NASA's Minnesota Space Grant Consortium (MnSGC)

Student Symposium
Book of Abstracts
March 27, 2021

Zoom links

- **"Main Room"** https://umn.zoom.us/j/7261550823 **(open 9 am to 3:45 pm)**
- **"Second Room"** https://umn.zoom.us/j/9772902391 **(open 9 am to 10:45 am for Session 1 and 12:50 pm to 2:30 pm for Session 4)**

https://www.mnspacegrant.org

Table of Contents

Timing for the Student Symposium

Audio checks for Session 1 (in Second Room) and Session 2 (in Main Room) (9:00 – 9:10 am)

Welcome and announcements in Main Room (9:10 – 9:15 am)

Break: slide show about the MnSGC and networking in Main Room (10:45 to 11:00 am)

Audio checks for Session 3 (in Main Room) and Session 4 (in Second Room) (12:50 – 1:00 pm)

Break: slide show about the MnSGC and networking in Main Room (2:30 to 2:45 pm)

Announcement of session winners and networking in Main Room (3:30 – 3:45 pm)

Zoom links

- **"Main Room"** https://umn.zoom.us/j/7261550823
- **"Second Room"** https://umn.zoom.us/j/9772902391

Technical Issues:

Please call James Flaten – 651-399-2423

Welcome to NASA's MN Space Grant Consortium's 2021 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 activities related to aerospace science and engineering 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 12 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 24 contributed talks by students who have worked on a variety of MnSGC research, higher education, and outreach projects in the past year. These talks are spread over two sessions – two in parallel in the morning and two in parallel in the afternoon – one in the "Main (Zoom) Room" and one in the "Second (Zoom) Room".

In the "Main (Zoom) Room" we are also pleased to offer a session (not in parallel, so everyone can attend) by 3 students who received NASA Center Internships in the summer of 2020, followed by a keynote student talk about efforts to darken SpaceX Starlink satellites so they don't interfere with astrophotography.

The symposium will end, again in the "Main (Zoom) Room" with a panel by several individuals with interesting career stories and advice to share with students. That panel discussion will be followed by announcements of awards to the top presentation from each of the 4 contributed student talk sessions.

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 student speakers:

Presenter	Title of the presentation
Augsburg University	
Kei Heltemes	- Electrolyte Gating and Magnetic Measurements of $Co_3Sn_2S_2$: A Materials Solution for Developing Next-Generation Electronics
Kong Yang, Leon Armbuster	- Impact of Spatial Arrangement of Passive Obstacles on First Passage of an Active System
Bethel University	
Isaac Vliem	- 2020 NASA Langley Academy Project: TURVTOL
River Beard	- A Portable Optical Atomic Frequency Standard
Jack Sisson	- Tracking detector upgrades and monitoring for the CMS Experiment
Bemidji State University	
Breanna Keith	- Investigating the Common Characteristics of Minnesota's Amphipod-Rich Depressional Wetlands
Carleton College	
Katy Oda	- Improvements in measuring rotational broadening in M dwarf stellar spectra
Ally Keen	- Rotational modulation of Zeeman signatures in M dwarf stellar spectra
Concordia College	
Amy Ott	- Plasma Physics in Python: A Computational Program for Spectral Line Analysis
Bailey Klause, Andrew Middendorf	- Investigation of the Magnetic Properties of Aluminum, Nickel, and Chromium Doped Goethite
Nicholas Lyle	- The Introduction of Arduino Microcontrollers in the Instrumentation Laboratory at Concordia College
Ben Bogart	- The MnSGC Quadcopter Challenge – a TA perspective
Fond du Lac Tribal and Community College	
Emily Lockling	- Development of a Collector Application for Invasive Species Surveying

Macalester College

Kayla Schang	- Human Exploration ISRU-based Mission Architecture (HEIMA) Mission to Ceres – Macalester RASC-AL
Daniel Clark	- Dynamics From Maurer Cartan Forms and Nonlinear Realizations

St. Catherine University

Anisa Tapper, Gillian Durand, Maddie Ross	- Observing Atmospheric Changes Caused by Solar Eclipses
Anisa Tapper, Gillian Durand, Maddie Ross	- Lower Atmosphere Neutron Detection Using Personal Neutron Dosimeters

University Minnesota - Duluth

Emily Haas	- Investigating Cosmic Ray Muons and their Velocities
Angela Martini	- Respiration Monitoring Utilizing Wearable Stitched Strain Sensors
Evan Schindler, Tyler Hobbs, Max Benson	- Spaceport America Cup - Intercollegiate Rocketry Engineering Competition

University Minnesota – Twin Cities

Crystal Compton	- Textile-based Contact Sensors for Space Suit Sizing and Fit
Noah Garon	- Textile – Mechanical Interface
Nathan Noma	- Verification of EKF Attitude Data with Computer Vision
Andrew Van Gerpen, Joe Poeppel	- Student-Developed Printed Circuit Boards for In-Class and Extracurricular Activities
Emily Siem, Seyon Wallo, Tommy, Alex Halatsis	- MnSGC Exploration-Flying Quadcopter Challenge: The UMTC Team Experience
(Jason) Sze Kwan Cheah	- Passivity-Based Set-Point Pose Regulation and Jacobian-Based Force Distribution of a Cable-Driven Parallel Robot
Paul Wehling	- Stratospheric Ballooning as a Freshman Seminar – a TA perspective

Career panelists:

Dr. Lindsay Glesener, School of Physics and Astronomy, University of Minnesota – Twin Cities

Christopher Gosch (UMTC alum with MnSGC connections), Northrop Grumman

Rachael Winiecki (UMTC alum), Wisconsin Air National Guard (former USAF test pilot)

Concurrent Session 1 (9:15 am – 10:45 am)

Moderator: Dr. James Flaten – University of Minnesota – Twin Cities

Time: 9:15 am -9:30 am

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Augsburg University

Student Presenter: Kei Heltemes

Mentors: Dr. Jeff Walter and Dr. Chris Leighton

Title: Electrolyte Gating and Magnetic Measurements of Co3Sn2S2: A Materials Solution for Developing Next-Generation Electronics

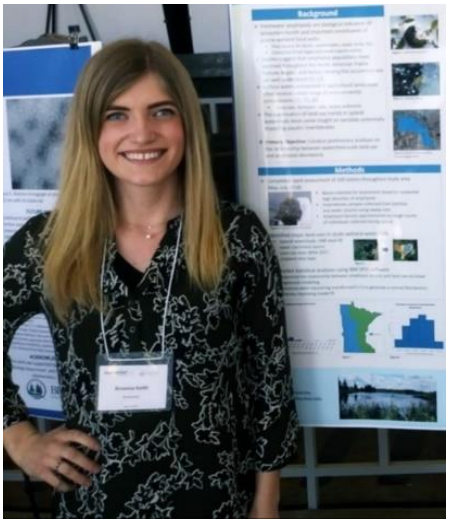
Increasingly impressive demonstrations of voltage-controlled magnetism have been achieved recently, highlighting potential for low-power data processing and storage. Magnetoionic approaches appear particularly promising, electrolytes and ionic conductors being capable of on/off control of ferromagnetism and tuning of magnetic anisotropy. A clear limitation, however, is that these devices either electrically tune a known ferromagnet or electrically induce ferromagnetism from another magnetic state, e.g., antiferromagnetic. Here, we demonstrate that ferromagnetism can be voltage-induced even from a diamagnetic (zero-spin) state suggesting that useful magnetic phases could be electrically induced in "nonmagnetic" materials. We use ionic liquid–gated diamagnetic FeS2 as a model system, showing that as little as 1 V induces a reversible insulator-metal transition by electrostatic surface inversion. Anomalous Hall measurements then reveal electrically tunable surface ferromagnetism at up to 25 K. Density functional theory–based modeling explains this in terms of Stoner ferromagnetism induced via filling of a narrow eg band.

Time: 9:30 am – 9:45 am

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Bemidji State University

Student Presenter: Breanna Keith



Mentor: Dr. Carl Isaacson

Title: Investigating the Common Characteristics of Minnesota's Amphipod-Rich Depressional Wetlands

Freshwater amphipods *Gammarus lacustris* and *Hyalella azteca* are aquatic crustaceans that play an important role in wetland food webs and are considered to be biological indicators of ecosystem health. Amphipod abundance has declined in the North American Prairie Pothole Region, but some wetlands continue to support high amphipod densities. Therefore, we conducted comprehensive surveys at 65 shallow lakes and semi-permanent wetlands throughout Western Minnesota to investigate how wetland and watershed-level characteristics influence amphipod abundance. Due to the scarcity of amphipod-rich wetlands, half of our basins were randomly selected and the rest were selected for known amphipod abundance; altogether, densities ranged from 0 to 7,000 amphipods per cubic meter. In this talk, I'll discuss our preliminary findings on relationships between amphipod abundance and wetland quality (e.g., aquatic vegetation and predator abundance, water chemistry, and anthropogenic impacts); collectively, these findings will help inform wetland management decisions that aim to improve aquatic ecosystem health and wildlife habitat.

References:

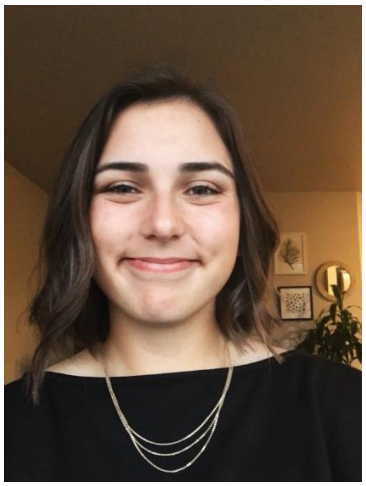
1. https://www.mprnews.org/story/2018/06/29/amphipod-crustacean-wetland-health-minn-research
2. https://www.dnr.state.mn.us/mcvmagazine/issues/2019/may-jun/freshwater-amphipods.html
3. https://www.researchgate.net/publication/330223230_Project_Title_Restoring_Wetland_Invertebrates_to_Revive_Wildlife_Habitat

Time: 9:45 am – 10:00 am

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Concordia College

Student Presenters: Bailey Klause, Andrew Middendorf



Bailey Klause

Andrew Middendorf

Mentors: Dr. Thelma Berquó and Dr. Graeme R.A. Wyllie

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

In this work, we investigated the effects of metal substitution on the magnetic properties of synthetic samples of the iron oxide goethite. We prepared goethite samples doped with multiple metal cations such as aluminum, nickel, and chromium. Mössbauer Spectra, hysteresis loops, and high and low-temperature magnetization curves were collected to observe the effects that substitutions would have on the magnetic properties of the iron oxides. From the Mössbauer spectra, it was concluded that phases other than goethite – namely, hematite and a superparamagnetic phase – were formed, as target cation substitution increased for the samples containing Al and Al+Cr. The magnetic hyperfine field decreased most for the samples with high target concentrations of Al and Al+Cr, which could indicate that more substitution is taking place when there are large amounts of non-iron cations in the system. The Néel temperature (T_N) data of the Al+Ni samples agree with this hypothesis, which is evidenced by the substantial decrease in T_N for high substitutions of Al. Additionally, the Néel temperature for the sample of 24 % Al is lower than the Néel temperature of the 4 % Al-20 % Ni sample, which suggests that nickel does not substitute as readily as aluminum.

Time: 10:00 am – 10:15 am

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Macalester College

Student Presenter: Kayla Schang

Mentors: Dr. Tonnis ter Veldhuis (faculty advisor), Kevin Kempton (technical advisor)

Title: Human Exploration ISRU-based Mission Architecture (HEIMA) Mission to Ceres – Macalester RASC-AL

The Macalester RASC-AL team is competing in the 2021 RASC-AL competition, designing a Human Mission to Ceres. This project expands on the Human Exploration ISRU-based Mission Architecture (HEIMA) concept, which uses materials mined from asteroids to make the mission feasible. Our design contains innovative features including inflatable spacecraft components, artificial gravity, an ice shell for radiation shielding, a greenhouse for fresh food, and a lander for crewed and robotic landings on Ceres. This HCTV is the first piece of the HEIMA architecture, which is focused on the long-term goal of building a busing system throughout the solar system, so investment in this mission would enable future solar system exploration. To complete this project, team members meet remotely to plan science goals and timelines, analyze life support systems, and design mission and vehicle components. We have written a proposal and produced a video presenting the concept. If accepted to the next competition stage, the team will continue developing the idea for the virtual RASC-AL forum in June, with financial support from the competition. The team is also supported by technical mentor Kevin Kempton (NASA Langley Game Changing Development office) and faculty advisor Dr. Tonnis ter Veldhuis.

Time: 10:15 am – 10:30 am

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: University of Minnesota - Duluth

Student Presenter: Angela Martini

Other Student Authors: Tim Dung Hoang, Crystal Compton

Mentor: Dr. Abigail Clarke-Sather

Title: Respiration Monitoring Utilizing Wearable Stitched Strain Sensors

Monitoring respiration is an important indicator for worker health status within extreme environments, such as astronauts during Extravehicular activity (EVA). EVA is strenuous on anyone, though females may experience greater injury rates wearing equipment designed for male anatomy. This research focuses on developing and evaluating a garment with a stitched strain sensor to monitor real-time respiration. The mechanical and electrical properties of the textile-integrated stitched sensor were analyzed through the stress-strain and resistance-displacement relationship, to determine how displacement of the stitched sensor, due to chest expansion and contraction during breathing, relates to respiration rate. The stitched strain sensor measures respiration rate via resistance changes from the changing loop geometry of the stitch during stretch and contraction, encircling the rib cage during breathing. A benchtop tensile testing device, MinStrain (developed by a University of Minnesota M.S. student, Stijn Vandycke), was retrofitted and used to measure the stress vs strain and resistance vs displacement simultaneously for eight stitched sensor textile samples. Measuring resistance changes related to stitched sensor displacement can indicate breathing, allowing monitoring of breathing rate in real-time. Future work includes testing the effectiveness of the stitched strain sensor on human subjects to measure breathing rate.

References:

1. https://files.zotero.net/eyJleHBpcmVzIjoxNjE1ODIyNzE2LCJoYXNoIjoiNzdlYjg3YTRmNTNjZTBkOTM2Yjc4MmQyZThiY2NmMGQiLCJjb250ZW50VHlwZSI6ImFwcGxpY2F0aW9uXC9wZGYiLCJjaGFyc2V0IjoiIiwiZmlsZW5hbWUiOiJTdGlqbiBWYW5keWNrZSAtIDIwMTggLSBNaW5TdHJhaW4gKDIpLnBkZiJ9/894a792fdad5cdde9cdf2a5dc14f03b541013ada8a745e6360ad184603e69a67/Stijn%20Vandycke%20-%202018%20-%20MinStrain%20%282%29.pdf (if link is expired contact presenter directly at <mart5513@d.umn.edu> for a copy)
2. https://www.nasa.gov/topics/humans-in-space

Time: 10:30 am – 10:45 am

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: University of Minnesota – Twin Cities

Student Presenter: Paul Wehling

Mentor: Dr. James Flaten

Title: Stratospheric Ballooning as a Freshman Seminar – a TA perspective

As a NASA Higher Education program, one major goal of the MN Space Grant Consortium (MnSGC) is to engage more higher education students (and faculty) around Minnesota with NASA-themed curricular and extra-curricular activities. With MnSGC support, the Aerospace Engineering and Mechanics (AEM) Department at the U of MN – Twin Cities has offered freshman seminars with an aerospace hardware "build" component since 2008. The first topic attempted, which is still taught regularly, is called "Introduction to Spaceflight with Stratospheric Ballooning." In the fall of 2020, I served as a teaching assistant for such a seminar, where teams of freshmen built miniature "spacecraft" (i.e. payloads) which were carried to over 100,000 feet in the stratosphere ("near-space") on a weather balloon mission. The class was taught in person, though some modifications were required due to COVID-19 restrictions. The most significant adjustment was that class members were not allowed to travel on a field trip to attend the balloon launch or recovery in person, but instead watched video streams and monitored live data telemetry. This talk will discuss my experiences and the value of such a class to motivate interest in STEM for students from all majors.

Reference:

1. ASEE conference paper about ballooning freshman seminars:
https://www.asee.org/public/conferences/20/papers/7457/download

Concurrent Session 2 (9:30 am – 11:00 am)

Moderator: Dr. Benjamin Stottrup – Augsburg University

Time: 9:15 am – 9:30 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Bethel University

Student Presenter: River Beard

Mentor: Dr. Nathan Lemke

Title: A Portable Optical Atomic Frequency Standard

Atomic frequency standards are reliable, high-precision oscillators with applications such as frequency modulated communications and atomic clocks. The most precise frequency standards rely on laser cooling to reduce instabilities such as Doppler broadening. These high-stability frequency standards are therefore confined to the laboratory and cannot be employed in applications such as GPS satellites. A basic design is described for an optical atomic frequency standard that uses a two-photon transition in rubidium to avoid the non-relativistic Doppler shift present in one-photon transitions, eliminating the need for laser cooling or trapping. Linewidth and amount of absorption are sampled and studied under varying environmental conditions and polarization states of the interrogating CW laser beams.

Reference:
https://sites.google.com/bethel.edu/bethel-amo

Time: 9:30 am – 9:45 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Concordia College

Student Presenter: Amy Ott

Mentor: Dr. Matthew Archmiller

Title: Plasma Physics in Python: A Computational Program for Spectral Line Analysis

A spectral analysis program, spectrum_fit, was written in the computer programming language Python as a computational tool for experimental plasma physics. Spectral analysis is used to determine plasma properties such as composition, temperature, and flow velocity, but is also useful in many other contexts. This program was designed to be used in a classroom setting for Concordia's growing plasma physics curriculum. Using an Argon lamp spectra as sample data, the SciPy library in Python was used to find the best-fit parameters of a curve fit to the spectral lines. Then, custom Gaussian and Lorentzian functions were used to determine the curve, given the best guesses for each spectral line's amplitude and wavelength. The fit was plotted against the data and the chi-squared and reduced chi-squared of the fit was calculated. Once the peaks' amplitudes and centers were found, they were compared to the National Institute of Standards and Technology's (NIST) Atomic Spectra Database for Argon to ensure accuracy. The Argon lamp's spectral lines were found to be roughly Gaussian in shape but skewed to higher wavelengths probably due to an asymmetric instrumental function.

Time: 9:45 am – 10:00 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: St. Catherine University

Student Presenters: Anisa Tapper, Gillian Durand, Maddie Ross

Anisa Tapper

Maddie Ross

Gillian Durand

Mentor: Erick Agrimson

Title: Lower Atmosphere Neutron Detection Using Personal Neutron Dosimeters

Measurements from High Altitude Balloon flights provide data for understanding atmospheric cosmic rays. The Regener-Pfotzer (R-P) maximum is the altitude where the ionizing particle count rate reaches an apex due to Galactic Cosmic Ray Showers (GCRS). The flux of secondary GCR particles depends on altitude, latitude, solar activity, and atmospheric composition. Secondary particles consist of ionizing particles, pions, muons, electrons, positrons, and photons. Through interactions, these particles undergo energy loss and decay while traveling through the atmosphere. Neutrons are a part of the secondary interaction. The main interaction layer of the GCRS exists at a higher altitude than that of the R-P maxima which is a result of this interaction. Measuring the neutral maxima in relation to the charged particle intensity directional measurements (horizontal, vertical and omnidirectional) is critical for understanding cosmic ray interactions. It is hypothesized that neutrons are generated in the upper atmosphere due to collisions between the GCR and nuclei of atmospheric oxygen and nitrogen, causing the nuclei to break into atomic and subatomic particles and cause higher numbers of neutrons to occur lower in altitude. An investigation was conducted using a personal neutron dosimeter, paired with a digital camera and Geiger-Müller omnidirectional and directional counters to establish a correlation between neutron counts and the altitude of charged particle maxima. The directional R-P maxima were supported by four Geiger-Müller (RM 80) planar detectors. A majority of neutrons detected passed through the dosimeter at lower altitudes than the directionally measured RP maxima, confirming the hypothesis. A greater occurrence of neutrons appeared below the main interaction layer in the upper atmosphere showing the importance of having charged and neutral detectors used in conjunction with each other to better understand the dynamics of the charged and uncharged particles in the atmospheric environment.

Time: 10:00 am – 10:15 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: University of Minnesota - Twin Cities

Student Presenters: Andrew Van Gerpen, Joe Poeppel

Andrew Van Gerpen

Joe Poeppel

Mentor: Dr. James Flaten

Title: Student-Developed Printed Circuit Boards for In-Class and Extracurricular Activities

Printed circuit board (PCB) design and fabrication has become an accessible option at the academic level due to intuitive design software, and quick and inexpensive fabrication. Data collection devices used in high-altitude ballooning applications must be capable of sustaining turbulence and rough landings. Methods commonly used in electronics prototyping such as breadboards and perf-boards are at risk of failure in this environment. Additionally, breadboards and perf-boards tend to weigh more and take up more volume within a ballooning payload. Not only do PCBs provide a more stable circuit for rough research conditions, but PCB design allows students to learn and practice engineering skills that are not attainable in the engineering curriculum. These skills include developing legible wiring schematics for more complex circuits and soldering. Pre-developed PCBs can also be used as a means of allowing students to focus more on a project's software and data analysis rather than the hardware and its respective connections when given a time constraint.

References:

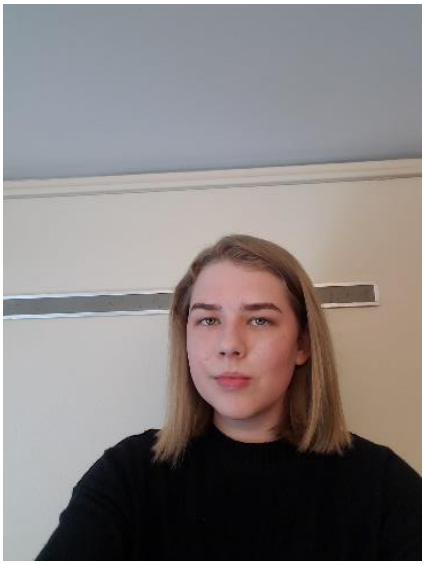
1. Eagle Software: autodesk.com/products/eagle/overview?plc=F360&term=1-YEAR&support=ADVANCED&quantity=1
2. Minnesota Space Grant GitHub: https://github.com/MNSGC-Ballooning

Time: 10:15 am – 10:30 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Carleton College

Student Presenter: Ally Keen



Other Student Authors: Katy Oda, Adam Ickler, and Freja Olsen

Mentor: Ryan Terrien

Title: Rotational Modulation of Zeeman Signatures in M-dwarf Stellar Spectra

Stellar rotation periods are important parameters of M-dwarfs for accurate exoplanet detections in radial velocity (RV) surveys. Periodic detection from photometric data is possible, but the necessary variations for measurement are often absent. Instead, we seek rotation-related variation in spectra of the well-studied M-dwarf GJ699 observed by the Habitable Zone Planet Finder (HPF). In examining the spectra, we find the equivalent widths of magnetically sensitive stellar absorption features vary periodically, matching the expected rotational modulation from Zeeman broadening. In comparison with literature values, we find the period of these variations consistent with previous rotation period measurements. With this new form of period detection, we are able to extract measurements for M-dwarfs where the photometric calculation is difficult.

Time: 10:30 am – 10:45 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Macalester College

Student Presenter: Daniel Clark

Mentor: Dr. Tonnis Ter Veldhuis

Title: Dynamics From Maurer Cartan Forms and Nonlinear Realizations

Professor Tonnis ter Veldhuis provides Macalester students with research opportunities in theoretical physics. In the Summer of 2020, a team of three students were introduced to the method of nonlinear realization of symmetries by studying Prof. Veldhuis's prior research regarding an application of the method to membrane dynamics (1). Subsequent developments of this prior work involved research into torsion and riemann curvature tensors, as well as metric compatibility, highlighting the connection between symmetry and space-time structure. The foundation of this work was the D=4 Poincare algebra in the D=3 Lorentz group covariant form.

After this introduction, each team member developed their own individual project. For my own original research, I began by constructing the D=4 Maxwell algebra, and obtained an invariant action corresponding to the dynamics of a charged particle in an external electromagnetic field through application of the same method of nonlinear realizations that I was introduced to earlier in the program. Further developments of my research involved a super-symmetrization of the Maxwell algebra, as well as an attempt to retrieve the action corresponding to spinning charged particles.

Reference:

1. https://arxiv.org/pdf/hep-th/0208184.pdf

NASA Center Internships (11:00 am – 12:00 pm)

Moderator: Dr. Demoz Gebre-Egziabher – U of MN – Twin Cities

Time: 11:00 am – 11:20 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: University of Minnesota – Twin Cities

Student Presenter: Crystal Compton

Mentors: Dr. Lucy Dunne, Linh Vu, Yaritza Hernandez, Dr. Han Kim, Dr. Sudhakar Rajulu, Dr. Brad Holschuh, Dr. Elizabeth Bye, Dr. Peter Marchetto

Title: Textile-based Contact Sensors for Space Suit Sizing and Fit

Spacesuits must provide sufficient fit and mobility for crew to successfully perform extravehicular activities (EVAs), particularly for future planetary EVAs. The quality of suit fit is influenced by complex interactions between the suit's geometry, mechanisms, and materials and the wearer's body geometry. Contact between the suit and the wearer's body is a key metric that can be used to understand body-spacesuit interactions. A wearable contact sensing technology can be used to measure how contact patterns vary across wearers of different body shapes and sizes performing functional EVA postures. The objective of this research is to develop and validate a conformable, textile-based, wearable contact sensing system that can be easily implemented into an existing inner-layer garment. The sensors use a binary approach to detect contact between two surfaces when the electrical circuit path is completed and provides quantitative measurements of fit in a spacesuit with minimal intrusiveness. The functional fit assessment method developed here is expected to provide useful information to improve suit design and define quantitative metrics for suit sizing and fit and enable a more detailed understanding of suit-to-body interactions during dynamic and functional EVA movements.

Time: 11:20 am – 11:40 am

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: University of Minnesota – Twin Cities

Student Presenter: Noah Garon

Mentors: Ami Yang and Nick Schleif

Title: Textile – Mechanical Interface

The goal of this project is to create a method of connection between the textile stripline and the hard electronics, like a printed circuit board (PCB) or a coaxial cable. Current standard hard to hard connections do not work to connect to textiles. Problems arise with the tearing of the fabric, burning of the yarns, or the general lack of connection points.
The goal is to create a connection that can be used in many wearable applications. Specifically, the background of the project comes from the connection that attaches the stripline antenna to the top of the primary life support system. To achieve an appropriate connection method, the connection must be compared to a set of standards. However, there is not an industry standard. To create this standard, a set of important characteristics was determined, after requirements of similar devices for these characteristics was compared.
Various styles of connection were developed that can be used for the antenna. Some methods focused on connections to the PCB and others to the coax cable. A variety of materials and methods to connect the two conductive traces to the antenna and to create a secure non-conductive connection.

Time: 11:40 am – 12:00 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Bethel University, St. Paul

Student Presenter: Isaac Vliem

Other Student Authors: Ryan Bonk, Bennett Bartel, Carson Stebbins, Catie Spivey, Chad Hite, Chris Titus, Hannah Oliver, Hunter Huth, Jamie O'Brien, Nicole Schneider, Songcheng Lin, Stewart Nelson, Terelle Cadd, Zachary Preston

Mentor: Dr. Elizabeth Ward, Christopher Newport University

Title: 2020 NASA Langley Academy Project: TURVTOL

The 2020 NASA Langley Academy team was assigned an open-ended project centered around designing a multi-modal autonomous rover for a team-chosen end goal. The final design is a multi-modal autonomous vehicle capable of navigating challenging environments through its unique capability to intelligently switch between ground-based and air-based travel without human in-the-loop interference. The team, which I was a part of, designed our rover from the ground up by going through a design process which involved analyzing trade studies of pertinent literature, creating requirement lists, brainstorming, CAD modeling, software development, and eventually, testing of critical systems in simulated and real environments. The result is a first iteration conceptual design which we have named TURVTOL – Terrestrial Unmanned Roving Vertical Take-Off and Landing. The TURVTOL design concept was found to be feasible based on simulated environment testing as a multi-modal vehicle. My role on the team primarily focused on software development, simulation environment development, software architecture development, documentation, and electrical subsystem development.

Reference:
https://aero.larc.nasa.gov/nasa-academy/

Keynote Speaker (12:00 pm – 12:50 pm)

Moderator: Dr. Demoz Gebre-Egziabher – U of MN – Twin Cities

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: University of Minnesota – Twin Cities

Presenter: Lauren Laufman

Mentor: Claudia Scarlata

Title: Starlink: The Loss of Our Stars

The night sky as we know it is changing - and not for the better. As low earth orbit satellite constellations grow in brightness and number, it becomes increasingly difficult for ground-based telescopes to take data uncontaminated by satellite trails. In addition, the Starlink satellites are so bright that they are visible without a telescope, contaminating the night sky for all observers. I will begin by explaining the current status of Starlink's operations and the satellite constellation industry as a whole. I will then present the results of several research groups measuring brightness of the original Starlink satellites and the reduced reflectivity VisorSat and DarkSat satellites, as well as their detailed analysis of how these satellites will impact large survey telescope operations, using the Vera C Rubin Observatory's Legacy Survey of Space and Time as a case study. Finally, I'll discuss the current efforts to address the dangers that satellite constellations pose.

References:

1. https://ui.adsabs.harvard.edu/abs/2020AJ....160..226T/abstract
2. https://ui.adsabs.harvard.edu/abs/2021A%26A...647A..54T/abstract
3. https://ui.adsabs.harvard.edu/abs/2021arXiv210100374M/abstract

Concurrent Session 3 (1:00 pm – 2:30 pm)

Moderator: Dr. Thelma Berquó – Concordia College

Time: 1:00 pm – 1:15 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Augsburg University

Student Presenters: Kong Yang and Leon Armbruster

Mentor: Dr. Moumita Dasgupta

Title: Impact of Spatial Arrangement of Passive Obstacles on First Passage of an Active System

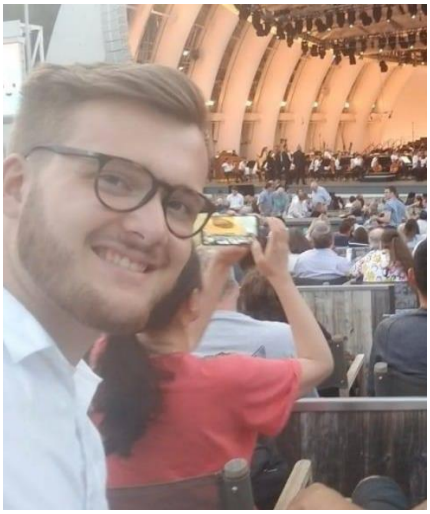
In our research with Dr. Dasgupta, we have explored the motion of an active particle system. There are many active motors at the microscale in biological systems which act in environments with a low effective diffusion constant. Our lab is interested to develop physical principles at the macroscale mimicking similar diffusion behavior that could then be generalized to the microscale. In the current research project we are exploring first passage time (FPT) of an active self-propelling object in the presence of passive crowders. We study the dependence of spatial orientation of the crowders on the first passage time of a mechanical self propelled robotic bug. Our collaborators have worked on a theoretical simulation of a self-propelled system to study its first passage time and behavior. Our project aims at experimentally verifying these simulation results as well as unravel some interesting physics particular to our system. Our experiments so far revealed that we have a superdiffusive system. We are using techniques like image tracking to obtain the trajectories of the self propelling bug. We then analyze these trajectories to obtain information like mean square displacement, first passage time etc. In our presentation we aim to give a glimpse of our research and learnings on this ongoing project so far.

Time: 1:15 pm – 1:30 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Concordia College

Student Presenter: Nicholas Lyle



Mentor: Dr. Thelma Berquó

Title: The Introduction of Arduino Microcontrollers in the Instrumentation Laboratory at Concordia College

The purpose of this research experience was to prepare activities for the course "Introduction to Instrumentation", offered at Concordia College to physics majors in their sophomore year. The laboratory activities are centered around the "Arduino Starter Kit" and the Arduino UNO microcontroller, which provides a low-cost, easy-to-use technology to design microcontroller-based projects. The goal is to build circuits and learn electronics fundamentals, such as Ohm's law, circuits in series and parallel, that will be referenced and expanded upon in the upcoming projects. In the proposed activities students learn how to use several electronics components such as LEDs, resistors, capacitors, potentiometers, various types of buttons and switches, various types of transistors, servos, piezos, and LCD panel. They learn how to make all these different components communicate properly within basic circuits. The software for programming the Arduino microcontroller is easy to use and also freely available, thus students also learn how to make these circuits communicate with programs written in the computer language C.

Time: 1:30 pm – 1:45 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: St. Catherine University

Student Presenters: Anisa Tapper, Gillian Durand, Maddie Ross

Anisa Tapper

Maddie Ross

Gillian Durand

Mentor: Erick Agrimson

Title: Lower Atmosphere Neutron Detection Using Personal Neutron Dosimeters

Stratospheric dynamics are observed to understand differences in measurements during annular and total solar eclipses. In preparation for the 2023 and 2024 eclipses, the team is utilizing new instrumentation to collect data on pressure, uncharged and charged cosmic rays, and temperature in the upper regions of the atmosphere, this will expand upon eclipse research done in the past. Hydrogen or Helium-filled High Altitude Balloons (HABs) carrying scientific instrumentation have been used to explore Earth's atmosphere during eclipses. The balloons ascend into the atmosphere until they burst at about 32 km. This altitude is recognized as the stratospheric region of the atmosphere with near-space conditions. Geiger–Müller (G-M) tubes detect charged particles within the stratosphere; replacing them with Silicon Photomultipliers (SiPMs) allows measurements of charged and uncharged particles to be taken with more sensitivity. The SiPMs weigh significantly less than G-M tubes and measure the different types of particles as well as energy distribution. Personal Neutron Dosimeters (PNDs) have been used to measure the uncharged particles within the stratosphere, the use of SiPMs will allow more sensitive measurements. The data collected during the upcoming solar eclipses will be compared to data taken during past eclipses to observe particle differences. New pressure sensors with a lower error rate to our future flights will be added, which will measure density in the atmosphere. Temperature measurements are taken throughout every flight to understand the stratospheric dynamics for that particular time. At least three flights will be conducted in preparation for these eclipses. These measurements provide necessary data used to understand changes in response to temperature during solar eclipses. Eclipse data is important in understanding differences in measurements taken during past eclipses and how data is different during two types of eclipses - annular and total solar.

Time slot: 1:45 pm – 2:00 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: University of Minnesota Duluth

Student Presenters: Evan Schmindler, Tyler Bobbs, Max Benson



Mentor: Jose Carrillo

Title: Spaceport America Cup – Intercollegiate Rocketry Engineering Competition

UMD's Bulldog Rocketry team has had the opportunity to compete in local competitions like the Space Grant Midwest High Powered Rocketry Competition. The experience gained has allowed Bulldog Rocketry to move on to larger international competitions like the Experimental Sounding Rocket Association's (ESRA's) Spaceport America Cup. This is the largest intercollegiate high-powered rocketry competition in the world. In the past two years that the team has been able to launch, we have placed 2nd place in the 30,000 ft, the student researched and designed motor category.
Despite not being able to compete in the summer of 2020, our club has been able to continue growing while facing challenges presented by the COVID-19 pandemic. We have been able to expand our off-campus space thanks to donations like the MnSPG that allow us to have limited in-person interactions. Students are able to gain hands-on experience designing and manufacturing all aspects of a high-powered rocket. Students also gain valuable life skills such as teamwork, leadership, time management, and communication while following each step of the engineering process.

References:
1. https://spaceportamericacup.com
2. https://www.soundingrocket.org/

Time: 2:00 pm – 2:15 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: Carleton College

Student Presenter: Katy Oda

Other Student Authors: Ally Keen, Freja Olsen, Adam Ickler

Mentor: Dr. Ryan Terrien

Title: Improvements in measuring rotational broadening in M dwarf stellar spectra

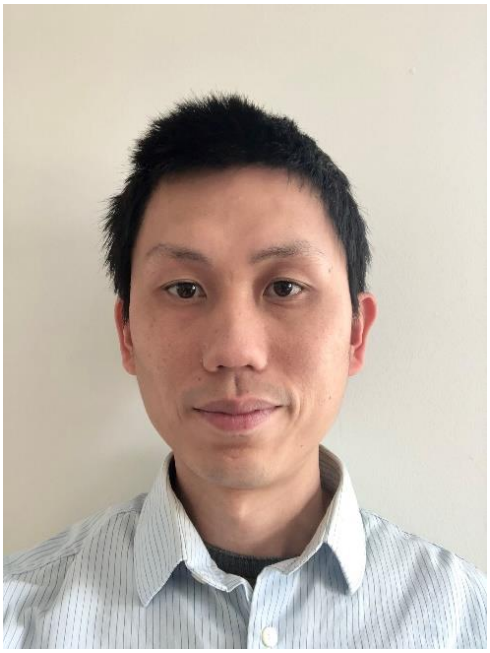
From age, to activity, to orbital configuration, measuring the projected rotational velocity (vsini) of stars can reveal a lot about the stars themselves. The Habitable Zone Planet Finder Spectrograph (HPF) measures the spectra of nearby stars, looking for shifts which occur as the result of orbiting planets. The absorption lines of those spectra also encode information about the stellar rotation rates. When a star rotates, its spectral features broaden; by cross-correlating with a mask of stellar features, we are able to measure the widths of the features and therefore estimate the vsini. We have worked to refine many aspects of this cross-correlation (CCF) method—including the calibration process, the features we measured, and how we implemented the CCF method—in order to improve the precision and stability of vsini measurements on HPF spectra. We discuss some examples of these refinements and how this work is helping to inform related analyses of HPF spectra.

Time slot: 2:15 pm – 2:30 pm

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Institution: University of Minnesota – Twin Cities

Student Presenter: (Jason) Sze Kwan Cheah



Mentor: Dr Ryan Caverly

Title: Passivity-Based Set-Point Pose Regulation and Jacobian-Based Force Distribution of a Cable-Driven Parallel Robot

This talk investigates the set-point pose regulation of a six degree-of-freedom cable-driven parallel robot (CDPR) from a passivity perspective. The proposed control method makes use of the existence of a passive input-output mapping from a modified control input in task space to the velocity and angular velocity of the payload. A pose regulation control law that does not require an attitude parameterization and instead uses the direction cosine matrix is presented and shown to achieve asymptotic closed-loop stability. An additional contribution of this work is the development of a novel Jacobian-based force distribution method to account for the redundantly-actuated nature of CDPRs. An optimal linear programming formulation of this method is shown to match the performance of existing approaches in the literature. A numerical CDPR example is presented to illustrate the implementation of the proposed pose regulation control law and force distribution method.

Concurrent Session 4 (1:00 pm – 2:30 pm)

Moderator: Erick Agrimson – St. Catherine University

Time slot: 1:00 pm – 1:15 pm

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Concordia College, Moorhead

Student Presenter: Ben Bogart

Mentors: Dr. Thelma Berquó, Concordia College; Dr. James Flaten, U of MN – Twin Cities

Title: The MnSGC Quadcopter Challenge – a TA perspective

The NASA MnSGC Quadcopter Challenge is a yearlong program that tasked teams with building a drone capable of navigating and exploring an unknown environment. In 2019-2020, teams were supplied with a kit that allowed them to build a basic drone that they then modified to meet the goals of the challenge. The kit also included an Arduino Uno and several sensors to help teach teams how to add data collection capabilities to their drones. To accommodate for additional challenges presented by the COVID pandemic, teams were instead supplied with a preassembled drone in 2020-2021. The kit also swapped out the Arduino Uno for a Teensy 3.5 to give any repeat participants experience with a different microcontroller. The program enhanced student and faculty capability in STEM, specifically in areas related to piloting a drone, soldering and wiring electronics, microcontrollers, CAD, 3-D printing, and technical writing. Serving as TA for this contest allowed me to become more proficient in these areas too. It also taught me how to create thorough documentation of technical processes and developed my capabilities as a leader in a STEM environment.

References:

https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2020_2021/
https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2019_2020/

Time: 1:15 pm – 1:30 pm

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: University of Minnesota – Twin Cities

Student Presenters: Emily Siem, Seyon Wallo, Thomas Lenz, Alex Halatsis




Mentor: Dr. James Flaten

Title: MnSGC Exploration-Flying Quadcopter Challenge: The UMTC Team Experience

The U of MN – Twin Cities (UMTC) fielded a team of four freshmen and sophomores to enter the MN Space Grant Consortium's "Exploration-Flying Quadcopter Challenge" during the 2020-2021 academic year. Team members practiced soldering, programming microcontrollers, and they also learned to fly the provided Blue Heron toy quadcopter with its live-streaming video camera. Then they investigated a variety of light-weight sensors, other microcontrollers and video cameras, and tested sample-return mechanisms for fluid and granular/solid samples, for potential use to help characterize and photograph/map an indoor "mystery" exploration area. The team overcame significant obstacles to meet, trouble-shoot, and test potential solutions in a "drone lab" on the UMTC campus, though COVID-19 excluded them from the drone lab for several months in the middle of the project. The team produced a written report and an oral report for a panel of judges, tried out their hardware and data analysis skills on a "walk-through" course followed by a "fly-through" course, then produced two short videos about their results and overall experience. The UMTC quadcopter team found this to be a valuable addition to their normal course of studies and they encourage others to participate in such MnSGC intercollegiate challenges in the future.

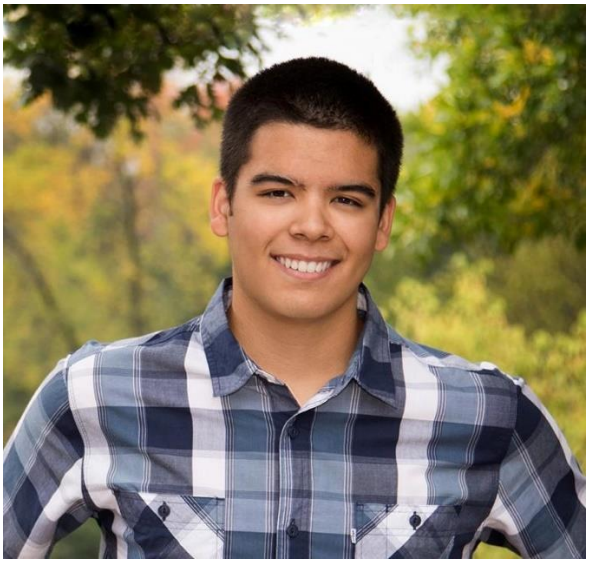
Reference:
https://dept.aem.umn.edu/msgc/MN_Space_Grant_Quadcopter_Challenge_2020_2021/

Time: 1:30 pm – 1:45 pm

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: University of Minnesota - Twin Cities

Student Presenter: Nathan Noma



Mentors: Curtis Olson, University of Minnesota - Twin Cities

Title: Verification of EKF Attitude Data with Computer Vision

Reliable and accurate attitude control and data is necessary to safely operate UAVs, especially on automatically generated missions. Onboard sensors collect attitude data which is processed through an Extended Kalman Filter, but this data is subject to inaccuracy and inconsistency from calibration bias and random error. So, video data collected during a flight is processed to provide a "truth" baseline against which the EKF data is compared. Through color channel isolation, masking, thresholding, and line detection, the horizon was detected in the video, and roll and pitch data were extracted. It was found that the video data matched very well with the EKF data, despite occasional edge cases causing inaccurate data. Future work is required to make this algorithm fully useable in a mission. For example, it doesn't work reliably in cloudy conditions, when there is glare from the sun, or when there is hilly terrain. In addition, all work was video postprocessing, so for real time data, the algorithm must run faster and be loaded onto a flight controller.

Reference:
https://www.uav.aem.umn.edu/home

Time: 1:45 pm – 2:00 pm

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Bethel University

Student Presenter: Jack Sisson

Mentor: Dr. Julie Hogan

Title: Tracking detector upgrades and monitoring for the CMS Experiment

This summer I had the opportunity to learn a little bit about the world of particle physics. We worked on prototyping a testing setup that we used to apply high voltages to silicon microstrip sensors used in the CMS tracking detector and to gather current and capacitance readings. During this project, my partner and I expanded our LabVIEW data acquisition programming skills and electrical equipment skills, as well as machining a new aluminum vacuum block. Over the second half of summer, we dived into development of the complex data quality monitoring software of CMS, and participated in data quality monitoring shifts to validate existing data. Everything I learned over the course of the summer productively contributed to my technical and intellectual skills.

Time: 2:00 pm – 2:15 pm

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: Fond du Lac Tribal and Community College

Student Presenter: Emily Lockling

Mentor: Dr. Carl Sack

Title: Development of a Collector Application for Invasive Species Surveying

In Minnesota, invasive species cause ecological and economic harm in eight percent of our lakes. Monitoring the distribution of invasive species is vital to their management and prevention of further spread because they impact both terrestrial and aquatic native species populations. A multiple-year long survey by Fond du Lac (FDL) Resource Management aims to capture and monitor invasive species near reservation boundaries. With studies that span multiple-years and many locations, often there are many surveyors and several data collection configurations, making analysis and organization time-consuming. To create a consistent format for rapid data collection in future years, I created a collector application using ArcGIS. Collector applications allow for spatial data collection in the field, they work on personal electronic devices, and they maintain a format defined within the data collection form. The development of this collector application will aid in the analysis of their study through the organization of their data.

Reference:
"Infested Waters List" Minnesota Department of Natural Resources:
https://www.dnr.state.mn.us/invasives/ais/infested.html

Time: 2:15 pm – 2:30 pm

Join Zoom Meeting: Second Room https://umn.zoom.us/j/9772902391

Institution: University of Minnesota Duluth

Student Presenter: Emily Haase

Mentor: Dr. Richard Gran

Title: Investigating Cosmic Ray Muons and their Velocities

Produced when cosmic rays collide with particles in the Earth's upper atmosphere, cosmic ray muons are best described as electrons, but with 200 times the mass and a greater capacity to penetrate matter, up to tens of meters into the Earth's crust. Using a cosmic ray muon telescope, we seek to detect muons and confirm that their velocity is roughly the speed of light. The telescope is comprised of four scintillators, vertically aligned, which are separated by distances on the order of meters. In particular, we use three setups distinguished by the distance between the first and last scintillator: 1) 0 m, used for calibration purposes, 2) approximately 2.5 m, and 2) approximately 5.5 m. We let it run for two weeks in order to collect hundreds of thousands of events before analyzing the data and isolating the incidents that are characteristically muons in order to calculate their velocities. We expected the results to generate a Gaussian distribution with a resolution of a couple of nanoseconds. Instead, we have observed anomalous peaks that speak to a systematic effect in either the experimental setup or the apparatus. Therefore, a secondary objective is to explore the precision limits of the apparatus.

Career Panel Discussion (2:45 pm – 3:30 pm)

Moderator: Dr. Demoz Gebre-Egziabher – U of MN – Twin Cities

Join Zoom Meeting: Main Room https://umn.zoom.us/j/7261550823

Panelist: Dr. Lindsay Glesener

Current affiliation: School of Physics and Astronomy, University of Minnesota – Twin Cities

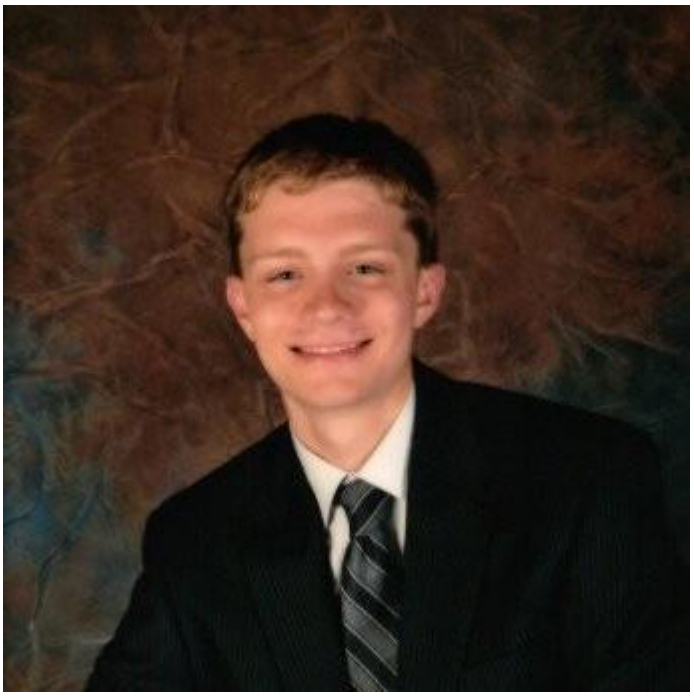
Headshot:

Bio:
Lindsay Glesener is an assistant professor in Physics at the University of Minnesota. A native Minnesotan, she earned her Ph.D. at the University of California at Berkeley in 2012, and returned to her homeland to join UMN in late 2015. Dr. Glesener analyzes data from ground-based and space-based solar observatories, and also develops technology for new instruments. For her thesis work she was honored with the Tomkins Instrumentation Thesis Prize from the Royal Astronomical Society. She is the principal investigator for X-ray instruments that fly on sounding rockets and small CubeSats to study the Sun.

Panelist: Christopher Gosch

Current affiliation: Northrop Grumman

Headshot:



Bio:
Always fascinated by rockets and airplanes, Christopher's passion for the field led him to pursue an Aerospace Engineering Degree from the University of Minnesota. During his time as a student, he was a member, and later student lead, of MNSGC's High Altitude Ballooning team, which conducts high altitude atmospheric research utilizing weather balloons. Additionally, he participated in Space Grant's Regional Rocketry Competition as a student and as a judge after graduating with a Bachelor's Degree in 2016. Since then, Christopher has been working in research and development as a Guidance, Navigation, and Controls Engineer with Northrop Grumman in Plymouth, Minnesota. In that role, the experience gained through his time working with MNSGC have proved invaluable in his professional accomplishments and success.

Panelist: Major Rachael Winiecki

Current affiliation: Wisconsin Air National Guard (former USAF test pilot)

Headshot:

Bio:
Maj Rachael Winiecki is the Assistant Director of Operations and F-16 Pilot in the Wisconsin Air National Guard. Prior to her current role she served as an F-35 Test Pilot and F-16 Test Pilot in the United States Air Force. In this position, she conducted elevated risk developmental flight test of unproven aircraft systems, identified deficiencies, and certified aircraft safety of flight. She planned, executed, and reported on flight tests to include mission system evaluation, weapons certification, envelope expansion, flying qualities, and handling qualities characterization. Additionally, she identified advanced technologies to improve system lethality, survivability and mission effectiveness; integrating parallel efforts across the Department of Defense and industry partners in pursuit of technical solutions to enhance warfighter capabilities.

Maj Winiecki was commissioned through the Reserve Officer Training Corps (ROTC) at the University of Minnesota. She completed three operational flying assignments in the A-10C including overseas deployments to the Pacific theater, Southwest Asia, and Eastern Europe. Maj Winiecki has a Bachelor's degree in Aerospace Engineering and Mechanics, M.S. in Aerospace Engineering, and a M.S. in Flight Test Engineering. She a graduate of the USAF Test Pilot School and is a senior pilot with over 2,200 hours in over 50 types of aircraft.