Poster Session Assignments

Poster Session A

1. **Activating STEM Muscles Through Space Farming**
   Christine Brillhart and Lisa S. Tsay
   MPS Space Farmer Coaches
   Jefferson Middle School, and Saginaw Valley State University

   As part of the efforts to support NASA's goal to provide astronauts with fresh vegetables and fruits in space missions, students in the Midland Public Schools District have been using simulated NASA growth chambers and materials to grow various NASA cultivars with the support of the Growing Beyond Earth program (a partnership between Fairchild Tropical Botanic Garden and NASA). Students have experimented with different growth variables, including the cut-and-come-again harvest method, water conservation, efficient fertilizer use, and LED grow light configurations. Through the ISS-simulated experiments, they've exercised plenty of STEM muscles, including detailed observational reports, experimental design, data and research results analysis, collaboration with STEM professionals, and communication of results with formal research presentations. In our presentation, we will discuss how those practices have helped shape their STEM practices beyond the classroom and share strategies for cultivating students' passion and ability to pursue STEM careers through space farming practices.

2. **Advanced Control of Led Lighting Systems in Sustainable Greenhouses**
   Kip Nieman, B.S. Chemical Engineering and Associates of Arts, PhD student, Chemical Engineering and Materials Science, Wayne State University

   Long term exploration and habitation in space will require ways of producing food, as resupply to distant locations may be unreliable. One attractive method is through the use of greenhouses which, if located on a body farther from the sun, will likely rely a significant amount of artificial lighting. It is likely that power generation will be limited, making it important that the greenhouse uses electricity efficiently. This is also a concern in terrestrial applications, and much research has focused on developing advanced control systems to manage greenhouse resources. This presentation investigates the feasibility of using these controllers to take advantage of the structure of the plants themselves, including the location of individual leaves, to minimize light usage by adjusting the output of individual LEDs. The progress towards developing a model is discussed, which is needed to predict the amount of photosynthetically active radiation reaching each leaf from each LED.

3. **Can increasing the density of external medium mimic microgravity?**
Grace Miller, Undergraduate, Cell and Molecular Biology, Grand Valley State University
Mark Staves, PhD, Professor, Cell and Molecular Biology, Grand Valley State University

We tested between the leading models for plant gravity sensing by growing rice seedlings in media with different densities, positioning roots parallel to the vector of gravity and light perpendicular to the roots. When the density of the external medium was increased, we saw a significant increase in negative phototropic curvature in blue light, suggesting that the gravity response was reduced when the density of the external medium was increased. These results are consistent with the gravitational pressure model and are not consistent with the statolith model. We then determined that increasing the density of the external medium has no effect on the distribution of statoliths. These results indicate that increasing the density of external media mimics microgravity. We will test this hypothesis by exposing Arabidopsis roots to increased density to test whether they respond in the same way that as Arabidopsis flown on the ISS and exposed to microgravity.

4. **Deep sequencing of Escherichia coli exposed to prolonged periods of microgravity simulation**
Dalton Raymond, Fabia U. Battistuzzi, Shailesh Lal

Safe human space exploration requires a deep understanding of how genomes (human and microbiome) are affected by this harsh environment. For example, it has been shown that increased mutation rate during prolonged periods of space travel can potentially increase virulence of bacterial pathogenesis, alter their host-specificity or lead to acquisition of antibiotic resistance. A previous report of 1000 generations of Escherichia coli cells grown in simulated microgravity reported only 16 genome wide non-neutral mutations, identified via a short-read sequencing approach (Tirumalai et al., 2017). However, the advent of long-read sequencing provides an opportunity to explore the accumulation of mutations in more depth and, in particular, in regions that are problematic for short-read sequencing (e.g., repetitive, low complexity). In our effort, we have used the same E. coli strain from the 2017 report and further extended the microgravity exposure by 500 generations. We will discuss the results from this study.

5. **Point of care small molecule detector for health monitoring in space travel**
Christopher Alexopoulos, Undergraduate Biology Student, Undergraduate Researcher, Chemistry Department, Oakland University

Space travel presents many challenges to Point of Care testing (POCT), however, developing technology that is capable of POCT is pivotal for long term space travel. This is because there is limited accessibility to on-board personal diagnostic tools to measure physiological well-being while in space. Often samples must be analyzed on Earth, and this introduces uncertainty while on space travel itself. We propose an electrochemical sensor that is capable of POCT to provide real time data on the physiological condition of astronauts through small molecule detection. The design features fentanyl as our model molecule and uses an anchor site system to absorb it onto the conductive polymer layer. Quantification is achieved through electrochemical impedance spectroscopy by establishing a calibration curve. Advancements in POCT technology will benefit long term space travel because real time data will allow for accurate decision-making and monitoring of astronaut health.

6. **Patient-Handling Tasks and Posture Classification with Machine Learning**
Ngoc Tran, Haniah Kring, Elsa Brillinger, Aine Snoap, Noah Bradford, Dr. Brooke Odle (faculty mentor), Dr. Omofolakunmi Olagbemi (faculty mentor)

Prolonged periods of time in space result in some astronauts experiencing low back pain (due to muscle, bone, and weight loss), similar to injuries professional nurses sustain. Studies have shown that 39% of registered nurses reported musculoskeletal injuries after two years of regularly performing patient-handling tasks in awkward postures. To explore mechanisms of injury, biomedical researchers may use Inertial Measurement Units (IMUs) to collect data in laboratory and clinical environments. Our aims are (1) to apply machine learning (ML) models to accurately predict patient-handling tasks and indicate the quality of posture using IMU and force plate data and (2) to determine an optimal combination of IMU sensors. Using trunk-and-pelvis IMU data from two participants performing three tasks with good and poor postures, the MiniRocket model was the fastest (123s) and also the most accurate (98.1%). Future work includes involving additional participants and expanding the range of tasks.

7. **Validating the Use of an IMU-based System to Capture Patient-handling Tasks**
Bridget Gagnier: Undergraduate student, Hope college Engineering department
Reese Moschetta: Undergraduate student, Hope College Engineering department
Yeageon Song: Undergraduate student, Hope College Engineering department
Dr. Brooke Odle: M.S and Ph.D Biomedical Engineering, B.S Bioengineering, Mentor, Hope College Engineering department

Manual patient-handling tasks are associated with low back injury. Computational musculoskeletal models may provide insight on injury prevention. Three participants completed simulated tasks while wearing reflective markers and inertial measurement units (IMUs). Knee and hip flexion-extension angles were

calculated from marker and IMU data and using OpenSense. Joint angles from the IMU system were compared to those from the marker data (Comparison 1) and OpenSense (Comparison 2). The average root mean squared error (RMSE) for Comparison 1 is 8.20¬∞ and 11.05¬∞ for the knee and hip, respectively. The average RMSE for comparison 2 is 1.56¬∞ and 1.08¬∞ for the knee and hip, respectively. With respect to the IMUs, OpenSense knee and hip flexion-extension angles are very comparable; and those from the marker data are fairly comparable. Future work will explore the feasibility of IMU and modeling approaches to understand low back injury risk with patient-handling tasks.

8. **Astro-Huskies Multiplanetary Regolith Pursuing Husky (MuRPHy)**
Karson Linders, Astro-Huskies Project Manager, Michigan Technological University
Paul van Susante, Ph.D., M. ASCE, M. AIAA, M. ISTVS Assistant Professor Mechanical Engineering Affiliate Assistant Professor of Civil, Environmental and Geospatial Engineering, Michigan Technological University

The Michigan Technological University (MTU) Multiplanetary Innovation Enterprise (MINE) Astro-Huskies have been participating in the NASA Lunabotics competition for 3 years. For our team, the first time in-person competition at NASA's Kennedy Space Center visitor center. With their robot, Multiplanetary Regolith Pursuing Husky (MuRPHy), the team was the first of only 4 Teams (out of 48) to complete the objective of traversing the simulated lunar terrain, excavating and delivering simulated material to the collection point. The team will use this experience at the competition and in Systems Engineering and Project Management as they prepare for the 2022-23 Lunabotics Competition as well as during the rest of their careers for those who graduated. The talk will discuss the experience, lessons learned and path forward.

9. **A Woman's Place is in Orbit: Roger That's Female-Centered 2022 Symposium**
Jack Daleske, Planetarium Manager, B.A., Grand Rapids Public Museum; Karen Gipson, Ph.D., Professor of Physics, Grand Valley State University; Samhita Rhodes, Ph.D., Professor of Engineering, Grand Valley State University; Rob Schuitema, B.F.A., Director of Public Programs, Grand Rapids Public Museum; Glen Swanson, M.S., Board member, Roger B. Chaffee Scholarship Fund; Deana Weibel, Ph.D., Professor of Anthropology, Grand Valley State University.

Roger That! is a celebration of space exploration in honor of Roger B. Chaffee, organized by GVSU in collaboration with Grand Rapids Public Museum (GRPM), featuring academic speakers and K12 outreach. The 2022 event was offered in hybrid modality, with prestigious online speakers on Friday morning, transitioning to in-person workshops, an open reception, and keynote speaker astronaut Col. Eileen Collins (in-person and live-streamed), supporting the theme of "Women and Space." Saturday saw a record number of organizations presenting outreach in-person at GRPM. The online aspects provided greater accessibility for both participants and speakers, while the in-person aspects supported community-building. Local schoolchildren were allowed to submit their design challenge projects in either format, and internal funding was acquired to create 100 STEM kits for local 5th graders. The 2022 MSGC grant covers the seventh symposium in February 2023, which is also planned as hybrid with the theme “History of Space Exploration.”

10. **Pathways to Explore - STEM Afterschool Enrichment**
Elizabeth Zinck, Outreach Coordinator, ExploreHope Academic Outreach, Hope College AND Susan Ipri Brown, MSME, Director, ExploreHope Academic Outreach and Associate Professor of Engineering Instruction, Hope College

ExploreHope partnered with Boys and Girls Club of Holland (BGCH) and area middle schools to provide career-based science, technology, engineering, and math (STEM) activities focused on middle school students. Students participated in either an 8 week, once-a-week after school program or several half day sessions. The project aims to increase students’ confidence in their ability to be successful in STEM skills and students’ consideration of STEM careers. Pathways to Explore introduces middle school students to the Engineering Design Process as well as different engineering disciplines. Hands-on projects are both more engaging and more realistic to the ‘real world’ of STEM than classes can be, hooking a larger range of students. Students also develop relationships with Hope College students who can model the college experience, and provide valuable advice about attending college as part of their career paths.

11. **Growing Space Plants in an Economical Way: ‘Smart’ Growth Chamber Configurations for Space and Earth Application**
Margaret E. Hitt, H.H. Dow High School; Sophie Cai, H.H. Dow High School

Effects of LED grow lights on Celesta F1 radish plants were studied using simulated NASA-Advanced-Plant-Habitat growth chambers, including two light quantities (300 PAR and 240 PAR) and three-color combinations (RGB+W, RGB, and White). The RGBW240 treatment ranked the best and RGB300 the second for growing radish plants in a confined space, considering plant compactness, plant health, edible biomass, nutrient values, and energy use efficiency. Both light treatments have the same Red/Blue spectrum ratio (6:1) and intensity ratio (1.68:1). The light quantity significantly affected radish compactness and edible biomass. Two negative correlations were found: the blue light segment with plant potassium concentration and the red-light segment with plant iron concentration. These results will help NASA scientists design a broader range of light recipes for plant experiments during space exploration missions and add information about growing radish plants indoors on Earth.

12. **Electromagnetic Detection of Failure in Electronic Interconnects and Solder Properties at Extreme Conditions**

Gavin Zimmer, Undergraduate Fellowship, Electrical Engineering, Saginaw Valley State University and Mohammad Khan, Research Seed, Electrical Engineering, Saginaw Valley State University

The electric reliability of interconnects is of great importance as it ensures desired signal transmission between chips or circuits. Detecting faults, cracks and defects by images from Scanning Electron Microscope, SEM, and Focused Ion Beam, FIB, is a traditional method. However, the process can introduce process-induced failure. The process can also be inconvenient to some extent for encapsulated structures. A possible alternative method for fault detection is electromagnetic method. To begin with the method, a simulation model for interconnects can estimate performance parameters such as insertion loss and return loss. A crack, a partial crack or narrowing of the interconnects can manifest variation of the loss parameters. This project intends to find a pattern of changes in the loss estimates for the structural variation. Interconnect model, through COMSOL, similar to Quilt Packaging one has been designed. In the model of transmission lines, various cracks are introduced which includes in the signal lines and ground lines. The other includes the cracks in all lines. The different depths of cracks are introduced such as 10%, 30%, 50%, 70% and 90% which will finally be used to indicated changes in S-parameters. The model is designed to indicate the changes of S-parameters for the cracks. The interconnects consider solder contact. The study also focuses on Pb-free solders property at various extreme thermal loads. The results indicate metal-solder contacts, excluding all other component in the circuit, reliable for the specific solders at temperature beyond their melting point.

13. **Handling Cyberattacks in Advanced Control of CubeSats**

Jihan Abou Halloun (PhD student, Department of Chemical Engineering, Wayne State University)- Helen Durand (Assistant Professor, Department of Chemical Engineering and Materials Science, Adjunct Assistant Professor, Department of Electrical and Computer Engineering, Wayne State University)

Satellites' data touch each aspect of our daily life, ranging from communication to observations helping scientists to learn about Earth and space. Cyberattacks on these satellites can put NASA's mission and objectives at risk. To address this concern, we proposed a reduced computation time algorithm to handle cyberattacks on sensors of a nanosatellite: CubeSat. In this talk, we will start by introducing model predictive control and why we will use it in order to achieve our goal. Then, we will define a CubeSat and discuss its dynamical model. We will discuss how this is incorporated in the optimization problem of MPC to provide, for each state measurement, an optimal solution at a discrete time instant. Since the goal of this project is related to the ability of the proposed algorithm to detect and mitigate cyberattacks on the CubeSat's sensors with low computational resources, we will also discuss the concept of cyberattacks on sensors and how these can be modeled on an example control system.

14. **Formation of Contact Binary Stars**
Larry Molnar, PhD, Professor, Calvin University Physics & Astronomy Department; Levi Carr, Undergraduate, Calvin University Physics & Astronomy; Jenn Lau, Undergraduate, Calvin University Physics & Astronomy

A contact binary is a binary star whose component stars are so close that they share the same atmosphere. Observations show these stars can eventually inspiral and merge. Our overall goal is to model stellar mass and orbital period distributions by exploring the physics of how contact binaries form and evolve over time. Over the previous two summers, Calvin researchers have developed a model for the evolution from first contact to merger of contact binary stars. Our goal this summer was to investigate how a binary can decrease its period and come into first contact. As individual stars form from large interstellar clouds, newly formed binaries are necessarily too far apart to be in contact. They must be brought together by some physical mechanism. We focused on two promising mechanisms that we think operate sequentially: Kozai cycles with tidal friction and magnetic braking.

15. **Development of Ultra-resilient Cementitious Composites for Future Automatic Construction using Lunar and Martian Regolith Simulants**
Xiaoqiang Ni, Graduate Student, Department of Civil and Environmental Engineering, Michigan State University
Luke Naughton, Undergraduate Student, Department of Civil and Environmental Engineering, Michigan State University
Qingxu "Bill", Jin, Ph. D.., P.E., Advisor, Department of Civil and Environmental Engineering, Michigan State University

NASA has the new and exciting mission of establishing a sustained presence on the Moon and Mars through safe and reliable infrastructure on their surfaces. The Agency is investing in advanced manufacturing technologies as enabling for space and planetary exploration such as the Moon to Mars Planetary Autonomous Construction Technologies project. One goal of these investments is to identify and utilize the available resources on the Moon and Mars to construct space-based infrastructure. To meet this goal, we have performed feasibility studies using lunar and Martian regolith simulants to prepare cementitious composites. The reactivity of the lunar and Martian regolith simulants has been tested using calorimetry and the formation of the reacted phases have been identified using thermalgravimetric analysis. Compression testes have also been performed and shown the inclusion of simulants negatively impact the compression strength. Future research will test the feasibility of adding fibers into the simulant composites.

16. **Measurement of the Graviton Mass using LISA**
Brett Bolen, Grand Valley State University

Currently there is a joint ESA/NASA mission to build a gravitational wave detector formed out of three spacecraft flying in a triangular constellation called LISA (Laser Interferometer Space Antenna). We propose to use a population synthesis code called COSMIC to create a realistic model of white dwarf binaries in the milky way and simulate how well LISA is able to detect if the gravitational wave have measurable dispersion. If general relativity is correct, there should be no dispersion but if GR is incorrect there could be dispersion of the wave as shown by Will. A second project is to show how one can describe seeming complex relativistic orbital mechanics of a LISA source comprising of a supermassive black hole and a stellar BH called a EMRI (Extremely Massive Relativistic Inspiral) into the junior level mechanics classroom.

17. **Neutral-Point-Less (NPL) Multilevel Inverter Topology with Single DC-link Capacitor: H-type Inverter**
Mikayla Benson, Graduate Student, Electrical and Computer Engineering Department, Michigan State University

High-voltage and high-power multilevel inverters (MLIs) have gained attention as the transportation electrification trend is rapidly expanding towards high-capacity mass transit systems. Conventional MLIs such as neutral point clamped (NPC) and T-type inverters provide high-voltage and high-power operation capabilities but require stacked dc-link capacitors with neutral point connection for zero voltage vectors. This neutral point connection generates a neutral current oscillating at three times the fundamental frequency, causing capacitor voltage imbalance and overvoltage stress on capacitors and switching devices. A neutral-point-less (NPL) MLI topology with a small and single dc-link capacitor, the H-type inverter, and its operating principle is proposed. The performance of the H-type inverter is investigated through simulation and compared to the T-type inverter. Simulation results show that the H-type inverter has 75% reduced dc-link capacitor current and voltage ripple, as well as less current waveform distortion, leading to smoother power output and a higher volumetric power density.

Poster Session B

1. **How iron oxide nanoparticles impact the auditory physiology and antipredator response of the house sparrow (Passer domesticus)**
Lindsay Jankowski, Undergraduate Student, Biology and Chemistry Departments, Hope College
Olivia Sprys-Tellner, Undergraduate Student, Biology and Chemistry Departments, Hope College

Increased urbanization poses challenges for wildlife. Urban development releases air pollutants into the environment. These air pollutants are primarily composed of particulate matter (PM) which can contain nanoparticles. Nanoparticles can bypass the blood-brain and blood-gas barriers and may accumulate in organs. Iron oxide nanoparticles (IONPs), Released in nonexhaust emissions are the most abundant airborne nanoparticles. IONP bioaccumulation can induce harmful health effects; interestingly, hearing deficits may be an early bioindicator of these downstream effects. We propose a connection between IONP bioaccumulation and decreased auditory sensitivity and investigate this using the house sparrow (Passer domesticus). House sparrows are ubiquitous and use vocal communication and therefore are an appropriate model. We conducted an auditory brainstem response (ABR) test before and after exposure to IONPs or a control. Subsequently, inductively coupled plasma spectroscopy determined iron concentration in collected organs. Our results could provide a potential methodology for studying the ecological repercussions of urbanization.

2. **PCR Assay for the Detection of Mosquito Vectors in Michigan**
Bridie McClusky, Graduate Student, Cell and Molecular Biology, Grand Valley State University.
Dr. Sheila Blackman PhD, Advisor, Cell and Molecular Biology, Grand Valley State University.

As climate change progresses, the threat of mosquito-borne arboviruses, such as West Nile and Eastern Equine Encephalitis, is expected to increase. Molecular methods can discriminate between taxa where morphological methods frequently cannot. We aim to develop a reliable molecular detection assay to surveille six mosquito vector species that are currently - or forecast to be - present, in west and central lower Michigan - Aedes triseriatus, Ae. vexans, Ae. albopictus, Ae. aegypti. Coquillettidia perturbans and Culex pipiens. We have identified mosquitoes to species and isolated and amplified an approximately 500 bp region of the Cytochrome C Oxidase, subunit 1 (COX1) gene. Further work will be aimed at amplifying species-specific amplicon lengths within the mitochondrial COX1 gene to facilitate identification of DNA to species with gel electrophoresis. This simple molecular assay will help document the spread of vector mosquitoes with climate change and thus notify authorities of the need for appropriate mitigation measures.

3. **Effects of Urbanization on House Sparrow (Passer domesticus) and House Finch (Haemorhous mexicanus) Songs**
Sarah Grimes, Biology Department, Hope College
Linda Nduwimana, Biology Department, Hope College
Eliza Lewis, Biology Department, Hope College
Kelly Ronald, PhD, Assistant Professor, Biology Department, Hope College

Urbanization and the accompanying auditory pollution can affect avian communication and song propagation. This study examined differences in active space, or the maximum distance a receiver can detect a signal, across an urbanization gradient. We utilized the house sparrow (Passer domesticus) and the house finch (Haemorhous mexicanus), as both species inhabit urban areas and rely on vocal communication. Fifteen songs from both species were obtained

for field trials. Bird communication was mimicked by playing back recorded songs with a speaker at urban, rural, and suburban locations in Holland, MI, and recorded at distances up to 100 meters. We expected bird song in rural areas to have a larger active space compared to urban environments due to less noise pollution. Preliminary results suggest a three-way interaction between species, exemplar, and urbanization level. Overall, this suggests that different songs have variable propagation patterns depending on habitat type.

4. **The Impact of DHA Supplementation on Neurogenesis in the Developing Embryo**
Grace Okros, Cell and Molecular Biology, Grand Valley State University, Merritt DeLano-Taylor, PhD, Cell and Molecular Biology, Biomedical Sciences, Grand Valley State University

Differentiation and the rate of division of neural stem cells (NSCs) are regulated by various factors, including our diet. The impact of prenatal supplements, such as the omega-3 fatty acid docosahexaenoic acid (DHA) -a long chain polyunsaturated fatty acid (LCPUFA)- have shown to be important for the development of neuronal cell membranes. The impact of DHA and other LCPUFAs on neuronal stem cell differentiation in-vivo has not yet been tested. In this study DHA and other LCPUFAs were introduced into the developing neural tube of chick embryos to determine their effects on NSC development. By examining the number of neurons in LCPUFA treated embryonic NSCs compared to the vehicle control, we found that DHA treated embryos had an increased number of neurons. The increase in neurons in the developing chick embryos supports the use of DHA as a prenatal supplement to assist in the development of the embryonic nervous system.

5. **Understanding the Controls of Solute Transport by Streamflow Using Concentration-Discharge Relationship in the Upper Peninsula of Michigan**
Fengjing Liu, PhD, Associate Professor, College of Forest Resources and Environmental Science, Michigan Technological University
John S. Gierke, Ph.D., P.E., Professor, Geological & Mining Engineering & Sciences, Michigan Technical University
Sierra L. Williams, Undergraduate Student, College of Forest Resources and Environmental Science, Michigan Technological University

As change within climate and land use continues to disrupt water budgets, water quality, and predictive power of hydrology within local and global ecosystems, there is rising importance to understand catchment dynamics and develop methods to effectively evaluate changes in these dynamics as they occur. The concentration-discharge (C-Q) relationship provides a possible solution on how to examine the relation between dissolved solutes in stream water and stream discharge. This relationship either follows a strong power-law relationship or follows no relationship, which could be used as a precursor for understanding catchment hydrology. Through analyzing this relationship, hydrological and

biogeochemical processes that control the solute transport by stream flow at catchment scales can be diagnosed, improving future stream quality and natural resource management.

6. **Running out of oxygen: Revealing the dynamics of bottom water hypoxia in a Great Lakes estuary**
Nate Dugener, B.S. in Environmental Science from Loyola University Chicago, Graduate Student, Annis Water Resources Institute at Grand Valley State University
Ian Stone, B.S. in Natural Resources Management from Grand Valley State University, Lab Technician, Annis Water Resources Institute at Grand Valley State University
Anthony Weinke, B.A. in Biology-Aquatic Science and M.S. in Biology-Aquatic Science from Grand Valley State University, Lab/Observatory Manager, Annis Water Resources Institute at Grand Valley State University
Bopaiah Biddanda, B.S. in Biology from St. Joseph's College, Bangalore University, M.S. in Marine Biology from Karnatak University, and Ph.D. in Marine Microbial Ecology from the University of Georgia, Principal Investigator/Professor, Annis Water Resources Institute at Grand Valley State University

Bottom water hypoxia, a condition of low oxygen, negatively effects freshwater and marine coastal estuaries globally. As climate change shifts climatological and ecological patterns, hypoxia continues to shift in duration and severity. We examined the dynamics of hypoxia over a decade (2011-2021) utilizing data from the Muskegon Lake Observatory buoy (MLO, https://www.gvsu.edu/wri/buoy/). During 2021, we analyzed the dissolved oxygen (DO) concentrations, conducted biweekly nutrient sampling, and investigated seasonal surface and riverine loading impacts on the drawdown oxygen. High spring precipitation and high summer algal growth correlated with high severity of hypoxia. Oxygen drawdown experiments revealed that riverine organic matter rather than surface production influenced hypoxia more readily in the spring, whereas the opposite was true in the summer and fall. Our findings on temperature and precipitation and seasonal oxygen drawdown have relevance to similarly afflicted ecosystems in the Great Lakes basin and lakes and estuaries everywhere.

7. **Relationships between Age, Relative Telomere Length, and DNA Methylation in Pteropus Bats (Flying Foxes)**
Erika E. Forest, MS Student, Department of Biology, Grand Valley State University
Amy L. Russell, Professor, PhD, Department of Biology, Grand Valley State University

Bats are the longest-lived mammalian order relative to body mass, but questions remain about mechanisms related to aging. Relative telomere length (rTL) decreases with age in most mammals, but the relationship between age and rTL

is highly variable among bat taxa studied to date. More recently, DNA methylation (DNAm), a type of epigenetic regulation, has been shown to be highly predictive of age in many species of bats. We examine the relationships between age, rTL, and DNAm in Pteropus pumilus and P. hypomelanus, pollinators and seed-dispersers crucial for restoring deforested habitats. We hypothesize (1) a negative linear relationship between age and rTL and (2) a correlation between rTL and DNAm, especially at age-related DNAm sites. We classify DNAm sites associated with rTL, identify genes near these sites, and investigate gene function. Exploring the relationship between these mechanisms provides deeper understanding of the process of aging in two ecologically important bat species.

8. **Numerical Estimation of Lyapunov Characteristic Exponents for the Fractional-Order Chen System**
Jadon Clugston, BSE, Graduate Student, Electrical and Computer Engineering, Western Michigan University
Damon Miller, PhD, Associate Professor, Electrical and Computer Engineering, Western Michigan University
Giuseppe Grassi, PhD, Professor, Department of Engineering for Innovation, University of Salento

Fractional calculus began with a 1695 letter from Guillaume del Hopital to Gottfried Leibniz, describing derivative and integral operators with non-integer orders. Recently, fractional differential equations (FDEs) with fractional derivative operators have been used to create more accurate and flexible models of physical systems, as compared to integer-order approaches. Dynamical systems can be chaotic, with extreme sensitivity to initial conditions and apparent randomness, while still being completely deterministic. Although FDEs technically do not describe dynamical systems, their solutions can exhibit chaotic properties. Lyapunov characteristic exponents (LCEs) measure the average divergence of trajectories starting from nearby initial conditions. A positive LCE indicates chaotic behavior. This work numerically investigates how the LCEs of the fractional-order Chen system vary with a varying fractional order.

9. **Evaluation of Model Simulated Ozone and its Precursors Using High-Resolution Model Simulations during the Michigan-Ontario Ozone Source Experiment (MOOSE)**
Noribeth Mariscal, Graduate Student, Department of Civil and Environmental Engineering, Wayne State University, Detroit, MI, 48202

Exposure to excess O3 levels can be detrimental to human health and agroecosystems. Southeast Michigan (SEMI) has been consistently classified as a nonattainment area for O3 based on NAAQS. Varied emission sources and complex meteorology are likely associated with these O3 exceedances. However, it remains unclear what physical and chemical processes lead to O3 nonattainment in SEMI, which is partially attributable to the lack of high-

resolution, in-situ observations in this region. In this study, we explore the distributions of O3 and its precursors (e.g., NOx and VOCs) over SEMI using a three-dimensional chemistry-climate model, MUSICAv0 (Multi-Scale Infrastructure for Chemistry and Aerosols, Version 0), constrained by MOOSE field campaign measurements during the summer of 2021. To better understand the local scale impacts of chemical complexity existing in SEMI, we refined the default horizontal resolution of ~14 km over the contiguous US to ~7 km over Michigan.

10. Œ≤-decay strength function of 54,52 Co

Gabriel Balk, Hope College, Paul Deyoung, Hope College

P process is believed to be responsible for the formation of heavy proton-rich nuclei in the universe.¬† Because p nuclei are short-lived, the specific properties of their reaction and decay paths are difficult to measure.¬† This work deals with the decays of two nuclei, 52,54Co.¬† Œ≤+ decays for each isotope were recorded with the Summing NaI(Tl) detector at the National Superconducting Cyclotron Laboratory.¬† A preliminary Œ≤-decay Intensity Function was derived with Total Absorption Spectroscopy. Total energy spectra, individual Œ≥ energy spectra, and multiplicity spectra for decays to levels in the child nucleus were modeled with GEANT4 based on information from the National Nuclear Data Center. The measured spectra, when fit with the simulated spectra, give the probability that a particular child level is populated during decay. Refined results, when compared to theory, will provide insight into the formation of p-nuclei elements.

11. Multidisciplinary Design Program (MDP) Projects at the Microdrone Sensor Lab

Aidan Gauthier, Undergraduate Student, CSE/NERS, UM; Dean Aslam, Ph.D., Professor, ECE, MSU; Xiaogan Liang, Ph.D., Associate Professor, ME, UM

We present current progress on the projects of the Microdrone Sensor Lab, developing low-power, low-cost devices to create a wireless sensor network for studying atmospheric phenomena and air quality. The projects include: a drone-carried particulate matter sensor, which reports data to an iPhone app for Realtime particulate matter data; a foldable airplane, which allows a single drone to carry and drop many of the devices in a single flight; a drone-carried optical microscope, for portable classification of airborne particles; and autonomous robotic control software for navigating ground-based sensor-carrying devices.

12. An Analysis of Eigenmode Activity in Visco-Resistive Magnetic Reconnection

Nicholas Kaipainen

Magnetic reconnection is the dynamically complex process in which energy is transferred from magnetic fields permeating a plasma into the particles that make up the plasma. One significant area where this occurs is in the Sun's atmosphere, driving events such as solar flares and coronal mass ejections. The equations describing this complex behavior are difficult to solve and parse for a better understanding of the system. This work studies the utility of a simplified model that frames the dynamics of the system in terms of its eigenmodes, both stable and unstable. It is theorized from prior studies that only a small fraction of the eigenmodes may be needed to quantify the system effectively. This is done here by numerically studying the resistive tearing instability in both linear and nonlinear regimes. The relevance of the eigenmodes over various system parameters, including viscosity, resistivity, and wavenumber, is discussed.

13. **The Snap-Through Behavior of Second Mode Buckled Beams**
Leo Jaramillo, Ethan Jansen, Dr. Mathew Smith

The snap-through of second mode buckled arches shows promise in various space relevant applications which includes energy harvesters, actuators, soft robotics, and miniature motors/pumps. Many studies on snap-through behavior have been composed of first mode arches; interestingly, higher mode arches have not been extensively studied. In 2019, Dr. Smith's group examined light driven snap-through of photo-mechanical polymer strips. However, the experimental system suffered from some specific limitations. The mechanics and the material used in Smith19 were not fully characterized which posed a challenge for studying buckled arches. To continue the work done by the Smith19 group, our approach was to decouple the material and mechanics of second mode snap-buckling, focusing on the mechanics of snap-through using mechanical force rather than light. A major accomplishment of our 2022 summer research was designing and building a testbed for measuring the mechanical force of our snap-through arches.

14. **Multipurposed Surface Coatings from Composite Dry Lubrication Schemes**
Nicholas Migaldi, Bachelor of Science in Engineering 2025, student research, Department of Engineering, Hope College
Alana Policastro Bachelor of Science in Chemistry 2024, student research, Department of Chemistry, Hope College

Two-dimensional (2D) materials are an attractive route to modulate interfacial behavior, positioning them well for potential use as multipurposed coatings for emerging technologies. There is a growing selection with well controlled composition, mechanical, and electronic properties. These properties can be further controlled by out-of-plane bending, such as through nano scrolling when 2D materials wrap around nanoparticles under sliding forces. Separately, surfaces with nanoscopic roughness can tune the bandgap of 2D materials through induced strain. This project seeks to understand the mechanical-electronic intersection of these effects. Molybdenum disulfide (MoS_2) and phosphorene 2D materials were used in conjunction with metal oxide nanoparticles of varying sizes, implemented to induce varying degrees of strain.

Sliding tests were carried out at nanoscopic and macroscopic length scales, with material characteristics assess with confocal Raman micro spectroscopy. This helps establish workable parameters for designing tailored multipurposed surface coatings.

15. **A New Universal Polarization Resolving Software Package for Solar Coronal and Heliospheric Observations**
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Mr. Daniel B. Seaton, Ph.D., Principal Scientist, Department of Space Studies, Southwest Research Institute, Boulder, CO
Mr. Chris Lowder, Ph.D., Principal Scientist, Department of Space Studies, Southwest Research Institute, Boulder, CO
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Mr. Mathew J. West, Ph.D., Principal Scientist, Department of Space Studies, Southwest Research Institute, Boulder, CO

The upcoming Polarimeter to UNify the Corona and Heliosphere (PUNCH) NASA small explorer mission will rely on a polarization resolver. We present a universal, open-source, polarization resolver developed in Python with this mission in mind. This resolver is capable of converting three-polarizer measurements to polarized brightness (pB) and total brightness (B) and vice versa. It is also capable of estimating error as a function of photometric errors, polarizer misalignments, and polarizer effectiveness. We show the potential of the package using existing data from the STEREO mission. We test the robustness of the resolver using synthetic, forward-modeled data with the dimensions and characteristics of the PUNCH datasets. The synthetic data is produced with different noise contributions to test the ability of the resolver to construct pB and B datasets under noisy conditions and assess unusable data. This polarization resolver shows promise to advance our understanding of the Sun and solar wind.

16. **Utilizing GPU and CPU Parallelization to Quickly Calculate Compton Scattering Cross Section in Magnetar Magnetosphere**
William N. Vance - Undergraduate Physics student at Hope College, Peter L. Gonthier - Professor of Physics at Hope College

Compton scattering is the process which we understand to yield the high-energy radiation we observe from magnetars, neutron stars with very strong magnetic fields. It is desired to model this process in Monte Carlo simulations, which will require calculating the Compton scattering cross section many times via a C++ code. For this reason, efficiency is highly desirable. Modern computers typically have multiple cores, and it is not uncommon that they have a GPU as well. Therefore, to achieve minimum computation time, it is necessary to be able to run the code on a NVIDIA GPU, as well as all of the CPU cores. Both types of parallelization can be achieved through OpenMP, a parallelization package. CPU

parallelization is done very frequently, and on a broad level un-complex. GPU parallelization, in comparison, is more of an art than a science. As such, the summer research focused largely on GPU parallelization.

17. Space Solar Cells, Radiation Damage of Halide Perovskite semiconductors
Dirk Visser (student), Andrew Bunnell(Hope Physics, Director of Physics laboratory), Dr. Paul DeYoung(Hope Physics Department chair), Dr. Jeffrey Christians (Hope Engineering/Mentor)

Halide perovskites represent a new frontier in regards to energy generation from solar sources in comparison to traditional silicon based cells. Perovskite solar cell use in space is a promising future because of their defect tolerance, but any solar cell in space encounters the problem of radiation degradation. Exposure to low energy protons leads to the creation of defects which reduces the efficiency of the cells. Mixed halide, mixed cation halide perovskites were chosen for initial studies as these have proven to reach high efficiency and show good stability under terrestrial stresses. Bare films of these halide perovskites were investigated to uncover intrinsic material degradation. After fabrication of the films, the perovskite films were irradiated with low energy protons (c.a. 300 keV) using Hope college’s particle accelerator. To measure the degradation of the films, photoluminescence of the irradiated sample was analyzed before and after irradiation with a fluorimeter. While initial data have proven inconclusive, future changes to procedures and measurements are expected to begin to tie sample proton dose to a reduction in photoluminescence intensity. The future of halide perovskites is promising and further research into the degradation of the films will begin to uncover the connection between material composition and the stability under proton irradiation.