Oral Presentation Abstracts

Session 1: "Earth & Space"

A Novel Approach to Echo Mapping of Supermassive Black Holes

Jacob Callebs, Undergraduate, Wayne State University Department of Physics and Astronomy

Active Galactic Nuclei are some of the most luminous objects in the universe, powered by the infall of matter onto a supermassive black hole at their centers. The energy emitted from gas close to the black hole can have a big impact on the host galaxy, so understanding the accretion process is important to understanding galaxy evolution. However, the angular size on the sky of the AGN is far too small to directly image (except for a couple of exceptionally rare cases). Instead, we use a technique called echo mapping to swap spatial resolution for time resolution by analyzing the time lags between emitting regions of the AGN. Going further, we can apply a novel approach to the data, allowing us to extract the specific geometry of gas clouds in the AGN of galaxy NGC 5548. Here, I will be presenting the results gathered from applying this new approach.

Stable and Radiogenic Isotopic Fractionation during Multistage Planetary Core Formation

Gabriel Nathan, PhD Student, Michigan State University Earth, and Environmental Science Department

Explaining the chemical and isotopic heterogeneity of bodies in the Solar System is an outstanding goal of planetary science. Among the proposed mechanisms that may induce isotopic variation in the Solar System is the segregation of metal and silicate within a magma ocean during the earliest stages of planetary core formation. Here, we use numerical simulations of planet formation to investigate the effects of metal-silicate equilibration on the isotopic composition of Solar System bodies. Additionally, we can determine the viability of Solar System formation scenarios based on how they affect the composition of stable and radiogenic isotopic systems in forming planets.

A NEW CANARY IN THE COALMINE: THE HOUSE SPARROW (PASSER DOMESTICUS) AS A MODEL FOR STUDYING THE EFFECTS OF POLLUTION

Dr. Kelly Ronald, Ph.D., Assistant Professor Hope College; Dr. Natalia Gonzalez-Pech, Ph.D., Assistant Professor Hope College; Ms. Lindsay Jankowski, Hope College; Ms. Molly McLinden, BA, Hope College; Ms. Olivia Sprys-Tellner, Hope College; Ms. Peyton Hallemann, Hope College; Mr. Jacob Bergstrom, Hope College; Ms. Linda Nduwimana, Hope College.

Urbanization has increased pollution in our cities; this pollution includes both physical particulate matter (PM) and sensory (e.g. noise) pollution. Our lab is interested in exploring the effects of urbanization on an avian model, the house sparrow (Passer domesticus). House sparrows cohabitate around humans and are exposed to the full range of anthropogenic pollutants. We combined both an observational and experimental approach to investigate how the Auditory Brainstem Response is altered with exposure to urbanization and iron oxide nanoparticles (IONPs), a main component of PM. We hypothesized that hearing sensitivity would be negatively affected by urbanization level and by exposure to IONPs. Our preliminary results suggest that auditory thresholds (i.e., the lowest level of sound that can be distinguished) are impacted by both an urbanization gradient and exposure to IONPs but that this relationship is frequency dependent. Our data will inform how avian species are impacted by human activity.

High order models for turbulent ocean-atmosphere interaction

Dr. Mustafa Aggul, PhD, Hacettape University; Dr. Alexander E. Labovsky, PhD, Michigan Technological University; Ms. Eda Onal, BS, Hacettape University; Mr. Kyle J. Schwiebert, MS, Michigan Technological University

Focusing on a simplified 2D setting, we investigate fluid-fluid interaction problems as a proxy for atmosphere-ocean interaction problems. We develop the first unconditionally stable model for turbulent flow problems in this setting. We next show how this model can be extended through the use of LES-C models, an exciting and new class of turbulent models, yielding a second order accurate scheme. This represents the first successful application of LES-C turbulence models outside a pure incompressible flow setting. All results are demonstrated with both numerical analysis and a variety of quantitative and qualitative benchmark problems.

Electrolaunch

Joshua L. Mehay - Business Management

The green energy wave is upon us. our Caelus launch system is in development. This system eliminates or significantly reduces the need for chemical propulsion rockets to leave the earth. We aim to transition rocketry to renewables.

Formation of Contact Binary Stars

Jenn Lau, undergraduate student majoring in Physics and Mathematics, Calvin University.
Levi Carr, undergraduate student majoring in Physics and Mathematics, Calvin University.

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 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.

Session 2: "Education"

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.

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.

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.

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.”

Energizing Our World: Pivoting between settings to impact students

Logyn Miller, GVSU Undergraduate Student; Chelsea Ridge M.Ed. GVSU Regional Math & Science Center; Kristofer Pachla PhD. GVSU Director of the CLAS Center for Experiential Education and Community Engagement; Diane Miller M.P.A., CBSP, GVSU Business & Community Outreach Coordinator

Building on the success and strength of previous camps, Grand Valley State University (GVSU) welcomed 28 middle grade students back to campus in June 2022 for a high impact camp. In collaboration with GVSU faculty and Consumers Energy, GVSU undergraduate students focused on providing a safe and fun summer camp that sparked the interest of underrepresented students in the STEM fields and positioned them to be stewards in their communities. GVSU pre-service educators served as content facilitators in sessions on energy, renewable sources, storage, sustainability practices, and innovation labs. The innovation lab gave campers the space to ideate answers to How might we share what we are learning with our community? Campers were challenged to imagine what is next in renewable energy and encouraged to engage with their communities. Throughout the camp, campers collected artifacts to take home and use to share their learning. Ongoing work focuses on community connections.

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.

Session 3: "Chemistry/Biology/Physics/Engineering"

Simulation and modeling of settling in polydisperse, gas-solid flows

Emily Foster, Ph.D.c mechanical engineering, E.I.T, Ph.D Candidate, Oakland University; Dr. Sarah Beetham, Ph.D mechanical engineering, Assistant Professor, Oakland University

Sedimenting flows occur in a wide range of industrial and natural systems, including pyroclastic density currents (PDCs), the most hazardous volcanic process. In systems with sufficiently high mass loading, momentum coupling between the phases causes mesoscale behavior, such as clustering. These structures are then capable of generating and sustaining turbulence in the carrier phase and directly impact large-scale quantities of interest, such as settling time. As an added complexity, many flows of interest consist of a polydisperse particulate phase. In this talk, we characterize the sedimentation behavior of a range of polydisperse gas-solid flows, sampled from a parameter space typically associated with PDCs. Highly resolved data is collected using an Euler-Lagrange framework and polydisperse settling behavior is contrasted with Stokes settling and analogous ensembles of monodisperse particles. In future work, a settling law will be developed which takes into account polydispersity.

Co-estimation of Parameters and State-of-Charge for Lithium-ion Battery Diagnostic: Comparative Study

Gabrielle Lochrie, Graduate Student, ME OU; Yongsoon Yoon, PhD, Assistant Professor, ME OU

This research aims to develop a lithium-ion battery diagnostic that can detect and isolate the faults of a current and voltage sensor. The proposed diagnostic encompasses two interrelated components: 1) faulty features extraction and 2) faulty features evaluation. In this talk, the recent results on faulty features extraction through

co-estimation of the model parameters and the state-of-charge (SOC) will be presented. Depending on modeling of the open-circuit voltage, two different equivalent circuit models are concerned: 1) a linear parameter varying model and 2) a parallel Wiener model. The parameters and SOC of each model are co-estimated using different anti-windup recursive parameter estimation techniques such as the recursive least squares with a directional forgetting and variable forgetting, and the Kalman filter with tracking of the desired covariance matrix under the realistic duty cycle. Different models with different estimation techniques are evaluated in terms of faulty feature extraction through numerical studies.

Emitting Electrodes Effect on a Two-Stage EHD Gas Pump with Uneven Applied Voltages

AKM Monayem Mazumder, PhD, Associate Professor, Mechanical Engineering and Saginaw Valley State University

Fluid flow driven by a two-stage electrohydrodynamic (EHD) gas pump is critically examined by experiments and numerical simulations. The flow is induced by pump with 24 emitting electrodes in two-stage charged at a combination of three different operating voltages (20 kV, 24 kV, and 28 kV). A numerical model is developed based on the experimental study. The three-dimensional governing equations for the electric and flow fields are solved using the finite volume method. The EHD-induced flow is calculated first, and its results are compared with the experimental data to validate the computational code. The numerical results enable vivid flow visualizations inside the channel, providing a great understanding of the development of the induced flow. The two-stage EHD gas pump, which can be produced and sustained air flows with a maximum volume flow rate is considered more efficient when it is operated with uneven applied voltages.

The Dependence of Cooling and Heating Functions on Local Radiation Fields

David Robinson, B.A., Graduate Student, Physics, University of Michigan
Camille Avestruz, Ph.D., Assistant Professor, Physics, University of Michigan
Nick Gnedin, Ph.D., Professor, Astrophysics, Fermilab and the University of Chicago

Cooling and heating functions determine the thermal pressure support of gas clouds and the energy budget of gas. These functions are a key component in how gas clouds collapse to form stars and subsequently galaxies. The radiative transfer physics underlying cooling and heating functions is known but is too computationally expensive to include in hydrodynamic simulations for realistic local radiation fields within galactic halos. Hence, a fast approximation to the dependence on the incident radiation field is needed to include local effects. We first discuss results from an existing approximation to heating and cooling functions in a simulation from the Cosmic Reionization on Computers project. We find that the simulated gas thermodynamics cannot be

adequately described by functions computed with a spatially constant radiation field. We also discuss ongoing work using machine learning to investigate what wavelength bands of the radiation field most strongly affect cooling and heating functions.

An Analysis of Organic Components in Egyptian Mummification Balms: The Old Kingdom to the Ptolemaic Period

Chelsea Van Buskirk, MS, Department of Chemistry at Eastern Michigan University; Ruth Ann Armitage, PhD, Professor of Chemistry, Department of Chemistry at Eastern Michigan University; Renee Stein, Chief Conservator, Michael C. Carlos Museum at Emory University

As probes are sent into the solar system and beyond in search of life and the conditions that would support it, it is likely they will encounter organic compounds. The molecules themselves will have changed due to oxidation and the passage of time and as such, understanding the changes these ancient molecules undergo requires studying the fragments left behind. Egyptian embalming materials from the collections at the Michael C. Carlos Museum were studied to investigate the degradation process of organic residues spanning from the Old Kingdom (2613-2181 BCE) to the Ptolemaic Period (332-30 BCE). Analysis of these materials shows fragments that are significantly different from what was initially present. However, understanding the degradation process and what those products are help us to analyze the original composition of the organic residue. This will help to inform the process of interpreting the origins of organic compounds encountered in space exploration.

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.