ACCESS

WOMEN IN SCIENCE & MATHEMATICS

2018-2019 RESEARCH SYMPOSIUM

19 April 2019

POSTER 1: Madeika Vercella
Electrochemical CO_2 Reduction with the Use of Amines
Dr. Caroline Saouma | Chemistry (COS)

POSTER 2: Isabel Adams
Using Dual Accelerometry to Measure Pelvic Floor Laxity
Dr. Robert Hitchcock | Biomedical Engineering (COE)

POSTER 3: Sarah Sullivan
An Analysis of Browser Cookie Attributes and Expiration Dates
Dr. Suresh Venkatasubramanian | Computing (COE)

POSTER 4: Taylor Christensen
Treatment of *S. aureus* and *P. aeruginosa* Biofilms using Phage and Antibiotic Combination (PAC) Therapy
Dr. Catherine Loc-Carrillo | Pathology, Med. Lab Sciences

POSTER 5: Rachel D'Agostini
Fabrication of an Electrocatalytic Ceramic Probe for Biofilm Destruction
Dr. Krista Carlson | Metallurgical Engineering (CMES)

POSTER 6: Caitlin Gallivan
Species-Specific Adaptations of the Drosophila Olfactory System
Dr. Sophie Caron | Biological Sciences (COS)

POSTER 7: Maria Jose Espino Reyes
Identification of Novel RIDD Targets Through QPCR
Dr. Julie Hollien | Biological Sciences (COS)

POSTER 8: Lauren Kochaver, Sierra Freitas
Bioinspired Freeze Casting to Understand the Mechanical Strength at Ceramic Interfaces
Dr. Steven E. Naleway | Mechanical Engineering (COE)

POSTER 9: Kara Sorenson
The Solvent Extraction Loading & Stripping of Rare Earth Elements
Dr. Michael Free | Metallurgical Engineering (CMES)

POSTER 10: Tessa McNamee
Baryon Acoustic Oscillations in Galaxy Clustering in a Mock Catalog
Dr. Zheng Zheng | Physics and Astronomy (COS)

POSTER 11: Maycee Redfearn
Surface Enhanced Raman Spectroscopy
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POSTER 12: Morgan Kelley
CHiLL: Composable High Level Loop Optimization
Dr. Mary Hall | Computing (COE)

POSTER 13: Cynthia Gardner
Ambient Resonance of Arsenic Arch
Dr. Jeffrey R. Moore | Geology and Geophysics (CMES)

POSTER 14: Boyana Martinova
Fast Minors Computation of Functions of Algebraic Varieties in Macaulay2
Dr. Karl Schwede | Mathematics (COS)

POSTER 15: Katrina Le
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A Numerical Study on Containers Optimizing Sloshing Frequencies
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POSTER 17: Tyler Ball
Using Electroanalysis to Determine Trends in Oxidative Addition Rates
Dr. Matthew S. Sigman | Chemistry (COS)

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Small Molecule Regulation of CRISPR Genome Editing
Dr. James Gagnon | Biological Sciences (COS)

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POSTER 23: Elle Tanner
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POSTER 24: Britney Shunn
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Dr. Catherine Loc-Carrillo | Pathology, Med. Lab Sciences

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Understanding the Genetic Basis of Vertebral Variation in the Domestic Pigeon
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Dr. Krista Carlson | Metallurgical Engineering (CMES)

POSTER 30: Ami Iverson
UDOT Air Mobility System
Dr. Greg Bayles | GAPP Lab, Computing (COE)

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COLLEGE OF SCIENCE

Anna Christopherson: Attempted Verification of Astronomical Pointing using Sun and Moon Shadows by the Telescope Array

Charles Jui, Physics and Astronomy

The earth is constantly bombarded by high energy particles called cosmic rays. Studying ultrahigh-energy cosmic rays has seen great progress over the past decade. Today, we are able to predict the cut-off point of the cosmic ray spectrum, but we are still unable to determine the origin of cosmic rays. In order to determine the origin of cosmic rays in the universe, the instruments used to observe a cosmic event, the collision of a cosmic ray with the atmosphere, must be accurate within a degree. We attempt to measure the theoretical sun and moon shadows, the absence of cosmic rays due to obstruction of the cosmic rays' trajectory towards the earth by the sun and moon, to determine the accuracy of the instruments within a degree. To find the sun and moon shadows, we calculated the angles between every cosmic event, the sun, and the moon. Results suggest that there is the presence of sun and moon shadows but there is not enough data to statistically prove their existence. Because we are unable to prove the existence of the sun and moon shadows, we are unable to determine the accuracy of the instruments. These results suggest that more data is required before we are able to find sun or moon shadows in the data and determine instrumental accuracy.

Emma S. Coates: A Numerical Study on Containers Optimizing Sloshing Frequencies

Christel Hohenegger, Mathematics

Violent sloshing of fuel in the tanks of liquid propelled rockets and spacecraft produce highly localized impact loads and pressure on tank walls which can affect the spacecraft's guidance system and compromise structural safety. In this study, we investigate the sloshing problem in an open container, including surface tension effects on the fluid free surface. Our goal is to determine the shape of the container with the given area that generates the largest sloshing frequency. Assuming the fluid is incompressible, inviscid, and irrotational, we derive the linearized shallow sloshing model, which is a fourth-order differential equation describing fluid sloshing. The analytical solution is given by the following function: $h_1(x) = \frac{1}{2}(1-x^2) - \frac{\kappa}{\sinh(1/\kappa)}[\cosh(1/\kappa) - \cosh(x/\kappa)]$ merically validate the theoretical result, where we solve the corresponding eigenvalue problem using finite difference methods for different container shapes.

Hana Fauver: Versatile Peptide Ligation with a Small Molecule Catalyst

Emily Kirkeby, Andrew Roberts, Chemistry

Chemists are, as of now, sitting on an untapped gold mine. Protein chemistry could play an important role in the field of therapeutics if it were more accessible. Current technology is limited in the sites available for peptide ligations, with the most widely used sites being cysteine and alanine. We have been creating a small molecule organocatalyst we believe will enable access to ligations at any amino acid residue. We are currently optimizing reactions and hope to apply this methodology to previously inaccessible proteins. This strategy could yield novel peptide therapeutics to treat a range of illnesses.

Sahar Kanishka: Small Molecule Regulation of CRISPR Genome Editing

James Gagnon, Biology

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) is a tool used in genomic engineering. The CRISPR-Cas9 endonuclease system cleaves DNA at specific places in the genome, directed by a guide-RNA sequence (Zhang). The DNA repair process occurs after cleavage and can generate insertion and deletion mutations that disrupt or modify gene function. However, there is a lack of tools to control the timing of editing in zebrafish, limiting CRISPR activity to the early embryo. The goal of my research is to test the ability of drug-responsive ribozymes to regulate CRISPR activity in zebrafish. In our design, a blocker RNA sequence prevents Cas9 guide-RNA complex from locating the target site. By adding a drug (guanine was tested), the ribozyme is activated and cleaves the

blocker sequence from the guide-RNA. The guide-RNA will then be able to locate its target site, initiating CRISPR activity. To assay CRISPR activity, we designed guide-RNAs that target the *Tyrosinase* gene, a pigmentation gene in zebrafish. The ribozyme used is initiated by guanine. With added guanine, we predicted the *Tyrosinase* gene would be impaired, therefore causing the zebrafish to lack pigmentation. Thus far our experiments have exhibited fully pigmented zebrafish. Efforts to refine the experiment by altering the methodology, dosages, and other factors will be pursued.

Boyana Martinova: Fast Minors Computation of Functions of Algebraic Varieties in Macaulay2
Karl Schwede, Mathematics
The mathematics software Macaulay2 is frequently used to locate where algebraic varieties have singularities because it has the functionality necessary to return the ideal of all minors of a certain size in a given matrix, a necessary step in identifying singularities. However, the current implementation is not optimized and takes a long time to execute. The software's default is to find determinants using the Bareiss algorithm which is efficient when the polynomials have a low degree and few variables, but very slow otherwise. We implemented a smarter cofactor expansion method to find the determinants of minors of size n x n. Our implementation made three major alterations: 1.) it recursively finds all n x n minors by first computing and storing the 2 x 2 minors to be used in a cofactor expansion to find all subsequent sizes of minors until n is reached, 2.) it only computes the necessary determinants at each step of the recursion and 3.) it implements multi-threading which allows different computations to occur simultaneously in separate threads. Timing of this method on a randomly generated matrix concluded that our optimized code completed computations approximately 50 times faster than Macaulay2's default method (Bareiss algorithm) and was even twice as fast as Macaulay2's existing cofactor expansion method. The code created outperformed Macaulay2's current implementation of the minors method and will be turned into a package and incorporated into the software.

Tessa McNamee: Baryon Acoustic Oscillations in Galaxy Clustering in a Mock Catalog
Zheng Zheng, of Physics and Astronomy
In the early universe, sound waves from the Big Bang propagated through baryon photon fluid at a fraction of the speed of light until the point that the universe cooled and became neutral through recombination. The result of these waves is a slight irregularity in the distribution of matter throughout the universe, as the wave-structure that existed before recombination "froze" in place once the universe cooled. The separation of these irregularities is the distance the sound waves traveled before recombination, approximately 150 Mpc (more commonly measured as 100 h^{-1}Mpc, where h is the dimensionless Hubble Constant with a value of 0.7). This characteristic distance is known as the Baryon Acoustic Oscillations (BAO) feature. Density perturbations in the initial distribution of matter result in a higher likelihood of galaxies to form, leading to the BAO feature being embedded in the distribution. Due to its regularity, BAO can be used as a standard ruler for us to measure the shape and expansion history of the universe. In this work, the BAO feature is measured in a mock galaxy catalog through counting galaxy pairs at different separations. This shows the usefulness of the mock for future large galaxy surveys, such as the Dark Energy Spectroscopic Instrument (DESI).

Bridget Phillips: Understanding the Genetic Basis of Vertebral Variation in the Domestic Pigeon
Mike Shapiro, Biology
Across the animal kingdom, morphological diversity is widespread. The genetic changes that lead to this vast diversity in morphology are still largely unknown. I am specifically interested in variation in the axial skeleton (vertebrae). The axial skeleton is an important part of the skeletal structure as it supports internal organs and as acts as an attachment site for other muscular and skeletal structures. Variations in vertebral number and identity can impact locomotion and other functions, and changes are often adaptive. While skeletal patterning varies, the processes that control axial skeleton development is highly conserved in vertebrate animals.

Identifying specific genetic differences between different species is difficult due to the immense amount of genetic changes between them, most of which are unrelated to the trait of interest. To study the genetic basis of morphological diversity, our lab uses the domestic pigeon (Columbia livia) as a model. Though work in the lab focuses on C. livia, many discoveries can be applied generally to other animals, because vertebrates share many genes with conserved function.

COLLEGE OF ENGINEERING

Isabel Adams: Using Dual Accelerometry to Measure Pelvic Floor Laxity
Dr. Robert Hitchcock, Biomedical Engineering
One in four American women suffer from pelvic floor disorders. The relationship between extended periods of intense abdominal pressure, pelvic floor laxity, and pelvic floor disorders is largely unknown. The Hitchcock lab is conducting a clinical study to determine the differences in pelvic floor laxity between nulliparous and parous women. To measure pelvic floor laxity, the lab uses accelerometer adapted intra-vaginal pressure transducers (IVTs) along with instrumentation modules (IMs) to measure pelvic floor and skeletal (hip) accelerometry, as well as intra-abdominal pressure data; each of which are simultaneously recorded while a subject completes a series of exercises. Investigating the relationship between pelvic floor laxity and intense, extended, periods of intra-abdominal pressure will help biomedical engineers and physicians better understand the causes of pelvic floor disorders.

Ami Iverson: UDOT Air Mobility System
The GApp Lab, Entertainment Arts and Engineering, School of Computing
UDOT wants to see if the state of Utah can host a drone delivery system and if existing infrastructure can handle this integration. A simulation is the best option for determining how many drones could be handled, and if it is possible to implement a drone delivery system in Utah. We created a drone delivery system in Salt Lake City with a Unity system called the Entity Component System. With this data-oriented approach to coding, the Entity Component System can be run with greater efficiency. Within the simulation, a user can track where each drone is, as well as the path and corridors drones can take. Thus, the user is able to edit the number of drones and maximum allowable speed that can be spawned in a given timeframe.

Syndey Rabbit: Improving and Testing the Encapsulation of Neural Implants
Florian Solzbacher, Electrical and Computer Engineering
The Utah Array was developed in the 1990s as a microelectrode device that can be implanted into the human brain to record and stimulate neurons. The Utah Array's Complex 3D architecture makes it difficult and expensive to manufacture; therefore, flat or planer test structures called Interdigitated Electrodes (IDEs) are first used to test new electrode materials and coatings. While many improvements have been made in the past decade, much of the current research revolves around improving long-term stability of these electrodes in vivo. This means improving both foreign body response and material stability. Traditionally, the polymer Parylene C has been used, and this polymer has demonstrated in vivo performance of up to 7 years. Regardless, long term implant failures have been observed, and in order to address failures we are exploring multilayer thin film encapsulation systems, meaning using more than one material to protect each electrode. Each layer serves a different function: the top layer should be compatible with the body, the next serves as a humidity barrier, and the final serves as an ion barrier. The hope is that the combination of these layers will provide the best long-term performance of electrodes in the body.

Sarah Sullivan: An Analysis of Browser Cookie Attributes and Expiration Dates
Suresh Venkatasubramanian, School of Computing
Browser cookies are important parts of everyday internet use. For example, cookies store information so a user doesn't have to login every time they visit a website, and allows them to store items in a virtual shopping cart. However, cookies can also leave a user's personal information vulnerable, and pose some very important security concerns. Additionally, many cookies last unreasonable amounts of time, and come from ad or other external services that are potentially invasive and unnecessary for website function. This study focuses on analyzing these ethical concerns by uncovering certain characteristics of these cookies -such as whether they are secure, how long they last, and whether they were created by the original website. It is hoped this study will serve to inform the average user of security concerns related to cookies and encourage them to monitor their personal cookie use.

Sierra Freitas and Lauren Kochaver: Bioinspired Freeze Casting to Understand the Mechanical Strength at Ceramic Interfaces
Steven E. Naleway, Mechanical Engineering
Freeze casting is a material construction process that allows porous ceramic scaffolds to be created. This process uses a slurry to directionally freeze and template ice crystals. There are four distinct stages: a slurry is made by mixing water, particles, and a binder then the slurry is frozen, allowing the particles to be templated by ice the water is sublimated, leaving only the templated particles the scaffold is sintered, allowing the particles to bind with one another and solidify the scaffold is infiltrated with epoxy to strengthen the final structure. Varying volume percents of particles can have an impact on the mechanical properties of the resulting scaffold. For example, the pore size of TiO_2 scaffolds changes with the volume percent of TiO_2 put in the slurry. This can be seen in the image below of different volume percents and their resulting structure. Based on the findings of past research, we believe that by creating a single scaffold with different volume percents of particles on the top and bottom, the mechanical properties of the resulting scaffold will be different. We will analyze these differences in properties, specifically in pore size and maximum compressive stress.

COLLEGE OF MINES AND EARTH SCIENCES

Rachel D'Agostini: Fabrication of an Electrocatalytic Ceramic Probe for Biofilm Destruction
Krista Carlson, Metallurgical Engineering
Biofilms can be very detrimental to the health of a patient, whether this is an infected implant or dental cavity. A biofilm is a microbial community in which cells are attached to a surface or other cell in a matrix formation. This bacteria matrix can cause harmful effects on the human body because they do not respond to typical destruction treatments and can lead to infections. In this study we are using a pen template to create a prototype electrocatalytic ceramic probe for the destruction of bacteria and biofilms. The probe included titanium wires with titanium dioxide (TiO2) tubular nanotubes. These wires are tested for the oxidation of the DPD dye as a model molecule. The color change during the reaction indicates oxidation potential, and feasible use of these probes for biofilms.

Riley Murray: Analyzing Trace Elements in Emission-Contaminated Urban Precipitation
Diego Fernandez, Geology & Geophysics
Inversions in urban areas like Salt Lake City trap pollutants from emissions which can contaminate precipitation on its way down from the atmosphere and on the ground. Studying trace elements in snow and rain can give us insight into local pollution and, with continued research, how precipitation could potentially filter these inversion-trapped trace elements out of the atmosphere. We've developed a method to collect precipitation for trace element analysis by inductively coupled plasma mass

spectrometry (ICP-MS) to study emission-contaminated snow and rain. To study contamination of the precipitation samples, we used an ICP-MS to record, in parts per billion, trace levels of over 40 elements. We focused on elements like sodium, magnesium, and aluminum to study the “dirtiness” of our samples as well as strontium and lead which may give us insight into the sources of contamination (urban versus natural deposition). To determine the concentration of these elements, we used the mass spectrometer to record, in counts-per-second, the amounts of individual elements in the samples. Results indicate that contamination correlates positively to the amount of time that had passed between deposition and collection. We also observed a trend between levels of contamination and the location of sample collection; rooftops tended to be “cleaner” than ground-level samples. When compared to data collected during an inversion, our findings indicate that snow traps more contaminants from the atmosphere upon deposition during an inversion. This result suggests that by studying urban precipitation, we can gain insight into the quality of the air andthe types of contaminants we are exposed to in an urban environment and how inversions can trap those contaminants.

MEDICAL LABORATORY SCIENCES, School of Medicine

Taylor Christensen: Treatment of *S. aureus* and *P. aeruginosa* Polymicrobial Biofilms using Phage and Antibiotic Combination (PAC) Therapy

Catherine Loc-Carrillo, Internal Medicine and Pathology

Surgical implants inside the body create the ideal environment for bacteria to live and grow. The immune system is unable to combat biofilms on these foreign bodies. Biofilms are aggregates of microorganisms attached to each other on a surface, with the aid of a thick matrix called extracellular polymeric substance (EPS). Many antibiotics are unable to penetrate into biofilms to kill bacterial cells. An adjuvant to antibiotic treatment to kill these biofilms is bacteriophage. To test different the efficacy of various antimicrobials, alone and in combinations, we grew polymicrobial biofilms (i.e., *S. aureus* and *P. aeruginosa*) on surgical mesh. In this study, the most effective treatment at reducing the bacterial load in polymicrobial biofilms was the combination of the antibiotic Cefepime + Phage cocktail. From these results, combining phage and antibiotics as an alternate to treat biofilms could prove to be a promising therapy.