Minnesota Space Grant Consortium (MnSGC)
Spring 2025 Student Symposium

Book of Abstracts

February 22, 2025
University of Minnesota

https://www.mnspacegrant.org

Table of Contents and Session Time Slots

Technical Issues:

Please, call James Flaten – 651-399-2423

Held in Tate Hall of Physics, U of MN East Bank campus, Minneapolis

- **Oral presentations all in Tate room 101**
- **Posters and outreach demonstrations in the lobby near Tate room 101**

Welcome to NASA's MN Space Grant Consortium's 2025 Student Symposium!

The Minnesota Space Grant Consortium (MnSGC) is part of the NASA-funded National Space Grant College and Fellowship Program (usually just called Space Grant) established by Congress in 1988. Nationally, Space Grant is a network of 52 university-based statewide consortia, including all 50 states plus the District of Columbia and Puerto Rico, with nearly 1000 mostly-higher-education affiliate institutions delivering programming nationwide. Space Grant provides support for higher education students majoring in STEM fields, NASA-themed higher education offerings plus research opportunities for faculty and students, NASA-themed professional development for pre-college and in-service and pre-service teachers, and informal education aerospace science and engineering activities for pre-college students and the general public.

The mission of the MnSGC is to provide a driving force for aerospace education in Minnesota. Program goals and objectives include diversity, competitiveness coupled with accessibility, ties with NASA Centers and enterprises, and relationships with local industries and state government. The MnSGC supports a variety of projects including higher education course development, hands-on flight hardware projects and research for higher education students and faculty, scholarship/ fellowship support for full-time students attending its 13 academic affiliate institutions of higher learning, NASA Center summer internships for college students attending any accredited MN college or university (when selected by NASA Center mentors), teacher and informal educator workshops, and NASA-themed activities in STEM (Science, Technology, Engineering, and Mathematics) for pre-college and general public audiences including public exhibits and occasional school visits. Learn more about the MnSGC by visiting https://www.mnspacegrant.org.

This student symposium features 12 contributed talks, 22 posters, and demonstrations by 3 student groups who have worked on developing NASA-related outreach activities for adults in the past year. Presentations for in-person attendees will be in Tate Hall of Physics on the U of MN Minneapolis campus (116 Church St SE, Minneapolis). Remote attendees may watch oral presentations on Zoom.

The contributed talks are spread over three sessions – one starting at 10:00 a.m., one starting at 11:45 a.m., and one starting at 1:45 p.m. Posters will be spread over two sessions: an "AM" poster session starting at 11:00 a.m. and a "PM" poster session starting at 2:45 p.m. The (in-person-only) intercollegiate challenge demonstrations (and lunch) will run from 12:45 p.m. to 1:45 p.m. We are also pleased to offer a keynote talk at 9:00 p.m. about the physics of superheroes. Students who received NASA Center Internships in the summer of 2024 and students who did MnSGC centrally-funded in-state internships will exhibit during the AM poster session.

Use the Table of Contents and Timing for the Student Symposium (above) and the abstracts (below) to help guide you through the day. Again, thanks for joining us!

Dr. Demoz Gebre-Egziabher, Director of the MN Space Grant Consortium, U of MN – Twin Cities
Dr. James Flaten, Associate Director of the MN Space Grant Consortium, U of MN – Twin Cities

List of participants:

Presenter	Title of the presentation
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Ethiopia Kebede	Examining the context of geomagnetic disturbances (GMDs) as observed by high altitude ultraviolet images from NASA's elliptically orbiting satellites IMAGE and Polar during the 2000-2002 period
Bethel University	
Jacob Panning	Lab Equipment in Mechanical Engineering
Bemidji State University	
Yves Onipede	Remote Sensing—Hyperspectral Imagery Analysis and Identification of Invasive Cattail Species
Concordia College	
Kate Hemmer and Jordan Masterson	Investigation of the Magnetic Properties of Aluminum, Nickel, and Chromium Doped Goethite
Matthew Mondry	Optical Properties of Bromide-Based-Inorganic Perovskites
Fond du Lac Tribal and Community College	
Aurora Salzer	NEBP From a Non-STEM Student's Perspective
Leech Lake Tribal College	
Adrien Wilson, Dezmond Smith-Leith	Leech Lake Tribal College's Participation in First Nations Rocket Launch
Macalester College	
Cain Rinkoski	Radio Interferometry and Synthesis Imaging Techniques
Sophia Stevenson	Dynamical Systems in Zero-Dimensional Space
Theo Darci-Maher	Analyzing RLMT Telescope Focus Images
St. Catherine University	
Sof Walker	Establishing a Split Root System using Medicago in Mars Regolith Soil

Ruby Moua	Urine For A Surprise: Investigating the Effects of Synthetic Urine on Plant Growth in Lunar Regolith
Subeyda Mohamed, Leisly Jara	From Moon Dust To Earth Growth: The impact of lunar regolith on the germination and growth dynamics of *Medicago truncatula seeds*
Leslie Agustin Vasquez, Catherine Quigley	Effect of Increased Porosity with Perlite on Brassica rapa Growth in Lunar Regolith
St. Cloud University	
Caitlin Andersh	A Methodology of Identifying Solar Eclipse Gravity Wave Signatures using Machine Learning and Geospatial Data
U of MN Duluth	
Tristan Suojanen	Analyzing Simulation Model Weight Behavior for DUNE Near Detector Sensitivity Study
U of MN Twin Cities	
Jesse Cook, Yoel Mekbeb	Eclipse Ballooning: 2023 and 2024 Experiences - MN Space Grant Eclipse Ballooning Team at U of MN Twin Cities
Sean Gilomen, Radha Vojjala, Lani Calderon	Flight Computers for Stratospheric Ballooning and High-Power Rocketry
Monica Robles, Aksinya Kamenshikova	Investigating Cosmic Rays: Stratospheric Cloud Chamber Development
Majid Ali, Keenan Raby	Stratospheric Rube Goldberg Machine Challenge
Joseph Shin, Daniel Margosian	Comparison of Low-Cost Geiger Counters for Stratospheric Ballooning
Karl Pederson, Sam Keller	Exploring the Radiative Environment of Space with Stratospheric Balloons
Sam Dietterich	Advancing Computational Electromagnetics Simulations For Antireflection Coating Development
Olivia Bartol, Devin Schwartz, Greta Wolsky	Free Floating Wearable Exercise System for Microgravity
Mykhail Sandacz (in-state intern)	Simulation using Direct Position Estimation in Cis-Lunar Space
Simeon Shaffar	The Experiments in X-Ray Characterization and Timing (EXACT) Mission

University of St. Thomas

Theodore Graham (in-state intern)	Spall Behavior of Pre-Twinned Materials
Luke Freimuth (in-state intern)	Additive Manufacturing and Blockage Ratio of NACA 0015 Airfoil Wind Tunnel Testing
Ryan Kappes	Exploring the Attenuation of Ionizing Radiation via Biological Processes Found in Fungi

NASA/Research – Center Internships

Grace Nelson, St. Olaf College	Developing Narratives in Space Exploration: Wallops Visitor Center Internship
Conrad Provost, Univ. of St. Thomas	Predicting MISE Detector Response Function to Jovian Environment with Geant4 Simulation
Donovan Magney, U of MN Twin Cities	Advancing Crewed Space Mission Research via Analog Missions

Keynote Speaker

Jim Kakalios, U of MN Twin Cities	The Physics of Superheroes

Intercollegiate Challenge: Outreach Demonstrations

U of MN Twin Cities: Yossef Emara, Eloisa Carrasco	Design and Implementation of a UAV Flight Control System with Manual and Autonomous Navigation
U of MN Twin Cities: Monica Robles, Pfirlani Calderon, Pámela Bóveda-Aguirre, Pengyang Li, Jack Geller, Elvin Daniel Hernandez-Rosas, Carlos Quintanilla Vasquez	The Essentials of Cable Systems: A Curriculum for College and Adult Learners
Macalester: Micayla Crane, Marine McKnight, Selah Miller, Will St. Andre, Theo Rosenberg	Modify your own rocket!

Keynote Speaker (9:00 am – 9:50 am) Room: 101 Tate Hall

Institution: **U of MN Twin Cities**

Presenter: **Physics Prof. Jim Kakalios**

E-mail address: **kakalios@umn.edu**

Title: **The Physics of Superheroes**

While scientists don't typically consult comic books when selecting research topics, innovations first introduced in superhero adventures as fiction can sometimes find their way off the comic book page and into reality. We'll describe the real physics that underlies the properties of materials, using examples from Spider-Man, Superman and Gormuu, warrior invader from the planet Kraalo! If Superman can leap a tall building in a single bound, what does that tell us about the gravity of Krypton? All this, and the answers to such burning questions as the chemical composition of Captain America's shield, and who is faster: Superman or the Flash? will be discussed. Superhero comic books often get their science right more often than one would expect.

Oral Presentation - Session A (10:00 am – 11:00 am) Room: 101 Tate Hall

Talk 1: 10:00 am – 10:15 am

Institution: **Leech Lake Tribal College**

Student Presenters: **Adrien Wilson and Dezmond Smith-Leith**

E-mail address for each presenter: **awilson4541@stu.lltc.edu dsmith-leith6638@stu.lltc.edu**

Adrien

Dezmond

Mentor: **Kelly Nipp, Leech Lake Tribal College**

Title: **Leech Lake Tribal College's Participation in First Nations Rocket Launch**
Link to Slides: LLTC Adrian Wilson Dezmond Smith First Nations Launch.pdf

First Nations Rocket Launch is an annual rocket competition that has been put on by the Wisconsin Space Grant for students attending a Tribal College or University (TCU), a Native-American-Serving Nontribal(NASNTI), or members of an active American Indian Science and Engineering Society (AISES) collegiate chapter to design, build, and fly a high powered rocket to be launched at the Richard Bong State Recreational Area in Kansasville, WI in late April 2025. Leech Lake Tribal College has participated in the rocket competition since 2010 and has successfully placed in the top three multiple times. This year Leech Lake will be participating in the Gateway Challenge as our team consists of all new members and we lack experience. This year's Gateway Challenge competition parameters will be discussed along with modifications our team is making to the rocket to increase our experience and gain extra points for award consideration. Team challenges will be discussed along with what our team hopes to get out of competing in high powered rockets.

Talk 2: 10:15 am – 10:30 am

Institution: **Concordia College**

Student Presenters: **Kate Hemmer, Jordan Masterson**

E-mail address for each presenter: **khemmer@cord.edu, jmasters@cord.edu**

Kate Hemmer

Jordan Masterson

Mentor:. **Thelma Berquó, Concordia College**

Title: **Investigation of the Magnetic Properties of Aluminum, Nickel, and Chromium Doped Goethite**

Link to Slides: Concordia Kate Hemmer Jordon Masterson Geothite.pdf

Goethite is an iron oxide commonly found on Earth's surface, and aluminum substitution is common in nature. This work aims to study the magnetic properties of goethite and how they were altered by increasing the contribution of aluminum, nickel, and chromium in its crystalline structure. We investigated fifteen samples of three sets of differently doped goethite. One set of samples was substituted with a target of 0, 4, 8,12, and 24 wt% Al. The second and third groups of samples consisted of a control sample of 0% Al, a constant 4 wt% of Al, and a target contribution of 0, 4, 8, and 20 wt% of Ni or Cr. A VersaLab PPMS apparatus was used to collect ZFC/FC magnetization curves in the temperature range of 50 to 400 K and hysteresis loops at 50, 150, and 300 K with a magnetic field up to 3.0 T. From one data set of ZFC/FC magnetization curves, differences were noticed between aluminum-substituted goethite and the Ni and Cr samples regarding the Néel temperature - the temperature above which goethite shows a paramagnetic behavior. Additionally, the hysteresis loops did not attain saturation and showed distinct patterns for the different cation substitutions.

Talk 3: 10:30 am – 10:45 am

Institution: **University of St. Thomas**

Student Presenter: **Ryan Kappes**

E-mail address for each presenter: **kapp4779@stthomas.edu**

Mentors: **Dr. Paul Ohmann, Principal Advisor (UST), Dr. Carolyn Zeiner, Consultant (UST), Dr. Rob Davies, Consultant (UST)**

Title: **Exploring the Attenuation of Ionizing Radiation via Biological Processes Found in Fungi**
Link to Slides: UST Ryan Kappes Radiotrophic Fungi Slides.pdf

There is growing evidence in scientific literature suggesting that certain fungal species possess unique biological mechanisms that enable them to withstand and even thrive in radiation-rich environments. This resilience is particularly intriguing for applications in space exploration, where exposure to ionizing radiation presents a significant challenge for both human health and spacecraft integrity. Studies have shown that melanized fungi exhibit radiation absorption properties that may contribute to their survival in high-radiation settings, such as the Chernobyl Exclusion Zone and even the International Space Station.

The motivation behind this research is to explore bio-derived radiation shielding concepts for spacecraft by leveraging radiation-resilient fungi. This study investigates the potential of fungal-based materials to serve as passive radiation shields, analyzing their absorption properties and the biological mechanisms responsible for radiation attenuation. By understanding these processes, this research aims to contribute to the development of sustainable, self-regenerating shielding solutions for long-duration space missions and extraterrestrial habitats.

Talk 4: 10:45 am – 11:00 am

Institution: **Bethel University**

Student Presenters: **Jacob Panning**

E-mail address for each presenter: **jwp74965@bethel.edu**

Mentor: **Dr. Raman-Nair, Bethel University**

Title: **Lab Equipment in Mechanical Engineering**
Link to Slides: Bethel Jacob Panning ME Lab Equipment.pdf

This explores the mechanical engineering equipment that facilitates the practical application of theoretical concepts. It focuses on the setup and refinement of methodologies for utilizing laboratory equipment to conduct experiments and collect data. By performing real-world tests, experimental results can be compared with established theoretical models, enhancing the effectiveness of laboratory practices and improving the accuracy of experimental validation in mechanical engineering.

In collaboration with Bethel University's Physics and Engineering Department and under the guidance of a faculty mentor Dr. Raman-Nair, this research aimed to develop and refine the use of various lab instruments for classroom instruction. The work focused on machines that perform tensile tests to determine key material properties, strain analysis tests for real-world visualization of calculations, and vibration analysis for predictive maintenance of machinery. These efforts contribute to enhancing hands-on learning experiences, improving laboratory methodologies, and bridging the gap between theoretical knowledge and practical application in mechanical engineering education. By refining the use of this equipment, students gain a better understanding of engineering principles and develop skills for future professional applications.

AM Poster Session (11:00 am – 11:45 am) Room: 1st Floor Lobby Tate Hall

Home institution: **St. Olaf College**

Student Presenter: **Grace Nelson**

E-mail address for each presenter: **grace.e.nelson@gmail.com**

Mentor: **Elizabeth Hall, Wallops Flight Facility**

Title: **Developing Narratives in Space Exploration: Wallops Visitor Center Internship**
Link to Promo video: https://youtu.be/fQSRt577onE
Link to Poster: St. Olaf Grace Nelson MnSGC Poster.pdf

My summer was spent at NASA Wallops Flight Facility located at Wallops Island, Virginia. Over the course of 10 weeks, I learned a lot about the space industry and informal STEM education. I witnessed guests actively engage with hands-on exhibits and foster their curiosity through facilitating public programs. I had the opportunity to host multiple activities at Wallops Visitor Center that spanned the solar system, engineering design, astronaut training, the Artemis mission, and much more. The final project of my internship included facilitating a public education program of my design. As a dancer and STEM enthusiast, I felt incredibly honored to have collaborated with a local ballet company to create a program combining STEM and the art of ballet. It was titled ‘Leaping Through Space' and contained topics about forces, energy, and motion. I would like to thank the Minnesota Space Grant Consortium for making this experience possible.

AM Poster Session (11:00 am – 11:45 am)

Home institution: **University of St. Thomas**

Student Presenter: **Conrad Provost**

E-mail address for each presenter: **conradprovost@gmail.com**

Mentors NASA Center: **Dr. Luz Maria Martinez Sierra (JPL), Dr. Brian Zhu (JPL), Dr. Martin Ratliff (JPL)**

Title: **Predicting MISE Detector Response Function to Jovian Environment with Geant4 Simulation**

Link to Promo video: https://youtu.be/Pna763TUE6U

Link to Poster: UST Conrad Provost poster.pdf

While on orbit, the Mapping Image Spectrometer for Europa (MISE) onboard the Europa Clipper spacecraft will be subject to the highly energetic jovian radiation environment. Electrons accelerated to relativistic speeds by Jupiter's strong magnetic field can penetrate the instrument's walls and deposit energy in the pixel array of the spectrometer, resulting in noise that interferes with the science-gathering ability of the device.

Geant4 Monte Carlo particle transport simulation is used to predict pixel hit behavior. Using Geant4's GDML File Parser for MISE geometry construction, a simplified spectrometer mechanical model is subjected to an isotropic radiation field of monoenergetic electrons for a range of energies. The simulations use a spherically distributed particle source geometry and. An origin-centered ideal array of HgCdTe pixels. Through simulation of possible particle trajectories, the energy deposition and location in the array are accessed for each particle that reaches a pixel. The statistics of noise-producing outcomes characterizes the sensitivity of MISE to electrons. Beyond a better understanding of MISE's electron-induced image noise, we hope to also use the information to assess the validity of our jovian trapped-electron model.

AM Poster Session (11:00 am – 11:45 am)

Home institution: **U of MN Twin Cities**

Student Presenter: **Donovan Magney**

E-mail address for each presenter: **donovanmagney@gmail.com**

Title: **Advancing Crewed Space Mission Research via Analog Missions**
Link to Promo video: https://youtube.com/shorts/vQM_XARUpmI
Link to Poster: U of MN Twin Cities Donovan Magney Analog Astronaut

Conducting space research is expensive, time-consuming, and inherently risky for astronauts. However, much of this research, particularly related to human factors, can be done on Earth through "analog missions." Analog missions are simulated crewed space missions held in various environments on Earth, testing anything from isolation, diet, to lack of sunlight. LunAres is one such environment located in Piła, Poland. The facility is set up to be modular (like real space facilities) and contains a simulated lunar environment full of soil that gives astronauts the illusion of the lunar surface. LunAres holds multiple missions throughout the year with 5-8 volunteers, known as "analog astronauts," who simulate two week missions.

I participated in their 4th mission of 2024 as the commander of my crew. We primarily served as subjects of research for various organizations, including Lunares themselves. We also worked on upgrading equipment for future missions and conducted extravehicular activities in the simulated lunar environment. The experience strengthened my leadership and engineering skills, allowed me to assist with real-life space-based research, and, most importantly, was incredibly fun! Overall, these missions provide significant benefits to both crewed space missions, and the individual volunteers that participate in these missions.

Website(s) / On-line Reference(s):
https://lunares.space/

AM Poster Session (11:00 am – 11:45 am)

Home institution: **University of St. Thomas**

Student Presenter: **Theodore Graham**

E-mail address for each presenter: **Grah9815@stthomas.edu**

Mentor: **Dr. Suraj Ravindran, U of MN Twin Cities**

Title: **Spall Behavior of Pre-Twinned Materials**
Link to Promo video: https://youtu.be/HL_seTT8pcI
Link to Poster: UST Theodore Graham Spall Strength poster.pdf

AZ31B is a magnesium alloy that demonstrates high specific strength, low density and corrosion resistance making it an ideal candidate for many aerospace and ballistic applications. AZ31B has been shown to exhibit improved ballistic performance after enduring a twinning process when compared to an as-received sample. While studies conducted surrounding the dynamic fracture toughness of AZ31B have indicated that it could have enhanced ballistic performance, spall strength analysis could provide further insight on twinning's effect on ballistic performance. In this study, spall strength experiments were conducted to investigate the dynamic properties that dictate ballistic performance. Symmetric spall experiments were conducted on both pristine and pre-twinned AZ31B samples using a powder gun at an impact velocity of 600 m/s. Additional analysis of the recovered samples was performed to examine the microstructural changes after impact. During the study, it was observed that the pre-twinned AZ31B exhibits varied spall strength, depending on microstructural orientation, compared to pristine samples.

AM Poster Session (11:00 am – 11:45 am)

Home institution: **University of St. Thomas**

Student Presenter: **Luke Freimuth**

E-mail address for each presenter: **lrfreimuth2@gmail.com**

Non-Presenting Student Author: **Teddy Graham**

Mentor: **Thomas Shepard, University of St. Thomas**

Title: **Additive Manufacturing and Blockage Ratio of NACA 0015 Airfoil Wind Tunnel Testing**

Link to Promo video: https://youtu.be/JkqhbeTBWh8

Link to Poster: UST Luke Freimuth Poster.pdf

Wind tunnel testing is a commonly used technique used to measure various flow characteristics of bodies of interest. Often, the geometry of these bodies is complex and difficult to accurately approximate with models scaled to fit a wind tunnel, making wind tunnel testing unreliable. In this study, two different facets of wind tunnel testing were studied. The first section of this study focused on the development of various techniques to improve the geometric accuracy of wind tunnel models made from resin printing, a type of additive manufacturing. This study resulted in the identification of multiple critical practices to consider when creating scale models for the use of wind tunnel testing. The second study focused on the discernment of the impact of blockage ratio, the relative size of a model compared to that of the wind tunnel, upon the flow characteristics of the model. These two joint studies aimed to improve the effectiveness and accuracy of wind tunnel testing as a device to measure flow characteristics of scale models.

AM Poster Session (11:00 am – 11:45 am)

Home institution: **U of MN Twin Cities**

Student Presenter: **Mykhail Sandacz**

E-mail address for each presenter : **sanda190@umn.edu**

Mentor: **Kirsten Strandjord, U of MN Twin Cities**

Title: **Using Direct Position Estimation for Navigation in Cis-Lunar Space**
Link to Promo video: https://youtu.be/_XOV495uE3g
Link to Poster: U of Mn Twin Cities Mykhail Sandacz poster.pdf

As humanity expands its presence in cis-lunar space, precise and autonomous navigation remains a significant challenge. Traditional navigation methods, including the Deep Space Network and optical navigation, face limitations in availability and accuracy. This study explores the application of Direct Positioning Estimation (DPE) as an alternative, leveraging Global Navigation Satellite System (GNSS) signals to provide accurate positioning in deep space. Unlike conventional GNSS receivers, DPE does not require continuous satellite lock and can derive position estimates from weak and intermittent signals.

To evaluate DPE's feasibility, we simulated GNSS signals along the Artemis I trajectory using a Spirent signal generator. We applied DPE at key locations along the flight path, comparing results to a simulated ground truth. Our findings indicate that DPE achieves absolute position errors within a few kilometers, demonstrating its potential for cis-lunar navigation. Future work will refine DPE's accuracy and apply it to real lunar mission data. By enhancing autonomous deep-space navigation, DPE presents a viable solution for upcoming Artemis missions and beyond.

AM Poster Session (11:00 am – 11:45 am)

Institution: **Concordia College, Moorhead, MN**

Student Presenter: **Matthew Mondry**

E-mail address for each presenter: **mmondry@cord.edu**

Mentor: **Saroj Thapa, Concordia College**

Title: **Optical Properties of Bromide-Based-Inorganic Perovskites**
Link to Promo video: https://youtu.be/eRvMNB2hNNc
Link to Poster: Concordia College Matthew Mondry Poster.pdf

Inorganic metal halide-based perovskites of the ABX_3 structure (with A = Cs^+ /Na^+, B = Pb^{2+}/ Ba^{2+}, X = Cl^-/Br^-/I^-) have attracted significant attention for their potential in optoelectronic applications, offering advantages such as earth-abundant elements, solution processability, and tunable optical properties including emission and absorption. However, challenges like lead toxicity and long-term stability hinder their widespread use. To address these issues, we have synthesized highly fluorescent bromide-based halide perovskites using a simple solution-processable method. This approach involves doping at both the B-site (Ba^{2+}) and A-site (Na^+) cations respectively to reduce lead content and enhance resistance to environmental factors. The resulting perovskites demonstrate desired optical properties, as evidenced by their emission, excitation, and absorption profiles. Furthermore, to further enhance stability and functionality, we are investigating the integration of these perovskites into 3D-printed structures. This approach offers a promising pathway to develop environmentally friendly, stable perovskite materials for advanced optoelectronic devices.

AM Poster Session (11:00 am – 11:45 am)

Institution: **Augsburg University**

Student Presenter(s): **Ethiopia Kebede**

E-mail address for each presenter: **kebedee@augsburg.edu**

Mentor: **Dr. Mark Engebretson, Augsburg University**

Title: **Examining the context of geomagnetic disturbances (GMDs) as observed by high altitude ultraviolet images from NASA's elliptically orbiting satellites IMAGE and Polar during the 2000-2002 period.**

Link to Promo video: https://youtu.be/hdpiFHXESeU

Link to Poster: Augsburg University Ethiopia Kebede GMDs and IMAGE.pdf

Large, localized 5 to 10-minute spikes in Earth's magnetic field are occasionally observed by ground-based magnetometers at high and middle latitudes. These events, named geomagnetic disturbances (GMDs), have been found to be associated with nearby intensifications of auroras viewed from ground-based auroral cameras. Large GMDs have become of increased interest in the last decade because they can induce geomagnetically induced currents (GICs) that can disrupt large-scale electric power grids and cause large-scale power outages such as the province-wide Ontario blackout in 1989 (Moldwin, 2022).

Because the numbers of research magnetometers and auroral cameras continue to be limited, elliptically orbiting high-altitude satellites can obtain global views of the aurora at far ultraviolet (FUV) wavelengths. However, no such satellite images have been available since the early 2000s, before the time of greatly increased interest in GMDs.

The goal of this study was to determine whether large GMDs could be observed using global satellite images. It is timely in that global satellite-based imagers (e.g., the Links mission) are a key component of missions recommended by the recently published Solar and Space Physics Decadal Survey (National Academies, 2024)

Website(s) / On-line Reference(s):

Moldwin, Mark, An Introduction to Space Weather, second edition, Cambridge University Press, 2022.

National Academies of Sciences, Engineering, and Medicine. 2024. *The Next Decade of Discovery in Solar and Space Physics: Exploring and Safeguarding Humanity's Home in Space*. Washington, DC: The National Academies Press. https://doi.org/10.17226/27938.

AM Poster Session (11:00 am – 11:45 am)

Institution: **U of MN Twin Cities**

Student Presenters: **Karl Pederson, Sam Keller**

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Non-Presenting Student Authors: **Daniel Kindem**

Mentor: **Ognjen Ilic**

Title: **Exploring the Radiative Environment of Space with Stratospheric Balloons**
Link to Promo video: https://youtu.be/onJqz9SFBm4
Link to Poster: U of MN Twin Cities Karl Pederson Sam Keller Poster.pdf

Experimentally validating new materials for space-borne applications has historically suffered from high costs and a relatively slow turnaround. The recent advancements of CubeSats and Small Satellites have significantly reduced the costs and planning time associated with these experiments. Despite this, these devices do not promote rapid iteration due to their prolonged mission lifetime. We present stratospheric balloons as an effective, low-cost method to reach a near-space radiative environment for rapid iteration. We first detail the planning required to independently launch stratospheric balloons: including equipment, flight calculations and predictions, and safety measures. We then demonstrate a novel payload for temperature characterization of materials in a near-space environment. Using a non-repeating LED sequence, we demonstrate the ability to precisely align camera footage with collected data. This process allows for direct comparison between solar orientation and temperature variation. We then highlight the ability to extend the duration of these flights through manual control of balloon venting at altitude. Our results highlighted stratospheric balloons as an effective platform for rapid iteration with potential to greatly expedite flight qualification of novel space-borne materials.

Website(s) / On-line Reference(s): https://iliclab.org/

AM Poster Session (11:00 am – 11:45 am)

Institution: **U of MN Twin Cities**

Student Presenters: **Olivia Bartol, Devin Schwartz, Greta Wolsky**

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Olivia Bartol


Devin Schwartz


Greta Wolsky

Non-Presenting Student Author: **Audrey Friesen fries289@umn.edu**

Mentors: **Dr. Lucy Dunne (UMN), Kaitlin Lostroscio (NASA), Christopher Beck (NASA)**

Title: **Free Floating Wearable Exercise System for Microgravity**
Link to Promo video: https://youtu.be/TLDdnkvLIr0
Link to Poster: U of MN Twin Cities Bartol Friesen Schwartz Wolsky poster.pdf

Maintaining muscle and bone density in microgravity is a critical challenge for astronauts on long-duration space missions. Current exercise systems, such as the Advanced Resistive Exercise Device (ARED), require dedicated space and contribute to structural stress on the International Space Station (ISS). This study explores the development of a free-floating, wearable resistance training system designed to target lower-body musculature while reducing reliance on hard-mounted exercise equipment. We present a comprehensive review of the physiological effects of microgravity, existing active and passive exercise methods, and novel actuator technologies, including shape memory alloys and pneumatic artificial muscles. By analyzing the limitations of current systems and defining key design criteria, we propose a framework for an innovative, self-contained exercise garment that could be used for space travel on the ISS or adapted for use on Earth to assist bed rest patients. This research serves as a foundation for future advancements in astronaut fitness and long-term space habitation.

Oral Presentation - Session B (11:45 am – 12:45 am) Room: 101 Tate Hall

Talk 1: 11:45 am – 12:00 pm

Institution: **Fond du Lac Tribal and Community College**

Student Presenter: **Aurora Salzer**

E-mail address for each presenter: **aurorasalzer@gmail.com**

Mentor: **Steve Highland, Fond du Lac Tribal and Community College**

Title: **NEBP From a Non-STEM Student's Perspective**
Link to Slides: FDLTCC Aurora Salzer NEBP From a Non-STEM Perspective.pdf

The National Eclipse Ballooning Project (NEBP) was a life-changing experience for many students. It provided an opportunity to explore and develop STEM skills by "advancing learners' abilities to conduct rigorous, relevant research using scientific data collected during eclipse campaigns and relevant NASA data," which is one of the NEBP Project objectives. But what was this experience like for students not directly going into a STEM field? Though many students were chosen for this project because of their major, some of us were chosen because we have mentors and peers who saw that regardless of our major, we were able to enhance the project and add insight and a diverse perspective that might not have been seen otherwise. As one of those students, I would like to share my experience of being part of this project, specifically as a member of the atmospheric science team, and how we, as a community, can help make STEM accessible for all.

Talk 2: 12:00 pm – 12:15 pm

Institution: **U of MN Duluth**

Student Presenter: **Tristan Suojanen**

E-mail address for each presenter: **suoja005@d.umn.edu**

Mentor: **Dr. Richard Gran, U of MN Duluth**

Title:**Analyzing Simulation Model Weight Behavior for DUNE Near Detector Sensitivity Study**
Link to Slides: U of MN Duluth Tristan Suojanen DUNE Detector.pdf

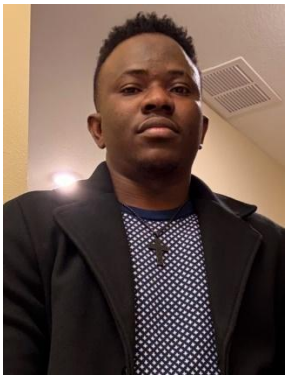
The Deep Underground Neutrino Experiment (DUNE) aims to answer questions about matter/anti-matter asymmetry, the unification of forces inside of atoms, and the interiors of neutron stars. This experiment consists of two neutrino detectors, one far detector already under construction in Lead South Dakota, and the other detector with construction plans at Fermi Lab near the source of DUNE's neutrino beam. One key aspect of the design of the near detector is a sensitivity study to confirm that the detector can constrain known interaction physics well enough to detect new oscillation physics. A part of this sensitivity study utilized a Monte Carlo simulation that modeled the neutrino interactions with liquid argon that we would see in the DUNE near detector. Within this simulation, we are actively developing model weights that alter the initial conditions of the neutrino interaction model yielding differing (simulated) final state results. I validated the behavior of a newly coded missing energy distortion and explored a use case beyond where it was developed. The code did NOT pass validation and this talk will describe what was different than what the code was expected to do.

Talk 3: 12:15 pm – 12:30 pm

Institution: **Bemidji State University**

Student Presenter: **Olatunji E. Onipede**

E-mail address for each presenter: yves.onipede@live.bemidjistate.edu



Mentor: **Dr. Carl Isaacson, Bemidji State University**

Title: **Remote Sensing—Hyperspectral Imagery Analysis & Identification of Invasive Cattail Species.**

Link to Slides: BSU Olatunji Onipede Hyperspectral Analysis.pdf

Invasive species pose significant challenges to ecosystem management, often outcompeting native flora and disrupting habitats. Hybrid cattail (*Typha spp.*) is one such species, known for its aggressive spread in wetland environments which pose significant problems to aquatic ecosystems, disrupt growth of native plants and fishes in the water bodies. This study aims to leverage Remote Sensing Hyperspectral Drone technology to map and estimate populations of invasive hybrid cattail species in wetlands which were among Minnesota Department of Natural Resources' (MN DNR) cattail management project. We aim to use hyperspectral imaging to precisely map vegetation to distinguish invasive cattail from native species.

Through the integration of remote sensing and advanced geospatial analysis, the study will provide accurate mapping and estimation of hybrid cattail populations across targeted areas. The mapping process will enable us to estimate the effectiveness of control measures by identifying and visually depicting areas of regrowth or infestation, thus informing us of the efficiency of management strategies or combinations of strategies as the case maybe. Additionally, the use of hyperspectral imaging offers an innovative approach to vegetation monitoring, contributing to a more sustainable and adaptive management framework, highly reduces field data collection, analysis time, and is more scalable, thereby ultimately reducing the total time for the project completion.

This research not only demonstrates the application of cutting-edge technology in managing invasive species but also emphasizes its potential for broader ecological applications, particularly in habitat restoration and conservation efforts. The findings will inform both geospatial methodologies and ecological management practices, aligning with sustainable environmental management goals.

Talk 4: 12:30 pm – 12:45 pm

Institution: **Augsburg University**

Student Presenter: **Phoebe Alva-Rosa**

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Mentor: **Dr. Forrest Friesen, Duke University**

Title: **Construction and Commissioning of a Cryogenic Silicon Detector Test Chamber and Beam Line for Proposed DRad Experiment**

Link to Slides: Augsburg Phoebe Alva Rosa Particle Detector.pdf

The deuteron is the only bound two-nucleon system, and as such, it is fundamental to know its properties to high degrees of accuracy. At very low momentum transfer, the electromagnetic properties of the deuteron, such as rms charge radius, can be predicted using theoretical models. The rms charge radius is thus a strong candidate for comparisons between experimental results and theory. Purpose: Recommission the 59◦ beam line in TUNL's Tandem Laboratory in order to test the efficiency of silicon solid state particle detectors operating under cryogenic temperatures in support of proposed measurements of the deuteron rms charge radius at Jefferson Lab. Methods: Expose the detectors to α particles from a 241Am source. The beam line is capable of delivering proton and deuterium beam to target, where they are scattered off of a thin gold foil into a Silicon Barrel Detector and Silicon Strip Detector (SSD). The SSD was mounted directly onto the exposed cold head of a cryo-cooler using an aluminum mounting plate in order to optimize thermal contact. Results: The 59◦ beam line was successfully recommissioned and a test chamber with cryogenic capabilities was constructed. A direct correlation between the temperature and detector leakage current was measured. Initial detector characterizations were performed. Conclusions: Decreasing the temperature of the SSD and Barrel detector also decreases the leakage current. This helps minimize the noise seen by the detectors. A full accelerator run will be necessary to finish the detector characterization. This chamber will allow for R&D of detector assemblies at temperatures significantly lower than typical applications.

Website(s) / On-line Reference(s):

D. B. N. P. J. Mohr, B. N. Taylor, Codata recommended values of the fundamental physical constants, Journal of Physical and Chemical Refrence Data (2010).

D. B. et al, Precision deuteron charge radius measurement with elastic electron-deuteron scattering., Experimental proposal submitted to Jefferson Laboratory, (2023).

O. Pooth, The CMS silicon strip tracker: Concept, production and commissioning. (Springer Science and Business Media, 2010).

Outreach Demo (12:45 pm – 1:45 pm) Room: 1st Floor Lobby Tate Hall

Home institution for each presenter: **U of MN Twin Cities**

Student Presenters: **Yossef Emara, Eloisa Carrasco**

E-mail address for each presenter: **emara004@umn.edu, carra166@umn.edu**

Mentor: **James Leger, U of MN Twin Cities**

Title: **Design and Implementation of a UAV Flight Control System with Manual and Autonomous Navigation**

Link to Promo video: https://youtu.be/5s2XN6TAXOI

Link to Materials: NONE UPLOADED YET - CHECK BACK LATER

Unmanned Aerial Vehicles (UAVs) require precise flight control and navigation for both manual and autonomous operations. This project presents the design and implementation of a quad copter based flight control system utilizing an Extended Kalman Filter (EKF) for state estimation, PID-based attitude and position control, SBUS-based radio interface for pilot input, and a motion capture system for an external reference. The system is implemented on an embedded platform using a Teensy microcontroller, integrating IMU-based sensor fusion in addition to camera localization to provide accurate attitude and position estimates. The framework supports real-time telemetry logging, failsafe mechanisms, and adaptive motor control for stable flight. By engaging in this project students gain experience in key technical areas that are essential for UAV development, including control systems, embedded systems, sensor fusion, and robotics, preparing them for advanced research and industry applications in not only UAV technology but also in autonomous systems and real-time embedded computing.

Outreach Demo (12:45 pm – 1:45 pm)

Home institution: **U of MN Twin Cities**

Student Presenters: **Monica Robles, Pfirlani Calderon, Pámela Bóveda-Aguirre, Pengyang Li, Jack Geller, Elvin Daniel Hernandez-Rosas, Carlos Quintanilla Vasquez**

E-mail address for each presenter: **roble146@umn.edu, calde241@umn.edu, boved001@umn.edu, li002858@umn.edu, gelle129@umn.edu, hern0529@umn.edu, quint239@umn.edu**

Monica Robles (top left), Pfirlani Calderon (top middle left), Pengyang Li (top middle right), Pámela Bóveda-Aguirre (top right), Jack Geller (top right), Carlos Quintanilla Vasquez(Bottom Left), Elvin Daniel Hernandez-Rosas (Bottom Right)

Mentor: **James Flaten, U of MN Twin Cities**

Title: **The Essentials of Cable Systems: A Curriculum for College and Adult Learners**
Link to Promo video: https://youtu.be/bbiW6NVragE
Link to Materials: NONE UPLOADED YET - CHECK BACK LATER

Our team has been working on developing outreach material with a main focus on cable systems. The curriculum is divided into four main hours, each with specific activities and challenges that give participants the opportunity to work with manual-driven cable systems. Hour 1 consists of a brief introduction to cable systems, their basic mechanics, and real life applications. This introduction includes physical and digital demonstrations of 1D, 2D, and 3D cable systems accompanied with explanations of basic physics concepts, terminology, and 2D vector mechanics. During hours 2 and 3 participants will design, analyze, and experiment with cable systems of various sizes. This first of which will include the building process to design a cable system to properly balance

a water bottle. The second system will be a claw-like system, where 8 cables are attached to a payload to introduce 3D motion and rotation. During the final hour, participants will focus on designing and constructing a payload, incorporating materials, and understanding their mechanics. The main challenge will consist of attaching the payload to a "room-sized" cable system and maneuvering it to accomplish a specific mission that simulates the docking of a spacecraft.

Website(s) / On-line Reference(s):

- Theory and Application of Cable-Driven Parallel Robots (Textbook)
- ScienceBuddies Make a Spacecraft Motion Simulator!

Outreach Demo (12:45 pm – 1:45 pm)

Home institution: **Macalester College**

Student Presenters: **Micayla Crane, Marine McKnight, Selah Miller, Will St. Andre, Theo Rosenberg**

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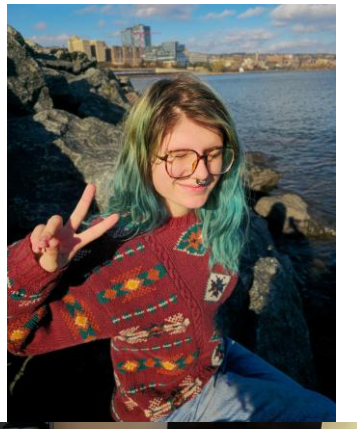


Non-Presenting Team Members: **Ayla Reynolds, Abby Justman, Jose Cristerna-Rodriguez, Matthew Cosentine, Tucker Snow, Allison Dvorak, Anna Wurtz**,

Mentors: **Tonnis ter Veldhuis, Camellia Schwartzman, Ben Crotteau, Macalester College**

Title: **Modify your own rocket!**
Link to Promo video: https://youtu.be/0UNCux5U0UQ
Link to Materials: Macalester model rocketry outreach project

This workshop guides participants through basic rocket concepts and dynamics, providing a deeper understanding through specific nose cone and fin modifications. Using a standard Apprentice model rocket, it is possible to gain a baseline understanding of rocket systems. Apprentice rockets

are used as they carry a parachute deploy system, standard motors, fin cans, body tubes, and nose cones, all standard rocket components. Participants in the lab will work to understand the significance of each aspect of the rocket by modifying either the nose cone shape or fin can number. Participants will familiarize themselves with online software to do so, then further their knowledge with simulations. Analyzing the simulation data reveals critical concepts about rocket dynamics, encompassing core ideas of drag and projectile motion. Following this method ultimately satisfies the intent of this project, familiarizing participants with a basic understanding of rockets while getting a hands-on understanding of the work they do. As individuals progress through and complete the workshop, they will be able to keep their Apprentice rockets at the end of the build.

Oral Presentation - Session C (1:45 pm – 2:45 pm) Room: 101 Tate Hall

Talk 1: 1:45 pm – 2:00 pm

Institution: **Macalester College**

Student Presenter: **Sophia Stevenson**

E-mail address for each presenter: **sstevens@macalester.edu**

Mentor: **Paul Herstedt, Macalester College**

Title: **Dynamical Systems in Zero-Dimensional Space**
Link to Slides: Macalester Sophia Stevenson Zero Dimensions.pdf

Dynamical systems move points around in space over time. In this project, we explore the properties of dynamical systems built on zero-dimensional spaces. In particular, we look at how these systems evolve in time, and claim that certain systems behave the same in both forward and reverse time. These systems and their classifications are relevant to the theory of quantum mechanics.

Beginning with our knowledge of one-dimensional space, this presentation will describe what zero-dimensional spaces look like, then delve into how we can construct interesting dynamical systems on these spaces. Finally, we will discuss the different classes of dynamical systems and how their structure predicts where points move over time.

Talk 2: 2:00 pm -2:15 pm

Institution: **U of MN Twin Cities**

Student Presenter: **Simeon Shaffar**

E-mail address for each presenter: **shaff257@umn.edu**

Mentors: **Demoz Gebre-Egziabher and Lindsay Glesener, U of MN Twin Cities**

Title: **Experiments in X-Ray Characterization and Timing - Development of the EXACT CubeSat**

Link to Slides: U of MN Simeon Shaffar EXACT CubeSat.pdf

Experiments in X-Ray Characterization and Timing (EXACT) is an experiment focused on advancing the technology necessary for pulsar-based navigation in deep space. As more spacecraft are built and launched for ambitious interplanetary and deep-space missions, traditional Earth-based navigation systems, such as the Deep Space Network, will face increasing limitations in availability and scalability. Pulsar-based navigation offers a promising alternative by using the periodic X-ray emissions from millisecond pulsars as natural beacons for spacecraft positioning.

To support this effort, a novel sensor called the Hard and Fast X-Ray (HaFX) was developed through a collaboration between the University of Minnesota and Montana State University. HaFX is designed to detect and analyze X-ray emissions from astrophysical sources with high precision. By characterizing these signals in space, researchers can evaluate the feasibility of using X-ray pulsars as stable, long-term navigation references for spacecraft operating beyond the range of traditional navigation infrastructure.

The HaFX sensor is scheduled for deployment on the International Space Station (ISS), where it will undergo extensive testing in the space environment. This deployment provides a critical opportunity to assess its performance under real-world conditions. The results from these tests will inform future iterations of X-ray navigation technology and help refine algorithms for precise position determination in deep space.

Website(s) / On-line Reference(s):
https://smallsat.umn.edu/exact/overview

Talk 3: 2:15 pm – 2:30 pm

Institution: **St. Cloud State University**

Student Presenter: **Caitlin Andersh**

E-mail address for each presenter: **caitlin.andersh@gmail.com**

Mentor: **Rachel Humphrey, St. Cloud State University**

Title: **A Methodology of Identifying Solar Eclipse Gravity Wave Signatures using Machine Learning and Geospatial Data**

Link to Slides: SCSU Caitlin Andersh NEBP Data Analysis.pdf

In October 2023 and April 2024, two solar eclipses occurred over the United States. During these events, participants of the Nationwide Eclipse Ballooning Project (NEBP) launched stratospheric balloons to collect atmospheric data. As part of the Minnesota Atmospheric NEBP team, I have been analyzing raw radiosonde data to study gravity waves—a phenomenon in which atmospheric parcels vertically oscillate, with gravity acting as the restoring force.

The research project I have designed involves building a machine-learning (ML) classifier in Python to identify both low- and high-frequency gravity wave oscillations. As designed, this classifier ideally pinpoints the time and location of observed gravity waves, assisting with geospatial data analysis by integrating observations into Google Earth Engine. This aspect allows for a utilization of satellite products to analyze thermal anomalies and other atmospheric factors thought to induce these oscillations.

In this presentation, I will provide my data analysis methodology for this project, covering aspects such as isolating gravity wave periodicity and oscillations within the raw data, training the classifier using the random forest technique, and an overview of applying the radiosonde data in Google Earth Engine.

Talk 4: 2:30 pm – 2:45 pm

Institution: **St. Catherine University**

Student Presenter(s): **Leisly Jara and Subeyda Mohamed**

E-mail address for each presenter: **samohamed849@stkate.edu, ljara881@stkate.edu**

Mentor: **Dr. Tami McDonald, St. Catherine University**

Presentation Title: **From Moon Dust To Earth Growth: The impact of lunar regolith on the germination and growth dynamics of *Medicago truncatula seeds***

Link to Slides: SCU Subeyda Mohamed Leisly Jara Moon Dust.pdf

The exploration of lunar regolith as a culture medium for terrestrial plants represents a pinnacle point between agriculture and space exploration. This study investigates Medicago seeds' germination and growth dynamics in a simulated lunar regolith and soil mixture. *Medicago*, known for its nitrogen-fixing capabilities, offers a unique way to evaluate the viability of plant life in extraterrestrial environments. A 50:50 mixture of lunar regolith simulant and Earth soil, a 100 mixture of lunar regolith, and a 100 mixture of Earth soil was compared in order to assess the overall effects on germination rates, root nodulation, and overall plant health. Key growth parameters were recorded over a defined growth period, including germination success, shoot length, root development, and nodule formation. The results revealed significant impacts of the regolith-soil mix on plant growth. While germination rates were similar between treatments, plants grown in the lunar regolith mix exhibited stunted growth and reduced root nodulation. This demonstrates how the symbiotic processes necessary for the development of Medicago seeds may be disrupted by the lunar regolith's physical and chemical characteristics such as its low nutrient availability These results emphasize the obstacles to using lunar regolith as a viable culture medium and the need for soil adjustments to enable sustainable plant life in extraterrestrial environments.

PM Poster Session (2:45 pm – 3:30 pm) Room: 1st Floor Lobby Tate Hall

Institution: **U of MN Twin Cities**

Student Presenter: **Sam Dietterich**

E-mail address for each presenter: **diett004@umn.edu**

Mentors: **Shaul Hanany, Qizhi He, U of MN Twin Cities**

Title: **Advancing Computational Electromagnetics Simulations For Antireflection Coating Development**

Link to Promo video: https://youtu.be/O5LXXMp5n8g

Link to Poster: U of MN Twin Cities Sam Dietterich Computational E&M poster.pdf

Astrophysics measurements require cryogenically cooled mirrors, filters, and lenses to minimize emission from optics. High-refractive-index ceramics are an attractive option in the millimeter-wave band because of their high transmission and high thermal conductance. A high index of refraction also leads to a high corrective power, which expands the aberration limited focal plane, allowing more detectors to be accommodated.

The high index of refraction causes high surface reflectivity requiring an anti-reflection coating. To make a cryogenically robust anti-reflection coating we are developing sub-wavelength structures on the surfaces of these ceramics.

Developing, customizing, and assessing the performance of such coatings requires RAM intensive computational electromagnetics (EM) solvers. RAM limitations have become the most important obstacle. To solve this, we are exploring different EM solver choices as well as machine learning options. In particular, physics informed neural networks (PINNs) may provide access to parameter regimes inaccessible to both numerical EM solvers and data driven neural networks.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **Macalester College**

Presenter: **Cain Rinkoski**

Email: **crinkosk@macalester.edu**

Mentors: **Tonnis ter Veldhuis, John Cannon (Macalester College)**

Title: **Radio Interferometry and Synthesis Imaging Techniques**
Link to Promo video: https://youtu.be/R_sXsIGN3Ko
Link to Poster: Macalester College Cain Rinkoski poster.pdf

Last summer, supported by NASA's Minnesota Space Grant Consortium (MNSGC), I attended the National Radio Astronomy Observatory (NRAO) Synthesis Imaging Summer School (SISS), where I gained foundational expertise in radio interferometry and synthesis imaging. Through lectures and hands-on workshops, I explored the principles of interferometric data acquisition, calibration, and imaging, utilizing tools such as the Common Astronomy Software Application (CASA). This training directly informed my research on cataclysmic variable stars (CVs)—binary systems consisting of a white dwarf and a main sequence partner which exhibit violent accretion processes. These systems are accessible analogues to more extreme compact binaries, and serve as excellent laboratories for studying accretion physics and the origins of Type 1a supernovae. Applying the techniques demonstrated at SISS, I analyzed data from the Karl G. Jansky Very Large Array (VLA) to investigate radio emission from CV ST LMi, aiming to constrain emission mechanisms and orbital dynamics. The research also integrated complementary simultaneous optical observations, strengthening the analysis and broadening the scope of the study. The experience not only enhanced my technical proficiency in handling interferometric data but also underscored the value of radio wavelengths in probing high-energy astrophysical phenomena.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **Macalester College**

Student Presenter(s): **Theo Darci-Maher**

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Non-Presenting Student Author: **Elliott Lewis**

Mentors: **Tom Finzell, Carleton College, Anna Williams, Macalester College**

Title: **Analyzing RLMT Telescope Focus Images**
Link to Promo video: https://youtu.be/VgGmSeTiWcA
Link to Poster: Macalester College - Theo Darci-Maher - Poster.pdf

The MACRO Consortium is a group of schools (Macalester College, Augustana College, Coe College, University of Iowa, and Knox College) that share access to the Robert L. Mutel Telescope (RLMT) located in southern Arizona. The RLMT takes focus images frequently during each night of observation. These images are used to keep the telescope in focus as the temperature changes. Such images yield a nine year dataset of ~25,000 images collected over a select set of fields on the sky. This consistency more easily shows variables affecting image quality in the same field of view. This exploratory project is the first examination of this vast archive. We focused on identifying factors affecting the image quality. To avoid image quality variation due to camera changes, we only analyzed the Andor iKon data from 2/7/2018 - 5/21/2019. This subset of data was chosen because it contains weather data and was taken with the camera that is currently on the telescope. The dataset consists of ~7,000 images. Applications of our results include optimizing telescope scheduling, improving image quality, and providing data for further MACRO research.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **Macalester College**

Student Presenter: **Miri Leonard**

E-mail address for each presenter: **mleonar2@macalester.edu**

Mentor: **James Doyle, Macalester College**

Title: **Creating a probabilistic seed dispersion model of Garlic Mustard**
Link to Promo video: https://youtu.be/I411GoS31Zs
Link to Poster: Macalester College - Miri Leonard - Poster.pdf

Garlic Mustard, or Alliaria Petiolata, is a common invasive plant in the Midwest with a biannual lifecycle. The goal of this research is to create a computer simulation of how Garlic Mustard spreads by implementing a probabilistic particle model. The simulation is based on a zero-dimensional deterministic model of Garlic Mustard created by Pardini et al. in 2009. We used the parameters and life cycle functions from the Pardini model and numerically compared our results with the Pardini results. Garlic mustard's main methods of dispersal are ballistic and animal transport. The program simulates these two transport methods by sampling appropriate probability functions that simulate these dispersal methods. Integrated results from our probabilistic model reproduces the main characteristics of the Pardini model while consistently producing slightly more plants. New effects emerge after adding 2-dimensional spatial dependencies that are not captured in the zero-dimensional Pardini model.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **St. Catherine University**

Student Presenter: **Sof Walker**

E-mail address for each presenter: **swalker289@stkate.edu**

Mentor: **Dr. Tami McDonald, St. Catherine University**

Title: **Establishing a Split Root System using Medicago in Mars Regolith Soil**
Link to Promo video: https://youtu.be/agV_oXKvKO0
Link to Poster: St Catherine Sof Walker poster.pdf

Astrobotany, the study of plant growth and development in extraterrestrial environments, has gained increasing focus as researchers work toward the goal of cultivating plants in space. Medicago truncatula is a legume commonly utilized in astrobotany because it is a model organism that rapidly develops and can establish symbiotic nitrogen fixation with a bacterium. Astrobotanists are using *M. truncatula* because of its potential to grow on Mars or lunar soil- a low-nitrogen environment. The split-root inoculation system and technique have been used historically for various experiment designs. Utilizing Kassaw and Frugoil's (2012) split-root technique, we established a dual root system for varied treatments using sand, surface, and Mars regolith soil combinations. Most of the experiment involved preparing media for plant agar culturing and manipulating plant root tissues. Maintenance of a sterile environment is essential for the entirety of the experiment. We found that using Kassaw and Frugoil design and media recipe (HMF media) allowed us to develop a dual root system using *M. truncatula* successfully. However, transplanting plants from agar to Mars regolith soil treatments resulted in high death. Future optimization will focus on improving the transplantation stage, particularly addressing the high mortality rates observed in Mars regolith soil. Adjustments to experimental design, including refining media formulations, adjusting growing containers, and utilizing better sterile techniques. These refinements aim to support the development and survival of *Medicago truncatula* using a split root system in astro-regolith soil.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **St Catherine University**

Student Presenter: **Ruby Moua**

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Non-Presenting Student Authors: **Ella Peters, Faith Bonse**

Mentor: **Dr. Rahul Roy, St Catherine University**

Presentation Title: **Urine For A Surprise: Investigating the Effects of Synthetic Urine on Plant Growth in Lunar Regolith**
Link to Promo video: https://youtu.be/-gh8CDJjgTI
Link to Poster: St Catherine Moua Bonse Peters poster.pdf

Our team's research on the germination and growth of Wisconsin Fast Plants, a rapid-cycling *Brassica rapa*, in nutrient-poor lunar regolith aims to provide valuable insights for scientists regarding plant growth in lunar environments. This research was part of a semester-long introductory biology lab where we went from ideation to experimentation and data analysis. Despite its availability, lunar regolith lacks key nutrients essential for plant growth, including nitrogen, phosphorus, potassium, and sulfur. Urine has long been used as a natural fertilizer, particularly in developing regions, due its rich nutrient content which supports plant growth and enhances produce yield . Recent studies aboard the International Space Station have also demonstrated the use of urine as fertilizer as in space environments. Given that urine contains several key elements essential for natural fertilization, including nitrogen, phosphorus, and potassium, which are vital plant growth, our team hypothesized that urine can serve as an effective nutrient source for the plants to grow and thrive in lunar regolith. We tested this by creating a synthetic urine recipe that closely mimicked the composition of an average crew member on earth. By varying the dilutions of synthetic urine, we assessed its ability to provide key elements such as nitrogen, phosphorus, and potassium to the growth of Wisconsin Fast Plants by measuring germination rates, leaf development, stem length, and overall growth.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **St. Catherine University**

Student Presenters: **Leslie Agustín Vasquez, Catherine Quigley**

E-mail address for each presenter: **lgagustinvasquez725@stkate.edu, cmquigley925@stkate.edu**

Catherine

Leslie

Non-Presenting Student Authors: **Brianna Valdez, Adaliz Garcia Quiterio**

Mentor: **Dr. Rahul Roy, St Catherine University**

Title: **Effect of Increased Porosity with Perlite on Brassica rapa Growth in Lunar Regolith**
Link to Promo video: NONE UPLOADED YET - CHECK BACK LATER
Link to Poster: St Catherine Agustin-Vasquez Quigley Valdez Garcia.pdf

Our team's research on the germination and growth of Wisconsin Fast Plants, a rapid-cycling *Brassica rapa*, in nutrient-poor lunar regolith aims to provide valuable insights for scientists regarding plant growth in lunar environments. This research was part of a semester-long introductory biology lab where we went from ideation to experimentation and data analysis. Despite its abundant availability on the Moon, lunar regolith lacks key nutrients essential for plant growth, including nitrogen, phosphorus, potassium, and sulfur and has poor porosity and water retention. Given that plant roots need accessible water in substrate pockets to grow well, our team hypothesized that adding perlite (expanded volcanic glass) to lunar regolith would improve growth. Perlite is commonly used in horticulture for water absorption and increasing drainage in the soil. We tested this by creating a mix of perlite and lunar regolith and testing water retention rates and the growth of Wisconsin Fast Plants by measuring their germination rates, stem length, flowers and fruit set.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **U of MN Twin Cities**

Student Presenters: **Jesse Cook, Yoel Mekbeb**

E-mail address for each presenter: **cook0690@umn.edu, mekbe003@umn.edu**

Yoel Mekbeb


Jesse Cook

Non-Presenting Student Authors: **Seyon Wallo, Jessica Glamm, Jasmine Thayer, Ashton Posey, Alex Halatsis, Ethan Thompson-Jewell**

Mentors: **James Flaten, U of MN Twin Cities**

Title: **Eclipse Ballooning: 2023 and 2024 Experiences - MN Space Grant Eclipse Ballooning Team at U of MN Twin Cities**

Link to Promo video: https://youtu.be/CRLKo0-L4L4

Link to Poster: U of MN Twin Cities Jesse Cook Yoel Mekbeb Eclipse Ballooning poster.pdf

The MnSGC-supported stratospheric ballooning team at the U of MN Twin Cities participated in the Nationwide Eclipse Ballooning Project (NEBP), an intercollegiate initiative culminating in using weather balloons to carry student-built payloads into the path of an annular solar eclipse in 2023 and a total solar eclipse in 2024. Our team also supported NEBP by serving as a "pod lead" to train other ballooning teams and by helping develop custom hardware such as an autonomous vent for altitude control, and software such as the HERMES telemetry GUI for tracking and flight operations. We also provided the PTERODACTYL flight computer and sensor suite to all “engineering” teams in the NEBP for data collection. Our team of 8 current students, one faculty advisor, and several ballooning team alumni traveled to New Mexico and Indiana for the annular and total solar eclipses, respectively. This presentation will outline our experiences, successes, and setbacks throughout NEBP, plus our broader stratospheric ballooning activities.

Website(s) / On-line Reference(s):

Thompson-Jewell, E., Wallo, S., Glamm, J., Halatsis, A., Cook, J., Mekbeb, Y., Thayer, J., Posey, A., Bazan, N., Sangelaji, E. & Flaten, J., (2024) "Stratospheric Eclipse Ballooning in 2023 and 2024: The U of MN – Twin Cities Experience Continues", *Academic High Altitude Conference* 2024(2). doi: https://doi.org/10.31274/ahac.17989

Cook, J., (2024) "Development of the HERMES Ground Station GUI for Antenna Pointing by NEBP Engineering Teams", *Academic High Altitude Conference* 2024(2). doi: https://doi.org/10.31274/ahac.17972

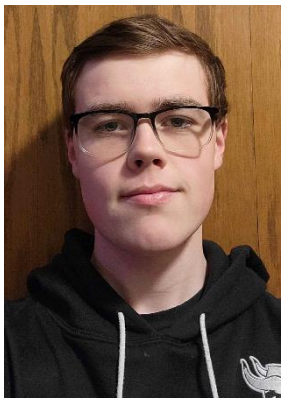
Mekbeb, Y., Thayer, J. & Flaten, J., (2024) "Using 360-degree Cameras on Stratospheric Balloon Flights", *Academic High Altitude Conference* 2024(2). doi: https://doi.org/10.31274/ahac.17988

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **U of MN Twin Cities**

Student Presenters: **Sean Gilomen, Radhakrishna Vojjala, Pfirlani Calderon**

E-mail address for each presenter: **gilom005@umn.edu, vojja001@umn.edu, calde241@umn.edu**


Sean Gilomen


Radhakrishna Vojjala


Pfirlani Calderon

Mentor: **James Flaten, U of MN Twin Cities**

Title: **Flight Computers for Stratospheric Ballooning and High-Power Rocketry**
Link to Promo video: https://youtu.be/oSmnaHTAa38
Link to Poster: U of MN Twin Cities Sean Gilomen Radha Vojjala Pfirlani Calderon Flight Compters poster.png

MnSGC students at UMN-TC have developed three microcontroller-based flight computers - the PTERODACTYL (Payload To Enable Recording Of Data And Communication Telemetry (While) Lofted), PADL-33 (Phully Adept Data Logger), and BERB (Barely Expandable Rocketry Board). These are designed for data logging of sensors in the demanding applications of stratospheric ballooning and high-power rocketry. Each microcontroller + sensor suite includes “basic” sensors: GPS, IMU, temperature, and barometric pressure. Each flight computer also provides status and error signaling using indicator LEDs and/or an OLED screen. Additionally, all three flight computers can be augmented to use additional sensors. The PTERODACTYL uses a Teensy 4.1 microcontroller and is on a relatively large printed circuit board (PCB) optimized for balloon flights, where multi-hour, high-accuracy data acquisition at 1 Hz is sufficient. The much-slimmer PADL-33 is built around an Arduino Nano 33 BLE Sense and can achieve faster data rates, making it more suitable for the rapid dynamics of rocketry, it can also be adapted for balloon missions. The BERB, currently in the breadboard development phase with PCB design underway, uses a Teensy 4.1 microcontroller and is tailored for the compact, small-diameter, high-update speed demands of high-performance, high-power rockets.

Website(s) / On-line Reference(s):

Wallo, S., Posey, A., Wehling, P., Van Gerpen, A. & Flaten, J., (2023) “PTERODACTYL: A Versatile Flight Computer for Stratospheric Ballooning”, Academic High Altitude Conference 2022(1). doi: https://doi.org/10.31274/ahac.15639

Posey, A. D., (2024) “PADL-33: A Low Cost Flight Computer for Stratospheric Ballooning and High-Power Rocketry”, Academic High Altitude Conference 2024(2). doi: https://doi.org/10.31274/ahac.17950

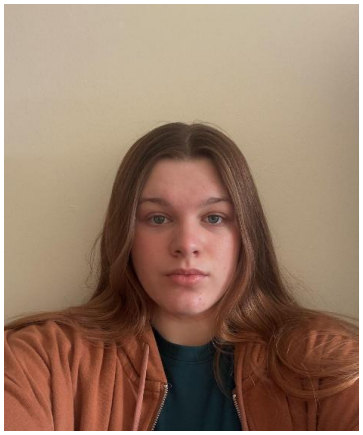
PM Poster Session (2:45 pm – 3:30 pm)

Institution: **U of MN Twin Cities**

Student Presenters: **Monica Robles and Aksinya Kamenshikova**

E-mail address for each presenter: **roble146@umn.edu, kamen039@umn.edu**

Monica Robles



Aksinya Kamenshikova

Mentor: **James Flaten**

Title: **Investigating Cosmic Rays: Stratospheric Cloud Chamber Development**
Link to Promo video: https://youtu.be/4bG8tuQLZAs
Link to Poster: U of MN Twin Cities Monica Robles Aksinya Kamenshikova Cloud Chamber poster.pdf

Cloud chambers allow for visualizing the trajectory of radiation within a supersaturated vapor. When radiation interacts with the vapor, droplets become ionized and form visible trails along the particle's trajectory. During a balloon flight, the trail activity within the cloud chamber varies with altitude. Our hypothesis was that the chamber activity would increase with increasing altitude, due to increasing amounts of cosmic radiation that penetrate the atmospheric overburden. On a stratospheric balloon flight, the peak of cloud chamber activity occurred around 68,000 ft, slowly dying down at higher altitudes. The main particles observed were believed to be high and low-energy electrons, protons, and an occasional muon. The process of deciphering which particles the paths relate to was done by comparing our images to cloud chamber results from the literature. Our initial hypothesis of an increase in activity was indeed met. However, as the flight progressed higher than 80,000 ft the low pressure began to create an unstable vapor environment in which individual trails could no longer be seen. A pressurized cloud chamber might be a future step to better-understand the amount of cosmic radiation and types of particles present at different altitudes in the troposphere and stratosphere.

Website(s) / On-line Reference(s) (max 3):
Nuledo Cloud Chambers, nuledo.com, used for particle trail identification.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **U of MN Twin Cities**

Student Presenters: **Mir Majid Ali, Keenan Raby**

E-mail address for each presenter: **ali00370@umn.edu, raby0009@umn.edu**

Mentor: **James Flaten, U of MN Twin Cities**

Title: **Stratospheric Rube Goldberg Machine Challenge**
Link to Promo video: https://youtu.be/HZcLEoKwn8Q
Link to Poster: U of MN Twin Cities Majid Ali Keenan Raby Rube Goldberg Machine poster.pdf

The purpose of this project was to design, build, and test a Rube Goldberg machine that was able to operate in extreme stratospheric environmental conditions. The mechanism had five independent steps, which were recorded by a camera. A 12 in x 12 in x 12 in payload was built for the Rube Golberg machine to reside in. As for the theoretical steps of the machine, first, an Arduino Nano determines the payload's altitude. As soon as it reaches 80,000 ft (24384 m), the Nano then sends power to a nichrome wire, causing it to heat up. The hot nichrome wire cuts a string, which releases a ball. That ball rolls down a spiral tube and sets off a mouse trap. Next, the triggered mouse trap pulls a magnet out of place allowing another magnet to fall down a copper pipe. Lenz's law is used to slow the fall of the second magnet. As the second magnet falls, it pulls on a string that raises a nail, setting it into place. As the payload continues to ascend, and the pressure continues to decrease, a balloon strategically placed will expand large enough to, finally, be popped by the nail. In practice, the string in contact with the nichrome wire was not taut enough, so it was never cut. Also, the balloon was pre-inflated too much and expanded to the desired size too early. Further testing is required.

PM Poster Session (2:45 pm – 3:30 pm)

Institution: **U of MN Twin Cities**

Student Presenters: **Joseph Shin, Daniel Margosian**

E-mail address for each presenter: **shin0405@umn.edu, margo130@umn.edu**

Mentor: **James Flaten, U of MN Twin Cities**

Title: **Comparison of Low-Cost Geiger Counters for Stratospheric Ballooning**
Link to Promo video: https://youtu.be/JFA3zQPRMEw
Link to Poster: U of MN Twin Cities Joseph Shin Daniel Margosian Geiger Counter poster.pdf

Stratospheric weather balloons can ascend to above 20 km, reaching the Regener-Pfotzer maximum where the cosmic radiation environment transitions from secondary particles to fewer-but-more-energetic primary cosmic rays. The Solar Max Ballooning Initiative seeks to characterize the Forbrush decrease in cosmic ray intensity, which occurs when coronal mass ejections (CMEs) from the Sun impact the Earth. As "informal" participants in this effort, our ballooning team is testing a variety of low-cost Geiger counters for potential adoption. Historically, we have flown RM-60 and RM-80 Geiger counters from Aware Electronics, as well as Neulog Geiger counter modules. However, both are now out of production. Seeking options especially for new teams, we have purchased Geiger Counters called "MightyOhm", "DFRobot: Gravity", "Shkalacar", "GQ GMC-500+", and "Radiacode 102." We are in the process of ground testing them, logging their counts with microcontrollers (not all of them are set up to log data), and preparing them for comparison testing on stratospheric balloon flights. Key research questions: Can these Geiger counters survive the high-radiation, low temperature, and low-pressure environment of "near-space"? and also Can these Geiger counters update fast enough to characterize the Regener-Pfotzer maximum, so as to accomplish the science goals of the Solar Max Ballooning Initiative?

Website(s) / On-line Reference(s): **links to vendors for 5 new-to-us Geiger counters available upon request**