Montana Space Grant Consortium
Student Research Symposium
Saturday April 16, 2016

# Student Presentation Abstracts

**Session: Biology & Chemistry I**
**Undergraduates**
Melissa Blauvelt and Kyle Montgomery
Flathead Valley Community College

## A Survey of Synechococcus Growth Parameters

The goal of this project is to optimize growth parameters of the Cyanobacterium Synechococcus by finding a model light spectrum to provide ideal maximal growth. This project employs measurement of chlorophyll content, cell count, and culture turbidity.

**Session: Biology & Chemistry I**
**Undergraduate**
Jeffery Kelly
University of Montana

## Effects of Fluoxetine on Aggressive Behaviour in Betta Splendens

Researchers at the University of Montana performed a replication of a study performed by Majlessi and Naghdi (2002) examining the effects of the selective serotonin reuptake inhibitor (SSRI) Fluoxetine on spatial learning in rats. Eight adult male rats were trained for five days in a Morris water maze with an Atlantis Trial setup with a final spatial memory test after a three-day rest period. An immunohistochemical analysis was performed on the subjects post-behavioural trials in order to examine the concentration and localization of serotonin and dopamine throughout the cortices of experimental and control subjects. Experimental subjects receiving 5mg/kg in saline vehicle of Fluoxetine demonstrated significantly longer latencies to reach the platform and slower swim speeds compared to control subjects who received sham dosages of saline solution. As is shown by the evidence, researchers find that Fluoxetine administration impairs spatial memory ability in rats in a Morris water maze while also blocking motoric activity.

**Session: Biology & Chemistry I**
**Undergraduate**
Margrethe Boyd
University of Montana

**Biophysical Applications of Surface Plasmon Resonance Biosensors**

When light strikes a metal surface, some of its energy is absorbed by loosely-bound valence electrons. Depending on the wavelength of light and the composition and geometry of the surface, the energy delivered can induce a resonant electron oscillation known as a surface plasmon resonance (SPR). In recent years, NASA has devoted considerable resources to SPR research for numerous applications including advanced detector systems, diffraction gratings, and biosensors, the latter of which are label-free, high sensitivity molecular detection systems. These SPR-based biosensors use molecules attached to a metallic surface that bind target ligands and shift the index of refraction of the system, altering the angle at which incident light is reflected to a detector. SPR biosensors can detect ligand concentrations as limited as 10 pg/mL in real-time, demonstrating especially high sensitivity, specificity and efficiency. Molecular detection with SPR eliminates the need for radioactive or chemical tags commonly used to identify protein structure and interactions, many of which have significant limitations in their use. While SPR biosensors have applications in many fields, specific interests lie in the areas of disease surveillance, drug development and mutation detection. With small modifications to our existing vacuum chamber, we will utilize this technique to explore the biophysical and biomedical applications of real-time biomolecular detection.

**Session: Biology & Chemistry I**
**Undergraduate**
Greg Durling
Flathead Valley Community College

**Molecular Systematics of the Flathead Valley Moonworts**

Moonworts are a group of fern consisting of 40 known species worldwide. Species level classification is difficult and carries a degree of uncertainty when using morphological practices. The goal of this project is to use molecular analysis and processes to identify species in the Flathead Valley and to create a comprehensive phylogeny.

**Session: Biology & Chemistry I**
**Undergraduate**
Heidi Fleury
Flathead Valley Community College

**Building Resilience: Expanding Pollinator Habitat in Irrigated and Dryland Agriculture**

The project objective was to find the most suitable sites for implementing pollinator plantings in dryland and irrigated agricultural operations in the Mission Valley of Montana. To determine suitable plant species and prime habitat for the plantings, habitat characterizations for several types of flowering plants were completed using soil, aspect and land cover data. An irrigation type layer was created to overlay on the prime habitat sites to better understand irrigation driven vegetative characteristics of the valley to help further classify site suitability for the plantings.

**Session: Biology & Chemistry I**
**Undergraduate**
Mallory Kelley
Rocky Mountain College

**Tumorigenic Retroviruses in Montana Fish Populations**

Montana fish are carriers of endogenous and exogenous retroviruses. Exogenous fish retroviruses often cause skin tumors that are seasonal in nature; forming during the year and then lysing as water temperatures peak and fish cohort for spawning. This temporal nature is unique for viruses, leading to a new and interesting question: how much does environment affect the viral replication cycle? This study aims to characterize the retroviruses found in Montana fish with tumors, as well characterize a novel gene found in these retroviruses and its role in tumor progression.

**Session: CubeSats**
**Undergraduate**
Hank Frank
Montana State University

**SSEL Summer Internship and Continuing Study**

The Space Science and Engineering Laboratory at Montana State University is an interdisciplinary center of expertise with faculty, staff, and facilities for space research and space technologies. I was introduced to the lab after being encouraged to apply for their summer internship by Dr. Stuart Snyder while conducting cavity ringdown spectroscopy research at MSU-B. I will discuss my internship work at the SSEL, including projects completed and tools utilized. I will also cover my involvement in the continuing of the FIREBIRD-II mission, as well as the upcoming

design, implementation, and delivery of our most current mission IT-SPINS. I will also discuss my transition to Montana State University and the current and future support offered by the Montana Space Grant Consortium, as well as my current and future missions with the SSEL.

**Session: CubeSats**
**Graduate Student**
Connor Julien
Montana State University

**Getting Closer to the Pad – Flight Test Results for a Radiation Tolerant SmallSat Computer System**

Over the past 10 years MSU-Bozeman has been developing a new computer technology that provides increased tolerance to radiation induced faults through a novel architecture implemented on commercial-off-the-shelf (COTS) Field Programmable Gate Arrays (FPGA). The fault mitigation approach in this computer involves breaking a commercial FPGA fabric into redundant tiles, each with the characteristics that they can fully contain the circuit of interest and also be individually reprogrammed using partial reconfiguration. Each tile contains a full computer system based on a Xilinx MicroBlaze soft processor. At any given time, three of the tiles run in triple modular redundancy (TMR) with the rest of the tiles reserved as spares. The TMR voter is able to detect faults in the active triad by voting on the tile outputs. A configuration memory scrubber continually runs in the background and is able to detect faults in the configuration memory of both the active and inactive tiles. In the event of a fault in the active triad, (either detected by the TMR voter or scrubber), the damaged tile is replaced with a known good spare and foreground TMR operation continues. The damaged tile is repaired in the background by reinitializing its configuration memory through partial reconfiguration. Faults detected in inactive tiles by the scrubber are also repaired in the background and reintroduced as spares. This approach mitigates single event effects (SEEs) in the FPGA circuit fabric in addition to SEE's in the configuration memory. The advantage of this approach is that foreground operation can continue while faulted tiles are repaired and reintroduced into the system in the background. Since bringing on a spare tile takes significantly less time than performing background repair via partial reconfiguration of the damaged tile, the system availability is increased. This approach has been shown to improve the mean-time-before-failure compared to TMR+scrubbing alone. In this paper, we discuss a recent sounding rocket flight demonstration at the NASA Wallops Flight Facility and an upcoming demonstration on the International Space Station. This paper is of interest to any student facing the challenges of building technology for flight testing.

**Session: CubeSats**
**Graduate Student**
Matt Handley
Montana State University

**SSEL Space Flight Computer (SFC) Design**

The Space Science and Engineering Laboratory (SSEL) at MSU is an interdisciplinary center of expertise with faculty, staff, and facilities for space research and space technologies. To date, SSEL has delivered eight CubeSats for launch in addition to many other payloads and experiments. These CubeSats have utilized both Commercial Off-The-Shelf (COTS) subsystems and in-house designed subsystems. As SSEL's experience has grown, there has been an increasing desire to replace COTS subsystems with in-house designs. In-house designs can more closely match the volume, power, and functionality requirements of a specific CubeSat mission while giving students hands-on design experience. For SSEL's NSF-funded IT-SPINS mission, a new Space Flight Computer (SFC) has been designed to meet the requirements of the mission. The SFC will be responsible for orchestrating the flow of commands and data between all other subsystems, including the primary scientific payload, electrical power system, attitude determination and control system, and radio. By leveraging existing SSEL hardware and software designs with space flight heritage, the overall design cost and time was greatly reduced.

**Session: CubeSats**
**Graduate Student**
Mykhaylo Shumko
Montana State University

**FIREBIRD-II: A Pair of Student-Built CubeSats at MSU to Explore Cutting Edge Science and Engineering in Space**

The FIREBIRD-II CubeSats are a pair of satellites which were built by engineering students and stuff at the Space Sciences and Engineering Laboratory (SSEL) at MSU. These satellites have two solid state particle detectors on board which measure electron precipitation from the Van Allen Radiation Belts. Particularly interesting precipitation features are called microbursts. They are characterized by a increase of the number of detected electrons for a period of tenths of a second. It is believed that these precipitation events are generated by Chorus waves in the magnetosphere. These waves are created by disturbances in the magnetosphere, similar to those that could be the cause for the auroras. The science team at SSEL is currently working to understand the energy dependence, temporal and spatial scale sizes, and geographic location of where these microbursts occur.

**Session: CubeSats**
**Graduate Student**
Noel Stewart
University of Montana

**Bison Sat: The First US Tribal College Cube-Sat Ever Be Built, Tested and Launched**

In order to make scientific observations of the earth, we rely on earth observing satellites that are often cost prohibitive. Launching a satellite weighing several tonnes into orbit can cost around $400 million. In 1999, a low cost satellite in the form of a cube , with a dimension of 10cm on a side and weight of about 1kg, was developed at Stanford and California Polytechnic State Universities. Following the successful launch of this “Cube Sat”, opportunities were granted to other education institutions from NASA to build, launch and use similar small satellites to execute science related and educational missions. Salish Kootenai College was the first Tribal college to be awarded such an opportunity. “Bison Sat” has been built for educational purposes as well as developing cost efficient and relevant scientific observations using visible narrow bandwidths, from a custom designed payload. We will test the ability to monitor changes in vegetation cover, obtain cloud and snow cover observations, and compare the Bison Sat imagery with other earth observing satellite images. There are many components to the Cube Today we will focus on the Payload or Camera that is aboard the Bison Sat. The Bison Sat's payload's resolution is far greater than most earth observing satellites in use today. The project will allow students to test new hardware, acquire cost efficient scientific observations from images, and to ultimately share the observations with the public and the younger generation of our reservation. A major goal is to increase students interest towards pursuing a career in one of the Science, Technology, Engineering and Mathematics (STEM) fields on our reservation, where resources are so limited. Bison-Sat was launched in October of 2016.

**Session: CubeSats**
**Undergraduate**
Hannah Mohr
Montana State University

**CubeSat Reconfigurable Computing Platform: Performance and Power Analysis**

The Space Science and Engineering Laboratory satellites FIREBIRD II flight units 3 and 4 have been in orbit for over a year, providing state of health (SOH) telemetry to the ground station. The first four months of flight unit 4’s SOH data were examined to gain insight to the success of the mission from an engineering perspective, determine what issues exist with the current system, and implement resulting design considerations in the next satellite mission, IT-SPINS. The primary areas of interest were long-term trends to observe slow deterioration, and short-term

anomalies to determine how the system responded and performed corrections. Ongoing work includes incorporating the results into the design of the next generation satellite power system.

**Session: Remote Sensing**
**Graduate Student**
Caitlyn Florentine
University of Montana

**Using Radiostratigraphy to Constrain Greenland Ice Sheet Dynamic Response to Enhanced Melt**

Radiostratigraphy in the Greenland Ice Sheet ablation zone provides a powerful, novel constraint on our understanding of ice sheet response to surface mass balance forcing. In select regions of southwest Greenland, theory and prior modeling suggest that emergent internal layers illustrated by radar data may be interpreted as internal particle paths. For these emergent layers to represent steady state, mass removed by surface ablation must balance with mass delivered by horizontal ice flow and flux divergence. According to satellite-derived ice velocity data and radargram-derived particle path length, it takes 100+ years for particles to emerge at the surface. Emergent layers within ablation zone radiostratigraphy therefore provide an opportunity to assess the balance between surface melt, horizontal velocity, and flux divergence on the long time step of a century. We develop a novel method for testing this balance and find that 2008-2009 satellite-derived ice velocity averages and 1958-2010 modeled surface ablation averages do not balance with emergent layer geometry. The imbalance defines a discrepancy between the century-long average steady state and modern conditions. We quantify and subsequently correct these discrepancies by adjusting average surface melt rates and ice speed to balance with emergent layer geometry. In doing so we find that steady state is upheld when faster average ice speeds are paired with enhanced average ablation rates.

**Session: Remote Sensing**
**Undergraduate**
Jeremy Gillin
Flathead Valley Community College

**Using remotely sensed data to determine post burn forest succession rate**

Forest Fire, a natural disaster, is a part of all of our lives. This talk describes successional regrowth by year, after the 2003 Roberts fire in Glacier National Park. Landsat images were used to determine burn severity and Normalized Difference Vegetation Index (NDVI). A comparison of two consecutive NDVI years, determine the regrowth for the later year. This comparison gave insight for regrowth after ten years.

**Session: Remote Sensing**
**Undergraduate**
Morgan Henderson
University of Montana

**Dynamic Scheduling of Microlensing Observations for Exoplanet Research**

Gravitational microlensing has a promising application as a method of exoplanet detection. Although there are drawbacks to this method, these drawbacks can be mitigated. Using dynamic observation-scheduling programs, difficulties presented by the highly time dependent nature of this method can be overcome. Such programs can be used to increase the efficiency of nightly observations and thereby improve the effectiveness of microlensing as a method for exoplanet detection.

**Session: Remote Sensing**
**Graduate Student**
Ruben Behnke
University of Montana

**Geographic and seasonal variations in humidity across the continental United States using regional networks**

Because humidity is the most difficult meteorological variable to measure accurately, the number and quality of humidity measurements has lagged behind that of other meteorological variables. Only in the past decade has the development of local and regional networks across the United States, collectively known as mesonets, increased the number of humidity observations to nearly match that of temperature and precipitation. My research has focused on assembling this data and running quality control procedures on it. While previous studies dating back as far as 1965 have used only about 200 stations to create maps of humidity for the United States, there are now over 12000 stations that can be used. Although these stations have short records, the large number of them provides new insight into local humidity patterns across the United States. This presentation will feature an overview of this research and take a look at some of the spatial and temporal variations in humidity across the United States shown by this data.

**Session: Remote Sensing**
**Graduate Student**
Mike Roddewig
Montana State University

**Airborne Lidar Surveys of Flathead and Yellowstone Lake for Fisheries Management**

Airborne laser radar ("lidar") is an emerging technology for surveying and studying freshwater fisheries. While it has been extensively applied in saltwater, research in freshwater is notably lacking. In our presentation we give an overview of data collected in 2015 in area lakes using an airborne lidar developed at the MSU Optical Remote Sensing Lab, focusing on the potential of lidar to locate invasive lake trout spawning locations in Yellowstone Lake easier and at far less cost than other modalities, and to map the location of plankton over large areas of water. We conclude with our plans for further work in the coming summer and fall seasons.

**Session: Remote Sensing**
**Undergraduate**
Colin Delaney
Montana State University

**IT-SPINS Earth Horizon Sensors**

The biggest unknown for the IT-SPINS mission is the sensor suite on the attitude control system. SSEL is planning on using IR Thermopile based Earth sensors to precisely determine attitude on ITSPINS. My research has focused on how these sensors will dynamically acquire the orientation of the satellite. Step one is to mathematically calculate how the sensors will determine orientation and understand the basics of Earth horizon infrared Thermopile sensors. The sensor is “on” when it sees the warm earth and “off” when it is looking at cold space. If we then rotate a small FOV sensor around an axis parallel to the surface of the earth, we will see a “pulse width” of the earth on the sensor. Using the precise rotation of the sensor via a gyroscope, we can find the angle subtended of the earth by the earth sensor. This angle is then related to the angle below the horizon my geometry.
Step two is to use STK in conjunction with Matlab to simulate how a satellite will use this earth sensor data to fine tune its rotation. STK is used to create the environment IT-SPINS will 'see' and Matlab is used to control STK and record data.

**Session: High Altitude Ballooning**
**Undergraduate**
Dylan Sagmiller
Montana State University

**Developing a New Method for Measuring the Volume of Helium in a High Altitude Balloon**

When launching various experiments on high altitude balloons it is often vital to know the ascent rate and the burst altitude since these values are needed in calculating an accurate flight path. In the past, the usual method was filling the balloon until it would lift a ballast that was approximately 1.2 times the payload weight and from experience the balloon would have a rise rate of about 1000 ft/min and a maximum altitude of about 100,000 ft. If the wind is blowing the balloon while doing the ballast test however, the usual result is the balloon would become overfilled. Another way of finding the rise rate and burst altitude is to be able to calculate them by first knowing the initial volume of helium used to fill the balloon. One way of calculating the volume of helium is by measuring the volume flowrate (L/min) as the balloon is filled, taking the average flowrate of the balloon fill, and then multiplying that flowrate by the total amount of fill time to find the volume of gas. This talk focuses on achieving this method by designing and building a Venturi flowmeter that operates on the principle of measuring the pressure difference across a constricting pipe and calculating the flowrate based on the density the gas. The flowmeter was built using 3D printed parts, pressure sensors, and Arduino components. The system was then tested for its accuracy by filling a bag with nitrogen inside a fixed volume while recording the fill time, calculating an experimental flowrate from the fixed volume and fill time, and then comparing the experimental flowrate with the average flowrate from the flowmeter. After multiple tests and modifications, the percent error for the flowmeter came to be approximately 11.5%. However due to the inherent inaccuracy of the validation method, it is uncertain on whether this error is primarily due to the flowmeter or from a systematic error in the testing method; validation of the system is ongoing.

**Session: High Altitude Ballooning**
**Undergraduate**
Reed Hovenkotter
University of Montana

**Improving High Altitude Balloon Trajectory Predictions**

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 data collection as they have the ability to record high vertical resolution data, have access to stratospheric conditions, and are cost efficient. Current accepted operational prediction software written by Allen Jordan at NOAA initializes with 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 its higher resolution meteorological output data and topographic information to initialize flight prediction software. Predicted landing locations 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 applications requiring stricter execution parameters of balloon borne platforms such as those required when making air quality measurements in and over urban areas.

**Session: High Altitude Ballooning**
**Undergraduate**
David Schwehr
Montana State University

**High Altitude Balloon Photography and Imaging**

Any near space payload design faces many challenges. High altitude balloon payloads must meet even more restrictions relative to size and weight requirements. Clear and presentable photography from high altitude is a goal of several teams that will be flying high altitude balloons during the total solar eclipse in North America in August of 2017. These teams are part of a program that have strict budgets and limited resources. This project aims to provide a system capable of capturing images from high altitude while meeting the demands of near space flight and remain feasible for the Eclipse Ballooning Project of 2017.

**Session: High Altitude Ballooning**
**Undergraduate**
Micaela Moreni
Montana State University

**Flight Termination for High Altitude Balloons**

In high altitude ballooning at least two forms of termination are required for a balloon to be qualified to fly. For latex balloons a “cutdown” system is often employed to sever the lead line while balloon burst qualifies as the second form of termination. On the other hand zero pressure balloons don’t burst and use two independent forms of termination to sever the lead line between balloon and payload. The BOREALIS Razor Cutdown System can uniquely be used for both latex and zero pressure balloons to either cut away or invert the balloon. Although the Cutdown System can serve as both the primary and secondary form of termination, a helium valve is currently in production that will not only serve as a unique and independent system but will also forgo the messy inversion process.

**Session: High Altitude Ballooning**
**Undergraduate**
Seth Kreitinger
Montana State University

**B.O.R.E.A.L.I.S - A sumer of 'HE' induced funny voices**

An overview of the projects I worked on as a BOREALIS summer intern, from a stabilizing camera to astrophotography. As well as where they have lead beyond the initial internship.

**Session: High Altitude Ballooning**
**Graduate Students**
Logan O'Beirne and Micah Price
Montana State University

**Space Public Outreach Team**

The Space Public Outreach Team (SPOT) provides free presentations about current NASA missions and research to Montana schools, youth programs, and community groups. Through this program higher education students utilize unique NASA content to become inspirational STEM role models for K-12 students and teachers. This year's presentations, "Pluto And Beyond" and "Astrotech: Gravity As A Tool", explore two of the most exciting, current scientific collaborations of our time. We review the specific strategies to our mission, show the relevant demographics, and discuss the effectiveness of our methods.

**Session: Biology & Chemistry II**
**Undergraduate**
Solange Martin
Flathead Valley Community College

**Antibiotic Potential of Lichen, Bryophytes, and Lycophytes**

Antibiotic resistance has become a global concern and efforts are being made to combat this issue. In this study, local bryophyte, lycophyte, and lichen species were identified, and tested for their antibiotic potential against Escherichia coli and Staphylococcus epidermis.

**Session: Biology & Chemistry II**
**High School**
Josh Botti-Anderson and Nirupa Gadi
C. M. Russell High School

**Neurosphere Injections and Tracking to Study Tau**

One of the hallmarks of Alzheimer's Disease is misfolding of the microtubule-associated protein tau. This pilot study used mice expressing wild-type (normal) tau and human tau. These mice were injected with stem cells in the form of neurosphere lines. In these neurospheres, neuronal stem cells expressed certain gene markers, which could be used to track their progression and survival following a neonatal injection of them into young mice. Not only did these neurosphere lines contain ubiquitously expressed genes, but also ones that enabled the tracking of pathology pertaining to neurodegenerative diseases in humans. One of the lines contained luciferase and green fluorescent protein expressing genes downstream of the universally expressed CAG promoter, which made it possible to track the progression and survival of neurospheres because of the fluorescence. Tet-Tomato line neurospheres allowed for the spotting of pathogenic prions, as well as for the location of synapses. Maptnull neurospheres expressed eGFP in place of tau, which made it useful to study the effects on mice brains from misfolding of tau. Brain extractions were done at different development stages in the mice's lives, followed by sectioning and antibody staining. To visualize the changes taking place, specific antibody stains were used for each of the neutrosphere lines. Both planar and confocal microscopes were used to capture images of the antibody-stained brain sections. These antibody stains were used in correspondence to the three neurosphere lines, and with laser microscopy, images were captured showing fluoresced areas of expression. The antibody stains used were Nestin, which was used on all of the brain sections and stained cell nuclei, GFAP, which stained astrocytes, Nestin, which stained stem cells, and NueN, which stained neuronal stem cells at the end of the cell cycle.

**Session: Biology & Chemistry II**
**Undergraduate**
Olivia Van Fleet
Flathead Valley Community College

**Water Flow, Mass Transfer, and Calcium Carbonate Deposition in Coral Reef Environments**

Calcifying corals are colonial organisms responsible for the rock-forming chemical deposition of solid phase calcium carbonate. Formation and growth of coral skeletons is dependent upon many interrelated chemical and physical processes. Most of these processes are flow dependent. In this work we have investigated methods by which water flow can be characterized in the laboratory and in the field, and methods by which natural flow characteristics typical of reef environments

might be reproduced in laboratory aquariums containing growing corals. NASA has a long-standing interest in calcium carbonate precipitation in marine environments on a global scale.

**Session: Biology & Chemistry II**
**Undergraduate**
MiKalley Williams
Montana State University

**Biosurfactants: Growth and Applications in Polar Regions and Space Frontiers**

Biosurfactants are useful amphiphilic microbial compounds that disperse media, biofilms and hydrocarbons by reducing interfacial tension. These compounds can be grown from a multitude of different organisms, and so can be easily optimized to maximize functionality in different environments. Bacteria isolated from polar regions that are capable of producing biosurfactants therefore have tremendous potential as bioremediation tools in extreme environments. It follows that these compounds could also prove immensely useful on spaceflight missions, since space conditions are similar to those found in polar environments. The focus of this project was the growth and interrogation of microbes previously isolated by the Foreman Research Group from a supraglacial stream on the Cotton Glacier, Antarctica. Testing was done to screen these isolates for their ability to produce biosurfactants. Three Janthinobacteria sp. isolates were selected for their ability to produce biosurfactants in the presence of canola oil, as was revealed by the production of high E24 emulsion stability values. The positive response of the isolates to the test and visual indicators suggests a possible production of biosurfactants with emulsifying and interfacial activities. Work in ongoing to measure the growth and surface tension effects of the samples.

**Session: Biology & Chemistry II**
**Undergraduate**
Erin McGowan
Flathead Valley Community College

**Bioremediation for a Better Flathead**

The Flathead Watershed has had water quality problems due to the nitrate loading from agriculture, sewage, storm water run-off, and other sources of contamination. In aims to remedy this issue, we have used mycoremediation and phytoremediation techniques in a hydroponic setting. With the addition of oyster mushrooms and golden willow, we have observed a reduction in nitrate levels.

**Session: Biology & Chemistry II**
**Undergraduate**
Dylan Gross
University of Montana

**Photoionization Cross-Sections and Rydberg Resonance Identifications of Br+**

Absolute single photoionization cross-section measurements for Br+ are reported in the photon energy range of 17.0 to 32.4 eV. The merged beam technique which uses counter-propagating ion and photon beams was used for these measurements. One Rydberg resonance series is presented, which originates from the 3P_2 parent ion state of Br+ and converges to the 2P_3/2 final product ion state of Br2+. The ground state and metastable state ionization thresholds for Br+ and Br2+ are not yet confirmed, but are discussed. Analysis of each Rydberg series is calculated using quantum defect theory.

**Session: Engineering**
**Graduate**
Andrew Hohne
Montana State University

**Wavelength-selective polarizer arrays based on optical nanostructures for atmospheric science**

The Nano Optics Group at Montana State University has been researching the use of gold nanostructures as polarizer arrays for cloud imaging applications. Specifically, the goal is to passively determine the phase of water in clouds by observing the polarization state of light scattered by these water molecules. The nanopolarizer design consists of two staggered gold wire-grids separated by a distance of much less than the wavelength of light. Nanofabrication processes must be used due to the small scale of these structures. Since this polarization signature in clouds only occurs at certain wavelengths, it is important that these nanopolarizers be wavelength selective, which is achieved by varying the spatial parameters of the structure. Optical testing of completed nanopolarizers has consistently shown that these structures function well as polarizers and have begun to show some wavelength selectivity. Computational modeling is being used to design new geometries that will be higher performing with a narrower spectral response.

**Session: Engineering**
**Undergraduate**
Shelby Mallin
Montana Tech

**NASA Ames Internship Experience RotCFD Rotor Performance Assessment Study**

To design safer and more efficient aircraft, Rotor Computational Fluid Dynamics (RotCFD) will be examined by running simulations of the influence of wind tunnel testing on a Large Civil Tilt Rotor (LCTR) wind tunnel model. While learning the process of the software to generate different simulations, many variables can influence the results of (unsteady) rotor simulations. The focus of this research is on the boundary dimensions and their impact on the performance of an unsteady rotor calculation in hover. An XV-15 tiltrotor is modeled in RotCFD and performance data is correlated with experimental data. Trials will be continuously run to find the minimum boundary area (computational domain), while maintaining the identical performance, and explain the effects of the boundary on the isolated rotor performance. We want to be able to better understand rotorcraft aerodynamic performance and RotCFD provides a quick and inexpensive way to meet those goals. With a greater understanding of rotorcraft, and tiltrotor in particular, future design improvements could be made to resolve congestion at airports by substituting tiltrotors with passenger airplanes that will not require runways for takeoff or departures.

**Session: Engineering**
**Undergraduate**
Shelley Mitchell
Missoula College

**Sustainable Electronic Waste Recovery in the Last Best Place**

The world is facing an increasing need for a sustainable solution to the disposal of electronic waste. Frequently this involves a NIMBY issue where waste is shipped to countries such as India and China, leading to threatening conditions for fragile ecosystems worldwide. By keeping valuable precious metals in our local technosphere, we not only reduce our carbon footprint caused by incineration, but also transportation. Using the work of Hoke (1940) we have developed a cost-effective protocol for recovering gold in a zero-waste manner with minimal carbon footprint and environmental impact. This research is anticipated to lead to a profitable entrepreneurial venture with a positive triple bottom line in the next three to five years.

**Session: Engineering**
**Undergraduate**
William Pardis
Flathead Valley Community College

**The Method and Manufacture of a Spectrophotometric pH Sensor to Further Understand Ocean Acidification**

No Abstract

**Session: Engineering**
**Undergraduate**
John Ryter
Montana State University

**Novel nanostructured ceramic coatings for extreme aerospace applications**

A signature trend in the aerospace industry is the constantly-increasing operation temperature of the gas turbines used to impart thrust, as higher temperatures lead to increased specific core power, better efficiency, and a reduction in environmentally-harmful byproducts. Current metallic-based turbine engine inlet components experience rapid corrosion due to the severe high-temperature combustion environment to which they are exposed. As a result, new high-strength, high-temperature, light-weight turbine engine inlet components are necessary for the continued advancement of aeronautical exploration. Silicon based ceramic matrix composite (CMC) materials are strong candidates for such components due to their high-temperature mechanical properties (such as strength and creep resistance), low density, and excellent high temperature oxidation resistance in clean, dry air as a result of the formation of slow-growing, protective silica ($SiO_2$) scales. This project analyzed the development of these scales in clean air environments and their corrosion under turbine operating conditions, while also working to develop a thin film protective coating to inhibit such corrosion.

**Session: Engineering**
**Undergraduate**
Nicholas Swenson
Montana State University

**Calibration of Cernox Thermometers at Cryogenic Temperatures**

For accurate thermometry, reliable calibration of the thermometer is crucial. Typically, this confidence is achieved through a chain of calibrations between thermometers, tracing back to an original comparison against physical standards. Unfortunately, it is often expensive (upwards of $500/thermometer) to have these calibrations performed. To this end, Montana Instruments has pursued a system to allow for in-house calibration of Cernox thermometers for use in its products. In

order for the system to be a viable alternative to current options, the system must calibrate the product thermometers within 0.1% of the reference thermometers (0.25% total uncertainty when including other sources of error) across the full working range of 2.5 K – 400K. To reach these constraints, a calibration fixture was designed to maximize the thermal stability of the system. Complementing the hardware is software that provides process automation and data validation. A discussion of the design choices and challenges that were encountered will be presented.

**Session: Poster**
**Undergraduate**
Scott Beauvais
Salish Kootenai College

**DEVELOPING A SANDBOX TO AID THE SKC NATURAL RESOURCES DEPARTMENT WEBSITE**

There are several ways to learn about places to go to college, however they always lead the person curious about the school to the website. This indicates that development of a good website for a program is important for future recruitment. The natural resources website was fairly basic when it was first released however over time more intricate details, such as faculty bios, were added to the website. The objective of the project was to develop a sandbox for the website, which required recreating the official website in the sandbox space, to observe features in action before adding them to the official website. A personal computer with a Virtual Machine installed on it was utilized to make the sandbox. WordPress with free plugins and templates resembling those utilized on the official website installed on it. The website was successfully recreated and work began on new features for the website. Future work requires the sandbox be made accessible to others.

**Session: Poster**
**Undergraduate**
Samantha Bisel
Great Falls College MSU

**Determining and Analyzing Superior Algal Growth Through Temporal Nutrient Manipulation**

Currently, algae is a hot topic in the scientific field as new uses are constantly being developed. Researchers require a continuous supply of algae; therefore, an efficient growth method must be determined. The purpose of this research was to analyze if the time at which a standard nutrient boost was added positively affected the cell population density of a determined fast growing algal species. First, three species—Chlorella, Scenedesmus, and Synura—were grown to observe which had the highest growth rate. A single nutrient boost was added to the different samples of the selected species; each sample received a boost at a different time. With the results, a

mathematical model using cell counts and absorbance values was developed to greatly improve the efficiency of future quantitative analysis in algal research.

**Session: Poster**
**Undergraduate from a Research Institution**
Taymee Brandon
University of Montana

**Purification and Characterization of Bromocresol Purple for Spectrophotometric Seawater Alkalinity Measurements**

The topic of my research is the sulfonephthalein indicator bromocresol purple (BCP) and its level of impurities. BCP is used as an acid-base indicator in oceanic titrations, which provides information on seawater pH and alkalinity determinations. Impurities in sulfonephthalein indicator salts often results in significant errors in seawater pH values (2). High-precision carbon system measurements are necessary to document the changes in ocean chemistry and pH due to anthropogenic CO2¬ uptake by the earth's oceans (2). To improve the error in seawater pH determinations and the general understanding of climate change, BCP must be purified and characterized. Previous work has described the use of flash chromatography to efficiently produce large batches of purified indicator, so this method was used to form a procedure for BCP purification (2). Once BCP was purified at a level useful for seawater pH calculations, the chemical can be characterized by more accurately calculating the constants associated with it. The spectrophotometric pH values obtained by measuring absorbance ratios are directly related to indicator molecular properties, such as molar absorptivity ratios and protonation characteristics (1). Once the accuracy of these values is improved, future and archived spectrophotometric pH data can be quantitatively revised by the improved indicator equilibrium and molar absorptivity values (1). Once effectively done, the purification of BCP will advance the understanding of ocean acidification in systems where the chemical is used.

**Session: Poster**
**Undergraduate**
Shane Cronin
University of Montana

**Absolute Single Photoionization of Rb5+ for the Determination of Elemental Abundances in Astrophysical Nebulae**

Absolute single photoionization cross-section measurements of Rb5+ ions were performed using synchrotron radiation and the ion-photon merged-beams technique. Measurements were made from 76.6 to 100 eV at a nominal photon energy resolution of 50 meV. This energy range spans the 3P0 ground state ionization threshold and the 3P1, 3P2, 1D2, and 1S0 metastable state thresholds. The spectrum includes autoionizing resonances that likely originate from the

ground and metastable states. These resonances are being identified using quantum defect theory in an ongoing data analysis program. The resulting identifications are used by astronomers to determine elemental abundances of trans-iron elements in astrophysical nebulae which are then used to improve models of stellar nucleosynthesis which in turn contributes to our understanding of the chemical evolution of the Universe.

**Session: Poster**
**Undergraduate**
Maddy Drake
University of Montana

**The Ion-Photon-Beam Endstation at Lawrence Berkeley National Laboratory: experimental techniques for measuring absolute photoionization cross-sections**

Historically, experiments in laboratory astrophysics have been motivated by the observations of astronomers and conducted by atomic physicists. Until recently, astronomers had not detected the photoionization signatures of any elements heavier than iron in astrophysical spectra. But now that these heavy elements have been detected in planetary nebulae, atomic physicists have begun a new era of heavy element photoionization experiments. Described are the techniques being used at the Advanced Light Source at Lawrence Berkeley National Laboratory to recreate the conditions in these nebulae by merging energetic beams of heavy ions with counter-propagating beams of ultraviolet radiation to measure absolute photoionization cross-section spectra with unprecedented energy resolution. The results of these measurements are being used by astronomers to benchmark their recent observations and to refine their models of stellar nucleosynthesis which are then used to inform our understanding of the chemical evolution of the universe.

**Session: Poster**
**Undergraduate**
Nathaniel Field
Montana State University

**Characterization of Nanostructured Deformable Optical Waveguides for Pressure Sensing**

The Nano Optics Group at Montana State University has been studying the possible use of deformable waveguides as a means of pressure sensing. These guides offer the possibility of measuring smaller changes in pressure as well as giving cost effective and easily replaceable sensors for applications which have a high degradation rate (i.e. robotics, biomechanical research). As deformable waveguide interferometry proves sensitive to modulations in pressure at the surface of the guide, we wish to understand, characterize, and eventually control the way the modulations affect the output through the addition of surface nanostructures to a

deformable material is a complicated process. In addition, small deviations in nanostructuring can sometimes lead to difficult to interpret characterization measurements. Preliminary testing shows some promising results with an increase in sensitivity to pressure in regions of guides where nanostructures are present. As issues with fabrication are resolved and deformable waveguides with multiple regions of unique nanostructures are made, testing should allow for a larger sensor with embedded location information to be realized.

**Session: Poster**
**Undergraduate**
Audrey Houghton
University of Montana

**Follow up on Wide-Field, Small Aperture Photometry to Identify Exoplanets**

Robotic telescope arrays capable of photometric observations can be used to run transit follow-up observations to detect exoplanets and test the robotic capabilities of the MINiature Exoplanet Radial Velocity Array. There are many challenges involved in scheduling observations, reducing and analyzing data, and fitting the light curve of a transit. After the data is taken and analyzed, we determine whether we have found an exoplanet, binary, or variable star.

**Session: Poster**
**Undergraduate**
Kimberley Lantrip
Flathead Valley Community College

**Lynx in the Lost Trails Wildlife Preserve? Using DNA Barcoding to Identify Wildlife Species**

In March 2000, the Canada lynx (Lynx canadensis) was listed by the U.S. Fish and Wildlife Service as a threatened species in the lower 48 states. There have been sightings of the Canada lynx by various wildlife biologists at the Lost Trail National Wildlife Refuge (LTWR) in Marion, MT. Fur traps designed to attract the Canada lynx were set-up at LTWR to obtain fur that could be identified using DNA barcoding techniques. The objective of this project was to derive a method which would allow for positive species identification from fur samples using DNA isolation, PCR, and DNA sequencing techniques, with the goal of aiding LTWR in obtaining critical habitat designation for the Canada lynx.

**Session: Poster**
**High School**
Katie Lee
Bozeman High School

**Coronal Mass Ejection Acceleration Timing**

Although coronal mass ejections (CMEs) are known to accelerate as they leave the sun, precisely when and where this acceleration occurs is not exactly defined due to a lack of data near the solar limb. In order to find these accelerations, I used data obtained from the STEREO satellites and analyzed it using the Interactive Data Language (IDL). The first step of the project was to reproduce results from an event previously studied by Dr. Jiong Qiu, who provided the IDL program I used. Currently, I'm analyzing an unstudied CME event to compare the acceleration patterns to the previously studied events.

**Session: Poster**
**Undergraduate**
Erin Legel
University of Great Falls

**The effect of core strengthening frequency on lower back pain in adults.**

Lower back pain is a reoccurring factor in many people's lives; it affects about two out of every three adults. Additionally, Astronauts returning from spaceflight are experiencing increased incidence of lower back problems. To date, there is no one rehabilitation program proven to prevent and/or treat lower back pain. The purpose of this investigation is to determine the effect of core strength and stability exercise frequency on lower back pain. A quasi-experimental, pre-test post-test design was employed. Eleven adult volunteers, between the ages of 18-30, with self-reported lower back pain were recruited for the investigation. Participants completed the Oswestry Low Back Pain Disability (OLBPD) questionnaire and were randomly assigned into one of two groups. Group one received 10 core exercises and completed the routine 2 times per week for a period of two weeks. Group two received the same exercises and perform the routine every day for the two-week period. The participants will complete their strength programs on April 9, 2016. At that time participants will complete the OLBPD questionnaire and pain scores will be compared between groups using independent t-tests. If the back pain from those involved in the study reduces with core strength, then perhaps astronaut specific core strengthening programs could be developed to reduce the complications experienced after spaceflight.

**Session: Poster**
**Undergraduate**
Nevin Leh
University of Montana – Missoula – Physics

**A Database for Storing Satellite Data Requests**

This poster will explain the process of creating a database to process and manage data requests for the FIREBIRD-II (Focused Investigations of Relativistic Electron Burst Intensity, Range, and Dynamics) satellites. It will explain the background regarding FIREBIRD data and the difficulties involved in down linking and storing such data. It will then introduce and define a database for storing this data and the difficulties of creating such a database.

**Session: Poster**
**Undergraduate**
Levin Mullaney
Montana Tech

**Model and High Powered Rocketry Staging Abort**

The long-term objective of this project was to build a flight computer that, using a three-axis accelerometer, could determine the attitude of a staged rocket. After a stage had ceased burning, the flight computer would determine whether it was safe to ignite the next stage or whether it should deploy the parachute. After testing multiple, different designs for the electronics, it was determined that the electronics have to be small and lightweight, to have a negligible effect on the rocket's stability. Also, due to the large forces exerted during flight, all the electronics must have solid connections to avoid disconnection, and loss of the system, during flight. Therefore, it was decided that a Raspberry Pi Zero would be the best option for developing this system. A mathematical model was also developed to allow the Raspberry Pi Zero to calculate the rocket's attitude based on values it receives from the three-axis accelerometer.

**Session: Poster**
**Undergraduate**
Shauna Muns
Missoula College

**Rocket Mass Heater Sensor System**

I am designing a system to measure emissions on the rocket mass heater.This will be to measure CO2, HC, CO, NOx, and Temperature.

**Session: Poster**
**Undergraduate**
Al Olszewski
Carroll College

**Two Way Communication Payload for Weather Balloon Testing**

University of Montana's Balloon Outreach, Research, Exploration and Landscape Imaging System (BOREALIS) high altitude ballooning program funded by the Montana Space Grant Consortium (MSGC) recently started flying a device call the AirCore developed by the National Oceanic and Atmospheric Administration (NOAA) to collect a measurement profile of atmospheric CO2 and methane. The data is used by a climate researcher at UM, Ashley Ballantyne. Undergraduate students from UM and Montana Tech have worked on various aspects of the project from construction of the AirCore to running data analysis using a ring down spectrometer. The goal of this project is to create a robust system for flight location monitoring and the ability to control termination, the flight crew can relatively choose the landing location, write a "how to manual" for other programs to duplicate, and make and/or suggest improvements. AirCore data analysis must be done as quickly as possible after the sample is acquired; therefore, accurate landing location information and control is vital. The purpose of development is twofold: 1. Since balloons do not typically carry transponders and are flown through trafficked airspace, UM BOREALIS desires a system the Federal Aviation Administration (FAA) can follow to warn other aircraft as a safety precaution. 2. Balloon payloads are usually recovered due to cost, desire for reuse, and/or scientific data transfer options. Having a reliable tracking and landing location mechanism is critical for operations.

**Session: Poster**
**Undergraduate**
Daniel Rogers
University of Montana

**Application of the Atomic Data of Trans-Iron Elements for Abundance Determinations in Planetary Nebulae**

Neutron(n)-capture elements (Z > 30) have recently been detected for the first time in astrophysical objects. These elements were detected in the faint spectra of a class of dying, medium-mass stars known as planetary nebulae. Astronomers use published atomic data to analyze these spectra to ultimately determine elemental abundances which in turn advances our understanding of stellar nucleosynthesis and the chemical evolution of the Universe. However, for several of these elements, accurate elemental abundance determinations are nearly impossible due to the lack of available atomic data. Using the Advanced Light Source at Lawrence Berkeley National Laboratory, we have undertaken a comprehensive program to measure accurate atomic data for these elements to inform these elemental abundance

determinations and to eventually be incorporated into the computational photoionization code Cloudy.

**Session: Poster**
**Undergraduate**
Katherine Stocker
Montana State University

**Mapping Localized Turbulence Using Total Solar Eclipse Shadow Band Observations With Radiosonde And Thermosonde Data**

An extension and application of the theoretical process behind the phenomena of total solar eclipse shadow bands. In-compressible fluid dynamics and applications of thin phase screen models provide insight to predicting the visibility of shadow bands during the 2017 eclipse. Quantitative details of Sun-to-Moon ratio, environmental conditions, and statistical behaviors are accounted for in formulating new ways to measure the phenomena for useful atmospheric profiling.

**Session: Poster**
**Undergraduate**
Skylar Tamke
Montana State University

**The development and design of a long range wireless system.**

The development and design of a long range wireless system. The system also needed a multipurpose power supply circuit that has been designed by this student. the video system runs on a commercial microcomputer called a Raspberry Pi 2 version B. The code runs with a easy to install package and steam line system. This will all be explained and lined out on the poster that will be created for this event.

**Session: Poster**
**Undergraduate**
Dylan Trafford
Montana State University

**High Altitude System Progression and Design**

This project was to facilitate high altitude balloon research projects through the design and application of embedded and control systems. The explored concepts are the ground up design process of an embedded system with concerns toward future applications and system critical design. The research highlights the importance of user interfaces and robust design techniques. The results developed into the flight systems we are using today for flight termination, monitoring and tracking.

**Session: Poster**
**Undergraduate**
Michael Vigers
Montana State University

**CHARACTERIZING THE MECHANICAL PROPERTIES OF BIOFILM EXTRACELLULAR MATRICES**

Bacterial biofilms are multicellular communities of bacteria that form on surfaces. They consist of bacteria embedded in a gel-like extracellular matrix. Bacillus subtilis is a soil bacterium that is a model for biofilm formation with an extracellular matrix that is composed primarily of polysaccharides (eps) and amyloid fibers (tasA). In fresh media, B. subtilis cells undergo a transition from swimming to matrix producing states, and form robust biofilms. Over time these films disintegrate and lose their mechanical integrity. This mechanical weakening is believed to be due to changes in the structure of the extracellular matrix, but little is known regarding how the structure of the extracellular matrix changes as the biofilm ages. We use a combination of bulk rheology, microrheology, and time-lapse photography to describe the mechanical properties of the extracellular matrix. We find that the presence of amyloid fibers create anomalous diffusion of water into the biofilm. These results could provide insight into biofilm removal strategies.

**Session: Poster**
**Undergraduate**
Savannah Whitfield
University of Montana

**Studying the Function of ybgL; an E. coli protein of unknown function**

Endonuclease VIII (nei) is a DNA repair enzyme that cuts single damaged bases out of DNA. In Escherichia coli (E. coli), it is made along with four other genes (in the nei operon), but the functions of the other genes are unknown. Chromate is an environmental toxicant that creates the kind of DNA damage that is recognized by the repair protein encoded by the nei gene. In this study, we wanted to see if we could use chromate to investigate the function of the other four genes that are made at the same time. To test this, single gene deletion mutants were treated with chromate and the effects on cell growth and DNA lesion (damage) formation were measured. Mutant E. coli missing the ybgL gene, the gene encoded immediately before nei, were found to be resistant to chromate. This suggests that the toxic DNA damage created by chromate needs ybgL to form in DNA. Double gene deletion mutants have also been generated to see if the effects are amplified when two genes are missing, indicating that the genes may be working together to repair or metabolize DNA damage. More detailed in vitro studies on ybgL have been performed. The gene was isolated and put into an expression vector to produce the ybgL protein to study. Purified ybgL protein was incubated with different types of oxidized DNA damage to see its effects. Results indicated the ybgL protein has

strong nuclease activity. This is the first indication of any function for this gene. We are now developing an in vitro assay using fluorescently labeled oligonucleotides. Studying the function of the nei operon and the ybgL protein to determine what they do for cells is a new discovery in the knowledge of DNA and protein interaction.

**Session: Poster**
**Undergraduate**
Daniel Wilkerson
University of Montana

**Calculating the Refractive Index Structure Parameter From Historical Data**

The index of refraction is challenging to directly measure. By instead calculating the refractive index structure parameter from historical data, we can create a model for the index of refraction that can be used to forecast changes.

**Session: Poster**
**Undergraduate**
Patrick Wurster
Salish Kootenai College

**Montana Surface Water Associated with the Bob Marshall Wilderness Complex**

This project utilizes Geographic Information Systems (GIS) and the National Hydrography Dataset Plus Version 2 (NHDPlusV2) to estimate surface water discharge in the state of Montana which flows through or originates in the Bob Marshall Wilderness Complex.