Poster Session Number Assignments

1. **Performance of Electrospray Propulsion for Gathering Single Polarity Data (PEP-GS)**
Dr. Kristina Lemmer, Professor, Mechanical and Aerospace Engineering Department, Western Michigan University.
Larissa McKenzie, Undergraduate Student, Mechanical and Aerospace Engineering Department, Western Michigan University.
Luke Halladay, Undergraduate Student, Mechanical and Aerospace Engineering Department, Western Michigan University.
Brendan Schulz, Graduate Student, Mechanical and Aerospace Engineering Department, Western Michigan University.
Douglas Adams, Undergraduate Student, Mechanical and Aerospace Engineering Department, Western Michigan University.

The Western Aerospace Launch Initiative (WALI) is a student group at Western Michigan University (WMU) aiming to launch West Michigan's first satellite. In collaboration with the University Nanosatellite Program and AFRL, the mission will demonstrate the viability of a porous borosilicate, passively fed, ionic liquid electrospray thruster in single polarity mode as an on-orbit propulsion system for small satellites. In doing so, telemetry, thrust, and spacecraft charge will be measured to determine future mission feasibility for single polarity electrospray thrusters. The satellite bus, thruster power processing unit (PPU), and a dual-function Langmuir probe are currently being developed at WMU across multiple campus laboratories. The thruster will be provided by the Space Propulsion Laboratory at MIT. This joint academic endeavor serves to increase spacecraft mission development skills in Southwest Michigan and solidify Michigan as a place for space.

2. **Optical Study of a Porous Emitter Ionic Liquid Ion Source**
Nathaniel Allwine, BS, Mechanical Engineering Ph.D. Student, Mechanical and Aerospace Engineering Department, Western Michigan University
Thomas Kerber, MS, BS, Mechanical Engineering Ph.D. Candidate, Mechanical and Aerospace Engineering Department, Western Michigan University
Nicholas Taylor, Ph.D., BS, Senior Research Associate, Mechanical and Aerospace Engineering Department, Western Michigan University

Kristina Lemmer, Ph.D., MS, BS, Professor, Mechanical and Aerospace Engineering Department, Western Michigan University

The electric propulsion community aims to replicate Low-Earth Orbit conditions during testing to enable testing-as-you-fly. Back-streaming particles, caused by primary beam particles impacting facility surfaces, are a concern for electrospray thrusters and can lead to errors in diagnostic equipment, electrochemical processes, and reduced performance. Photoemission near electrospray emitter tips, previously attributed to secondary species emission (SSE), lacks a comprehensive explanation. This study investigates the origins of photoemission and its connection to SSE. Testing at the Aerospace Laboratory for Plasma Experiments utilized a porous-media passively-fed ionic liquid electrospray with optical access to the emitter. Results showed three types of emitted light: from the emitter, emitter and extractor, and predominantly the extractor. Higher extractor currents intensified photoemission, suggesting it originates from ion impingement on the extractor, not solely a facility effect. Photoemission intensity correlated with emitter voltage, peaking around ¬±1400 V, while the beam dump material and distance had a weaker correlation.

3. **CRISPR-Cas13d Mediated RNA Interference in Plants for Reverse Genetic Studies**
Reed Arneson, Ph.D. candidate, Graduate Research Assistant. College of Forest Resources and Environmental Sciences, Michigan Technological University. Yinan Yuan, Ph.D., Assistant Professor. College of Forest Resources and Environmental Sciences, Michigan Technological University.

Future long-term space missions and extraterrestrial settlements will need space-productive plants that are able to respond to these harsh environmental stresses, including drought and different soil composition. Genetic engineering, which involves manipulating gene expression of plants to increase tolerance, is one such method to generate productive plants in space. However, to allow for effective genetic engineering, research needs to be conducted into stress responsive genomic loci, such as those relating to drought, to understand how they function. Reverse genetics, where gene expression is altered and differences are compared, is one method to explore gene function. Currently, we are generating a novel, strand-specific CRISPR-Cas13d RNA interference system to knockdown RNA expression for plants. This system and resulting plasmids can be easily used and adapted by researchers to target almost any RNA strand of interest for knockdown. We are currently testing this system with a drought responsive linker histone locus in Populus.

4. **Classifying Patient Handling Techniques to Reduce Risk of Musculoskeletal Injury in Nursing Students**
Giovanni Battaglia, Undergraduate student, Computer Science department, Hope College

Emanuel Sanchez, Undergraduate student, Computer Science department, Hope College
Brooke Odle, Ph.D., Assistant Professor, Engineering, Hope College
Omofolakunmi Olagbemi, Ph.D., Assistant Professor, Computer Science, Hope College

Nurses suffer musculoskeletal injuries at a higher proportion than the general population due to physical strain and poor posture during patient-handling tasks; studies show that back injuries occur at a rate of 28.9 cases per 10,000 registered nurses. The purpose of this study is to apply multivariate time series classifiers (MTSCs) to classify six patient-handling tasks and the quality of subject posture (good, poor, or neutral) during these tasks. Manikins weighing 44 lbs, 66 lbs, and 110 lbs simulated patients. In this proof-of-concept study the XCM, ResNet, and MiniRocket MTSCs were trained with data collected from four non-nursing students using features from the data that were identified as most critical by the explainable classifier XCM. MiniRocket proved to be the most accurate classifier (96.2% model score). The next stage of this study will involve nursing students with varying degrees of experience in a simulated clinical environment.

5. **The impact of aerosolized iron oxide nanoparticle exposure on behavior of the house sparrow (Passer domesticus).**

John Wenderski: undergraduate student, Biology department at Hope College
Sarah Grimes: graduate student, Purdue University College of Science
Dr. Kelly Ronald: Ph.D. in biological science, assistant professor of biology, Biology department at Hope College
Dr. Natalia Gonzalez-Pech: Ph.D. in chemistry, assistant professor of chemistry, Chemistry department at Hope College

Increased urbanization poses a threat to avian viability due to the introduction of air pollutants. Metallic nanoparticles, a component of particulate matter, can invade the bloodstream and brain and alter behavior. Zinc oxide nanoparticle exposed chicks showed lowered antipredator behavior, and silver injected mice showed lowered movement time. Although urban birds showed decreased exploratory and risk-taking behavior, both of which are critical to reproductive fitness, it is unclear if this is due to environmental demand or cognitive changes from air pollution exposure. Thus, this project will examine the effects of iron oxide nanoparticles (IONPs), as they are very abundant in cities, on the risk taking and exploratory behavior of house sparrows (Passer domesticus), as they occupy environments all across the urbanization gradient. In a novel-environment foraging test, we predict increased risk-taking, as measured by initial foraging latency, and decreased exploratory behavior, as measured by flight time and sites visited.

6. **Understanding exotic black hole orbits using effective potentials**

Brett Bolen

Gravitational wave astronomy is an emerging observational discipline that expands the astrophysical messengers astronomers can use to probe cosmic phenomena. The gravitational waveform from a source encodes the astrophysical properties and the dynamical motion of mass within the system; this is particularly evident in the case of binaries, where the overall amplitude of the system scales with physical parameters like mass and distance, but the phase structure of the waveform encodes the orbital evolution of the system. Strongly gravitating systems can show interesting and unusual orbital trajectories, as is the case for ``extreme mass ratio inspirals,'' observable in the millihertz gravitational wave band by space-based gravitational wave detectors. These sources can exhibit ``zoom-whirl'' orbits, which make complicated waveforms that are useful for mapping out the gravitational structure of the system. Zoom-whirl behavior can be intuitively understood in the context of effective potentials, which should be familiar to students from classical orbital theory in mechanics. Here we demonstrate and explain zoom-whirl orbits using effective potential theory around Schwarzschild black holes and present an interactive tool that can be used in classroom and other pedagogical settings.

7. **Characterization of seven bogs along a climate transect of Michigan peatlands.**
Abigail Brewer, undergraduate student, Departments of Geological and Environmental Science, Hope College
Michael Philben, PhD, Assistant Professor, Departments of Geological and Environmental Science, Hope College

We collected peat cores from seven bogs along a climate transect extending from southern Michigan to the upper peninsula with the goal of predicting how carbon cycling in peatlands will respond to climate warming. Cores from seven bogs were collected via a Russian-style peat corer to extract samples measuring one meter deep at each site. After returning to the laboratory, each core was visually inspected, and changes in color and composition were recorded. The peat was then cut, weighed, dried, and ground up into a powder for further analysis. In this poster, we will present results from a preliminary geochemical characterization of the cores from each site, including in pH, carbon and nitrogen content and extractable metal concentrations. We will also present preliminary results of lead-210 dating of the peat cores, with the ultimate goal of determining if recent warming has already affected C accumulation along the climate transect.

8. **The Last Step in Contact Binary Star Formation**
Levi A. Carr, Calvin University Physics & Astronomy Dept.
Henry Phippen, Calvin University Physics & Astronomy Dept.
Professor Larry Molnar, Calvin University Physics & Astronomy Dept.

Many stars have companions orbiting so closely that they share a common atmosphere: contact binary stars. Last summer we explored which mechanisms bring these stars into such close proximity. This summer we built on this by considering how pairs respond when atmospheric matter first flows between them. How the size of a star responds to a change in its mass, the parameter zeta, is the determining property for what happens to the pair at first contact. Understanding the outcomes requires computation of zeta in three situations: 1) the adiabatic (instantaneous) response of a star; 2) the thermal (equilibrium) response of the star; 3) the response of the star's Roche lobe (gravitational sphere of influence). We present these calculations, showing how the relative values of the three zetas determine the stability of an interacting system. One highlight is the natural explanation for different responses of sun-like stars and more massive stars.

9. **An Evaluation of the Effects of a STEM Summer Camp on Middle School Student's Attitudes Towards STEM**
Jenna Case, B.S., M.S. Candidate, STEM Outreach Graduate Assistant, Grand Valley State University Regional Math and Science Center
Chelsea Ridge, B.A., M.Ed, Co-Director of the Regional Math and Science Center, Grand Valley State University Regional Math and Science Center
Diane Miller, B.S., MPA, Business and Community Outreach Coordinator, Grand Valley State University Regional Math and Science Center and MiSTEM Network.

The research project investigated the effects of a science, technology, engineering, and mathematics (STEM) summer camp on middle schooler's attitudes toward STEM topics. The summer camp, Energizing Our World (EOW), was held on GVSU's campus and focused on renewable energy and sustainability. The students were offered the option to continue their summer STEM experience after camp using a predetermined curriculum. Students were given the opportunity to present their summer STEM projects in the fall at a STEM weekend at GVSU. Their attitude toward STEM and reflection on STEM abilities were measured using the S-STEM survey at the beginning of camp, end of camp, and after the extended experience. These scores were recorded and analyzed for significant differences using statistical methods.

10. **Fast, memory-efficient spectral clustering with cosine similarity**
Guangliang Chen, PhD in Applied Math, Associate Professor of Statistics and Data Science, Hope College

Spectral clustering is a popular and effective clustering method but known to face two significant challenges: scalability and out-of-sample extension. Here we extend the work of Chen (ICPR 2018) on the speed scalability of spectral clustering in the setting of cosine similarity to deal with massive or online data that are too large to be fully loaded into computer memory. We present a streamlined memory-efficient algorithm that only uses a small number of batches

of data (as they become available), with memory and computational costs that are independent of the size of the data. Experiments are conducted on benchmark data to demonstrate the fast speed and excellent accuracy of the proposed algorithm.

11. **Michigan Launch Alliance - Bridging the Gap Between Industry and Academia**
Dawson Coats
Joshua Boverhof
Jaden Groenheide
Christopher Osburn

Michigan Launch Alliance is a new initiative dedicated to bringing students within the Mid-Western United States together to learn, adapt and refine rockets and other aerospace related projects. The goal of MLA is to give opportunities to students no matter the current University/College attended. The projects developed by MLA, are developed to connect academia and industry by giving students applicable experience to use in their careers. MLA is developing a bi-propellent rocket capable of competing in either the IREC (Intercollegiate Rocket Engineering Competition), or the FAR DPF (Friends of Amatuer Rocketry, Dollar Per Foot) competition. To complete this goal, the team needs to develop a bi-propellent engine that is capable of taking a launch vehicle on a sub-orbital trajectory.

12. **The 2023 Roger That! Symposium - Space and History**
Jack Daleske, B.A., Planetarium Director at Grand Rapids Public Museum
Karen Gipson, Ph.D., Professor of Physics and Interdisciplinary Studies at Grand Valley State University
Glen Swanson, M.A., Chaffee Scholarship Fund Board Member
Deana Weibel; Ph.D., Professor of Anthropology at Grand Valley State University

Roger That! is a celebration of space exploration in honor of Roger B. Chaffee. The 2023 theme of this annual collaboration between GVSU and Grand Rapids Public Museum (GRPM) was Space and History. Experts delivered online presentations on Friday morning, and the event transitioned to in-person activities at GVSU at 4pm, culminating with an inspirational presentation by astronaut Jose Hernadez (in-person and live-streamed). Meanwhile on Friday, GRPM offered school field trips, and on Saturday GRPM hosted Spanish-language star talks and numerous family-friendly activities, as well as another presentation by Hernadez. MSGC supplemental funding enabled 150 STEM kits to be provided to local fifth-graders, and a record number of local schoolchildren submitted Design That! entries. Online aspects enhanced accessibility for both participants and speakers, while in-person aspects supported community-building and hands-on learning. The 2023 MSGC grant covers the hybrid symposium in 2024 on February 9-10, which is themed Life in Space.

13. **Exploring the Reactivity and Mechanical Performance of Cementitious Composites Using Lunar and Martian Regolith Simulants**
Nathan Denning, Undergraduate Student, Department of Civil & Environmental Engineering, Michigan State University
Matias Leon-Miquel , Graduate Student Mentor, Department of Civil & Environmental Engineering, Michigan State University
Dr. Qingxu "Bill" Jin, Faculty Mentor, Department of Civil & Environmental Engineering, Michigan State University

NASA has key strategic plans to establish a sustained presence on the surfaces of the Moon and Mars through resilient infrastructure. To do this, it is essential to identify and utilize the available resources on the Moon and Mars to construct space-based infrastructure. Research has shown that Lunar and Martian regolith simulants could be the precursors to producing viable construction materials in space. In this study, the hydraulic and pozzolanic reactivity of 6 different simulants in their ,as-received state was assessed to evaluate the feasibility of regolith-based composites. As expected, simulants did not show promising hydraulic reactivity results. Nevertheless, pozzolanic reactivity assessed by lime solution conductivity measurements showed high reactivity in Martian simulants. Additionally, the mechanical properties of early regolith-based strain-hardening composites were assessed (focusing on flexural performance) which showed consistently superior results compared to regular concrete throughout all the simulants tested.

14. **Effects of acute hypoxic exposure in the olfactory system of adult zebrafish**
Skylar DeWitt, Undergraduate Student, Neuroscience Program and Biology Department, Hope College, Holland, MI

Hypoxia, the lack of sufficient oxygen in tissues to sustain homeostasis, has a deleterious effect on brain health. Zebrafish display a high degree of neuroplasticity, which allows for the study of neural repair mechanisms after hypoxic exposure. Thus, we aim to uncover the effects of oxygen deprivation on the olfactory system and olfactory-induced behavior of zebrafish. To induce hypoxia, zebrafish were placed in a tank with hypoxic levels of 0.6-0.8 mg/mL dissolved O2 (DO) for 15 minutes. Following a recovery period of 1 day (1dph) post hypoxia, zebrafish brains were dissected and processed for histology and immunohistochemistry. Additionally, olfactory function was evaluated via behavioral assays that utilized the odorant cadaverine. Hypoxic exposure led to increased astrocytic activation, reduced olfactory lamellar thickness, decreased olfactory-mediated behavior, and observable tissue structure changes. This study illuminates hypoxia's effect on olfactory morphology and function.

15. **Comparing Insect Biodiversity Between Curb-Cut Rain Gardens and Residential Lawns in the Plaster Creek Watershed**
Naomi Dykstra, Student, Biology Department at Calvin University
Julia Klooster, Student, Biology Department at Calvin University

Global insect biodiversity is at a major decline. The drop in population can largely be attributed to a loss of natural habitat through conversion into urban and agricultural land. In the city of Grand Rapids, Plaster Creek Stewards have implemented many green infrastructure projects, including more than 200 rain gardens. These curbside gardens benefit the watershed by soaking up rainfall, reducing flash flooding, but they also bring a native landscape to urban areas. The purpose of this research project is to compare insect biodiversity between the native rain gardens and grass lawns. Seven sites were randomly selected, and four data collections were done throughout the summer. Insects were collected using pitfall traps and nets and were identified to Family. So far, the data indicates that curb-cut rain gardens are inhabited by more unique families of insects than the lawn counterpart.

16. *Debris of Giant Impacts*

Emily Elizondo, Graduate Student, Department of Physics and Astronomy, Michigan State University
Seth Jacobson, PhD, Assistant Professor, Department of Physics and Astronomy, Michigan State University

The giant impact phase is what many hypothesize to be the final stage of terrestrial planet formation. This phase consists of collisions between planetary embryos that range in size from about a lunar-mass to a Mar-mass. However, there is much debate about the number and violence of the collisions that occur. Within each scenario debris is produced from the collision and may have settled within the asteroid belt. The amount of debris produced within each scenario can be compared to an upper mass limit differentiated asteroids with origins though to be of the terrestrial planets. We will use an astronomical N-body simulator to model one of the leading formation scenarios to track and quantify the amount of debris that ends up in the asteroid belt. The results produced will be compared to the upper limit and will give us an inclination of the validity of the formation scenario.

17. *Warming effects on greenhouse gas production across a climate transect of Michigan peatlands*

Gael Figueroa-Enriquez, Geology/Environmental & Chemistry Department, Hope College, Holland, MI
Michael Philben, PhD, Assistant Professor, Departments of Geological and Environmental Science, Hope College

We collected cores from seven peat bogs along a north-south transect of Michigan to assess the impacts of warming and climate history on greenhouse gas production. From each core, we constructed six microcosms by adding 10 grams of peat to a serum bottle, for a total of 42 microcosms. The headspace of each microcosm was flushed with N2 at the beginning of the experiment, and again after 10 and 20 days, to maintain an anaerobic environment. Replicate microcosms from each site were incubated at 13¬∞C and 23¬∞C for 30 days. We measured the CO_2 and methane concentration in the headspace of the microcosms using a GC-FID with a methanizer. We found that warming consistently increased both CO_2 and methane production. Additionally, methane production was consistently higher in the southern sites, indicating that sites with warmer climate histories harbored a more active community of methanogenic microorganisms.

18. Design and fabrication of an ultra-wideband microstrip antenna with frequency band notch ability using defected ground

Ghazaleh Hajimazdarani
Alimohammad Hajiadineh
Simin Mashi
Massod Atashbar

A novel design of a microstrip monopole antenna for super wide band applications is presented. In the design procedure of this antenna the goal was to improve the bandwidth as much as possible by the use of multi-resonance technique. After providing a base design for ultra-wide band performance, band-notch characteristic is also added to the performance of the antenna by the means of cutting additional slots with appropriate dimensions on the radiating patch of the antenna and also by using defected ground structure. The designed antenna is able to cover the frequency band of 3-10 GHz with a fractional bandwidth of 110% while providing a notched band operations at 4.4-5.7 GHz. The measured results show good agreement with simulated Data which confirms the usefulness of the antenna design.

19. A Passive Smart E-Textile Capable of ECG Monitoring

Dr. Dinesh Maddipatla, Ph.D Electrical and Computer Engineering, Western Michigan University
Dr. Simin Masihi, Ph.D Electrical and Computer Engineering, Western Michigan University
Masoud Panahi, MS Electrical and Computer Engineering, Western Michigan University

Cardiovascular diseases are the leading cause of death globally, necessitating continuous monitoring. To monitor these diseases closely, a fully wireless ECG sensing system is being developed that can be seamlessly integrated into a shirt. The system provides accurate ECG signal measurements without any discomfort to the user. The sensing electrodes are made of carbon composite on a fabric platform and do not require any skin preparation or gel. This makes the system reusable and attractive for the user's convenience. The system is operated using wireless power transfer from the user's phone, eliminating the need to find a power outlet or replace batteries. The ECG signals are wirelessly transmitted to the user's smartphone, where they can be analyzed or stored. This data can be

used to expand our knowledge of the causes and effects of cardiovascular diseases.

20. The effects of 600 keV proton irradiation on the properties of YBCO thin-film superconductors.

Hope Weeda
Joseph Fogt
Trevor Harrison
Dr. Kyuil Cho, Department of Physics, Hope College

We studied the effect of 600 keV proton irradiation on thin film Cuprate superconductors. A 500 nm thick YBCO-1237 sample was subjected to a series of proton irradiations with a total fluence of 7.2 x 10^16 p/cm^2. Upon irradiations, the superconducting critical temperature (T_c) was drastically decreased from 90 K towards zero Kelvin, and the normal state resistivity increased accordingly. The rate of T_c reduction to resistivity increase will be used to discuss the fundamental property of the superconductor.

21. An Omics Strategy to Study Spaceflight Effects on Intracellular Communication in Arabidopsis thaliana

Margaret E. Hitt, H.H. Dow High School, President & Founder of Dow High Space Farmers, NASA Intern (GeneLab for High Schools)
Brook Hill, Fatima Khawaja, Ryan Buschman (GeneLab for High Schools)
Elizabeth A. Dr. Blaber, PhD, Assistant Professor, Department of Biomedical Engineering, Rensselaer Polytechnic Institute
Jennifer C. Claudio, NASA Ames Research Center

Recent studies in space biology have shown that spaceflight stressors differentially regulate cell wall synthesis and growth. It is well-understood that the cell wall acts as a barrier against environmental and pathological stresses. However, the mechanism of how the cell wall integrity (CWI) pathway responds to spaceflight stressors still needs to be studied. This presentation will first share the results of our analysis of GeneLab Dataset 321, a study from NASA's Open Science Data Repository investigating spaceflight's effects on unfolded protein responses (UPR). Next is the proposed omics approach to investigating spaceflight effects on intracellular communication in Arabidopsis thaliana. The role of IRX7 (a gene associated with secondary cell wall biogenesis) in cell wall modification and UPR regulation will also be discussed. Studying IRX7 silencing and overexpressing may provide insight into how spaceflight stressors impact intracellular communication in space plants and thus help inform optimizing space crop production.

22. Multipurpose lubricants from composite nanomaterials

Benjamin Jackson, Undergraduate Researcher, Chemistry and Engineering, Hope College

Emerging technologies have shown increasing dependence on lubrication and wear protection. Composite systems composed of nanoparticles and two-dimensional (2D) materials are well-positioned for potential use as multipurpose liquid lubricants for applications such as electric vehicles or renewable energy systems. Nanoparticle additives, like zirconium dioxide, form thin tribofilms between sliding surfaces that protect the material from mechanical wear. 2D materials, such as phosphorene and MoS_2, have well-controlled chemical composition, mechanical performance, and electronic behavior. The interaction of 2D materials with nanoparticles showcase low friction through a nanoscrolling mechanism where the 2D material wraps around the nanoparticles. The induced strain further selectively controls the bandgap in 2D materials, useful for electronic applications. This project seeks to investigate the potential of a composite system with tribofilm forming nanoparticles, a reduced friction environment as a result of nanoscrolling, and adjustable electronic and optical properties from 2D material deformation.

23. Emission Behavior of Single Emitter Passively-fed Ionic Liquid Ion Source During Startup

Thomas Kerber, MS, Ph.D. Candidate, Mechanical and Aerospace Engineering Western Michigan University.
Hannah Sargent, BS, Graduate Student, Mechanical and Aerospace Engineering Western Michigan University.
Kristina Lemmer, Ph.D., Professor, Mechanical and Aerospace Engineering Western Michigan University.
Nicholas Taylor, Ph.D., Sr. Research Associate, Mechanical and Aerospace Engineering Western Michigan University.

The development of high specific impulse, high efficiency propulsion devices operating at low power using the electrospraying process has faced challenges in operating lifetime and sub-theoretical thrust efficiency. To improve performance, a more complete understanding of the emission process is necessary. High-speed ion current on the extractor electrode and downstream beam detector electrode of a passively-fed ionic liquid ion source electrospray thruster was measured. The voltage applied to the emitter was rapidly alternated in a square-wave pattern at several frequencies, amplitudes, and between positive polarity to ground, negative polarity to ground, and positive to negative polarity. The time delay between full-scale voltage on the emitter and ion current on the beam detector decreased with increasing frequency and increasing voltage, and was eliminated when emitter voltage was switched directly from positive polarity to negative polarity. The standard deviation in delay time for repeated switches with constant operating parameters was also evaluated and shown to decrease with increasing voltage. Multiple steps in the ion current during onset were observed, this is attributed to the formation and emission from discrete sites across the surface of the emitter. The number of steps during onset increased with increase voltage. An analytical model of the time delay is used to support the hypothesis that the measured variance in emission onset time at fixed emitter voltage is driven by differences in the number of pores feeding the Taylor cone between repeated tests.

24. Development of a liquid chromatography method for the quantification of carbohydrates in peat soils

Christopher Klaver, Seeking Undergraduate, Chemistry Department, Department of Geology and Environmental Science, Hope College

Dr. Michael Philben, PhD. Marine Science, Professor of Chemistry and Geology, Chemistry Department, Department of Geology and Environmental Science, Hope College

Peatlands are currently an important carbon sink. However, climate change threatens to cause the release of carbon dioxide and methane from peatlands due to increased decomposition, forming a positive feedback loop. The biochemical composition of peat is an important indicator of the peat's current degradation state and ongoing vulnerability to decomposition. Our project this summer was to analyze the carbohydrates content of peat cores as an indicator of organic matter quality. Currently we are developing two different approaches. Both approaches begin with acid hydrolysis to convert carbohydrate polymers to sugar monomers. In the first method, monomers are derivatized with 1-Phenyl-3-methyl-5-pyrazolone (PMP) and then analyzed via HPLC/Diode array detector for total carbohydrates. In the second method, the underivatized sugars are analyzed directly via LCMS. We will use these methods to characterize differences in degradation state along a climate transect of Michigan peatlands.

25. Impact of climate change and restoration on phosphorus loading in impaired wetlands

Kate Lucas, B.S., Graduate Student, Biology, Annis Water Resources Institute, Grand Valley State University
Alan Steinman, Ph.D., Allen and Helen Hunting Research Professor, Annis Water Resources Institute, Grand Valley State University

Restoring wetlands can increase biodiversity and water quality. Prior agricultural practices in a coastal wetland restoration site in west MI have caused high legacy phosphorus concentration in sediments. Sediment dredging is being considered as a restoration tool to control internal phosphorus loading (IPL). Climate warming is resulting in increases to both mean temperature and temperature extremes, which may affect IPL. I tested the effects of simulated dredging, increased mean temperature, and increased temperature variability on IPL by incubating sediment cores in a controlled laboratory experiment. Unexpectedly, dredged sediment cores had higher SRP release rates throughout the incubation compared to undredged cores. Temperature regime had less of an effect on P flux; however, elevated mean temperatures resulted in greater IPL rates compared to ambient and variable treatments. These preliminary results indicate

dredging may not be the appropriate restoration technique; however, more analyses are underway to further our insights.

26. Electronic Realization of a Fractional-Order Chaotic Oscillator

Jadon Clugston, B.S., Electrical and Computer Engineering, Western Michigan University
Damon A. Miller, Ph.D., Associate Professor, Electrical and Computer Engineering, WMU
Giuseppe Grassi, Ph.D., Professor, Innovation for Engineering, University of Salento

Fractional-order calculus generalizes ‚Anormal integer order derivatives and integrals to orders other than integers, such as fractional, real, or even complex orders. Fractional-order differential equations (FDEs) are differential equations that are comprised of fractional-order derivatives and are a generalization of ‚Anormal integer-order differential equations. A fractional-order integrator was developed and implemented in analog electronic circuitry. Using numerical optimization, the poles and zeroes of a transfer function were found so that the transfer function approximately matches the characteristics of an ideal fractional-order integrator over a specified frequency range. The approximation is then realized using analog electronic circuitry. These approximations were used to implement a fractional-order two-scroll chaotic oscillator attractor. Lyapunov characteristic exponents (LCEs) measure the average divergence of trajectories starting from nearby initial conditions. LCEs for the physical realization of the fractional-order two-scroll chaotic attractor were evaluated and compared to theoretical results.

27. The Formation and Effect of Electric Fields on Atmospheric Coarse Mineral Dust

Ian Norwood, BS Astronomy and Physics (UW Madison)/Frontiers in Optics Certificate and Advanced Computational Physics Certificate from MTU Graduate School, Ph.D. Candidate, Michigan Technological University Physics Department

Global climate models inadequately account for most of the observed coarse dust mass in the atmosphere. Simulations and in-situ measurements suggest the neglect of Coulomb forces on particles' settling times as a potential source of bias. Models accounting for measured electric fields in dust generating plumes suggest the greatest impact of electric fields on these particles’ settling times occurs at diameters near 10 micrometers. Here, I collect individual levitated particle charge lifetime data around this size range using electrodynamic levitation. The combination of previous methods used for larger particles will be used to interpolate charge lifetimes between these size ranges and better determine the frictional charging rate for a given distribution of particles. Additionally, I will utilize a humidity-controlled group-charging apparatus to measure particle charge polarity dependence on size. These experiments will

quantify the formation, magnitude, and lifespan of electric fields produced during initial dust transport in the atmosphere.

28. **Bogs on the brink: detecting the effects of warming on a climate transect of Michigan peatlands**
Michael Philben, PhD, Assistant Professor, Hope College Department of Geological and Environmental Science

Michigan's lower peninsula spans the southern boundary of the climate window for Sphagnum-dominated peatlands. Climate warming may be shifting this climate window to the north, jeopardizing the extensive carbon stocks currently sequestered as organic matter in these peatlands. We investigated the effects of warming on carbon and nitrogen cycling using a space-for-time substitution approach along a climate transect of seven field sites. The transect extends from Portage to Newberry, and spans 5¬∞C of mean annual temperature. At each site, we measured greenhouse gas production rates in microcosm experiments, measured in situ rates of nitrogen mineralization using Plant Root Simulators, and collected a 1-m peat core for Pb-210 dating. Our results indicate that rates of both carbon and nitrogen cycling increase with warming. Pb-210 dating will be used to determine if warming has already started to alter the net C balance of these marginal peatland ecosystems.

29. **Probing massive contact binary evolution via measurements of orbital period changes**
Henry O. Phippen, undergraduate, Physics and Astronomy Calvin University
Levi A. Carr, undergraduate, Physics and Astronomy Calvin University
Prof. Larry Molnar, BS MA PHD, Physics and Astronomy Calvin University

Many stars have companions orbiting so closely that they share a common atmosphere: contact binary stars. High and low mass systems differ significantly in key observable properties such as mass ratio. Models of the behavior of more massive systems have recently been published under the approximation that the internal structures of the stars are not affected by their being in contact. A key observable of these models is the rate of orbital period change at different stages of their life. The goal of this work was to test model predictions about period derivatives. We determined derivatives by gathering published data sets and analyzing them with a Python pipeline we wrote. Preliminary analysis of our results does not support the published models. However, other mechanisms for producing short term period change may complicate the interpretation.

30. **Batch manufacturing of polyelectrolyte biomaterial capsules with tailored internal micro-environments through use of electrospray technologies.**
Rafael Ramos, Dept. of Biomedical Engineering, School of Medicine, College of Engineering, Wayne State University
Howard W.T. Matthew. Dept. of Chemical Engineering & Materials Science, College of Engineering, Wayne State University

Studying the physiological effects of space travel creates a need for high fidelity, in vitro models of complex tissues. Tissue constructs engineered using a bottom-up modular approach offer a solution to this problem. Here, we expand on a previously reported method of cell encapsulation using glycosaminoglycan-stabilized chitosan membranes generated by polyanion-polycation interactions. The resulting hollow capsules allow for cellular growth and organization within a defined spherical volume, and the internal environment can be tailored through inclusion of extracellular matrix based biomaterials. We have enhanced this technology through an electrospray method that extends the feasible range of capsule sizes down to 200ÔÇ±50 ÔÅ≠m. This size regime allows encapsulation of cells at densities of >107 cells/ml while minimizing diffusion limitations and the likelihood of central necrosis in cellular spheroids. These electrospray capsules may serve as ideal modular units in the development of tissue constructs for physiological modeling using lab-on-a-chip and bioreactor approaches.

31. Advancements in Sustainable Propulsion Technologies for Space Exploration

Nilton Renno
Ayesha Saeed

As humanity's aspirations in space exploration continue to expand, the quest for sustainable propulsion technologies becomes increasingly critical. This presentation explores the remarkable advancements in sustainable propulsion technologies poised to reshape the future of space exploration. From revolutionary electric propulsion systems to innovative nuclear thermal propulsion concepts, we journey through the cutting-edge of propulsion technology. These advancements promise to substantially enhance mission efficiency, reduce environmental impacts, and provide cost-effective solutions for NASA's deep-space and interplanetary missions. Moreover, this abstract highlights the indispensable role of interdisciplinary collaboration between academia, industry, and space agencies. These synergies not only drive propulsion technology innovation but also ensure seamless integration into the evolving landscape of space exploration. The presentation also spotlights Michigan's contributions to these sustainable propulsion endeavors, showcasing the state's pivotal role in shaping the future of space exploration while aligning with NASA's strategic interests. Join us to explore the thrilling frontier of sustainable propulsion technology, a catalyst for the next era of space exploration.

32. Unlocking Quantum Communication: Advancing Secure Space Connectivity

Nicholas Sebasco, PhD student, Electrical and Computer Engineering, Michigan State University
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NASA is committed to integrating secure quantum communication into its overarching communication infrastructure. This presentation offers an overview of MSGC Fellowship research. The first part explores my initial internship at NASA Goddard Space Flight Center (GSFC), where we made significant progress in generating entangled photons via Spontaneous Parametric Down Conversion (SPDC), a crucial step towards quantum communication. The presentation also highlights practical applications of SPDC, particularly in Quantum Clock Synchronization, studied during my second GSFC internship. We delve into intriguing phenomena, such as the emergence of fermionic behavior in bosonic photons due to entanglement. Detailed analyses of waveguide modes within the nonlinear optical crystal used for SPDC photon generation will also be presented, shedding light on the underlying physics. Lastly, we will discuss ongoing research efforts directed at implementing quantum communication, including Quantum Clock Synchronization, in the extreme environmental conditions expected during NASA's Artemis mission on the lunar surface.

33. Temperature sensitivity of nitrogen mineralization in peat from bogs across a Michigan transect

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Seven peat bogs across a latitudinal transect of Michigan were used to analyze inorganic nitrogen (nitrate and ammonium) release from peat to predict the impact that climate warming has on peatland nitrogen cycle. More nitrogen release is expected in samples kept at warmer temperatures (simulated climate warming) and also from samples from lower latitudes. 1-m peat core samples were taken at each site. 20 g of acid washed sand was added to upper chambers of microlysimeters (two-chambered filter towers). 50 g of peat was added onto the sand and was left to equilibrate for a week. Microlysimeters were leached with 80 mL of 0.01M CaCl,ÇÇ solution and nitrogen was quantified using ion chromatography. Microlysimeters were incubated for two weeks before leaching procedures were repeated. A separate field-based cation-anion exchange analysis was performed through the installation of plant root simulators.

34. Implications of Iron Oxide Nanoparticle Exposure on the Auditory Physiology and Iron Bioaccumulation in House Sparrows (Passer domesticus)

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Peyton Hallemann, Chemistry and Biology Departments, Hope College
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Urbanization has dramatically increased, resulting in increased air pollution and particulate matter (PM). Inhaled nanoparticles within PM can be detrimental to health; they can bypass the blood-brain and gas barriers and accumulate in organs. Bioaccumulation of iron oxide nanoparticles (IONPs) has been linked to cancer and organ poisoning. Interestingly, air pollution exposure has also been linked to hearing deficits, which suggests hearing declines may be an early bioindicator of future complications arising from pollution exposure. This project aims to determine the effects of IONPs on the auditory physiology and iron bioaccumulation in the house sparrow (Passer domesticus). Auditory brainstem response tests were conducted before and after exposure and organs were collected to determine iron levels via inductively coupled plasma spectroscopy. Our results will shed light on the impact of air pollution on avian physiology and provide a framework for understanding the downstream ecological implications.

35. Analysis of Collisionless Magnetic Reconnection Through Truncated Eigenmode Decomposition

Nathan Stolnicki, Hope College Department of Physics
Zach Williams, Assistant Professor of Physics, Hope College Department of Physics
Adrian Fraser, Postdoctoral Scholar, University of Colorado Boulder

Collisionless magnetic reconnection is examined through the evolution of the tearing instability described using a two-fluid model (Ottaviani and Porcelli, 1995). In contrast to standard modeling approaches, we examine these processes via a weighted eigenmode decomposition. In assessing the relative importance of all of the eigenmodes (as determined by their amplitudes), we find the unstable/stable pair to contribute dominantly to the overall system dynamics, while the marginal modes are of minimal importance. Importantly, the stable eigenmode is not negligible as linear theory would predict, but grows to be of comparable importance to the unstable mode. We explore a simplified computational model for collisionless tearing consisting only of this stable/unstable pair. The effectiveness of this model is determined by calculating the percent error between this expansion and full nonlinear evolution. This work was funded and made possible by the Michigan Space Grant Consortium under grant number 80NSSC20M0124.

36. Time-resolved Ion Energy Measurements Using A Retarding Potential Analyzer for Electric Propulsion Applications

Austen Thomas, MS, Graduate Student, Mechanical and Aerospace Department Western Michigan University
Kristina Lemmer, PhD, Professor, Mechanical and Aerospace Department Western Michigan University

To completely characterize the evolving state of a plasma, diagnostic tools which enable measurements of time-resolved behavior are required. In this study a gridded ion source with superimposed oscillations was utilized to verify the

functionality of a high-speed retarding potential analyzer (HSRPA), at frequencies equivalent to the low frequency oscillations occurring in hall effect thrusters (HETs). The work presented here has demonstrated the capability of a standard RPA in conjunction with high-speed circuitry to produce time-resolved IEDFs at higher frequencies and beam potentials not previously investigated. Tested frequencies ranged between 20 ‚Äì 80 kHz with 10 Vpp oscillations at a mean beam potential of 570 V. Additionally, measurements were conducted with several waveforms, functioning as the superimposed oscillation, including a sinewave, triangle wave, and noisy sine wave. The HSRPA was able to successfully reconstruct time series data utilizing data fusion techniques, producing time-resolved IEDFs at all frequency set points and waveforms.

37. **Gravitational Waves from a McVittie Spacetime**

Zachary Tyler, Undergraduate student, GVSU Physics Department

This paper provides numerical solutions to timelike geodesics within the Schwarzschild and McVittie metrics. The Schwarzschild metric represents a static, non-spinning black hole. While the McVittie metric appears to be Schwarzschild close to the origin, but an expanding FLRW space (cosmology) far away. The main goal of this research is to show the difference in the gravitational wave patterns between static and expanding spacetimes. Both FLRW and Schwarzschild-DeSitter spacetimes are discussed within the numerical context of calculating geodesics. The numerical methods used are Runge-Kutta and Adams/BDF method, both within python.

38. **The effects of 600 keV proton irradiation on the properties of YBCO thin-film superconductors.**

Hope Weeda, Department of Physics, Hope College
Joseph Fogt, Department of Physics, Hope College
Trevor Harrison, Department of Physics, Hope College
Dr. Kyuil Cho, Department of Physics, Hope College

We studied the effect of 600 keV proton irradiation on thin film Cuprate superconductors. A 500 nm thick YBCO-1237 sample was subjected to a series of proton irradiations with a total fluence of 7.2 x 10^16 p/cm^2. Upon irradiations, the superconducting critical temperature (T_c) was drastically decreased from 90 K towards zero Kelvin, and the normal state resistivity increased accordingly. The rate of T_c reduction to resistivity increase will be used to discuss the fundamental property of the superconductor.

39. **Molecular functionality and nanoparticle influence on surface tribopolymerization.**

Ashton Wolford, Undergraduate Researcher, Chemistry and Engineering, Hope College
Lindsay Martin, Undergraduate Researcher, Chemistry, Hope College
Reilly LaGrand, Undergraduate Researcher, Chemistry, Hope College

Meagan Elinski, PhD, Assistant Professor of Chemistry, Hope College

Tribology has been increasingly relied on due to emerging technologies requiring more efficient lubrication and surface protection qualities. Processes in mechanochemistry rise to mitigate these issues, as research continues to look for tribochemical reactions that allow for antiwear film formation. This work is aimed at developing a deeper understanding of surface chemistry, and the different impacts that various molecules have on tribopolymerization and surface wear. Molecules comparing relative positions of alkene and alcohol functionalities, cis-2-nonen-1-ol and 8-nonen-1-ol, are added to a polyalphaolefin oil (PAO4) and used as lubricants in sliding processes subjected to steel on steel interactions. The use of nanoparticles, specifically nanodiamonds, are also implemented in order to observe impacts on tribopolymerization as well as wear, which is analyzed using optical microscopy. An in depth understanding of tribopolymerization resulting from different surface chemistries and molecular structures could result in advancing surface lubrication schemes.

40. Estimated number of observed white dwarf binaries for LISA in both gravitational waves and optically

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Brett Bolen, Department of Physics, Grand Valley State University
Shane Larson, Department of Physics, Northwestern University

A new era of in astrophysics has begun known as multimessenger astronomy. In multimessenger astronomy astronomers study astronomical sources using different types of ‚Messengers' particles such as photons, neutrinos, cosmic rays, and gravitational waves. LISA (Laser Interferometer Space Antenna) is a gravitational wave detector launching in 2034 that will detect gravitational waves in the millihertz frequency range. COSMIC (Compact Object Synthesis and Monte Carlo Investigation Code) is a rapid stellar population synthesis code which simulates the evolution of binary systems within a galaxy. We will analyze COSMIC data containing binary white dwarf systems which emit gravitational waves detectable by LISA and whose apparent magnitude in visible light is bright enough in the electromagnetic spectrum to be detectable by space-based telescopes.

41. The large-scale atmospheric and hydroclimatic dynamics of recent extreme dust storms in Central Asia

Xin Xi, PhD, Assistant Professor, Department of Geological and Mining Engineering and Sciences, Michigan Technological University

Extreme weather and climate events are among the most pressing societal challenges of our times. During recent years, Central Asia was hit by several extreme dust storms, causing hazardous weather conditions and persistent high particulate concentrations. Currently, there are substantial knowledge and methodological gaps in understanding the physical mechanisms, variability, and

predictability of such events. In this presentation I will present detailed case analysis to elucidate the anomalous atmospheric and hydroclimatic conditions associated with intense dust outbreak in Central Asia, and explore the teleconnection processes underlying the favorable environment for enhanced wind erosion. Main results suggest that the extreme dust events were triggered by two compounding factors: cold air outbreak linked to atmospheric blocking, and growing-season drought and desertification linked to tropical SST anomalies.

42. Development of a Wearable ECG Monitoring Device for Real-Time Arrhythmia Detection using Dry Fabric Electrodes with Machine Learning Techniques

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Arrhythmia is the irregular beating of the heart caused when there is an issue with the heart arteries, valves, or muscles and can be deadly, it can be diagnosed using an electrocardiogram machine, blood tests, and echocardiogram e.t.c. However, all the methods of diagnosing arrhythmia are very expensive and require trained medical personnel with equipment for quick diagnosis. The research proposed the use of fabricated dry electrode ECG sensor to measure the heart electrical pulse, process the signal from the sensor and transmit the data to the cloud server for processing using IoT microcontroller. The MIT-BIH arrhythmia dataset was downloaded and different machine learning classification algorithms such as KNN, SVM, ICA, random forest and decision tree were used for the arrhythmia classification, however, the random forest has the highest accuracy of 97.88% compared to the others. The research will assist patients to urgently seek medical attention when arrhythmia is suspected.

43. Development of the tangent linear and adjoint model of the global online chemical transport model MPAS-CO2

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Sha Feng, Pacific Northwest National Library
Jeffery Stewart, Tomorrow.io
Xiaoxu Tian, Tomorrow.io
David Baker, Colorado State University
Martin Baxter, Central Michigan University

We describe the development of the tangent linear (TL) and adjoint models of the MPAS-CO2 transport model, which is a global online chemical transport model developed upon the non-hydrostatic Model for Prediction Across Scales-

Atmosphere (MPAS-A). The primary goal is to make the model system a valuable research tool for investigating atmospheric carbon transport and inverse modeling. First, we develop the TL code, encompassing all CO2 transport processes within the MPAS-CO2 forward model. Then, we construct the adjoint model using a combined strategy involving re-calculation and storage of the essential meteorological variables needed for CO2 transport. This strategy allows the adjoint model to undertake long-period integration with moderate memory demands. To ensure accuracy, the TL and adjoint models undergo vigorous verifications through a series of standard tests. The adjoint model, through backward-in-time integration, calculates the sensitivity of atmospheric CO2 observations to surface CO2 fluxes and the initial atmospheric CO2 mixing ratio. To demonstrate the utility of the newly-developed adjoint model, we conduct simulations for two types of atmospheric CO210 observations: tower-based in situ CO2 mixing ratio and satellite-derived column-averaged (XCO2). A comparison between the sensitivity to surface flux calculated by the MPAS-CO2 adjoint model with its counterpart from Carbon Tracker-Lagrange (CT-L) reveals spatial agreement but notable magnitude differences. These differences, particularly evident for XCO2 , likely arise from differences in vertical mixing between the two systems. Moreover, this comparison highlights the substantial loss of information in the atmospheric CO2 observations due to CT-L's simulation length and spatial domain limitations. Furthermore, the adjoint sensitivity analysis demonstrates that the sensitivities to both surface flux and initial CO2 conditions spread out throughout the entire northern hemisphere within a month. MPAS-CO2 forward, TL, and adjoint models stand out for their calculation efficiency and variable-resolution capability, making them competitive in computational cost. In conclusion, the successful development of the MPAS-CO2 TL and adjoint models, and their integration into the MPAS-CO2 system, establish the possibility of using MPAS's unique features in atmospheric CO2 transport sensitivity studies and in inverse modeling with advanced methods such as variational data assimilation.