl Briggs, Department of Ecology, Evolution, and Marine Biology

Batrachochytrium dendrobatidis (Bd) is a highly virulent fungus in amphibians which causes the skin disease chytridiomycosis. This skin disease is responsible for population declines and extinctions in amphibian species worldwide, but little is understood about the transmission of the fungus in natural systems. It has been theorized that the spread of this fungus is facilitated by disease reservoirs, such as nematodes living in decaying material near ponds with amphibian populations. Previous laboratory studies have found that the nematode *Caenorhabditis elegans* can become infected with Bd which makes it a potential disease reservoir. However, it is unclear whether these organisms are disease reservoirs in natural systems. For this study, we performed a series of laboratory experiments to see whether worms can truly be inoculated with Bd and what types of effects does infection have on the worms. In order to further analyze the relationship between nematodes and Bd, we collected nematodes in areas of Northern California that have amphibian populations infected with Bd. We plan to explore whether these nematodes can be infected in a natural setting and thus could potentially be a disease reservoir for Bd.

Exploring the Mechanisms Behind Declining Olympia Oyster Populations After the Thomas Fire Mudslides

Brandon Quintana, Environmental Studies, University of California, Santa Barbara
Erin Winslow, Hunter Lenihan, Bren School of Environment Science and Management

The Olympia Oyster, *Ostrea lurida*, is the only oyster species native to the West coast of North America. Populations once ranged from British Columbia to Baja California, but have declined dramatically due to coastal development and polluted coastal inlets. The decline of these native oysters is problematic because they provide many ecosystem services such as shoreline stabilization, water quality improvement, food for many fishery species, and habitat for many migratory birds. The Carpinteria Salt Marsh, a University of California Natural Reserve, was historically had one of the largest natural populations of Olympia Oysters in Southern California. However, a recent survey of the salt marsh in early 2019 found a 76% decrease in the Olympia Oyster's population from historic levels. It is hypothesized that the recent debris flows after the 2018 Thomas fire dramatically altered the ecosystem which lead to the decline of the Olympia Oyster population. However, the exact mechanism behind how the debris flow caused the population decline is unclear. We predict that the debris flow physically altered the distribution of the benthic substrate, moving ideal substrate for oyster recruitment into areas outside the ideal temperature and salinity range for Olympia Osyters. To test these predictions, study sites across the salt marsh look for potential recruitment of oyster larvae. We have found one oyster recruit on a site with preferred substrate, temperature, and salininty. Understanding the lasting effects of natural disasters on this foundation species can inform future adaptive management of wetlands as frequency of natural disasters increase.

The Influence of Hagiography on the Franciscan Order (1226-1317)
Jesse Ramirez, Religious Studies, University of California, Santa Barbara
Professor Carol Lansing

The Franciscan order changed drastically between the 13th and 14th centuries, and I argue that hagiographies about St. Francis caused this shift. The hagiographical works of Thomas of Celano, brothers Leo, Rufino, Angelo, and St. Bonaventure presented ideas about Francis' status and faith that were different from Francis' own writings. These depictions shifted the order's view of him from a historical authority figure into a saintly authority figure for the order. I first explore Francis' own writings to provide a basis for how he viewed his status and faith. I then compare this to the changes that occurred between Francis' hagiographies by Thomas of Celano, the three brothers and St. Bonaventure. I conclude with a look into the role that these changes played in the development of the Franciscan order from 1226-1317. Friars argued over correct interpretations of Francis' understanding of poverty, however Franciscan poverty was largely the creation of his hagiographers. While Francis considered poverty to be significant, his own writings never gave it the preeminence that his hagiographers did. This study then reveals the profound effect that hagiography has on religious and political environments because Francis' hagiographers rewrote him into a devotional figure to meet the needs of the growing Franciscan order.

The Effects of Immigration Experience on Health and Healthcare in Ethiopian and Eritrean Americans
Nardos Shiferaw, Cultural Anthropology, UC Santa Barbara
Dr. Barbara Harthorn, Department of Anthropology

Since the 1980s there has been a significant increase in black immigrants in the US, which consists of immigrants mostly from African countries. Despite the growing population of black immigrants, most research regarding immigration and health in America, and particularly in California, is centered on Latinx and South East Asian populations. However, there are differences between immigration experiences that these distinct populations face which suggests that specific research on these African immigrants is necessary in order to serve the unique needs they face. Looking at the main immigration pathways of both populations which consists of obtaining legal permanent resident status through family reunification, diversity programs, and refugee admissions; this study focuses on the views of second-generation Ethiopian and Eritrean Americans regarding how their parent's immigration experience affects their personal and family's health and access to quality healthcare. Through semi-structured interviews with second-generation Ethiopian and Eritrean Americans, this study explores the ways these different immigration pathways affect the health outcomes of multiple generations of immigrant families. The conclusions that can be derived from this research are the ways immigration experience and status affect health and access to quality healthcare.

Development of Dynamic Nuclear Polarization Hardware to Aid in DNP Research
Raymond Thicklin, University of California Santa Barbara
Alisa Leavesley Ph.D., Asif Equbal Ph.D., Songi Han Ph.D. Chemistry Department

Dynamic Nuclear Polarization (DNP) is a phenomenon that has been theorized since the discovery of the Overhauser effect in 1953. Dynamic Nuclear Polarization (DNP) is a principle that has the fundamental purpose of enhancing Nuclear Magnetic Resonance (NMR) signal. In order to aid in the research of DNP medical applications, the Han lab at the University of California Santa Barbara researches the physics of how DNP works. The DNP hardware that the lab currently uses lacks sample exchange abilities and the hardware has an inefficient cooling system. Both of these limitations inhibit the rate at which the lab can produce data for DNP research. A new DNP hardware design utilizes a more efficient cooling system and sample exchange capabilities. The Han lab seeks to install this new DNP hardware and begin conducting research on the physics of DNP with it. Before starting the research, the lab must assure that its DNP signal acquisition is on par with the current DNP hardware. The

hypothesis of this project is that the newly fabricated DNP hardware will acquire the same intensity of signal per sample as the current DNP hardware. In this project, we designed, manufactured, installed the new DNP hardware. The hardware was also tested against the previous DNP hardware design using standard samples. The integrated signals were found to be the same between the new and old hardware designs

Problem-based Initiatives for Powerful Engagement and Learning in Naval Engineering and Science (PIPELINES)

http://pipelines-csep.cnsi.ucsb.edu/

The Problem-based Initiatives for Powerful Engagement and Learning In Naval Engineering and Science (PIPELINES) program is an 8-week immersive experience, where teams of undergraduate students compete in finding the most innovative and effective design solutions to real-world Naval engineering and science design projects. Interns attend weekly meetings, special seminars, and sharpen their problem-solving and entrepreneurial skills through a course on Applied Creativity and Innovation.

Fueling Innovation: Pressure Vessels

Elise Bartel, Civil Engineering, California Polytechnic State University, San Luis Obispo
Ryan Espinosa, Mechatronic Engineering, California State University, Chico
UCSB Grad Mentor: Melanie Adams, UCSB Mechanical Engineering Department
EXWC Supervisor: Jeremiah Monzon, NAVFAC EXWC Capital Improvements, Petroleum, Oils, & Lubricants

Our project is to design, build, and test a small-scale fuel pipeline, using non destructive testing techniques. The main goals of this project are to hydrostatically test our pipeline and have it become a testing and training platform for future Petroleum, Oils, & Lubricants engineers. The current solution is to train engineers at an existing fuel pipeline, which can lead to safety risks due to a lack of previous exposure to operating procedures.
Some of the design requirements and constraints that we faced were related to the materials, durability, mobility, and time. The pressure vessel and components are made of steel. The strength of the vessel was simulated using Finite Element Analysis and analyzed with the Von Mises criterion. For mobility, we have a cart to support our pressure vessel. Completing each step in a timely manner was our last major constraint.
Our proposed solution includes a three-foot long, a four-inch diameter, steel pressure vessel with an attached testing tree. The tree includes an assembly of pipes, pressure gauges, valves, and hoses. For the hydrostatic test, we will pump water into our vessel through this tree and record data using a flow meter, pressure gauge, and dead weight tester. Using theoretical calculations, the procedure focused on hydrostatically testing our vessel at 100 psi. The vessel will be pressurized for varying periods of time, allowing us to determine the integrity of the pipe and any points of leakage.
Our final product will allow Petroleum, Oils, & Lubricants engineers to learn how to use non-destructive testing equipment both properly and effectively.

Threat Detective: Cyber Physical Protection

Alessandro Guaresti, Computer Science and Information Technology, CSU Channel Islands
Sebastian Magana, Electrical Engineering, University of California Santa Barbara
Issac Navarro, Computer Engineering, University of California San Diego
Gregory Norton, Computer Science, Naval Postgraduate School
UCSB Grad Mentor: Esther Showalter, UCSB Computer Science Department
EXWC Supervisor: Jorge Lacoste, NAVFAC EXWC, Public Works

The Navy faces cyber threats from adversaries who grow more capable and persistent every day. The stakes are high: if an attacker targets a critical control system, the consequences could be millions of dollars in damage, injury, or even loss of life. In order to develop defenses against these attacks we developed a rapid testing network security platform. The platform has three components: simulation, data collection, and threat detection. After selecting a system to test, simulation is accomplished by constructing a threat detection model using Node-Red software. Next, realistic network traffic can be collected and logged in a database using the ELK stack. Our demonstration showcases a model communicating by Modbus protocol, which is a legacy networking protocol that is still widely used despite glaring security vulnerabilities. We collect and analyze network traffic generated from simulated attacks. Our example uses the TCP SYN flood denial of service attack. The last step is threat detection, which we plan to accomplish via machine learning using the Amazon SageMaker service. By training the machine learning agent using network traffic generated from the model, we can establish a baseline for normal network activity, and raise alarms when anomalies are detected.

A Bird's Eye View: Monitoring the California Least Tern Using Unmanned Aerial System (UAS) Imagery

Joseph Jennings: BS: Computer Science, BA: Music, California State University Channel Islands
Michael Petracca: BS: Computer Science, BS: Mathematics, California State University Channel Islands
Jeremy Pulido: BS: Computer Science, BS: Mathematics, BS Physics, California State University Channel Islands
UCSB Grad Mentor: Natasha Krell, UCSB Geography Department
EXWC Supervisor: Jean Pan PhD, NAVFAC EXWC Environmental

The fields of ecology and computer science are not commonly thought of as being used together however this process of thinking is rapidly changing. In the modern world, people are constantly looking for ways to work more efficiently with the assistance of computers. This search for efficiency has led to the growth of several fields such as artificial intelligence which can be used to augment and assist people with their work. The use of these technologies can make work safer, more cost effective, and less intrusive to the environment. Through our work we are attempting to develop an autonomous system that can be used to identify target objects in a landscape. To demonstrate this system, we are surveying the endangered population of the California Least Tern on a local Southern California Beach. We used a geospatial mapping program called ArcGIS Pro alongside several machine learning principles and an artificial intelligence to collect and process our data. Our results show that it is possible to autonomously analyze an image and successfully identify and retrieve a count of the specified target objects. Our work is significant to the future of Navy operations, especially in the field of ISR: Intelligence, Surveillance, and Reconnaissance.

Don't Crack Under Pressure: Creating a Pressure-Tolerant Circuit Board

Juan Carrillo, Mechanical Engineering, University of California, Berkeley
Emily Chapman, Civil Engineering, University of Delaware
Ryan Nedbailo, Engineering Physics, Colorado State University
UCSB Grad Mentor: Nathaniel Tucker, UCSB Electrical and Computer Engineering Department
EXWC Supervisor: John Hunter, PhD, NAVFAC EXWC, Oceans Department

The U.S. Navy uses many underwater electronics such as underwater cables for communication purposes and/or gathering data. Currently, the U.S. Navy uses large metal canisters to house these electronics at great ocean depths. These canisters are about 12 inches long, 4 inches in diameter, and weigh about 25 pounds. They are designed for specific ocean depths as they need to be able to withstand varying ocean pressure. Therefore, the farther down an electronic has to go, the bigger the canister it will require. The issue with these pressure vessels is that they can be a waste of space if the electronics that will be used are small in comparison to the canisters. The goal of our project was to find a new way to house circuit boards underwater to replace these bulky pressure vessels. We went with a high strength, compact case design. We designed and printed a printed circuit board (PCB) of an LED flasher and soldered surface mount components. Our case consists of 4 layers: a top and bottom plate, the circuit board layer, and a well layer. The material utilized was G10 Garolite, a high strength fiberglass. To sandwich the case together, we used a pressure tolerant epoxy and a capillary sealant. The two cases were tested in the Deep Oceans Lab in the Port Hueneme Naval Base up to 4,500 psi. Both LEDs stayed bright all the way up to 4,500 psi.

Moor than an Anchor: Expeditionary Mooring Systems

Alejandro Navarro, Aerospace Engineering, California Polytechnic State University San Luis Obispo
Angela Sarni, Ocean Engineering, University of New Hampshire
UCSB Grad Mentor: Matt Kirchner, UCSB Electrical Engineering Department
EXWC Supervisor: LT Reece Comer, NAVFAC EXWC, Oceans

The U.S. Navy is addressing a capability gap in their expeditionary warfare forces performing missions abroad. Existing practices for mooring large warfare vessels require barges, cranes, underwater construction teams, and specialized training. This increases cost and precious time, which is not conducive to expeditionary missions. To resolve this complication, a temporary mooring system was designed to fit into three shipping containers (8 x 8 x 6.5 ft) that can be carried on a C-130 cargo aircraft to destinations around the world for rapid deployment. The containers are devised to act as a kit containing all the necessary mooring system components, equipment, and procedure documents.

The kit will be comprehensive, including an assortment of line lengths for varying depths, an assortment of anchor types for varying bottom compositions (mud, sand, coral, rock, etc.), all the necessary connectors, buoys, and a penetrometer for remotely detecting the bottom composition. The assembled mooring system was modeled with an amphibious assault ship (LHA/LHD) plus simulated wind, current, and wave loads using AQWA and Orcaflex software. The resultant dynamics and stability of the system were analyzed for future design iterations.

University of California
Leadership Excellence through Advanced Degrees (UCLEADS)

https://www.graddiv.ucsb.edu/admissions/outreach/uc-leads

The University of California Leadership Excellence through Advanced Degrees (UC LEADS) program is designed to engage and educate California's future leaders by preparing promising students for advanced education in science, technology, mathematics and engineering (STEM). UC LEADS is designed to identify upper-division UCSB undergraduate students with the potential to succeed in these disciplines, but who have experienced situations or conditions that have adversely impacted their advancement in their field of study.
UC LEADS Scholars embark upon a two-year program of scientific research and graduate school preparation guided by individual Faculty Mentors. Scholars are provided an excellent opportunity to explore their discipline, experience a research environment, and improve their opportunities for future study in their chosen field. The Scholars gain valuable educational experience from the University, and are better prepared and more diverse graduate applicant pool, and the State, well-educated future leaders.

Determining the Ionizing Source of Green Pea Galaxies using the Spectral Synthesis Code Cloudy
Haley Bowden, Physics, University of California, Santa Barbara
Dr. Crystal Martin, Department of Physics

Astronomical observations over the last decade have revealed luminous galaxies known as Green Pea Galaxies for their green appearance and small-size. The observed emission-line spectrum from Green Pea Galaxies indicates the presence of high energy photons and therefore a very hot source of ionizing radiation within the galaxy. In an attempt to understand the physical properties of these galaxies I used the existing code Cloudy, which predicts spectra of the galaxy's gas and dust by accounting for specific input parameters. By using Cloudy to determine the spectrum we would observe given model sources, I can compare to find which simulation best parallels the observations we have of these galaxies. Green Pea Galaxies were thought to be well described by an HII region model photoionzied by O stars, yet a population of O stars does not produce the amount of HeII ionization that we observe. One alternative source we are interested in continuing to investigate is an x-ray binary. X-ray binaries, rare astronomical phenomena that have been observed in nearby galaxies, are types of binary star systems in which the matter from one star, a red supergiant, falls onto the other, a neutron star or black hole. This infalling matter forms an accretion disk around the receiving star, releasing high energy photons. Hence, the presence of x-ray binaries in Green Pea Galaxies may explain their observed spectrums.

Utilizing Spyiropyran as a Photosurfactant to Control Nanoemulsion Breakage
Michelle Chiu, Biology, University of California, Santa Barbara
Dr. Javier Read de Alaniz, Department of Chemistry and Biochemistry

Nanoemulsions can encapsulate water-insoluble molecules, making them useful tools for biodelivery of hydrophobic drugs. The challenge is maintaining nanoemulsion stability until the time of desired release and destabilizing on-command. While internal cargo from nanoemulsions can be released in various ways, using less-invasive means widens the potential range of applications. Light is a powerful tool as it is noninvasive, controllable and stimulates different molecules at certain wavelengths. To effectively control nanoemulsion release, we have synthesized and optimized the use of a UV-responsive photosurfactant. Surfactants are amphiphilic molecules that stabilize

nanoemulsions. Here, we utilize the hydrophobic photoswitch spiropyran and the hydrophilic polymer PEG to synthesize a spiropyran-PEG photosurfactant, which experiences reversible conformational change when exposed to UV light. The light causes the spiropyran to switch to its charged, hydrophilic form, rendering it a poor surfactant because of the reduced amphiphilicity, thus destabilizing the nanoemulsion. Prior to running release studies, we optimized the size and stability of our nanoemulsion system using ultrasonication and Dynamic Light Scattering, through which we have formed stable hexadecane-in-water nanoemulsions using the co-surfactant Tween20. To study the efficiency of triggered release under various conditions of irradiation time and surfactant concentration, we irradiate the nanoemulsions and quantify the release of the inner oil. We are working to optimize quantification methods using solvent layering and UV-vis spectroscopy to collect and quantify the released, colored oil. Due to the unique responsiveness of spiropyran to multiple stimuli, we are also investigating other methods of inducing breakage through the addition of salt and acids.

Mextal Oxide Catalyzed Epitaxy (MOCATAXY) Growth of β-(AlxGa1−x)2O3/Ga2O3 Heterostructures
Evelyn Deagueros, Physics, University of California, Berkeley
Dr. Jim Speck, Department of Material Science

β-Gallium oxide is a promising material for high-performance power electronics because of its desirable material properties and its lower cost of production compared to other semiconductors, e.g. SiC and GaN. In particular, modulation-doped field effect transistors based on β-(AlxGa1−x)2O3/Ga2O3 heterostructures see the formation of a two-dimensional electron gas (2DEG) at its interface that enables higher channel mobilities because of its confinement of extra electrons and its screening effect. However, due to the low solubility of Al2O3 in the range of temperatures used by Plasma Assisted Molecular Beam Epitaxy (PAMBE), T<800ºC, AlGaO/GaO heterostructures with high enough Al content across various directional planes has yet to be realized. Recently, Metal-Oxide Catalyzed Epitaxy (MOCATAXY) growth of β-(AlxGa1−x)2O3/Ga2O3 with Indium as a surfactant, has broaden the growth domain and growth rate of these heterostructures, leading to an Al content of x=0.20, 4% higher than the maximum achieved under "conventional" growth. In an effort to move to more scalable substrates, we investigate the nature of this growth for (-201) and (001) β-Ga2O3. By systematically changing growth parameters (e.g. substrate temperature, Al and In fluxes), we were able to reach Al concentration of x=0.10 and x=0.15, for (-201) and (001), respectively, while maintaining relatively smooth surface morphology.

Synthesis of Phase-Pure Lead Halide Ruddlesden–Popper Phases with Melt Processing
Isaac Diaz, Chemistry / Material Science, University of California, Los Angeles
Dr. Michael Chabinyc, Department of Material Science

Two-Dimensional (2D) Hybrid Perovskites have emerged as a more stable and versatile class of materials than their three- dimensional (3D) counterparts. One such class of 2D perovskite materials are Ruddlesden–Popper phases with the general formula (L)2An-1PbnI3n+1, where L is a large, organic spacer cation that divides the structure into layers of size n. Properties such as bandgap and exciton binding energy largely depend on the number of octahedral layers in sheets (n). In addition, in order to tune for a certain optoelectronic property or gain a fundamental understanding of a certain n value perovskite, a phase- pure sample is desired.
Upon solution processing by spin-coating, 2-D Perovskites yield a wide mixture of n - value phases. Melt processing allows for both highly crystalline and phase pure samples to be create. Previously phase-pure samples of (ß-Me-PEA)2(MA)2Pb3I10(n=3) have been synthesized. However, Methyl ammonium (MA) is known to be thermally unstable, inhibiting the thermal stability at high temperatures required for melt processing. Thus, replacing the organic cation MA+, with the inorganic cation Cs+ allows for a more thermally stable 2D perovskite to be created. We present an attempt to recreate the melt processing previously developed by Mitzi et al, to create phase-pure (ß-Me-PEA)2(MA)2Pb3I10 (n = 3) thin films. By modifying the procedure, we attempt to synthesize phase- pure (ß-Me-PEA)2(Cs)2Pb3I10 (n=3) thin films. Photoluminescence and X-Ray Diffraction measurements are used to assess the phase purity of melt processed samples created using different synthesis parameters.

Poliovirus 3C Protease Cleaves Syntaxin Fusion Proteins to Redirect Host Membrane Trafficking
Shay Ellaboudy, Biology, University of California, Santa Barbara
Dr. Thomas Weimbs, Department of Molecular, Cellular, and Developmental Biology

The enterovirus species of positive strand RNA viruses, including poliovirus, EVD68, and EVA71, replicates in association with cellular membranes. Recently, the induction of autophagy was found to play a major role in enteroviral replication and virion assembly. Here, we find that a viral protease cleaves host proteins, disrupting normal membrane trafficking. We hypothesize that the virus specifically cleaves these host proteins to channel membrane traffic towards the autophagic pathway, facilitating the genomic replication and assembly of viral progeny. We propose a model for the selective cleavage of host proteins and subsequent redirection of membranes, allowing the virus to repurpose host membrane trafficking to promote pathogenesis.

Morphological and Optical Study of Organic Photovoltaics
Miguel Flores Martinez, Chemistry, University of California, Merced
Dr. Thuc-Quyen Nguyen, Department of Chemistry and Biochemistry

Organic Photovoltaics (OPVs), made from carbon-based materials, are considered as third-generation solar cells. Being lightweight, thin, flexible and potentially even (semi-)transparent, OPVs bear unique properties that cannot be realized with conventional Si-photovoltaics. OPVs can be solution processed, opening the possibility of energy-efficient, large scale roll-to-roll fabrication. In our laboratory studies we fabricate OPVs based on the polymer donor PTB7-Th and the non-fullerene acceptor IOTIC-4F by spin-coating in conventional and inverted structure. Each layer of the device structure as well as residual catalyst from synthesis of both donor and acceptor material in the active layer can have major impacts on device performance. Employing tapping mode Atomic Force Microscope, we study the morphology of Glass/ITO substrates, poly (3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT: PSS), and the active layer. The influence of the commonly used catalyst palladium-tetrakis(triphenylphosphine) on film morphology of the active layer is studied with AFM. In the second part of this work, we investigate the optical properties of PEDOT:PSS with UV-Vis measurements for the purpose of optical device simulations.

Using Infrasound to Study Volcano Eruption Activity at Tungurahua, Ecuador
Charusheela Garapaty, Earth Science, University of California, Santa Barbara
Dr. Robin Matoza, Department of Earth Science

One way geophysicists study active volcanoes is to analyze the infrasound signals they produce. Infrasound is sound with frequencies too low for humans to hear, ranging from 0.01 to 20 Hz. It is important to monitor volcanoes because eruptions and other volcanic activity can present major hazards to local populations and infrastructure.
This summer I have been studying infrasound data from the stratovolcano Tungurahua in Ecuador, which is in proximity to over 25,000 people. During 1999-2016, Tungurahua exhibited almost continuous eruptive activity, including both explosive and effusive phases. Explosive eruptions disturb the atmosphere, generating large-amplitude infrasound signals we can detect using specialized microphones. These signals can be used to constrain characteristics, timing, and location of eruptions.
In 2006, two small-aperture infrasound arrays were installed 37 km (RIOE) and 251 km (LITE) from Tungurahua as part of the Acoustic Surveillance for Hazardous Eruptions (ASHE) project [Garces et al. 2008]. Both arrays operated near continuously until 2013, providing an exceptional multi-year acoustic record of varied eruptive activity at Tungurahua. I am analyzing the waveforms and frequency content of this data collected from Tungurahua in 2006-2013 with Python and MATLAB. I will be comparing my results to weekly eruption reports on the Smithsonian Global Volcanism Program website.
Our goal is to further utilize the available data to document the multi-year infrasonic source and local propagation variations at Tungurahua. Ultimately, the aim of this research is to further develop infrasound technology as a volcano monitoring tool, and to better evaluate its capabilities and limitations.

Opaleye Sprint Treatment
Tina Nguyen, Marine and Coastal Science, University of California, Davis
Dr. Erika Eliason, Department of Ecology, Evolution, and Marine Biology

Fish are experiencing rising average temperatures in the ocean in addition to higher exposure to extreme temperatures daily and seasonally. Species that can adapt to these temperature changes more quickly have an advantage, and we predict that their diets can influence their ability to acclimate, or respond physiologically to new conditions. Fish consumption tends to be more carnivorous towards the poles and herbivorous towards the equator, suggesting that diet may impact the way fish cope with temperature changes. Opaleye, a fish species native to Santa Barbara waters, are an ideal model to study diet effects on thermal acclimation due to their omnivorous diet and the fact that they have been shown to change their diet with environmental temperature in the wild. Using sprinting performance as a proxy of fitness, we test the interactive effects of diet strategy and temperature on juvenile opaleye. We hypothesized that herbivorous and omnivorous fish performance would be greater than that of carnivorous fish in warmer temperatures, while in colder temperatures, carnivorous diets would confer greater performance. If this is true, it would suggest that fish and other ectotherms may be able to alter their diet to respond to temperature stress.

Vine Inspired Soft Robot for Endotracheal Intubation
Luis Ramirez, Mechanical Engineering, University of California, Irvine
Dr. Elliot Hawkes, Department of Mechanical Engineering

Endotracheal Intubation (ETI) is a technique performed in emergency procedures where a ventilation tube is inserted into the trachea. ETI requires the placement of a laryngoscope into the mouth to allow a medical professional to move the dorsal portion of the lounge to expose the superior portion of the trachea. Although seasoned medical professionals' success rates can be repeatably high, there are perilous complications if performed incorrectly, a large amount of practice is essential for proper intubation, and ETI can only be performed by trained professionals. To minimize the risk of causing negative outcomes, we are using vine-inspired growing robots to insert a guide channel directly into the trachea to increase the repeatability of successfully inserting an intubation tube. The focus of our growing robot is aimed towards conforming to the overall shape of the oral cavity to lift the tongue and exposing the vocal cords of the trachea. With the incorporation of a second, narrower vine robot, we can gently and passively enter the trachea without damaging the vocal cords. This second vine robot serves as a guide channel where an individual without any medical background can quickly and correctly insert an intubation tube and begin providing ventilation. We hypothesis that through testing our device on intubation models and cadavers, individuals with no medical background will have repeatable success rates performing ETIs without complications.

Formation of Carbon Through Pyrolysis Using Different Inlet Streams
Matthew Salazar, Chemical Engineering, University of California, Santa Barbara
Dr. Eric McFarland, Department of Chemical Engineering

The pyrolysis of hydrocarbons produces hydrogen gas and solid carbon; the hydrogen gas produced can be used as a fuel source that does not release carbon dioxide when combusted. This project focused on the formation mechanisms of carbon on a molten salt catalyst surface. The effects of hydrogen on the morphology and the rate of formation of carbon through the pyrolysis of methane were examined. In addition, the pyrolysis of different higher molecular weight hydrocarbons and the types of solid carbon they produced were also examined. The formation of carbon was observed using digital video imaging and the structure of the carbon was analyzed using Raman spectroscopy. Most of the carbon produced in the experiments had similar patterns of formation process and similar structure except for the carbon produced using acetylene, which had a distinctly different morphological pattern.

UCSB-HBCU Scholars in Linguistics Program (UCSB-HBCU)

https://ucsbhbculing.com/

This project is funded from the Research Experiences for Undergraduates (REU) Sites program in the SBE Directorate and the University of California UC-HBCU Initiative. The UCSB-HBCU Scholars in Linguistics program establishes a partnership between UCSB and HBCU faculty to establish a pathway for HBCU students to enroll in UCSB's graduate program in linguistics. This REU site is designed to increase diversity in the linguistic sciences by investigating the linguistic choices that underrepresented minority students make as they navigate higher education. The research sheds light on the role of language in social mobility, an important but understudied aspect of educational and economic advancement. It therefore supports the prosperity of underrepresented minorities and many findings are likely to generalize to and thus benefit other American populations.

"I'm not Black, I'm—": Exploring the Role of Language in the Identity Formation of Black Undergraduates that are Descendant of the Transatlantic Slave Trade
Mea Anderson, African and African American Studies, Stanford University
Jazmine Exford, Anne Charity Hudley, Ph.D., and Mary Buchotlz Ph.D., Department of Linguistics

My interests within the Talking College Project surround identity formation within Black communities, specifically in the context of communites that are descendant of the Transatlantic Slave Trade. I am investigating the ways in which language contributes to these communities' sense of self and their identification of and with other Black ethnic groups. At this point in my research, I have found that Black language is very much intertwined with individual and intra-community identity but not across different ethnic identities. These and other findings are critical to understanding the impact of whiteness and traumatic histories on various Black communities and how the legacy of such institutions impact the way young Black people are able to find comfort and value in their own identity. This valuation of self contributes greatly to the quality of Black undergraduates' experiences in college and can make or break their ability to find community amongst their peers.

The Effects of Socioeconomic Status and Parental Educational Attainment on the Linguistic Practices of Black Students at PWIs
Ericka Canon, Linguistics, Emory University
Jazmine Exford, Anne Charity Hudley, Ph.D., and Mary Bucholtz, Ph.D., Department of Linguistics

In this presentation, I highlight how Black students who attend predominantly white institutions (PWIs) use and negotiate their language practices in various spaces throughout their institution. I place particular focus on how socioeconomic status and parental educational attainment are factors that may affect their language attitudes and practices. The data is derived from 8 sociolinguistic interviews I conducted with Black students who attend various PWIs in California and Atlanta. They discussed their experiences with access to campus resources, their parents' attitude towards language and their career choices, and their interactions with both Black and non-Black faculty, students, and staff. My preliminary findings suggest students with different socioeconomic statuses and/or parental educational attainment have different experiences and levels of comfort in regard to navigating the linguistic landscape of higher education. For instance, the students who come from a household where one or both parents have attended college and/or come from a higher socioeconomic status find it easier to acclimate to the linguistic expectations of PWIs. These same results are not found with first-generation and low-income students. Thus, further research concerning the linguistic experiences of Black college students from different socio-economic statuses and parental education attainment must be conducted in order to create solutions that are inclusive and supportive toward these unique groups. This study contributes to the discussion surrounding the obligations that PWIs must have when they recruit students who are first-generation and/or of low socio-economic status for purposes of making the university more equitable and diverse.

Performance Denuded: The Function of Language through Campus-derived Colloquialism

Dominique J. Cassamajor, Theatre Arts & Performance Studies, Morehouse College
deandre miles-hercules, Anne H. Charity-Hudley, Ph.D. and Mary Bucholtz, Ph.D., Department of Linguistics

When investigating the nuances of socio-linguistics in undergraduate research, past practitioners commonly fail to factor in the underlying oral narratives of those students at the intersection of multiple marginalized communities. Albeit, with nuances, come new scholars, and what do new scholar bring? New projects. The Talking College Project is a research-based, participant-interview heavy undergraduate study that aims to increase inclusivity and mitigate discrepancies of social exclusion with particularly African-Americans in the broader college space. I specifically focus on Performance Theory and coinciding modules of how language is performed as both an art form and a coping mechanism in day-to-day interactions. With meshing these two topics together, this presentation highlights the patterns in anecdotes of students of color and the copula for how they navigate their socio-civic space of their respective institution. The students' use of regional slang, contextual colloquialism, utilization of Standard American English and how/why they activate each in both the environment and manner that they do, is under investigation. With the agency to maneuver and investigate the present-day society that we live in through a lens as multifarious as Linguistic studies with a Performance studies framework, I'm avid to perpetuate the vision of the UCSB-HBCU Scholars in Linguistics Program to the world at large and further redesign post-secondary education systems through research and service not just for inclusivity purposes, but for the visibility of experience as well.

Evaluating the Raciolinguistic Practices of African-American Students in Higher Education

Christopher E. Holt, Speech-Language Pathology & Audiology, North Carolina A&T State University
deandre miles-hercules, Anne H. Charity Hudley, Ph.D. & Mary Bucholtz, Ph.D., Department of Linguistics

In this presentation, I highlight the metalinguistic perspectives and experiences of African-American students at Historically Black Colleges/Universities (HBCUs), who are often erased in discussions of African-American undergraduates. I focus on the motif of "talking/acting white" in students' experiences and the broader landscape of Black academic life. Students who participated in these sociolinguistic interviews were selected through word-of-mouth and snowball sampling. Interviews were recorded using audiovisual equipment conferencing services such as Zoom & Skype or recorded using an audio recorder and analyzed by hand coding to examine trends in commentary and re-occurring linguistic phenomena. Preliminary findings suggest that many students who attend HBCUs and were accused of talking/acting White were accused between the 8^{th} – 11^{th} grade. African-American students attending PWIs have not been surveyed at this time. Additionally, students report social experience differences occurred, but daily linguistic practices were unchanged. The entire definition of the "Black" experience is changing, not just at the university level, but also in the context of the population in the United States because of the linguistic features and individuals who may be singled out because they are portrayed as "not Black enough". These experiences shape how universities are portrayed, students feel their presence is valued, and the types of social and institutional issues present at their respective universities. In order for universities and faculty to cater to the needs of the students, it is necessary to discuss and listen to the students who experience these issues.

African American Code Switching with Devices

Jonathan Johnson, Psychology, Kentucky Wesleyan College
Jamaal Muwwakkil, Anne H. Charity Hudley, Ph.D. and Mary Bucholtz, Ph.D., Department of Linguistics

Imagine sitting in a Tesla, a vehicle that is promised to be the "perfect" technological vehicle without the capacity to properly hear black Twitter read to you on your daily commute. This presentation attempts to highlight African American college students linguistic experience found between them and Natural Language Processors, like Siri, on college campuses. To examine this phenomenon, interviews with African American college students were conducted. The students recruited were from a wide array of majors and backgrounds. These recordings were solicited by means of audiovisual mediums such as Zoom, Skype, FaceTime, etc. and were recorded on an audio-recorder. These messages were hand-transcribed and coded in Google Sheets. The preliminary findings incur that African American English (AAE) is significantly underrepresented in the realm of Natural Language Processing. In the current digital age, this lack of representation has consequential polarizing effects concerning linguistic dominance. An increase of experts in the field of African American English would be required to create a more representative corpora and build Natural Language Processing models that represent AAE. On a grander scale this representation has the potential to reduce bias implications in AI algorithms.

Student Athletes' Perspectives of Language Use on the Field and in the Classroom

Sierra Smith, Communicative Disorders, Jackson State University
Jamaal Muwwakkil, Anne Charity- Hudley, Ph.D., and Mary Bucholtz, Ph.D., Department of Linguistics

Student-athletes' experiences and successes on the field have been thoroughly researched, but the focus of language in black student athletes' day to day lives has been overlooked. I highlight the perspectives and experiences of African American student athletes and their linguistic practices among them. I highlight variation between them and their teammates as opposed to them and their coaches, as well as their academics peers and instructors. I do so to better understand if (dis)alignment with spoken varieties affect feelings of belonging among Black athletes and their coaches. In this study, I conducted Sociolinguistic interviews with student athletes from Predominantly White Institutions (PWIs) and Historically Black Colleges and Universities (HBCUs).

Navigating African American English in University Housing

Alexandria Williams, Sociology, University of California Santa Barbara
Jamaal Muwwakkil, Anne Charity Hudley, Ph.D., and Mary Bucholtz, Ph.D., Department of Linguistics

The goal of this study is to investigate the dynamics of how Black students navigate use of AAE and cultural practices within living communities in university housing amongst peers of various ethnic backgrounds. The research comprises sociolinguistic interviews from Black students in predominantly White institutions (PWI) and Historically Black Colleges and Universities (HBCU) discussing their living experiences among Black and non-black students in their university. Findings suggest Black students who grew up in primarily White communities find it easier navigating relationships between peers who are non-black in university housing, as opposed to those who grew up around Black people. Additionally, Black student from Black communities tended to find their sense of community outside university housing or living in Black housing. This study contributes to campus climate literature highlighting the difference AAE usage makes in residential life and maintaining relationships with others who do not speak the same dialect or share the same culture, the amount of belonging they feel at the university.

Even the Rat was White: Creating Representation within Higher Education

Kamrynn Williams, Psychological & Brain Sciences, Language Culture & Society, UCSB
Jammaal Muwwakkil, Anne Charity Hudley, Ph.D., and Mary Bucholtz, Ph.D., Department of Linguistics

The lack of non-white professors is a self-perpetuating issue in higher education. Meaning, people tend to hire people that look like them, making it difficult to increase the amount of faculty of color. When looking to increase the success of Black students it is useful to also look at the diversity of faculty. Of the 42 faculty members in the Department of Psychological and Brain Sciences at UCSB, there are 3 people of color. Two identifying as Asian-American and one African-American. Through sociolinguistic interviews, I investigated how Black students orient differently with Black faculty and how the lack of black faculty may have affected their experiences in higher education. With this research, I hope to provide a starting point for diversifying faculty and curriculum starting the psychology department at UCSB and allowing this change to influence change in other departments and universities. In turn, increasing Black students' success and sense of belonging.