Montana Space Grant Consortium
Student Research Symposium
Saturday April 18, 2015

Student Presentation Abstracts

Session: Remote Sensing II

Undergraduate

Reed Hovenkotter
University of Montana – Missoula

Improving High Altitude Balloon Trajectory Predictions with WRF

Research being done by Montana Space Grant Consortium (MSGC) involves producing better high altitude balloon trajectory predictions using the Weather Research Forecasting System (WRF). Balloon borne platforms are essential for remote sensing operations as they have the ability to record high vertical resolution data, access to stratospheric conditions, and are cost efficient. Current accepted operational prediction software uses the Global Forecasting System (GFS), which has very coarse resolution for short duration balloon flights. To increase forecast flight trajectory accuracy we are running WRF and using it's higher resolution meteorological output data and topographic information to initialize MSGC's developed software model to calculate predictions for a balloon's path. Predicted landing location via GFS and WRF are compared against actual landing location for evaluation of model choice on initial conditions. Early analysis indicates better predictive results utilizing WRF. Implications are important for remote sensing applications requiring stricter execution parameters of balloon borne platforms such as those required when making air quality measurements in and over urban areas.

Session: Biology & Chemistry

Undergraduate

Nick Glynos
Flathead Valley Community College

Oyster Mushrooms: More Than Just Food; An Ethnomycological Survey of Pleurotus ostreatus

Oyster mushrooms are amazing organisms with the potential to provide for humans in many ways. As a food source this mushroom is nutritious, delicious and easily cultivated at home. As a medicine, this mushroom shows antibacterial and cholesterol lowering properties. And as an environmental tool, this organism has the ability to degrade many unwanted toxic contaminants and provide bioremediation potentials. This project aims to shed light on some of the current uses of oyster mushrooms while also expanding the possibilities for future experimentation and discovery.

Session: Biology & Chemistry

Undergraduate

Zoe Glasser Breeding and Coby Cates
Flathead Valley Community College

Cyanobacteria: The Good, The Bad, The Beautiful

We are developing methods to survey, culture, and isolate Cyanobacteria. In our approach we are comparing metagenomic analysis with cultivation and identification using 16S ribosomal sequences. Our presentation we describe our current progress, and project goals

Session: Middle & High School STEM Engagement

High School Student

Timothy Small
Simms High School

Presence of Ozone and Methane in the Lower Atmosphere

An ozone hole has appeared above Antarctica every year for three decades. Ozone is important because it protects life from harmful ultra-violet light which causes cancers. Greenhouse gases help contribute to climate change. Ozone and methane are greenhouse gases. This research evaluates for the presence of these gases above northern Montana. To evaluate the presence of ozone and methane, an Arduino was assembled with sensors. Code was written to activate the sensors and collect data. The sensors were attached as a payload on a Borealis balloon, which was launched to near space. Ozone decreased with altitude. Methane also decreased with altitude. Ozone and methane reading were affected by low temperatures. As a result, a conclusion could not be drawn from the ozone data. However, the temperature adjusted values for methane do show a slight decrease in methane with altitude.

Session: Middle & High School STEM Engagement

High School Student

Michelle Simpson
Simms High School

Hydroponics Vine Plants VS Ground Plants

Is there a way to reduce starvation? Hydroponics is the practice of using a tank of water to grow plants and not using soil. Hydroponics requires a small area and small amounts of water to grow food. Benefits include: less land, less water, less fertilizer, less pesticides, and less fuel consumption. Small hydroponics farms can be established to sustain individual families and create small business development. This research evaluates the growth of selected plants in hydroponic tanks. Vine and ground plant seeds were germinated and then placed into five hydroponics tanks. Plant growth was recorded for four weeks. T-test results accept the null hypothesis, meaning there was no difference in mean growth of stems between plant groups.

Session: Engineering

Undergraduate

Jordan Leone
Montana Tech

The Construction and Testing of a Mobile Magnetic Gradiometer System for Unexploded Ordinance Detection

The objective of this project was to design and build a mobile, non-magnetic cart to house a magnetic gradiometer and then test the effectiveness of the system in detecting unexploded ordinances. The magnetic gradiometer system consisted of two GPS antennas, and two fluxgate magnetometers. Each fluxgate magnetometer records the x, y, and z components of the magnetic field and the differences in each instrument's data can be used to calculate a magnetic gradient. A series of preliminary tests were conducted to determine the optimal distance apart that each fluxgate magnetometer should be placed. These preliminary tests showed that a distance of 0.5 m produced an acceptable magnetic gradient reading. After determining the equipment's optimal positions, the cart was constructed out of non-magnetic materials. The cart's body was constructed of 3 inch PVC with a Plexiglas base to house the magnetic gradiometer system. The final step in the project was to bury a simulated unexploded ordinance in a field and then use the magnetic gradiometer system to collect data over the entire field. The data was then used to calculate the magnetic gradient to determine the effectiveness of the system in detecting unexploded ordinances. A preliminary evaluation of the data suggests that the system can detect the simulated ordinance.

Session: CubeSats

Undergraduate

Hannah Mohr
Montana State University – Bozeman

Small Satellite Electrical Power System

The Electrical Power System (EPS) collects, stores, and supplies power. For cubesat applications, the primary restrictions of the EPS are mass, volume, radiation tolerance, number of battery charge/discharge cycles, and temperature. At the same time, the payload voltage and current requirements must be met. It is important to develop a system that accounts for the limitations of small satellite architecture while remaining robust in performance. The goal of this project is to develop an understanding of the functionality of the FIREBIRD Phoenix EPS and improve efficiency. Background research was conducted to compare Direct Energy Transfer (DET) and Maximum Power Point Tracking (MPPT) EPS designs, as well as distributed versus centralized systems. The FIREBIRD Phoenix board was tested in the lab to determine operation ranges and verify performance. Improvements to be made to the board include correcting the PCB component footprints and re-instantiating the Buck/Boost Battery Regulator.

Session: Remote Sensing II

Undergraduate

Shelby Mallin
Montana Tech

AirCore Sampling System

The AirCore Sampling System is a presentation regarding how the AirCore was constructed, what it is used for, and the data that was recorded after launch. The AirCore is stainless steel coiled tubing with Sulfinert coating that allows for an inexpensive way to measure carbon dioxide and methane in the atmosphere. The AirCore was flown on a balloon with a specific weight limit and the data conducted was used against the atmospheric pressure to measure the differences in the trace gases as the pressure increased. A Picarro analyzer was used to determine the amount of trace gases found in the atmosphere.

Session: Astrophysics

Undergraduate

Travis Glenn
University of Montana – Missoula

Mapping the Interaction between the Interstellar Medium and The Solar System: Tools for the IBEX Mission

The Interstellar Boundary Explorer (IBEX) Mission, launched in 2008, has been mapping the region of space between our solar system and interstellar space. Since its launch in 2008, it collected enough data to create six complete sky maps of the interstellar boundary, with a resolution of roughly 6 x 6 degrees. I will be describing a software visualization tool I have written for creating sky maps of the particle counts, with the capability of binning the data into variable-sized macropixels. The tool creates Mercator, Mollweide and 2 hemispherical maps that have the capability to display the particle count of a given pixel. It can also be used to quantify the differences between sky maps and can create a histogram of the variation in count rates within a given macropixel. The tool is interactive, allowing the user to select a given coordinate on which to re-center the map projections. I will also present preliminary analysis of the time variation in the structure of the interstellar boundary.

Session: Middle & High School STEM Engagement

High School Student

Adeline Hahn
Fairfield Middle School

Radiation and Ultraviolet light in the Lower Atmosphere

The levels of ultraviolet light, radiation and CO2 in the lower atmosphere affect life. Radiation and ultraviolet light can cause cancer. Increased CO2 levels raise temperatures, causing climate change. Radiation, ultraviolet light, and CO2 were tested in the atmosphere. The temperature lapse rate was compared to the atmospheric lapse rate. It is hypothesised the radiation and ultraviolet light would increase with altitude, and that CO2 would increase to 400 ppm. The temperature lapse rate is predicted to follow the atmospheric lapse rate by dropping 6.5 degrees celsius/kilometer. The humidity would increase through the layers of clouds, before decreasing, and pressure would start at 90 kilopascals and decrease to 2 kilopascals. The project required arduino sensors, code, and a weather balloon filled with helium. The sensors were soldered to an arduino board, and tested individually and together. The sensors were launched on a NASA Borealis balloon, which rose to approximately 23,500 meters. It landing 20 miles east of Fort Benton. The radiation and ultraviolet light supported the hypothesis and increased with altitude. The barometric pressure also supported the hypothesis and dropped from 88 kilopascals to 2.5 kilopascals. The radiation increased to 15 counts per second, which is very dangerous. The CO2 sensor maxed out at background levels. It dropped slightly at 2500 meters. The temperature lapse rate was -6.11 degrees Celsius per 1000 meters of altitude gain. This is close to the atmospheric lapse rate of -6.5 degrees Celsius per 1000 meters. The next step of this project is to separate the ultraviolet lights and test for other gases, such as ozone, methane, and oxygen.

Session: Remote Sensing I

Graduate

Ruben Behnke
University of Montana – Missoula

Data quality control: luxury or necessity? A case study in the development of gridded humidity data for the United States.

All fields of research and practical use collect and analyze data. This is especially true in meteorology, where observational data form the basis for everything from everyday forecasts to long term climate studies. It is often assumed that data provided by NOAA and other professional organizations is high quality, and can be used without question. This is not the case, however, and users in all fields of research need to be aware of this. The development of high resolution, gridded daily humidity for the United States at the University of Montana is used to show this.

Session: Astrophysics

Graduate

Sean Brannon
Montana State University – Bozeman

Spectroscopic observations of evolving flare ribbon substructure suggesting origin in current sheet waves

A flare ribbon is the chromospheric image of reconnection at a coronal current sheet. The dynamics and structure of the ribbon can thus reveal properties of the current sheet, including motion of the reconnecting flare loops. We present imaging and spectroscopic observations from the Interface Region Imaging Spectrograph (IRIS) of the evolution of a flare ribbon at high spatial resolution and time cadence. These reveal small-scale substructure in the ribbon, which manifest as oscillations in both position and Doppler velocities. We consider various alternative explanations for these oscillations, including modulation of chromospheric evaporation flows. Among these we find the best support for some form of elliptical wave localized to the coronal current sheet, such as a tearing mode or Kelvin-Helmholtz instability.

IRIS is a NASA Small Explorer mission developed and operated by Lockheed Martin Solar and Astrophysics Laboratory. This work is supported by contract 8100002702 from Lockheed Martin to Montana State University, a Montana Space Grant Consortium graduate fellowship, and by NASA through HSR.

Session: Astrophysics

Undergraduate

Andrea Johnson
University of Montana - Missoula

Absolute Photoionization of Rb2+ Ions for the Determination of Elemental Abundances in Astrophysical Nebulae

Absolute single photoionization cross-section measurements of the trans-iron elemental ion Rb2+ were performed using synchrotron radiation and the ion-photon, merged-beams technique. Measurements were made at a photon energy resolution of 20 meV in the energy range from 37.25 eV to 44 eV which spans the 2P3/2 ground state ionization threshold and the 2P1/2 metastable state ionization threshold. Autoionizing resonances arising from the ground and metastable states are identified using quantum mechanics and quantum defect theory. These identifications are used to determine for the first time the elemental abundances of trans-iron elements in astrophysical nebulae. These elemental abundance determinations are then used to improve the most current models of stellar nucleosynthesis which are the primary source of information in our growing understanding of the chemical evolution of the Universe.

Session: CubeSats

Undergraduate

Noel Stewart
Salish Kootenai College

BisonSat: the Salish Kootenai College CubeSat Mission

The Salish Kootenai College CubeSat, BisonSat, will fly on the National Reconnaissance Office GRACE mission scheduled for launch in August 2015. BisonSat is one of several NASA-sponsored and DoD-sponsored CubeSats that will be deployed into low Earth orbit on this mission. This presentation will provide an overview of the design of BisonSat, testing performed to demonstrate flight readiness up to integration in March 2015, and plans for on orbit science operations. BisonSat has a visible light CMOS camera designed by Salish Kootenai College that will be used for assessing changes in vegetation cover, obtaining cloud and snow cover observations, and measuring the height of tropical storm clouds.

Session: Remote Sensing I

Undergraduate

Kobi Hudson
Rocky Mountain College

Process of Sending an Experiment to the ISS

Sending an experiment to the ISS is a long and tedious process. The process of sending the the Algal Growth and Remediation (AGAR) project is one I have been involved with since the Fall of 2013. This experiment has been a learning process in the growth of algae, development of design, and the process of obtaining the ability to do aerospace research.

In this presentation I will be discussing the process that myself and the team has gone through to get our project to the point it is at now. I will discuss dealing with NanoRacks and the paperwork involved in the process with them and NASA. I will also discuss how the changes in new information from NanoRacks redesigned and shaped the current design we have. The presentation will also cover the timeline of the project and what we hope to accomplish with the experiment.

Session: Remote Sensing I

Undergraduate

Noel Stewart
Salish Kootenai College

Visualizations of Diverse Satellite Images for Comparisons of Environmental Conditions.

There are various multi/radar sensors that monitor and measures environmental parameters aboard weather satellites. The weather satellites include but are not limited to the Geostationary Environmental Satellite (GOES), Next Generation Radar (NEXRAD), and the Global Precipitation Satellite (GPM). It's great to have multiple instruments that monitor weather and climate, however there is a problem. Not all of these instruments cover the same area, have the same resolution, and are used for the same environmental analysis. I have completed case studies with the data from each of the satellites and radar's for comparisons of precipitation from multiple sensors for cases of heavy precipitation and flash flooding. The sensors that were compared, include the dual Frequency Radar from NASA GPM, WSR-88D dual polar-metric radar, rain gauges, and cloud top properties from GOES Multispectral Imager Data. The Multi-Radar and Multi Sensor (MRMS) system developed at the National Severe Storms Lab was used to perform comparisons (http://gpm.ou.edu). This study has helped evaluate uncertainties in the measurements of each instrument aboard the weather satellites, and has helped determine the utility of the MRMS for providing useful guidance on precipitation amounts for flash flooding forecasting.Also,I will conclude by discussing software that will be used to finish my research project that has the capabilities of overlaying all of the data from the different weather satellites onto one screen.

Session: Remote Sensing I

Undergraduate

Timothy Basta
Montana State University - Bozeman

Continued Development of High Altitude Balloon Systems

The BOREALIS program, part of the Montana Space Grant Consortium at MSU, is a student based high altitude ballooning program. Students involved in this program design, construct, and fly their own experiments. Over the last year, the BOREALIS program has been flying a neutral buoyancy system that allows the team to vent a quantity of Helium from the balloon during the flight, causing the balloon to float at a constant altitude. Over the 2014 summer internship period, a new prototype of this valve was constructed to reduce the weight of the system, and to increase it's effectiveness and reliability. This system, as well as several others were met with success over the summer internship period. The details of these experiments will be covered in greater depth within the body of the talk.

Session: Remote Sensing II

Undergraduate

Nichole Murray and Elizabeth Carlson
Montana State University – Bozeman, Carroll College

Got Control? Revolutionizing Ballooning Flights

Control, predictability, and accuracy are comforting aspects in everyday life. Not only are control, predictability, and accuracy important in life but also especially in the STEM fields, thus giving purpose for developing mathematical models and coding programs that generate this stability. The BOREALIS program utilizes high-altitude ballooning weather forecast predictions in order to obtain a general sense of the best days in which to plan a flight and predict landing sites within a 20 mile radius. This presents a lack of control, predictability, and accuracy. Thus, we developed an in-flight landing prediction model and software integrated for real-time Internet utilization for the operations flight director to determine flight duration, control, predictability, and accuracy of the landing site for safer payload recovery. This was accomplished by adapting coordinates of ascent position data, being transmitted from an Iridium tracking satellite, to calculate wind speed and direction. Using these coordinates, we generated an accurate, real-time wind field model for predicting the descent path. This model was checked against later raw in-flight and sounding data. The model was adapted for the Internet using PHP, Java, HTML, and C++. The final product was an Internet site that predicted the landing point to a range of 0.3 to 3.75 miles with less variability; approximately a 79% increase in accuracy.

Session: Engineering

Undergraduate

Carol Baumbauer
Montana State University – Bozeman

Nanostructures for Optical Polarization Engineering

The Nano Optics group at MSU engineers optical devices with nanoscale features, including polarization control devices. These are anisotropic gratings made from silicon and other isotropic materials that are designed to reflect or transmit light of certain polarization states. These devices are fabricated at MSU using the Montana Microfabrication Facility and the Imaging and Chemical Analysis Laboratory. Reflective quarter waveplates reflect circularly polarized light when 45 degree linearly polarized light is incident on them. They can be used in optical MEMS imaging systems for medical diagnostics like cancer detection without biopsies. Reflective quarter waveplates have been successfully fabricated and optically characterized. The group is currently working on creating an array of linear polarization filters, which together can be used to determine the polarization state of incident light. These will be used in climatology research, and are useful because the polarization of light scattered from clouds depends on the phase composition of water in the clouds. The development of the required tools and technologies for the design and realization of polarization optical devices based on nanostructures provides a technology platform with a broad range of interdisciplinary applications.

Session: Engineering

Undergraduate

Dylan Sagmiller
Montana State University – Bozeman

Integrating 3D Printing into BOREALIS Projects

While constructing the necessary components for a typical BOREALIS project, it is often necessary or at the very least beneficial to utilize parts with complex or out-of-the-ordinary geometries. Unfortunately however, these pieces can be difficult to construct using elements from the hardware store. 3D printing is a recent and exciting technology that could potentially be capable of producing the configurations required for the intricate applications of BOREALIS experiments and depending on the model used, can be an affordable addition to a lab's arsenal of equipment. Over the course of the summer, a Velleman K8200 was used in several projects as a means of testing its limits in component manufacturing. This endeavor revealed limitations such as lack of precise tolerance in dimensions, the need for additional machining after a part is made, and the orientation the part has as it is being printed. Despite this shortcomings however, these initial findings have shown that successful parts can be produced while at the same time allowing aspiring mechanical engineers to have active hands on experience in CAD design when using this technology.

Session: Remote Sensing II

Undergraduate

Trevor Clark
Montana State University – Bozeman

Development and testing of a method utilizing low cost components to transmit live HD video from the balloon

The BOREALIS program provides undergraduate students various scientific and engineering opportunities on a high altitude ballooning platform. At altitudes nearing 100,000 feet above the surface of the earth otherwise simple things become complex. Students routinely collect atmospheric data, similar to what sounding balloons record. Over the past year and a half a major focus of the BOREALIS program is to transmit images, and ultimately video, from the edge of space. This focus has led to development and testing of a method utilizing low cost components to transmit live HD video from the balloon.

Session: Astrophysics

Undergraduate

Devin Hansen
Montana State University – Bozeman

Projected Constraints on Lorentz-Violating Gravity with Gravitational Waves

Gravitational waves are excellent tools to probe the foundations of General Relativity in the strongly dynamical and non-linear regime. In this talk I will consider one such foundation, Lorentz symmetry, which can be broken in the gravitational sector by the existence of a preferred time direction, and thus, a preferred frame at each spacetime point. This leads to a modification in the orbital decay rate of binary systems, and also in the generation and chirping of their associated gravitational waves. I will examine whether waves emitted in the late, quasi-circular inspiral of non-spinning, neutron star binaries can place competitive constraints a proxy of gravitational Lorentz-violation: Einstein-\AE{}ther theory. I will show that a gravitational wave detection consistent with General Relativity can only place competitive constraints on gravitational Lorentz violation when using future, third-generation or space-based instruments. I will also show that a single electromagnetic counterpart to a gravitational wave detection is enough to place constraints that are 10 orders of magnitude more stringent than current binary pulsar bounds, even when using second-generation detectors.

Session: Middle & High School STEM Engagement

Undergraduate

Daniel Rogers and Joseph Davis
University of Montana – Missoula

Homemade Radio Telescope and the importance of Radio Astronomy

This is a research project for Astronomy honors. Students built a homemade radio telescope to listen to the Sun and Jupiter and collect data to match up with solar events on the Sun and planetary events on Jupiter. Radio Astronomy is often overlooked at the undergrad level and this will help provide a base for future research at the University of Montana if we can get funding for more advanced radio telescopes.

Session: Remote Sensing II

Undergraduate

Scott Miller
Montana State University – Bozeman

Pointing high gain antennas at high altitude balloon payloads.

To send picture and video data back from high altitude balloon flights an automated antenna pointing system was developed. The method of tracking will be explored along with performance from several test flights.

Session: Astrophysics

Undergraduate

Chantanelle Nava
University of Montana - Missoula

Simulating the MINERVA Exoplanet Discovery Campaign

MINERVA (Miniature Exoplanet Radial Velocity Array) is a dedicated observatory searching for exoplanets around nearby stars. Observing campaigns like MINERVA's, with a goal of discovering new planets, cannot finalize observing methods until simulations have been performed to determine what methods maximize detections. Simulating an observing campaign for a brand new observatory is a difficult task, however, because many factors contributing to the success of the campaign are relatively difficult to predict. In such a case, it is necessary to rely on information from relevant sources, such as other projects and observatories, for information to constrain the simulation. In this talk I will discuss how data from current projects can be used to inform models of factors such as observational cadence and noise for up and coming scientific projects. As an example, I will present details of how I have implemented data from projects like HatNET, CHIRON, and Kepler to simulate MINERVA's exoplanet discovery campaign.

Session: Biology & Chemistry

Undergraduate

Dustin Williams
Carroll College

Epoxidation Kinetics

The kinetics for the transformation of cyclohexene to 1,2-Epoxycyclohexane were quantified using FT-IR techniques. The mechanism for epoxidation proposed by Limnois and Kokotos was investigated using FT-IR, H NMR, and C NMR. The equilibrium constant for the reaction of acetonitrile and hydrogen peroxide to form ethanimidoperoxoic acid was quantified using FT-IR.

Session: Astrophysics

Undergraduate

Eric Sandberg
University of Montana – Missoula

Project MINERVA – Searching for Nearby Earth-like Exoplanets

Our galaxy is full of exoplanets, but scientists have yet to find many small planets near to Earth that have suitable conditions for life. The MINERVA project is dedicated to finding these nearby Earth-like exoplanets. Two telescopes are already set up on Mt. Hopkins, AZ, and two more will be ready to go by May 2015. The University of Montana along with three partner universities will be using these four telescopes to acquire data every night. I will discuss the science goals and current status of the project, as well as the specific roles of the University of Montana team.

Session: Remote Sensing I

Graduate

Caleb Pan
University of Montana – Missoula

On the validity of Google Earth Engine for Crysopheric Sciences

Today remotely sensed data is ubiquitous throughout a number of disciplines, inherently facilitating cross-disciplinary research. With the high-demand and popularity of these datasets, Google has recently developed a new platform to facilitate remote sensing data acquisition and image processing, named Google Earth Engine. In theory, Earth Engine allows the user to quickly access, composite, process, and download data collected from the Landsat missions and from the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite. Our here presented research examines the applicability of Earth Engine for monitoring glaciers at regional and continental scales. The ease and access to big data supplied by Earth Engine allows for the first time quick, robust, and repeatable steps to monitor glaciers at a potentially global scale.

Session: CubeSats

Undergraduate

Matt Handley
Montana State University – Missoula

FIREBIRD-II: Lessons Learned in the Low-Power High Data-Rate CubeSat Constellations

The Focused Investigations of Relativistic Electron Burst Intensity, Range, and Dynamics (FIREBIRD) mission consists of four 1.5U CubeSats. The first two launched on December 2013 (FIREBIRD-I) with the second set achieving orbit in January of 2015 (FIREBIRD-II). Although of similar design, improvements were made to the FIREBIRD-II spacecraft which increased overall mission reliability. These improvements were based off lessons learned from FIREBIRD-I and included: a re-design of the power system, upgrades to data storage, increased GPS performance, and the addition of secondary payload to qualify new technologies. Since launch of the FIREBIRD-II spacecraft, many more lessons have been learned in the ground operations of the two satellites, including downlink time optimization, data integrity, and utilization of secondary ground stations.

Session: Remote Sensing I

Undergraduate

Jordan Maxwell
Montana State University – Bozeman

Characterization of Cryomagma Candidate Materials

Recent satellite missions to the Jovian and Saturnian moons have captured images of geological features thought to be cryovolcanoes. The validity of this speculation can be determined through an analysis of the eruptive capability of materials that would fuel these cryovolcanoes. The thermal properties of a cryomagma candidate determine the growth of crystals within the material, which in turn affects the viscosity — a property that determines whether a material can erupt. Therefore, a measurement of the thermal properties of a cryomagma candidate can provide data on the eruptive capability of the material. A technique for determining the thermal conductivity and diffusivity is the dual-thermistor probe method. Calibration of the thermistors used in this method presents a challenge. Through careful calibration, these thermistors can be characterized, and measurements of cryomagma candidates can provide insight into cryovolcanism on the icy satellites.

Session: Remote Sensing II

Undergraduate

Carl McShane
Montana State University – Bozeman

Sounding Rocket Flight Computer Interface

An overview of requirements, design considerations, construction and testing of a sounding rocket flight computer interface designed for the MOSES project including a look at lessons learned for the continuing design.

Session: Engineering

Undergraduate

Daniel Douglass
Montana Tech

Study of nano-enhanced resins and their effect on the Tensile Strength of Fiber-reinforced Composites

Previous research has been conducted to enhance polymers with the use of nanoclay particles. It has been made clear through previous research that the addition of nanoclay to reinforced composites showed improvements in flexural strength and modulus. Although it is clear that the nanoclay improved the flexural strength of the composites, this research project is being conducted to determine if the tensile strength can be improved.

Session: Poster

Undergraduate

Tammy Burke
Dawson Community College

Got Science?

Our community service project is providing a two day science camp for junior high students. The camp will be packed with fun but educational hands on experiments giving the students the opportunity to expand their knowledge in biology, physics, chemistry and A&P. Our goal for this camp is to encourage and enhance the students interest in a science related career. Our experiments will consist of squid dissection, osmosis, stomp rockets, fermentation, supersaturated solutions, and others.

Session: Poster

Undergraduate

Katherine Stocker
Montana State University – Bozeman

A Theoretical Investigation of Shadow Bands for 2017 Eclipse

Using the scintillation theory of eclipse shadow bands to investigate possible measurements of the phenomena during the total solar eclipse of august 2017.

Session: Poster

Graduate

Briana Jones
Montana State University – Bozeman

Development of a singly-resonant OPO for carbon cycle science

The human impact on the global carbon cycle is a complex scientific question that is affecting the health of the environment by changing the balance between incoming and outgoing radiation as well as by affecting other geochemical cycles such as the nitrogen and water cycles. The need for improved understanding of the global carbon cycle has led to a U.S. Carbon Cycle Science Plan that aims to coordinate carbon cycle science research to determine how the carbon cycle is being modified, what the consequences of these modifications are, and how best to mitigate and adapt to the changes in the carbon cycle and climate. A differential absorption lidar (DIAL) is proposed for spatially mapping both carbon dioxide (CO2) and methane (CH4) concentrations. Modeling indicates that for measurements with less than 2% error relative to ambient levels of atmospheric CO2 or CH4, a laser transmitter will need to produce over 3 mJ of pulse energy with a pulse repetition rate of 1 kHz at either 1.571 um or 1.645 um where CO2 and CH4 have appropriate absorption features for DIAL measurements. The goal of this work is to evaluate the potential for a novel singly-resonant optical parametric oscillator (OPO) for the DIAL laser transmitter. The OPO will be based on large aperture periodically-poled magnesium-oxide-doped lithium niobate (PPMgO:LN) as the nonlinear optic material. Results from initial experimental measurements of Nd:YAG pumped PPMgO:LN optical parametric amplifier (OPA) are presented. These results are used in the SNLO model, a community-based nonlinear optical model developed by Sandia National Laboratory, to show that up to 20% conversion efficiency is achievable for the OPO. This indicates that the OPO will allow the specifications needed for the DIAL instrument to be met.

Session: Poster

Undergraduate

Victoria Kong
Carroll College

Developing and Applying New Thin Film Combinatorial Techniques for the Discovery of New Metal Oxide Semiconductors for the Efficient Photoelectrolysis of Water

One of the most promising sources of renewable energy is solar powered water photoelectrolysis in which energy from sunlight is stored within a chemical bond of hydrogen (H2) and oxygen (O2). Recently, we have developed a new combinatorial metal oxide semiconductor thin film synthesis technique to aid in the discovery of new photoelectrolysis materials. The technique reproducibly generates high quality continuous gradient semiconductor films through the use of a screen-printing technique. This screen-printing technique is a cost and time-efficient method of creating a ternary phase diagrams that contain every possible three constituent alloy combination of the metal oxide. The metal oxide thin films are screened for potential photo-activity using the Solar Hydrogen Research Activity Kit (SHArK). The screen-printing technique and recently discovered photoelectrolysis semiconductors will be discussed.

Session: Poster

Undergraduate

Amy Bump
Rocky Mountain College

Isolation and characterization of an allelochemical from Russian olive, Elaeagnus angustifolia.

Plants excrete compounds that can be beneficial or detrimental to the receiving organism. The detrimental compounds are referred to as allelochemicals and typically inhibit growth, delay germination, and may result in death. Previous unpublished work at Rocky Mountain College has indicated that leaves of the invasive tree species, Russian olive, contain a substance that causes delayed germination and stunted root growth in radish bioassays. The main goal of this study is to extract, isolate, and characterize the compounds causing this delayed germination via bioassays and analytical chemistry techniques. Our current results indicate that extractions of leaves using polar solvents may contain an allelochemical. Future work will include separation of the extract with chromatography and the characterization of the compound. Implications off this research include better infestation management practices and potential applications in agriculture and land management.

Session: Poster

Undergraduate

Eric Wall
University of Montana – Missoula

Evolution of the parasitic bacterium Bdellovibrio bacteriovorus, in a multi-host system: A model for the origin of mitochondria

Mitochondriogenesis was a major transition event in the evolution of complex life. In modern Eukaryotic cells, mitochondria specialize in oxidative phosphorylation. It is widely accepted that mitochondria originated as free-living gram-negative bacteria outside the cells in which they now reside. Still debated, however, is the process by which these free-living bacteria came to reside in another cell, a process referred to as mitochondriogenesis. One hypothesis for mitochondriogenesis suggests that originally the mitochondrion's ancestor was a parasite of its host, but that over time it evolved a cooperative relationship. To create a laboratory model of mitochondriogenesis, we are attempting to select for a partnership between an Escherichia coli strain, CV103, that specializes in glycolysis and a predatory bacterium, Bdellovibrio bacteriovorus, that is highly efficient at oxidative phosphorylation. One of the crucial first steps in creating such a partnership is to convert B. bacteriovorus from an E. coli predator to an E. coli commensal. Using experimental evolution, my project aims to create a selective conditions in which attenuated B. bacteriovorus cells have a fitness advantage over virulent cells, which could open up the possibility for B. bacteriovorus to evolve a commensal relationship with its E. coli host.

Session: Poster

Undergraduate

Todd Larson
Montana State University – Great Falls College

Scalability of Algae Photobioreactor for Support of Education in S.T.E.M. Fields

The goal of this project is to determine the quantity of biolipids that can be created per unit mass of algal biomass grown. This, in turn, would allow determination of the quantity of algal biomass needed to produce the required volume of biolipids needed for use in the organic chemistry classes at GFC MSU. This experiment would ultimately serve to help students better understand the biological and biochemical processes involved therein. These concepts would include, but are not limited to, the processes within photosynthesis and the effects of certain environmental conditions on the photosynthetic process, as well as understanding the chemical pathways through which sunlight is used to make organic molecules such as carbohydrates, proteins, and lipids.

Session: Poster

Undergraduate

Dylan Gross
University of Montana - Missoula

Laboratory Astrophysics: the merged-beams technique for measuring absolute atomic and molecular photoionization cross sections

The laboratory astrophysics technique is described in which a beam of ions and a high-energy-resolution beam of monochromatic photons are merged to obtain absolute photoionization cross-section measurements. This technique is vital in astronomy as absolute photoionization cross-section measurements are required to accurately determine elemental abundances in many astrophysical objects. These abundance determinations are subsequently used by astronomers to expand our understanding of stellar nucleosynthesis and thus the chemical evolution of the Universe. The details of the technique include the generation, acceleration, steering, and purification of the ion beam, the generation of a monochromatic photon beam, the merging of these two counter propagating beams, and the collection of product photo-ions. Also detailed are the techniques involved in measuring absolute photoionization cross sections.

Session: Poster

Undergraduate

Nate Field
Montana State University - Bozeman

Pressure Sensing with Deformable Wave Guide Interferometry

Sensors are an important part of many modern technical endeavors. Space exploration, industrial mechanization, and even medical applications are coming to use more automated sensing to drive systems. Highly sensitive pressure sensors are useful for all of these applications, however, they can be expensive to produce and therefore are not desirable in applications that may cause too much wear over time. Using optical materials and interferometry, we believe we can generate a cheaply manufactured, disposable, easily calibrated sensor. Our project is divided into two main sections: fabrication and measurement. We fabricate the deformable wave guiding materials from silicon polymers and then we use interferometers with modular reference beams to test the phase of the test materials when pressure is applied. The ultimate goal of this project is to take these deformable wave guiding materials and network them in a fiber-based system that will act as a sort of synthetic skin for mechatronic applications. The materials to make these sensors will be relatively inexpensive, making it less of a concern to dispose of damaged sensors. In addition, the use of unique nanostructures in the guides will allow for simple calibration and high precision in the pressure location sensing.

Session: Poster

Undergraduate

Stewart Tyler
Montana State University – Bozeman

Thermal Vacuum Energy Analysis

Thermal conditions in space can be the cause of many troubles for different types of space-faring equipment. From the inability to properly dissipate heat in a vacuum to needing to regulate the temperature of various components on board there are many different ways the thermal design of a spacecraft can have an impact on any particular mission. For this reason it's very important to understand how various heat loads can affect the performance of the craft. Here at SSEL we test our equipment by running it through a thermal vacuum chamber where the equipment is tested at both the extreme high and low temperatures. Because of this the characterization of the thermal vacuum is vital to pre-flight testing and with every new project it only becomes that much more important to understand how it truly functions. The set up for the MSU thermal vacuum is a relatively simple one, but this can be misleading. Many different analyses of the chamber have produced acceptable results for the lab but none to the degree of precision required. Much of this is because of the lack of quantified energy being deposited into the chamber by the system itself. During the last semester while here at SSEL it's been a goal to quantify these numbers and be able to more accurately characterize the temperature, energy, and heat flux of the thermal-vac system as a whole.

Much of the initial analysis was done using previous tests where data had been collected for both the thermal shroud itself and for the satellite structures that were being tested at the time. While these were good sources of data they did suffer from shortcomings such as not having as many test points as would be desired and therefore most of the characterization depended on making broad assumptions about the relationships between individual test points. While still in the process, and ANSYS model is in the works to give a theoretical definition to the various thermal curves. It is desired that with this there will be a more visual and intuitive sense to the ways the thermal vacuum operates. Finally, there is a proposed test taking place in the thermal-vac sometime within this next summer. With the permission of those in control of the system it would be invaluable to set up more data points so that the experimental data can be a better representation of the reality.

While hard results that differ from what has already been uncovered about the system, these new procedures should shed more light on how the system operates and what can be done to improve upon its design. The ultimate goal here is to make the structure perform in such a way that the different points of interest such as energy generation and heat flux are always known to within a reasonable degree. Once this is done the thermal-vac can be utilized with a significantly higher degree of confidence. In conclusion this project is a way for SSEL to better its understanding of pre-flight testing and the hardware that we use, from the flight hardware to the test hardware. There will never be a wholly 100% accurate solution to the mechanisms used in testing. This, however, should not deter one from seeking that solution out, one step at a time.

Session: Poster
Undergraduate

Ryan Beagles
Salish Kootenai College

SKC fabricated solar panels for the BisonSat

Salish Kootenai College's (SKC) Cubesat, BisonSat, will launch in August on the NRO Grace mission. The satellite will be powered by six solar panels, two of which were designed and fabricated by the BisonSat team. The BisonSat panels are based on Spectrolab's Triangular Advanced Solar Cells (TASC). This poster will describe the steps taken to create the panels from conception to final construction as well as the engineering decisions made during production of the panels. The SKC fabricated panels perform favorably compared to commercially available Cubesat solar panels.

Session: Poster
Undergraduate

Hank Frank
Montana State University - Billings

An Investigation of the Chemistry of Atmospheric Ozone Using Cavity Ringdown Spectroscopy

The first phase of this project involves using CRDS to establish a natural half life of ozone. Data on the half life of ozone is limited, and to the best of our knowledge, it has never been directly measured using CRDS. In this phase of the project, the cylindrical cavity is pumped to a near vacuum, and then injected with ozone. Using CRDS to continually monitor the ozone levels in the cavity, data is taken for roughly three hours at a time, and that data will be used to calculate a particular half life for ozone in the geometry of the chamber. This phase is repeated with varying temperatures and pressures.

Phase two involves using CRDS to study ozone chloride reactions. Once again, the chamber is brought to a near vacuum. During this phase, sand coated with dry chloride salts is placed in the cylindrical chamber along with ozone, and CRDS is used to measure the real time concentration of ozone in the chamber. By comparing the half life of ozone determined in the first phase, and the half life of ozone measured in the second second phase, the speed at which ozone is reacting can be determined. Standard gas chromatography/ mass spectrometry is then used to determine the amount of perchlorate in the reaction cavity. These two results are then used to calculate reaction data.

Session: Poster
Undergraduate

Margaret Eisen
University of Great Falls

Mycobacterium tuberculosis Resistance to PZA

The aim of this project is to understand the mechanism of horizontal gene transfer and, more specifically, how resistance arises via mutations in Mycobacterium tuberculosis (TB). In particular, its resistance to the drug Pyrazinamide (PZA) will be examined. I will conduct two phases of this research. The first will be to observe horizontal gene transfer in everyday bacteria. The second phase will be to insert the mutant pncA gene that confers PZA resistance to a competent, non-virulent bacteria, E. coli, and study the rate of transfer in PZA-resistant TB. By doing this, it will be possible to better understand the mechanisms by which PZA-resistant bacteria transfer resistance and learn more about the mutations of this disease.

Session: Poster
Undergraduate

Aubree Honcoop
Montana State University - Billings

An Investigation of Ozone using Cavity Ringdown Spectroscopy

Ozone, or O3, is both a vital part of the Earth's atmosphere, as it reflects some of the ultraviolet rays from the sun, but toxic at the surface to many organisms. As such, it must be in near perfect balance to sustain life as it is currently known. Ozone reacts as strong oxidizer, and so the understanding of ozone chemistry could lead to a better understanding of what atmospheric composition allows for life. This experiment will take special interest in the atmospheric conditions of Mars, as the presence of ozone on Mars in the right balance would be a good indicator of the possibility of the ability to maintain life.