Higher Education Research Council
Undergraduate Research Fellows
Boise State University
Final Report

Academic Year 2023-2024

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Introduction

The Institute for Inclusive & Transformative Scholarship oversaw the HERC Undergraduate Research Fellowship at Boise State University Fall 2023 and Spring 2024. HERC funds were used to support Boise State undergraduate students who had minimal research experience with a 12-week mentored research opportunity during the fall and spring semesters. Funds provided by the Higher Education Research Council supported a total of 20 students across 12 different STEM disciplines.

On behalf of the Institute for Inclusive & Transformative Scholarship, we thank the Higher Education Research Council for their generous support in helping build meaningful experiential learning experiences for Idaho students and supporting faculty research.

The Higher Education Research Council provided $65,000 in funding to support STEM undergraduate research at Boise State University this year. Please see the table below of how stipends and travel awards were dispersed.

HERC Funding:

Stipends	**Amount**	**Details**
Fall Semester Research Stipends	$27,000	9 fellows, receiving $3,000 each
Spring Semester Research Stipends	$33,000	11 fellows, receiving $3,000 each
Travel grants	$5,000	See table below
Total	**$65,000**	

Conference	**Amount**	**Details**
Society for Range Management	$800.00	1 student presented at the conference in Sparks, NV.
American Chemical Society National Meeting	$800.00	1 student attended the conference in New Orleans, LA.
Max Planck Institute	$700.00	1 student to attend the Max Planck Institute in Germany.
Conference for Undergraduate Women in Physics	$1350.00	6 students attended the conference in Bozeman, MT.
Pacific Sociological Association Annual Conference	$1350.00	6 students attended the conference in San Diego, CA.

The titles and abstracts of the student projects are on the following pages.

Fall 2023 Fellows

Benjamin Bailey - Material Science and Engineering

Title: Advanced Scanning Probe Microscopy and Infrared Nanospectroscopy Characterization of Atomic Layer Deposited and Etched Thin Films

Abstract: Because modern semiconductor device features are smaller than the diffraction limit of standard optical microscopes, higher resolution electron and scanning probe microscopies are routinely employed for device characterization. In particular, atomic force microscopy (AFM) and associated advanced scanning probe microscopy (SPM) techniques can map nanoscale surface topography and morphology as well as provide insight into electrical, magnetic, and mechanical properties. More recently, with the development of AFM-IR, AFM can be combined with infrared (IR) spectroscopy to provide chemical identification with ~10 nm resolution. Here we report AFM characterization of area selective atomic layer deposition (ASALD) and etching (ASALE) of molybdenum disulfide (MoS 2), a layered two-dimensional (2D) semiconductor that shows great promise due to its atomically thin structure and impressive electrical properties. High resolution AFM is used to characterize ALD film quality and ALE morphology, while advanced SPM modes are employed to measure electrical properties of interest. Additionally, AFM-IR is brought to bear to provide insight into the ALE mechanism and reaction products. These results hold promise for advancing the characterization and integration of novel 2D materials into semiconductor device manufacturing.

Ammon Butler - Mechanical Engineering

Title: Improving Ni-Mn-Ga Alloy Actuation: Effects of Micro-Peening on Mechanical and Magnetic Properties

Abstract: As miniaturization in modern devices advances, the demand for efficient, compact actuators becomes increasingly critical. Traditional mechanical systems often face limitations in size and response time at small scales, highlighting the need for new materials that can deliver both high performance and scalability. Magnetic shape memory alloys (MSMAs), such as Nickel Manganese Gallium (Ni-Mn-Ga), offer solutions for small-scale actuators due to their combination of magnetic actuation and superelasticity. This research investigates how controlled surface treatments enhance the mechanical and magnetic properties of Ni-Mn-Ga. We focus on a technique called “micro-peening,” in which microscopic glass beads are shot at the sample surface using pressurized air. A Ni-Mn-Ga sample was first polished with a 3-micron slurry and then micro-peened with pressures ranging from 10 to 25 psi, increasing in 5-psi increments. For each surface treatment, we performed multiple mechanical compression tests with a custom-made micro-mechanical tester and magnetic actuation experiments with a standard vibrating sample magnetometer. The results reveal that specific intermediate treatments yield optimal mechanical and magnetic properties by “smoothing” the actuation process, suggesting potential pathways to improve Ni-Mn-Ga’s performance in technical devices requiring reliable actuation.

Samantha Butler - Biology with a Cellular, Molecular and Biomedical Emphasis

Title: Eat the Raw Cookie Dough
Abstract: Salmonella is a highly antibiotic-resistant Gram-negative bacteria that is the most reported bacterial food-borne disease. Despite increases in awareness and sanitation, the incidence of Salmonella has continued to increase. A vaccine to combat this important pathogen in agriculturally important animals would help to protect humans. AB5 toxins are key bacterial virulence factors and have been used as vaccine antigens. We have previously characterized an AB5 toxin of S. Typhimurium, called ArtAB, to better understand its role in pathogenesis. We hypothesized that other AB5 toxins can be found using Salmonella whole genome sequence searches. We identified a homologous toxin with 31% identity to ArtAB in S. Montevideo (PltC). Using PCR, we have also identified PltC in isolates of S. Typhimurium and cloned it into a plasmid for expression in E.coli. Similar process has been used to identify a toxin from Diarizonae that has two B-subunits to clone into E. Coli. Protein purification using D-galactose or Fetuin affinity was not successful to purify the pltC A and B subunits, and other methods are currently being explored including cloning the B subunit alone. In addition, we have tested the DNA from bovine fecal samples to determine if the artAB gene is present and will test these samples for pltC in the future. Western-blot was used to test for an immune response, but the process was unsuccessful. This work will support future studies involving antigen and antibody testing with the goal of animal studies and clinical trials to develop a novel bovine Salmonella vaccine.

Sarah Cole - Material Science and Engineering

Title: Synthesis of Uranium Nitride Nuclear Fuel
Abstract:In order to sustain the U.S. nuclear reactor fleet, the industry is currently bolstering its advanced fuel cycle through the development of novel fuel forms. Advanced Technology Fuels (ATF) such as uranium nitride (UN) offer higher uranium density, higher thermal conductivity, and lower coefficient of thermal expansion compared to currently used uranium dioxide (UO2) fuels. These properties have the potential to lead to increased power uprates, longer cycle lengths, and improved performance. While there are numerous synthesis techniques for UN, this study focuses on the carbothermic reduction of UO2 prior to nitriding due to its cost, efficiency, and process scalability. Synthesized UN powder was characterized for phase purity before being high energy planetary ball milled (HEPBM), pressed, and sintered in order to study the effects of the ball milling processing step on final sintered density.

Maria Jessica Cruz - Public Health

Title: It's 110° Fahrenheit Outside! Managing Heat & Protecting Workers
Abstract: Global temperatures and heat waves have increased due to climate change over the years, which can severely impact the health and safety of the outdoor working population groups. Agricultural workers are among the vulnerable populations impacted by heat stress due to the demanding work they perform under direct sunlight and in poor working conditions. In light of this, a literature review was conducted to identify and synthesize effective interventions to help decrease heat stress and prevent these severe health impacts. Findings were synthesized from 10 articles and summarized in educational outreach materials that were developed. These include a trifold pamphlet, poster, and business card infographic for distribution to community organizations and farmworkers. Feedback was solicited from farmworker-serving community organizations, and the materials were translated in Spanish. The effective interventions that were identified

during the literature search and highlighted in the materials includes heat education and awareness training; water, rest, and shade; cooling interventions; workplace modifications; clothing; and team monitoring.

Lindsey Jenkins - Chemistry

Title: The Physiochemical Properties of Perfluoronated Environmental Pollutants
Abstract: Perfluoroalkyl substances (PFAS) persist in the environment and have been shown to disrupt the Earth's carbon cycle and negatively contribute to the Greenhouse Effect. PFAS have been found to have unique properties, such as ice nucleation and increased hydrophilicity, compared to their nonfluorinated versions. In order to improve models to predict climate change, a molecular understanding of the physicochemical behavior of PFAS molecules on environmentally relevant aqueous surfaces is needed. Sum Frequency Generation (SFG) spectroscopy and surface tension afford the ability to determine surface behavior of PFAS. Here, we compare three different chain length of PFAS to their nonfluorinated compounds at the air/water interface. In the hydrogen bonding region, fluorinated PFAS have shown to increase the O-H stretch SFG signal which correlates to more ordering of water molecules at the surface. In addition, surface tension measurements were completed to determine apparent surface pKa. The high surface activity of PFAS adds additional challenges to standard analytical techniques used in environmental chemistry. This study explores these distinctive physiochemical properties with the goal of rational design of remediation techniques for PFAS from the environment.

Autumn King - Biology

Title: Comparing the retentiveness of coarse particulate organic matter transport of a natural and restored stream
Abstract: We looked at how well, or how far, coarse patriciate organic matter, or leaf material, travels downstream during both high and low stream discharge. We did this to compare the function of two steam's retentive capabilities, which are dependent on several different factors such as particle type, size, and instream features. The retentiveness of a stream can be what determines how well nutrients are retained within a stream system. We compared a natural and a restored stream. The Diane Moore Nature Center served as the location for our artificially constructed stream segment. Dry Creek, located within the Dry Creek Experimental Watershed, served as the location of our naturally occurring stream segment. Both streams are in Boise, Idaho within a 30-minute drive from Boise State University.

Ryn Oliphant - Physics

Title: Improving Prediction of Solar Material Properties through Software Engineering
Abstract: It is possible to inexpensively generate electrical power from the sun with panels made from carbon-based molecules. The challenge is in finding the organic molecules that are both easy to make and efficient at catching light and converting it into power. It is therefore important to understand how charges move through these molecular systems, and we use kinetic Monte Carlo simulations to investigate these processes. Because the scientific software for performing kinetic Monte Carlo simulations of charge transport in organic materials is relatively new, there are open challenges with improving software performance, correctness, and generalizability. In this work, we focus on scientific software development of the package MorphCT and identify and prioritize areas for improvement. MorphCT calculates charge hopping rates between organic

molecule pieces, and we recognize instances of pairs of organic pieces breaking assumptions that MorphCT depends upon. We add logic to the library to help users manage these corner cases more effectively. These advances help make tangible connections between materials structure and performance, while also making the computational workflows that we use to study them more transparent, reproducible, usable, and extensible by others.

Aviana Smith - Physics

Title: Investigations Into the Electrical Double Layer at the Membrane Interface
Abstract: The formation of an electrical double-layer (EDL) is a consequence of the electrostatic interactions that occur at the interface between a charged surface and an electrolyte. The asymmetrical distribution of coions and counterions at the interface leads to charge accumulation, development of capacitances, and large variations of the electrical properties in terms of electric field, potential, and conductance. The EDL is a key concept in electrochemistry, which is important for energy storage in supercapacitors or electrocatalysis. However, the implications are even more important for biological systems; all cells are surrounded by a charged membrane, and any modification of electrical properties leads to changes in the biological functions essential for cellular physiology. Despite all of the progress made in understanding the structure and properties of EDL over the last century, a complete physical model and a proper mathematical frame have not been ascertained. Consequently, the understanding of predictable relationships between the interface properties and biological functionalities are still in the incipient phase. To fill the gaps in our knowledge, we developed an experimental system suitable for gathering relevant data on the electrical properties of the interface by employing both inorganic and organic interfaces; this interface is also viable for physical and mathematical modeling.

Spring 2024 Fellows

Lucas Arsenith - Civil Engineering

Title: Effect of Terrain Resolution on Rockfall Dispersion
Abstract: Rockfall events are a geohazard that can pose a significant threat to infrastructure and life in mountainous areas. The trigger mechanism for these events varies but is usually due to undercutting of an existing slope, physical weathering including freeze/thaw cycles, anthropogenic factors such as excavation, environmental factors, and seismic events. Corrective measures are expensive and involve using nets, anchor bolts, or removing hazardous rock masses. Historically, two-dimensional modeling techniques have been used for sites where rockfall is a risk but these are limited in their functionality and accuracy. Three-dimensional modeling techniques are currently evolving and being used to accurately predict where boulders that detach from the slope will land. My study aims to address current issues with using a three-dimensional rockfall model such as data collection, required inputs, accuracy, and calibration. For this portion of my study, I will be comparing models created using site-specific LiDAR data and downsampling the point cloud to analyze the effects of topography resolution and boulder size on the distribution of the final resting boulder locations, known as dispersion. I hypothesize boulders in models with higher-resolution topography will have a tighter dispersion when compared to lower-resolution topography. I will continue to work on this research topic as a master's student and further investigate how the dispersion of boulders compares with terrain resolution. From this research, I hope to produce a three-dimensional calibrated rockfall model for this site.

Giada Brandes - Mechanical Engineering

Title: Assessing EtCO2 Levels Exhibited During Nose Deformation
Abstract: Obstructed breathing during sleep creates a challenge for nasal respiration during the night, affecting nearly 24% of the population between ages 30 to 60 years old. Neonates and infants have underdeveloped nasal cavities which cause higher nasal resistance because of their radially smaller middle cavity and the lack of an inferior meatus, resulting in less airflow. The long-term goal of this work is to apply the mechanics of adult breathing and nose deformation to infant breathing and test design.

Skyler Chase - Computer Science and Geoscience

Title: Infrasound-Based Avalanche Event Classification: Leveraging Deterministic Techniques for Machine Learning Dataset Creation
Abstract: Avalanche detection and classification play a crucial role in ensuring safety within mountainous transportation corridors. Infrasound, which encompasses sound frequencies below the human audio range, serves as a valuable indicator of avalanche activity and other related events. Previous studies have predominantly utilized deterministic methods to identify infrasound events, although distinguishing events associated with avalanches remains a challenge. To address this gap, leveraging machine learning techniques becomes imperative for accurate classification. However, this necessitates a robust labeled dataset. In this study, we present a novel tool that utilizes correlograms to visualize infrasound events. These visualizations serve as a foundation for event classification, enabling the distinction between avalanche and non-avalanche sources.

Leah Engle - Global Studies

Title: Climate Change Opinion Dynamics
Abstract: Climate change is a term used on a regular basis in society today. Science has proven that the climate has been changing over the years and has found direct ties to these trends and human actions. Nevertheless, Yale research has found that 48% of Idaho residents still deny that humans are causing this global warming, which is 6% above the national average. This sizable minority is hindering our society's ability to move towards a greener tomorrow. Therefore, we plan to use deep canvassing methods in hopes to start conversations about human impacts on climate change and further understand how it can be used to influence people's ideas. A thorough systematic review of similar literature pertaining to climate change and social perspectives was conducted to form a strong background and understanding of this research. Through the data collected from the systematic reviews, cognitive interviews, and deep canvassing methods we expect to see positive results and an increase in awareness of the impacts that humans have on climate change.

Jadyn Hart - Mechanical Engineering

Title: Flux Mapping of a High Heat Flux Solar Simulator
Abstract: Concentrating Solar Power (CSP) is a form of renewable energy generation that utilizes solar irradiance to create useful heat. The extreme operating conditions under high temperature and solar flux can cause maintenance issues, increase operational costs, and decrease conversion efficiency under varying solar irradiance conditions. A solar simulator can be utilized to model similar conditions to those in CSP energy

generation in order to test different materials for solar receivers and heat transfer fluids. Since these experiments must be accurate to CSP conditions, the solar simulator should be characterized for heat flux distribution across the focal plane. A heat flux distribution map will be made of the high flux solar simulator using radiometer readings at locations with varying heat flux on the focal plane, and grayscale images will allow for correlation between flux and brightness using image analysis software. Using this strategy, a heat flux distribution map will be generated from the grayscale images for each of the individual lamps and all four lamps in order to calibrate the lights to a focal point and ensure peak flux is reached within the simulator.

Lauren Homza - Biology

Title: Visual Predator Detection in a Nocturnal Moth

Abstract: Detecting an approaching predator allows animals to employ evasive maneuvers in order to avoid being eaten (1). My study provides evidence that the greater wax moth (Galleria mellonella) may use visual stimulus to detect approaching predators (sensu 2). I also present preliminary data showing that the luna moth (Actius luna) may also be using visual stimulus to avoid predation. Using forceps, I tethered moths by the ends of their abdomens in front of a computer screen and induced flight. Once the moths were flying steadily I presented 1 of 6 "looming threats". I presented each moth with the stimulus up to six times. I calculated the frequency of predator avoidance behaviors after the onset of the stimulus and compared it to the frequency of those behaviors for the ten seconds preceding the onset of the stimulus. If moths are using their visual system to detect predators this brings a new dimension to understanding moths' anti-predator strategies, particularly given the two species used in this study are nocturnal. Flight cessation is generally considered a "last ditch" evasive maneuver, which points toward visual stimuli being an important component in the likelihood of a moth escaping predation in the final critical moments of an attack.

Amelia Jobe - Computer Science and Social Science

Title: "The Best Minds in Technology": How Meritocratic Language in Amazon Job Postings Perpetuates Gender Inequality

Abstract: I conducted a mixed-methods analysis of all Amazon internships advertised to undergraduate students during the spring 2024 semester to investigate how seemingly gender-neutral language in job postings works to reproduce gender inequality in technology-related fields. In my analysis, I found that when the percentage of women in the given field decreased, the amount of meritocratic and status-based language increased. These meritocratic phrases in job postings appeared to be gender-neutral but really worked to reproduce existing structures of gender inequality. In theory, merit acts as a great equalizer. In actuality, it can justify inequalities by rewarding those with pre-existing privileges and punishing those with social barriers to success. The male-dominated mature of the tech industry shapes technological ideals of merit in masculine ways. This masculinization of merit acts as a primer for masculinized cultural matching, which reproduces masculine hegemony in elite technological spaces such as Amazon.

Ethan LaHaug - Political Science

Title: Are Separately Elected Lieutenant Governors More Likely to Seek Other Statewide Offices?

Abstract: A major difference across state governments is whether lieutenant governors run on a team or separate ticket as the governor. However, we lack research on the effects of this difference. Moreover, lieutenant governors are rarely studied at all, perhaps due to the perception that lieutenant governors generally

have a minor role in state policymaking and governance. Despite their limited direct influence in many states, the lieutenant governor's office may serve as an important pipeline for other elected offices, especially governorships. Lieutenant governors who run separately for their office will have more experience running their own campaign, providing more name recognition, an established campaign organization, and fundraising networks that are beneficial for seeking higher office (e.g., Desmarais, La Raja, and Kowal 2014). Consequently, they may have more interest in and resources for seeking to move up the political ladder (Francis and Kenny 2000).

How does the election process of lieutenant governors affect their future careers? Are lieutenant governors who are separately elected more likely to run for higher office? If so, are they more successful? How do other factors like the powers of their office, partisanship, geography, and gender further shape their career decisions? We expect lieutenant governors who are separately elected will have more progressive ambition and access to resources, making it more likely they will seek higher office.

To answer these questions, we are collecting biographic and political data on lieutenant governors holding office in the past two decades for all 45 states with lieutenant governor offices. This research will extend our knowledge of this rarely studied statewide office and the people holding this office. It will also help us better understand state political pipelines and how the election method of lieutenant governors affects their future careers.

Katie Markthaler - Geoscience

Title: Moving Mountains: Determining Temperature Distribution in the Himalaya's Earliest Metamorphic Rocks

Abstract: The Himalayas of northern India expose a rare sheet of ultrahigh-pressure rocks, called the Tso Morari Complex, uplifted from at least one hundred kilometers depth. The widespread exposures of this rock complex provide an exceptional opportunity to examine the dynamics of how ultrahigh-pressure metamorphic rocks form and are exposed at the surface. These exposures have allowed us to sample geographically distributed rocks. In this project, I collected temperature data on four samples distributed along a 90-km long NW-SE transect across the entire complex. Additional thermometry from Thompson et al. (2024) is also available. I measured concentrations of temperature dependent zirconium in the mineral rutile using Laser Ablation - Inductively Coupled Plasma Mass Spectrometry. Using calibrated equations, we then estimated the maximum temperature experienced by these rocks at an assumed pressure of 25 kbar. Temperatures broadly increase from ~570 °C in the extreme northwest to ~625 °C ~45 km to the southeast, reaching ~770 °C in the extreme southeast. These are the first Zr-in-rutile data collected on geographically distributed samples across the Tso Morari complex. Although we have not yet calculated pressures, these data suggest possibly deeper origins of rocks to the southeast compared to the northwest, so that the sheet is tilted from its original orientation as it was exhumed. This implication is consistent with structural data that indicate NW-directed transport during exhumation (Long et al., 2020).

Ryan Samolis - Physics

Title: Whole River Contaminant Degradation Depends on Transport Processes in River Sediments

Abstract: Pollutants in rivers expose aquatic species and human populations to harmful contamination. In rivers, contaminants can naturally transform into equally potent "daughter" compounds. These transformations most commonly occur once contaminants have been carried by river water into a shallow,

reactive region of river sediments called the hyporheic zone. While mathematical models are useful tools for predicting parent and daughter contaminant exposure in rivers, they make assumptions about what processes dominate in the hyporheic zone, which limits our understanding of contaminant fate at the river scale. Here, we compared two hyporheic zone reactive transport models with differing transport assumptions – diffusion vs.advection – to understand how each process impacts the integrated effects of transport, surface-subsurface exchange, and subsurface reactions on whole river contaminant degradation. We found that the assumed transport process does not control whole-river parent-to-daughter transformation, but it strongly controls daughter compound degradation. Specifically, daughter degradation rates are highest when contaminants are advected through the hyporheic zone, compared with diffusion. Our results indicate contaminant degradation patterns depend on the transport mechanism in the hyporheic zone. Therefore, practitioners should consider both the toxicity of contaminants and the dominant physical processes in the hyporheic zone when predicting contaminant fate in river systems.

Miranda Trester - Biology with a Cellular, Molecular and Biomedical Emphasis

Title: Surveillance of Animal and Patient Samples for Pathogens

Abstract: I analyzed pathogens in patient and wild animal samples found using Next Generation Sequencing with the Illumina Respiratory Pathogen ID/AMR Enrichment Panel (RPIP). I found that Coronavirus OC43 was prevalent in many clinical samples in patients who had tested negative for COVID-19 and Influenza but were still exhibiting respiratory and other symptoms. I also found Coronavirus OC43 through sequencing of a ground squirrel's genome. I analyzed the base pair alignment of each of our patients' pathogen samples and the ground squirrel to the strain found in NCBI to determine if mutations had occurred. This research opens the door to furthering our understanding of how pathogens are transmitted between humans and animals. Additionally, many of the patients who tested negative for COVID-19 but had Coronavirus OC43 exhibited much harsher symptoms (such as throwing up) than patients usually exhibit with this pathogen.