Montana Space Grant Consortium
Student Research Symposium
Friday April 20, 2012

Student Presentation Abstracts

Session: Computing & Engineering
Undergraduate from a Small Institution

Katherine Steiner
Montana Tech – Mathematics
Paul Martino, Katie Hailer, Douglas Steiner

Analysis of Gas Phase Carbene and Amino Acid Reactions using Labeling Electrospray Deposition

Described here is a systematic study of gas phase carbene reactions with standard amino acids using Labeling Electrospray Deposition (LESD). LESD is a novel mass spectrometry based covalent labeling technique, with an application similar (and complimentary) to Hydrogen Deuterium Exchange (HDX). The technique involves covalent attachment of carbene labels along the polypeptide chain during electrospray ionization. ESI-MS analysis reveals data shifted by mass units indicating both the location and number of carbene labels. Based on a survey of the primary literature, this study is the first of its kind, and will enhance interpretation of LESD data from protein (and other biomolecule) structural studies.

Each amino acid studied is located in the center of a short peptide chain (i.e. XXXZXXX) and run through the LESD process several times in order to label the peptide with variable concentration (micromolar range). Each labeled peptide is then analyzed by LC-MS/MS, and the ratio of singly labeled to unlabeled ion intensities will establish a labeling affinity, while instrument signal for different peptide concentrations will be used to compute reaction rates. Experiments will be repeated for each standard amino acid in order to construct graphs of labeling affinity and reaction rates for all peptides arranged in order of increasing affinity or reactivity for comparison. The goal of this work is to establish gas phase carbene/ (methylene for this study) amino acid reactivity.

Session: Computing & Engineering
Undergraduate from a Research Institution
Skyler Rydberg
Montana State University-Bozeman – Electrical and Computer Engineering
Ethan Keeler, Jacob Ruzicka, Wataru Nakagawa

Development and Optimization of PMMA Thin Films for Nano-Optical Fabrication

The purpose of this project is to create a group of stable Poly(Methyl Methacrylate) (PMMA) thin film recipes, to be applied to a silicon substrate by means of spin-coating, for the fabrication of various useful nano-optical devices. Two types of thin films are needed for the fabrication of the desired devices, a PMMA monolayer and a bi-layer consisting of two different molecular weight PMMA layers. The monolayer recipes need to achieve stable layers at 200nm, 250nm, and 300nm thickness. Spin curves for varying concentrations of PMMA were recorded and recipes designed that yielded the desired layer thicknesses. The existing PMMA bi-layer recipe yields a thin film thickness of approximately 150nm, which is too thick for very fine feature production and too thin for thick metal depositions to be cleanly lifted off. This coupled with a poor layer thickness ratio required a reworking of the bi-layer recipe. Spin curves for varying concentrations of the two molecular weight PMMA layers are presented, and usable recipes for fine feature production (100nm bi-layers) and thick metal liftoff (200nm bi-layers) have been developed. Several examples of useful nanostructured optical devices based on these recipes are also presented.

Session: Computing & Engineering
Undergraduate from a Small Institution
Daniel Parod
Rocky Mountain College – Physics

Vertical Integration of Renewable Electrical Generation Methods

One of the most pressing issues facing the human race is a way of developing methods of generating electricity in a manner that is both technologically feasible and broadly sustainable [1]. Unfortunately, the renewable energy technologies available to us today are rife with shortcomings which deal a serious blow to both their viability and their sustainability [2-4]. Such shortcomings include large environmental impact, limited operation times, limited areas of utilization, and high costs [1-5]. These factors mean that while the U.S. has increased its total generating capacity by 1.082 trillion kWh between 1990 and 2010, renewable generation only increased by 68 billion kWh over the same period [6].

A possible solution to the problems which constrain increased future use of renewable energy sources lies in the integration of the various types of renewable electricity generation in an effort to counteract their individual weaknesses with the combined strengths of the whole. In an effort to explore how such integration could possibly function, current solar thermal, geothermal, and environmental technologies are analyzed to determine their respective strengths and weaknesses and then are combined in an integrated system designed to mitigate the factors which limit their individual usage. The end goal of such research is to decrease the costs and increase the efficiencies associated with renewable energy technologies.

1: Biello, David. "The False Promise Of Biofuels." Scientific American 305.2 (2011): 58-65. Academic Search Elite. Web. 30 Jan. 2012.
2: Berberi, Pellumb, Spiro Inodnorjani, and Riza Aleti. "Integration And Optimization Of Alternative Sources Of Energy In A Remote Region." AIP Conference Proceedings 1203.1 (2010): 920-925. Academic Search Elite. Web. 12 Feb. 2012.
3: Wald, Matthew L. "The Power Of Renewables." Scientific American 300.3 (2009): 56-61. Academic Search Elite. Web. 1 Mar. 2012
4: Mary H. Dickson, Mario Fanelli. “What is Geothermal Energy?” Istituto di Geoscienze e Georisorse, CNR , Pisa, Italy (2004). International Geothermal Association. Web. 14 Jan. 2012.
5: LePoire, David J. "Exploring New Energy Alternative." Futurist 45.5 (2011): 34-38. Academic Search Elite. Web. 4 Jan. 2012.
6: U.S. Energy Information Administration, “Monthly Energy Review,” May 2011, http://www.eia.gov/totalenergy/data/monthly/

Session: Computing & Engineering
Undergraduate from a Research Institution

Adam Gunderson
Montana State University-Bozeman - Electrical Engineering
Celena Byers, David Klumpar

Emergency Locator Signal Detection and Geolocation Small Satellite Constellation Feasibility Study

Aircraft Emergency Locator Transmitters (ELTs) are vital in helping search and rescue (SAR) teams in locating downed aircraft. Currently there are two types of ELTs available; one transmits at 121.5 MHz and the other at 406 MHz. The transmitters operating at 121.5 MHz have since been abandoned by satellite tracking systems even though these beacons are still available for non-commercial aviation use. Space based receiver decommissioning of 121.5 MHz systems was largely due to an inefficiency of the Very High Frequency (VHF) transmitter beacons; which have a 97% false alarm rate and only provide aircraft location within approximately 20 km of the transmitter. 406 MHz ELTs replaced the old VHF system but many do not broadcast GPS location data. While the Federal Aviation Administration (FAA) mandates all commercial air traffic use the 406 MHz transmitters, many privately owned aircraft still utilize 121.5 MHz and non-GPS 406 MHz ELTs. Small satellites have the capability of providing global coverage for a geolocation SAR constellation due to their low-cost and easily duplicated platform. This study assesses several identifying factors and risks regarding the implementation of such a small satellite SAR system that supports ELTs. Results from this study show that the need for an emergency locator signal detection and geolocation constellation can be seen as a low-cost solution to the current need for a 121.5 MHz and 406 MHz ELT detection system.

Session: Astronomy & Space Physics
Undergraduate from a Research Institution

Virginia Price
Montana State University-Bozeman – Physics

Cosmic Ray Detector

Using the BOREALIS high altitude ballooning system we can fly Geiger counters to detect cosmic rays. Cosmic rays vary with altitude in the atmosphere, showing a "shower" effect. Radiation in the atmosphere is measured with a Geiger counter and compared to altitude to determine the radiation profile above the Earth. In the future, two Geiger counters will be mounted on top of each other to detect incidence radiation to rule out background radiation from materials on Earth and in the atmosphere.

Session: Astronomy & Space Physics
Undergraduate from a Research Institution

Brian Redman
Montana State University-Bozeman – Electrical Engineering

Testing a Low-cost All-Sky Infrared Cloud Imager

Information about cloud patterns is useful for climate science studies and Earth-space optical communications research. Thermal infrared sky imaging is a technique that records cloud patterns by measuring the heat radiation emitted by the clouds. This method is particularly well suited for continuous ground-based measurements of cloud cover statistics because it functions equally well during day and night. Sophisticated infrared cloud imagers have been developed previously at Montana State University, but there is an interest in exploring the capabilities of lower-cost systems. A prototype of a low-cost infrared cloud imager capable of imaging the entire sky dome has been developed. The prototype of this system uses a metal dome to reflect the whole sky to an off-axis infrared camera. The algorithms to analyze the disordered image were also developed.

Session: Astronomy & Space Physics
Undergraduate from a Research Institution
Andrew Crawford
Montana State University-Bozeman – Mechanical Engineering

Propulsion of an Intern: A Journey through NASA's Jet Propulsion Laboratory (JPL), Deep Space, Mars, and Beyond

This presentation involves the research and activities involved with Andrew Crawford's 2011 JPL/Space Grant summer internship. The driver and progression of the research will be explored regarding the Deep Space Network and JPL, as well as the other involvements with multiple facets of the Laboratory that came to fruition over the course of the summer and the following year.

The primary research shows the detailed solid modeling design process and structural analysis of the LNA (Low Noise Amplifier) feed platform to be constructed and installed on the new BWG (Beam Wave Guide) Type-2 tracking antenna in Canberra, Australia, as well as all future similar BWG Type-2 antennas builds in Madrid, Spain, and Goldstone, California. The Deep Space Networks new BWG Type-2 antennas use beam waveguides to funnel and extract the desired signals received from spacecraft and outer space, and the feed platform supports and houses the LNA (Low Noise Amplifier) feed-cone and cryogenic cooling equipment used in the signal transmission and receiving process. NASA's Deep Space Network currently operates and uses three tracking facilities strategically placed 120 degrees apart from each other around the earth, enabling and maintaining constant contact with spacecraft. The summer project formulation, requirement gathering, solid modeling, and material procurement will be examined in detail.

While at JPL, I was fortunate enough to be a part of the final preparations and transportation of MSL, JPL's new rover Curiosity, as my mentor was tasked with the transport of the rover from JPL to Kennedy Space Center. A detailed visual examination of the work will be presented.

While at JPL, I also had the great opportunity to have my own NASA/JPL blog, run through the education department, showcasing the vastness of talent and wonderments of JPL and NASA in the theme of education. The blog soon took on a national following, including an interview and showcase with ESPN, and continues to this day with a strong following and future guest interviews and posts slated with astronauts, scientists, and other JPL and Mars Exploration personnel.

Session: Astronomy & Space Physics
Group Presentation
Ethan Keeler, Drew Moen, Courtney Peck, Chris Zimny
Montana State University-Bozeman – Electrical and Computer Engineering, Physics
Kevin Repasky

Design, Construction, and Implementation of a Ground-Based Solar Spectrograph for the National Student Solar Spectrograph Competition

A solar spectrograph is an instrument that takes incoming sunlight over a majority of the electromagnetic spectrum and separates the light into its constituent frequency components, or spectrum. The components are then sent to a detector that measures intensity, which reveals the location of spectral properties of the light such as absorption and emission lines. The National Student Solar Spectrograph Competition (NSSSC) is a Montana Space Grant Consortium hosted and NASA IRIS sponsored competition where undergraduate student teams from across the country design, build, and implement a ground-based solar spectrograph to perform any solar related task and to demonstrate their spectrographs for the competition in May 2012 in Bozeman, MT. Each team was awarded a 2,000 dollar budget to build their spectrograph, which could not be exceeded and all spectrographs needed to follow regulations in the NSSSC guidelines. The team designed the spectrograph to be capable of imaging the Sun across the visible spectrum using spatial filters and a standard photo detector rather than a traditional charge-coupled device due to budget constraints. The spectrograph analyzes the spectrum of small sections of the Sun to determine how the spectrum varies across solar features such as the corona, active and quiet regions. In addition to solar imaging, the spectrograph analyzes the solar spectrum by comparing the measured to the theoretical spectrum calculated from the blackbody equation.

Session: Ballooning & Remote Sensing
Undergraduate from a Research Institution
Jason Bishop
Montana State University-Bozeman – Chemistry

Hands-on Science with MSU BOREALIS

The BOREALIS high altitude ballooning program provides important hands-on experience in science and engineering for Montana students. Our society is dependent on technology and currently has serious problems due to a gap in understanding between the general population and scientists. This gap in understanding leads to distrust of people in the scientific community by the layperson, and permits opportunists to take advantage of the uniformed. Additionally the scientific community suffers from the exclusion of the general population, since an informed populace acts as a sort of checks and balances system preventing money and politics from influencing the sciences. Hands-on experiences are available to and beneficial for people of all walks of life and are therefore key in breaking down these barriers. BOREALIS is an opportunity for students such as myself to actually see and touch the things talked about in class and therefore give theoretical concepts intuitive meaning.

Session: Ballooning & Remote Sensing
Undergraduate from a Research Institution
David Riesland
Montana State University-Bozeman – Electrical and Computer Engineering

High Alititude Ballooning Timer-based Cutdown System

The FAA (FAR Part 101 section 101.35) requires that high altitude sounding balloons posses two independent methods by which a flight can be terminated. With traditional latex sounding balloons the primary means of flight termination is that the balloon bursts at altitude. Low cost small payload zero pressure balloons have recently become available for use by higher educational ballooning programs. For both systems, but particularly for zero pressure balloons there is a need to have functional user controlled flight termination systems. I present here the design and operation of a simple low-cost timer based system. This system controls the activation of a hotwire cutter to sever the lead line connecting the balloon and the payload. I will present designs for both the electrical and mechanical systems in place.

Session: Ballooning & Remote Sensing
Undergraduate from a Research Institution
Joseph Lutgen
Montana State University-Bozeman – Computer Engineering

Micro Loggers and Sensors

This presentation will cover the micro loggers and different sensors used over the summer. How to make and use the micro loggers will be the main subject.

Session: Computing & Engineering
Undergraduate from a Research Institution
Spencer Abdo
Montana State University-Bozeman – Mechanical Engineering
John Bognar

Building an Icing Cloud Water Tunnel

Icing clouds are very often a problem for aircraft during every season. Dr. John Bognar of Anasphere, Inc. is developing a sensor that detects these icing conditions before they become too severe. In this presentation I will describe my experience as an intern for Anasphere, Inc. during the summer of 2011. It was during this internship, sponsored by MSGC, that I designed, built, and tested a wind tunnel that simulates icing conditions that pilots experience while flying.

Session: Ballooning & Remote Sensing
Group Presentation

Elizabeth Clem, Tiffany Heetderks, Rachael Luhr, Stephani Schielke,
Kathryn Schipf, Laurie Smoot
Montana State University-Bozeman – College of Engineering

Design of a High Altitude Balloon Payload to Carry an Ionizing Radiation Sensor

During the summer of 2011, six undergraduate engineering students formed an interdisciplinary design team to build a high altitude payload. This project was sponsored though a NASA ESMD Innovative Project grant with the purpose of engaging more females in the area of aerospace engineering. The project was carried out during an 8 week summer program at MSU-Bozeman. The payload was designed to fly on the MSGC BOREALIS (Balloon Outreach, Research, Exploration and Landscape Imaging System) high altitude balloon platform. The purpose of the payload was to carry a custom radiation sensor that is being developed at MSU as part a separate NASA sponsored research project investigating techniques to provide fault tolerant computer systems. The sensor is capable of determining the spatial location of ionizing radiation strikes. The payload consisted of electronics to log information from the sensor, a self-contained power system and a capsule that provided thermal protection and impact mitigation. This presentation will cover the details of the design, fabrication and testing processes in addition to the results obtained during the flight.

Session: Graduate Student Session I
Alexander Engell, Michael Schuh
Montana State University-Bozeman – Physics
Michael Schuh, Juan Banda, Jason Scott, Piet Martens, Rafal Angryk

Building Solar Flare Forecasting Model Using Multi-Parameter Extraction and Rule-Based Classifiers

Solar flares and coronal mass ejections primarily originate in active regions. They produce energetic particles and photons that impact our way of life on Earth. Such space weather events can cause blackouts by affecting power grids, give astronauts dangerous levels of radiation, disrupt telecommunications and satellites, and require rerouting of polar flights; all at the cost of millions of dollars to companies and governments. We combine physical parameters known to be associated with flares such as properties along polarity inversion lines in active regions with image analysis parameters such as entropy and mean. Our forecasting model acts on active regions that produce a range of flare magnitudes as they rotate on the solar disk. The parameters taken from a wide range of instrument wavelengths are then correlated to the occurrences of the flare magnitudes and timings. From the correlations we are able to establish ranges of flare magnitudes and timings associated with the ranges of parameter values.

Session: Graduate Student Session I
Michael Schuh
Montana State University-Bozeman – Computer Science
Juan Banda, Pietro Bernasconi, Rafal Angryk, PetrusMartens

A Comparative Evaluation of Automated Solar Filament Detection

We present a comparative evaluation for automated filament detection in H-alpha solar images. By using metadata produced by the Advanced Automated Filament Detection and Characterization Code (AAFDCC) module, we adapted our Trainable Feature Recognition (TFR) component to accurately detect regions in solar images containing filaments. We first analyze the module's metadata and then transform it into labeled datasets for machine learning classification. Visualizations of data transformations and classification results are presented and accompanied by statistical findings. Our results confirm the reliable event reporting of the AAFDCC module as well as our ability to effectively detect solar filaments with our TFR component.

Session: Graduate Student Session I

Karthik Ganesan Pillai
Montana State University-Bozeman – Computer Science
Rafal Angryk, Piet Martens, Hasari Toshun

Verification of co-occurence of filaments and sigmoids

Co-location mining in spatio temporal events is identifying the subset of spatio temporal events that occur together in space and time. In this presentation, co-location mining techniques are used for the verification of hypotheses about co-occurence (in space and time) of filaments and sigmoids. In particular the question of how many sigmoids contains filaments and correlation between observed sigmoidality of sigmoids and the chirality of filaments are addressed.

Session: Graduate Student Session I

Gary Lowe
Montana State University-Bozeman – Physics
Andrew Liebmann, Sachiko Tsuruta

Temporal and Spectral Analysis of PKS 0558-540

I present results from 5 long X-ray observations of the radio-loud narrow line Seyfert I galaxy PKS 0558-504 obtained through XMM-Newton. This source is characterized by both short and long term variability, a large soft excess and a steep power law. The 0.3-12 keV lightcurve shows several flaring events where the intensity changes by a factor of 2 within 20k seconds. The power density spectrum shows no long term periodicity but possible semi periodicity at times. A slight anti-correlation exists between intensity and hardness ratio indicating a hardening of the continuum during low flux states. No time lag between hard and soft X-ray energy bands was observed analyzing the lightcurve's hardness ratio and cross-correlation. The long-timescale fractional variability and the short-timescale fractional variability show energy dependent variability. The spectrum is modeled well with a power law and two blackbodies with the second blackbody possibly representing a hot spot of the accretion disk.

Session: Physics
Undergraduate from a Small Institution
Ian McKay
Rocky Mountain College – Aviation
John Jurist, Vadim Rygalov, Kelly Donin

Human Atmospheric Entry

Human Atmospheric Entry defines survivable envelopes for human beings entering the Earth's atmosphere in free fall. We calculate physical forces and barriers which must be overcome in order to successfully allow human atmospheric entry. This includes calculations of trajectory, energy transfer and technology that could be used to mitigate potential hazards. The presentation will also include potential applications for human atmospheric entry such as escape from a disabled aerospace vehicle as well as possible military applications like project SUSTAIN (Small Unit Space Transportation And INsertion).

Session: Physics
Undergraduate from a Small Institution
Kelly Donin
Rocky Mountain College – Physics
John Jurist, Vadim Rygalov, Ian McKay

Human Atmospheric Entry: Impact Tolerance Model for Prolonged Acceleration Profiles

Due to the recent test jump at 21,818 meters (71,581 feet) by Felix Baumgartner as a part of the Red Bull Stratos project, there is renewed interest in the limits of human tolerance and survivability during an escape at high altitudes. The current altitude record for a parachute jump from a balloon is 31,330 meters (102,800 feet) set by Joseph Kittinger in 1960. For accelerations longer than a second or two, fluid shifts become significant and influence acceleration tolerances. Currently, NASA uses the Brinkley Dynamic Response Model, which can be cumbersome, as an indication of impact tolerance. In this project on human atmospheric entry, we attempt a simpler model for impact tolerance that is consistent with the NASA extended tolerance standards for prolonged acceleration profiles. The impact tolerance model to be defined takes the tolerance time versus acceleration standards used by NASA for extended accelerations and integrates an arbitrary acceleration pulse as a function of the fractional time tolerance of each given acceleration level within the arbitrary pulse. The findings from this project suggest that escape from a high altitude and high speed aerospace vehicle or from a re-entering spacecraft is potentially survivable. This may also potentially contribute to understanding survival envelopes for separation from high speed and high altitude aircraft, which may be useful to the US National Space Security Office and the US military.

Session: Physics
Group Presentation
Dan Kirkpatrick, Clark Vowell, Michael Wardell
Montana State University-Billings – Chemistry, Physics
Stuart Snyder

Detection of Atmospheric Ozone Using Cavity Ringdown Spectroscopy

Cavity ringdown spectroscopy to detect trace concentrations of atmospheric ozone is being developed at Montana State University Billings. The principles of cavity ringdown spectroscopy will be explained. The experimental layout will be described and preliminary results will be presented. Potential applications of this technique to investigations of ozone chemistry in a simulated Martian atmosphere will also be discussed.

Session: Physics
Group Presentation
Matthew Barton, Steven Barton, Richard Shular
Montana State University-Billings – Physics

Thermally Assisted Laser-Induced Fluorescence of Atomic Sodium

Research to determine flame temperature using thermally-assisted laser-induced fluorescence (TALIF) is described. TALIF is a form of laser-induced fluorescence that uses the thermal energy from a flame to further redistribute the population of laser-excited electrons to neighboring energy states. In this work, sodium atoms were aspirated into a flame and then excited using a two-photon process. Each of the two photons have a wavelength of 578.89nm, which excites the ground state electrons to populate the 2D5/2,3/2 excited state. The laser-excited electrons are collisionally redistributed to higher energy levels. The densities of these states are described by Boltzmann statistics. The TALIF signals are spectrally-resolved using a 1-meter monochromator, and detected with a photomultiplier tube (PMT). The resulting signals are recorded with a box car averager interfaced with LabVIEW. The intensity of the LIF signal is directly proportional to the sodium concentration, however, as long as the concentration is held constant, this does not play a role in the relative intensities resulting from TALIF. Because distribution is temperature dependent, the recorded relative intensities of the TALIF signals can be used to determine the temperature of the flame. This technique could be altered for use with any flame, from the natural gas-compressed air flame, as was used in this set up, to plasma torches where temperatures range from 7,000K to 20,000K. Using TALIF to determine flame temperatures offers the advantage of being a non-intrusive method that has a high degree of spatial resolution. Traditional mechanical methods can perturb the flame and fail at higher temperatures. The TALIF method also has the advantage of having stronger signals over other spectroscopic methods such as emission spectroscopy.

Session: Graduate Student Session II

Kristen Crandell
University of Montana-Missoula – Division of Biological Sciences, Organismal Biology & Ecology

From Ground to Air: Take-off flight in birds

A bird's graceful transition from ground to air appears effortless, yet requires the coordination of two very different locomotor systems: the legs and wings. This transitional stage involves the use of legs to produce ground-reaction forces against a perch to accelerate the bird in to the air. Following, the wings must take over to maintain airborne velocity. In contrast, aircraft on the ground depend on engines to provide thrust and move forward, and fixed wings to create enough aerodynamic force to drive the craft away from the ground, and upward. Recently, engineers have returned to vertebrate flight for insight into the design principles that allow effective navigating of complex terrain, including transitioning between ground and air for micro-air vehicles. Here, I explore the contribution of leg and wing during this crucial transition phase in two species with different wing morphology: Zebra finch (Taeniopygia guttata, n=4) and Diamond dove (Geopelia cuneata, n=3). In both bird species, the first wingbeat following take-off provides significantly less lift and thrust than the subsequent two wingbeats. The finch produce force equivalent to 68% bodyweight, not enough to stay in the air without relying heavily on the initial acceleration provided by the legs. Doves produce force equivalent to 80% bodyweight on the first wingbeat, and produce a smaller force with the legs. Additionally, timing between force application of the legs and wings between species is significantly different, with the wings operating before leaving the perch in doves, but not finch. Previously, I have established that birds with long, pointed wingtips such as the diamond dove are capable of producing additional thrust prior to their first downstroke. This study shows a delicate balance in two ways of force production during this critical transitional period to flight, and provides insight to our understanding of locomotion during periods of rapid acceleration.

Session: Graduate Student Session II

Nicholas Childs
Montana State University-Bozeman – Physics
Anthony Shu, Andrew Collett, Keith Drake, Mihaly Horanyi

Conceptual Demonstration of Hypervelocity Dust Particle Detection

We describe the principles of charged dust grain detection in the laboratory, and their connections to the physics classroom. Electrostatic dust accelerator systems, capable of launching charged dust grains at hypervelocities (1-100 km/sec) , are a critical tool for space exploration. Dust grains in space typically have large speeds relative to the probes or satellites which encounter them. Development and testing of instruments which look for dust in space therefore depends critically on the availability of fast, well-characterized dust grains in the laboratory. One challenge for the experimentalist is how to measure the speed and mass of laboratory dust particles without disturbing them. Detection systems currently in use exploit the well known effect of image charge to register the passage of dust grains without changing their speed or mass. We describe the principles of image charge detection and provide a simple classroom demonstration of the technique using soup cans and pith balls.

Session: Graduate Student Session II
Graduate Student
Alexander Michaud
Montana State University-Bozeman – Land Resources and Environmental Science
John Dore, Deborah Leslie, Berry Lyons, David Sands, John Priscu

The active role of biological ice nuclei in hailstone formation

Evidence for biological ice nucleation (BIN) exists for rain and snow, but the role of bacteria and other biological particles in hail formation has yet to be investigated. Hailstones provide a model system for the study of BIN and, therefore, bioprecipitation. Furthermore, hailstones are a natural, in situ sampler of a strong, convective storm cloud. This study exploits the structure and formation of hailstones to test the hypotheses that bacteria and other biological particles play a role in nucleating hail and the upper troposphere contains viable organisms which are sampled by hail. Hailstones from three storms have been dissected and analyzed using several techniques. First, meltwater was analyzed for concentration and activity temperature of biological ice nuclei in the inner core (embryo) of the hailstones. Second, stable isotopes of water provide insight into the temperature of freezing and height of layer formation within hailstone. Third, culturable bacteria from different layers have provided an understanding of the distribution of organisms in the storm cloud and their physiological potential for ice nucleation and survival through the upper atmosphere. Biological ice nuclei concentrations are 4 to 10 times greater than what is found in snow and rain, respectively, and nucleates ice at temperatures as warm as -5.5°C. Stable isotope data suggests that ice was formed at similar temperatures, which are within the range of BIN and not abiotic ice nucleation. Bacterial isolates from the embryo are closely related, based on DNA evidence, to known ice nucleation active bacteria. Lastly, there is a unique, cyclic pattern which develops throughout the layers of large hailstones for all parameters analyzed. In one of the layers, which formed at the top of the cloud, a novel bacterium was isolated and illustrates a hailstones ability to act as an upper atmosphere sampler. From these three lines of evidence, it may be concluded that bacteria or other biological particles are responsible for nucleating the embryo and therefore hailstones.

Session: Graduate Student Session II
Meredith Rainey
Montana State University-Bozeman – Ecology
Andrew Hansen

Use of MODIS habitat data and MODIS-derived phenology metrics to improve models of wildlife corridors

Advances in the availability of remote sensing data and power of GIS software have greatly contributed to ecologists' ability to quantify habitat suitability for wildlife across landscapes and, in turn, to predict locations of wildlife movement corridors. Corridor models are now considered integral tools for wildlife conservation planning. However, their performance has rarely been tested against empirical data, and they have never incorporated climate-related habitat covariates such as vegetation indices and snow cover, which may be critical to long-distance movements of some species and are expected to be altered by climate change. These oversights limit confidence in the use of corridor models for conservation planning as well as their potential utility for predicting the effects of climate change on connectivity. I have addressed these issues by 1) incorporating climate-related habitat covariates (MODIS NDVI and snow cover; modeled SWE) into habitat models for migrating elk and dispersing wolverines, 2) using these models to predict migration and dispersal corridors for these species, and 3) validating predicted corridors against GPS collar data from migration and dispersal movements. I found that predicted migration and dispersal routes of elk and wolverines, respectively, were often reasonable, but that, for elk, models excluding climate-related covariates outperformed those that included them. I am now exploring the use of derived phenology metrics capturing temporal patterns in vegetation green-up in place of raw MODIS data, which are expected to provide a less noisy, more ecologically relevant measure of vegetation quality for elk.

Session: Graduate Student Session II
Jennifer Hane
Montana State University-Bozeman – Electrical and Computer Engineering
Brock LaMeres

A Fault-Tolerant Computer Architecture for Space Vehicle Applications

The discovery of new methods to protect electronics from harsh radiation environments outside earth's atmosphere is important to the future of space exploration. Reconfigurable, SRAM-based Field Programmable Gate Arrays (FPGAs) are especially promising candidates for future spacecraft computing platforms; however, their susceptibility to radiation-induced faults makes their use a challenge. This presentation describes the design and testing of a redundant fault-tolerant architecture for use with FPGAs. It is based on a combination of triple modulo redundancy (TMR), numerous spare units, repair (scrubbing), and environmental awareness techniques, which work together to provide the system with superior reliability. Four implementations of this architecture, each with a different task, were designed and tested. Markov modeling of these four systems confirms that they will all be highly reliable under typical earth orbit conditions. The results also demonstrate that the inclusion of numerous spares and the sensor both lead to substantial improvements in the Mean Time Before Failure, over a traditional TMR system with only three modules and scrubbing.

Session: Aerospace Technology
Undergraduate from a Research Institution
CJ Hadwin
Montana State University-Bozeman – Electrical Engineering

HRBE and Beyond: Montana State University's Future In Space

Since 2003, the Space Science and Engineering Lab has had the goal of putting MSU on the map as one of the country's premier space science universities. From MEROPE, to Explorer 1 Prime, to Montana's first satellite, HRBE, SSEL has shown that it intends to do just that. Currently in the process of developing three more spacecraft, SSEL has enjoyed credibility and recognition from the successful launch of HRBE aboard NASA's NPOESS mission from Vandenberg Air Force Base in October of 2011. This presentation will include an overview of SSEL's past missions, including HRBE, and a glance into the future of cutting edge technologies that SSEL will be launching in to orbit over the next several years. Contributors and/or partners to these exciting projects include MSGC, NASA, the NSF, The Air Force Research Lab, and several other leading organizations in the aerospace industry.

Session: Aerospace Technology
Undergraduate from a Small Institution
Robert Davis
Salish Kootenai College – Computer Engineering

Salish Kootenai College CubeSat Mission

The SKC CubeSat is being built by a team of students and faculty to provide SKC engineering and science students with design, test, and flight operation experience. This project will expose tribal college students to NASA-focused careers. The primary mission goal for the SKC CubeSat is to acquire images of the Flathead Indian Reservation. A secondary goal is to use this imagery for atmospheric and hydrologic research. The SKC CubeSat is a 10x10x10cm cube with a mass less than 1.33kg and will be the first satellite built by students and faculty from a Native American college. The SKC CubeSat team will follow the procedures of the NASA systems engineering project life cycle for the design, build, and flight of its CubeSat. The SKC CubeSat was recently selected for flight through the 3rd NASA CubeSat Launch Initiative program.

Session: Aerospace Technology
Undergraduate from a Research Institution
Andrew Crawford
Montana State University-Bozeman – Mechanical Engineering

Multiple Spacecraft Adaptability for Small Satellite Ground Operations

The Multiple Spacecraft Adaptability for Small Satellite Ground Operations research involves analysis of the Montana State University (MSU) and Space Science and Engineering Laboratory (SSEL) current small satellite ground operations and mission procedures, and adapting those procedures for compliance with upcoming multi-spacecraft missions.

With the recent successful launch of Montana's first satellite, HRBE, currently in Earth orbit collecting and down-linking science data to MSU, there is a fundamental need to examine lessons learned and ground operations efficiency, in advance of the upcoming FIREBIRD satellite launch and mission, which involves multiple spacecraft.

The Space Science and Engineering Laboratory is currently configured to run in-house ground operations of spacecraft, including down-linking of science data, up-linking commands to the spacecraft, and monitoring the spacecraft systems health from the space telecommunications operations center located within the lab. With the upcoming FIREBIRD mission slated to launch in 2013, which involves two spacecraft, fundamental changes and new configurations regarding the ground station operations need to be researched and implemented.

Research involves antenna-tracking capabilities for multiple spacecraft, data-download and transmit paths using multiple ground station computers, as well as current equipment feasibility and compatibility to handle multiple transmit/receive functions simultaneously from two spacecraft. The research will provide fundamental configuration options for future missions.

Session: Aerospace Technology
Group Presentation
Adam Gunderson, Nathan Fite, David Racek, Matthew Handley
Montana State University-Bozeman – Space Science and Engineering Lab

Launch and Continued Operations of the Hiscock Radiation Belt Explorer

The William A. Hiscock Radiation Belt Explorer (HRBE) is a Montana Space Grant Consortium CubeSat satellite developed by the Space Science and Engineering Laboratory (SSEL) at Montana State University. HRBE was launched into a low Earth elliptical orbit on a Delta II Rocket October 28th from Vandenberg Air Force Base in California. Its mission is to study the Van Allen radiation belts, which contain highly energetic electrons trapped in the Earth's magnetic field. HRBE's instrument consists of a Geiger tube donated by Dr. Van Allen; which it uses to measure the intensity and variability of these high energy electrons that are located in and around the Van Allen radiation belts. Since the first months of HRBE operations the satellite has currently exceeded its mission goal by operating in space for more than 111 days and continues to be in a good state of health. This presentation will cover day-to-day satellite operations and the efforts that led us to be able to fully operate and command the satellite from Montana State University. It will also discuss how users from around the globe can submit science data from HRBE's beacons and our current efforts to parse the solar panel and science data in our archives.

Session: Education & Outreach
Undergraduate from a Research Institution
Ryan Hannahoe
Montana State University-Bozeman – Education

An MSGC Sponsored Education, Public Outreach & Affairs Internship with the NASA James Webb Space Telescope Mission

Later this decade, the James Webb Space Telescope (JWST) will launch from Earth to unlock some of the most thought provoking questions of our time. JWST is the successor of the Hubble Space Telescope, stands 3 stories high and spans the size of a tennis court. This telescope will reside 1-million miles from our planet. JWST will study the formation of galaxies, planets outside of our Solar System, and newborn stars, by using the infrared part of the Electromagnetic Spectrum. In my presentation, I will give a brief overview of JWST and discuss what it was like to intern on the mission's Education, Public Outreach & Affairs Team. I will also speak about leading the development of and co-authoring educational content for jwst.nasa.gov and the Smithsonian's National Air & Space Museum, as well as assisting with the professional development of educators at the NASA Goddard Space Flight Center.

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Session: Education & Outreach
Undergraduate from a Research Institution
Alyssa Peck
Montana State University-Bozeman - Mathematical Sciences

Methods for exploring life course trajectories of MSGC significant award winners

Montana Space Grant Consortium, MSGC, is a NASA funded education and outreach program geared to promote Science, Technology, Engineering, and Mathematics (STEM fields) to the public. Since its inception in 1991, 107 fellowships and 371 scholarships have been awarded to students intending to pursue STEM related fields with special consideration given to underrepresented groups such as women and ethnic minorities. The assessment of programs such as the Montana Space Grant Consortium often involves tracking students' career paths in the years immediately following their funding. Those paths often follow complex trajectories through different work and school experiences, modeled as a variety of different discrete states, or categories. Methods have recently been developed for modeling these "life trajectories" that allow investigation into the influence of different students in defining those trajectories and for explorations for the grouping of typical patterns of trajectories. This project will attempt to process the current MSGC data base into a useful format and assess the different methods available for this type of analysis. Because of limited information currently available, a simulated data set will be constructed to illustrate the use of the methods. The current data set has issues with missing observations and follow up information on students has only been collected since 2005. As a result of this and the intention of MSGC to continue collecting student data, this project will focus on the potential use of these methods for program assessment.

Session: Education & Outreach
Undergraduate from a Research Institution

Hillary Stacey
Montana State University-Bozeman – Chemistry and Biochemistry

Astrobiology and Montana

Montana has a special place in the world of astrobiology. Yellowstone National Park is home to some of the best analogs to extreme life and even a possible origin of life. Why do we study the origin of life, and how are we studying it? Astrobiology matters in Montana.

Session: Education & Outreach
Group Presentation

Ryan Hannahoe and Gustav Nollmeyer
Montana State University-Bozeman – Education, Statistics
Mary Leonard

Turning Eyes to the Big Sky Project: Learning Optics in Middle-School

The Turning Eyes to the Big Sky Project (TEBSP) offered public schools in southwestern Montana a unique opportunity to strengthen science instruction. The project implemented, in a formal setting, a nationally established informal science curriculum on light and optics, the Hands-on Optics Terrific Telescopes Curriculum (TTC). TTC was implemented in 16 elementary and middle school classrooms, reaching 408 students during the 2010/11 school year; this presentation reports on the middle-school sample of TEBSP. As part of the project, we conducted a teacher workshop and assessed student learning outcomes and teachers' experiences with the curriculum. The goals of our assessments were to improve our understanding of how students learn key optics-related principles, provide evidence of the learning outcomes of TTC, and to find out how teachers adapt it for use in formal settings. Our research established that students in every TTC classroom learned optics concepts, uncovered new non-scientific conceptions students have about optics, and identified ways to support and supplement the curriculum for use in classrooms.

Session: Poster
Undergraduate from a Research Institution
Katherine Babbitt
Montana State University-Bozeman – Mechanical Engineering

Design and Development of a Seebeck Coefficient Measurement System

Numerous processes in today's world generate wasted heat energy. The use of thermoelectric materials, a unique group of materials capable of directly converting a temperature difference to electrical energy, is one such way to harness this wasted heat. Thermoelectric materials act as solid-state devices with no mechanical moving parts and, thus, are completely silent and available in very small to large configurations for modularity in a wide range of heat recovery applications. One way to characterize the capability of a thermoelectric material is by determining the material's Seebeck Coefficient. The Seebeck Coefficient is the measure of a material's efficiency at producing a voltage from a temperature difference. The objective of this project was to design and build a Seebeck Coefficient measurement system in order to characterize a variety of thermoelectric materials. The system will be integrated with Agilent Benchlink Data Logger program in order to record temperature differences and voltage differences. With this data, the optimal temperature difference to produce the maximum output voltage can be determined for the material. This measurement system will be used in later research in order to determine the Seebeck Coefficient of compound semiconductors fabricated through the use of a directional solidification furnace.

Session: Poster
Undergraduate from a Small Institution
Matthew Barton, Steven Barton, Richard Shular
Montana State University-Billings – Physics

Thermally Assisted Laser-Induced Fluorescence of Atomic Sodium

Research to determine flame temperature using thermally-assisted laser-induced fluorescence (TALIF) is described. TALIF is a form of laser-induced fluorescence that uses the thermal energy from a flame to further redistribute the population of laser-excited electrons to neighboring energy states. In this work, sodium atoms were aspirated into a flame and then excited using a two-photon process. Each of the two photons have a wavelength of 578.89nm, which excites the ground state electrons to populate the 2D5/2,3/2 excited state. The laser-excited electrons are collisionally redistributed to higher energy levels. The densities of these states are described by Boltzmann statistics. The TALIF signals are spectrally-resolved using a 1-meter monochromator, and detected with a photomultiplier tube (PMT). The resulting signals are recorded with a box car averager interfaced with LabVIEW. The intensity of the LIF signal is directly proportional to the sodium concentration, however, as long as the concentration is held constant, this does not play a role in the relative intensities resulting from TALIF. Because distribution is temperature dependent, the recorded relative intensities of the TALIF signals can be used to determine the temperature of the flame. This technique could be altered for use with any flame, from the natural gas-compressed air flame, as was used in this set up, to plasma torches where temperatures range from 7,000K to 20,000K. Using TALIF to determine flame temperatures offers the advantage of being a non-intrusive method that has a high degree of spatial resolution. Traditional mechanical methods can perturb the flame and fail at higher temperatures. The TALIF method also has the advantage of having stronger signals over other spectroscopic methods such as emission spectroscopy.

Session: Poster
Undergraduate from a Research Institution
Tim Basta, Jason Creighton, Brendan Lawrence, Garrett Peebles
Montana State University-Bozeman - Mechanical Engineering, Electrical Engineering, Earth Sciences

Balloon Borne Optical Alignment System

High altitude balloons represent a time and cost-effective means of deploying payloads to the edge of space. At float altitude, ~125,000 feet, very little of the Earth's atmosphere remains and astronomical observations can be made in absence of atmospheric distortion. One of the many challenges associated with making astronomical observations from a balloon is the need for a control system that will orient the optical device, such as a telescope, to a fixed location in the sky. In this poster we will describe our design concept for the control system we will be building, that will compensate for any motion in the balloon platform to orient a narrow-field instrument such as a solar telescope or a coronagraph. The orientation of the alignment system will be based on an inertial measurement unit and a global position system to determine the attitude and heading of the balloon gondola. In order to maintain the sun within the field of view of the telescope the output from these devices will be interpreted and corrections will be made to the alignment system within a resolution of 1 arc minute. Verification of the performance of the system will be made by taking photographs or video through a solar telescope or coronagraph over time.

Session: Poster
Undergraduate from a Small Institution
Nathan Boll
University of Montana-Western – Mathematics

Molecular Hydrodynamics

This project analyzes the fluid dynamics of individual particles on the molecular scale during chemical reactions within an aqueous flow path of small radius. This motion is governed by a synthesis of ideal flow and stochastic Brownian motion, and manipulated through the application of controlled temperature gradients. Various computer simulations were performed utilizing MATLAB which demonstrated the significant changes in displacement associated with corresponding temperature gradients. The results may be useful in drug delivery systems and nanotechnologies.

Session: Poster
Undergraduate from a Research Institution
Fredrick Bunt, Edward Kleinsasser, Kelly Lennard, Katie Roskilly
University of Montana-Missoula - Physics and Astronomy

Ripple Mark Mapping-Camas Prairie Project

The focus of this project is on the integration of a three-dimensional camera system and a tethered balloon to attain stereoscopic photographs of the prominent glacial ripple marks in Camas Prairie Montana. Our objective with the UM-BOREALIS tethered balloon is to create a three dimensional image for a digital elevation model (DEM) of these ripple marks left over from Glacial Lake Missoula. The uses of such a model include potential comparison data for the Mars Science Laboratory Mission. In 2011 stereoscopic images were taken in the area, but at too low resolution to achieve the desired geospatial accuracy and precision of .5 feet. This poster will outline previous work done on the project and future enhancements to be initiated this summer.

Session: Poster
Undergraduate from a Research Institution
Andrew Crawford
Montana State University-Bozeman – Mechanical Engineering

Multiple Spacecraft Adaptability for Small Satellite Ground Operations

The Multiple Spacecraft Adaptability for Small Satellite Ground Operations research involves analysis of MSU's and Space Science and Engineering Laboratory's current small satellite ground operations and mission procedures, and adapting those procedures for compliance with upcoming multi-spacecraft missions. With the recent successful launch of Montana's first satellite, HRBE, currently in Earth orbit collecting and down-linking science data to MSU, there is a fundamental need to examine lessons learned and ground operations efficiency, in advance of the upcoming FIREBIRD satellite launch and mission, which involves multiple spacecraft. The Space Science and Engineering Laboratory is currently configured to run in-house ground operations of spacecraft, including down-linking of science data, up-linking commands to the spacecraft, and monitoring the spacecraft systems health from the space telecommunications operations center located within the lab. With the upcoming FIREBIRD mission slated to launch in 2013, which involves two spacecraft, fundamental changes and new configurations regarding the ground station operations need to be researched and implemented. Research involves antenna-tracking capabilities for multiple spacecraft, data-download and transmit paths using multiple ground station computers, as well as current equipment feasibility and compatibility to handle multiple transmit/receive functions simultaneously from two spacecraft. The research will provide fundamental configuration options for future missions.

Session: Poster
Undergraduate from a Small Institution

William Dixon
Montana Tech - Electrical Engineering
Matt Donnelly

Accuracy of Power System Phasor Measurements in Noisy Signal Environments

The bulk electric power grid is being subjected to an increasing level of stress as many factors, including the need to integrate more renewable energy sources, place ever-increasing demands on the existing infrastructure. Phasor Measurement Unit (PMU) technology is being promoted as one tool in a broad strategy to more actively control the bulk power grid. PMUs are devices which measure electrical waves on transmission lines, the electrical grid, substations, etc. Many PMUs can be used as protective relays, measurement devices, and perform synchronized real-time measurements. PMUs are considered one of the most important measuring devices for the future of power systems and the smart grid. A PMU is, in essence, a digital filter. As such, the device's frequency response characteristics can be managed to suit a particular need. One application for a PMU is to assess and control electromechanical oscillations on a power grid. These oscillations can pose a serious reliability risk; they can, if left unchecked, cause regional blackouts of the grid. The research will consist of inputting known abnormal waveforms into a PMU. Using signal processing the PMU's output data will be analyzed and interpreted in order to further the understanding of how the PMUs filter works.

Session: Poster
Undergraduate from a Research Institution

Kyle Gray
Montana State University-Bozeman - Electrical Engineering
Dale Hiscock, Ethan Keeler, Wataru Nakagawa

Optimization of Polarization-Resolved Silicon Nanostructure Characterization System

In order to characterize silicon optical nano-structured devices involving polarization manipulation, a suitable measurement system is needed. In this work, we describe several improvements that have been made to such a system, in order to improve its performance and ease of use. These improvements address a number of functional aspects of the system, including the sample handling mechanism, the polarization stability, system calibration, and the data collection software. In addition, example measurements on polarization-selective nano-structured optical devices made using the improved system are presented. This information can be used to improve both the design and manufacturing processes for these devices, enabling the development of novel nano-structured optical devices for interdisciplinary applications.

Session: Poster
Undergraduate from a Small Institution
Judy Hudgins
Salish Kootenai College - Computer Engineering

SKC CubeSat

The Salish Kootenai College (SKC) CubeSat is a 10x10x10cm, less than 1.33kg, miniature satellite that will be the first Earth-orbiting satellite built by students and faculty from a Native American educational institution. The primary mission objectives are: 1. Provide SKC engineering and science students with design, test, and flight operation experience, 2. Expose tribal college students to NASA focused careers, and 3. Targeted image acquisition of the Flathead Indian Reservation. The science objective of the SKC CubeSat will be to perform atmospheric and hydrologic science measurements from SKC CubeSat imagery. The SKC CubeSat team will follow the NASA systems engineering project life cycle for the design, build, and flight of its CubeSat. The SKC CubeSat team has been awarded a slot on a launch vehicle set for the fall of 2013 or 2014, through the NASA CubeSat launch Initiative. If successful, the SKC CubeSat will be in a low earth orbit that periodically passes over the Flathead Indian Reservation, allowing it to complete the primary mission and science objectives.

Session: Poster
Undergraduate from a Research Institution
Jeff Ibey, Jamesen Motley, Virginia Price, David Riesland
Montana State University-Bozeman - Mechanical Engineering, Physics

Spectrography in Industry: Detecting Contaminants on Metal With a Solar Spectrograph

In industry, contaminants such as oils left on materials after machining can pose problems. This project details the process of designing, fabricating, and building a spectrograph which uses a series of mirrors and a diffraction grating to determine the presence of contaminates on a metal sheet using the sun as a light source. Wavelength and intensity are recorded with high resolution using low-cost materials. As maximum resolution is the goal, every element of the design has this consideration. The optic configuration used is the Czerny-Turner configuration, which allows mirrors to be individually adjusted to produce the best resolution. Also, only one intensity sensor was used to travel through the entire spectrum, recording intensity vs. wavelength. This both minimized the cost and increased the resolution of the measurement.

Session: Poster
Graduate Student
Casey Kanode
Montana State University-Bozeman – Science and Natural History Film Making
Adam Kobelski, David McKenzie, Kate Webbink, Kathryn Williamson

The Space Public Outreach Team (SPOT)

The Space Public Outreach Team (SPOT) provides free presentations about current NASA missions to Montana schools, youth programs, and community groups. The interactive SPOT presentations utilize slides, videos, animations and an inquisitive approach to relay the excitement of new discoveries in space science. NASA research and careers here in Montana are highlighted in each show. Graduate student managers coordinate with teachers to schedule a visit. Then, undergraduate presenters from a variety of majors are recruited learn the presentations and travel to schools to give the presentations on-site. Presenters usually travel in male-female teams and serve as enthusiastic college role models for the younger students. The presenters also bring a “Teacher Pack” of additional information, posters, and handouts for the teachers to share with their students after the SPOT presentations. During the 2009-2010 and 2010-2011 school year, SPOT reached over 10,000 Montana students, including many students from rural and underrepresented communities.

Session: Poster
Graduate Student

Casey Kanode and Kathryn Williamson
Montana State University-Bozeman – Science and Natural History Film Making, Physics
Angela Des Jardins, Joey Key, David McKenzie, Shannon Willoughby

NASA Education Activity Training (NEAT): Professional Development for Montana K-12 Teachers

Piloted during the 2011-2012 academic year, the NASA Education Activity Training (NEAT) teacher workshop program has introduced five solar astronomy and space weather activities to over forty Montana K-12 teachers. Because many Montana schools are geographically isolated (40% of Montana students live more than 50 miles from a city) and/or serve traditionally underrepresented groups (primarily Native Americans), professional development for teachers can be costly and time consuming. However, with funding shared by the Atmospheric Imaging Assembly EPO team and the Montana Space Grant Consortium, graduate student specialists are able to host the two-hour NEAT workshops on-site at the schools free of charge, and participating teachers earn two continuing education credits. Leveraging the existing catalogue of research-based NASA activities, the featured NEAT activities were chosen for their ease-of-use and applicability to Montana science standards. These include three advanced activities for older students, such as a paper plate activity for the June 5th, 2012 Transit of Venus, Kinesthetic Astronomy, and the Herschel Infrared experiment, along with two simpler activities for the younger students, such as Solar Cookies and the Electromagnetic War card game. Feedback surveys show that NEAT workshop participants were interested and engaged in the activities and planned on using the activities in their classrooms. With such positive responses, the NEAT program has been a huge success and can serve as a model for other institutions looking to increase their space public outreach and education.

Session: Poster
Undergraduate from a Research Institution
Richard LeCoultre
University of Montana-Missoula - Division of Biological Sciences

Processing of ribosomal RNA in Borrelia burgdorferi

Borrelia burgdorferi, the microorganism that causes Lyme disease, has a unique organization of the genes encoding the ribosomal RNAs in its genome. Ribosomes catalyze translation, the synthesis of proteins, which is an essential process in all cells and the target of many antibiotics. Ribosomes are composed of both ribosomal RNA (rRNA) and ribosomal proteins. rRNA is responsible for most of the crucial activities in translation. The rRNA is generated by transcription, processed by ribonucleases (RNases), and then assembled into ribosomes. My project focuses on an effort to obtain an understanding of the mechanism by which ribosomes are produced in B. burgdorferi. I hypothesize that RNase III processes the largest rRNA, based on precedence in other bacteria, and I have used a biochemical approach to study the role of RNase III. I have produced recombinant RNase III and an artificial RNA substrate to perform binding, cleavage, and kinetics assays. In addition, I have determined the rRNA processing sites using 5’ Rapid Amplification of cDNA Ends (RACE) on the small subunit rRNA. These analyses enable me to determine whether and how processing of these subunits is taking place. A significant outcome of this data is to contribute to knowledge of ribosome biogenesis in an organism with an unusual rRNA gene organization. Furthermore, my results could provide insight for new antimicrobial therapies against Lyme disease.

Session: Poster
Undergraduate from a Research Institution
Genevieve Lind
University of Montana-Missoula - Biology

Mapping male aggression and courtship circuitry: characterizing octopamine and GABA neurons in the Drosophila brain

All animals, including humans, must respond to environmental and social cues in order to survive. Behavioral responses to the environment typically involve extensive neural networks and complex genetic interactions. I am using the fruit fly, Drosophila melanogaster, as a model organism to examine the neural networks involved in aggression and reproductive/courtship responses to social cues. Recent studies indicate that courtship is the default behavior for a male fly. In response to a second male fly, courtship must be inhibited in order for aggressive behavior to be initiated. Gamma-aminobutyric acid (GABA) is the predominant inhibitory neurotransmitter in many organisms including Drosophila as well as humans, and could be a potential mechanism through which courtship is inhibited and the transition to aggressive behavior is made. In addition, previous studies have established the octopamine (OA) neuromodulatory system as an important component of the choice between aggression and courtship behavior. Male flies with altered OA levels display elevated levels of male-male courtship and reduced levels of aggressive behavior. Using several genetic expression techniques and confocal microscopy, I identified a subset of OA neurons that also express GABA. Furthermore, I determined this octopamine-GABA neuronal subset also expresses male forms of Fruitless (FruM), a gene necessary for the establishment of sex-specific behaviors. This distinct subset of neurons expressing a neuromodulator (OA), an inhibitory neurotransmitter (GABA), and male specific proteins (FruM), could play a critical role in regulating behavioral transitions between courtship and aggression. We are currently examining the behavioral effects of manipulating the activity of these neurons in courtship and aggression assays. Understanding the neural networks involved in behavioral responses to the environment in Drosophila could lead to our understanding of behavior in higher organisms, including humans.

Session: Poster
Undergraduate from a Research Institution
Lars Osborne
Montana State University-Bozeman – Electrical Engineering
Michael Zwach, Matt Carberry

Lunar Micro-Rover Project

The Lunar Micro-Rover (LMR) Project has been ongoing since 2006, engages students in the development of prototype spacecraft and rover systems. The micro rover exists as a test bed demonstration for this need and applies modern technology to a rover allowing the capability of exploring other planetary surfaces. The devices contained within our Lunar Micro Rover (LMR) allow the rover to support micro-payloads, lunar exploration, and remote operation. Additional measures to extend mission time for surface exploration involves the implementation of phase change materials for thermal management and radiation mitigation.

A fleet of 6 rovers have been developed in roughly four years, each developed from inception to fully functional in under 10 weeks. Field tests such as the NASA D-Rats simulation have provided means for demonstration of rover capabilities. Further technologies under development for the project include improved thermal control for greater flexibility in mission scenarios, improved filtering and optimization methods for inertial measurement and navigation, and real-time fault-tolerant software design.

Session: Poster
Undergraduate from a Research Institution

Deborah Ross
University of Montana-Missoula – Physics
Jeanette Comstock

Case study using mobile sounding station to improve short term weather forecasting

It has been agreed upon by the meteorological community that the current radiosonde network being the "backbone" for upper air observations has limited temporal and spatial samples. An increase in either temporal or spatial resolution would be exceedingly helpful (Kaiser, Pevear 2009). Additionally, it is well known that accurate weather observations improve spot weather forecasts, a special forecast issued to fit the time, topography, and weather of each specific fire. Radiosonde data is used to initialize numerical models for weather forecasting. The current spatial resolution of radiosonde data in Montana is 500km and the data is retrieved two times daily. We will establish and test a methodology to assess the degree of improvement provided by short-term weather forecasts issued for a particular location using input parameters from a mobile radiosonde sounding system at the same location hence increasing spatial resolution to approximately 8km from the forecast site.

Session: Poster
Undergraduate from a Small Institution

Tashina Russette
Stone Child College - Natural Resources

Normalized Difference Vegitation Index (NDVI) Comparing

In our research we wanted to use the tethered blimp camera system. We looked in to finding the Normalized Difference Vegetation Index of some plants in the Stone Child College garden and wanted to test and compare to find out what would be a better method for determining their health. To get our results we took pictures of the sweet grass bed in our garden, with the tethered blimp using the NDVI camera system; we also took samples of fresh sweet grass and looked at them using the reflectance spectrometer. We did the math and observed the pictures and came up with the conclusion which method would be a better method for measuring NDVI of our garden. From the data we gathered we analyzed them and came to a conclusion that the NDVI camera system is a more productive way of measuring the health of the sweet grass bed.

Session: Poster
Undergraduate from a Research Institution
Sam Sorensen
Montana State University-Bozeman - Computer Science
Nathan Little

Atmospheric Profiling Sensing Module

High-altitude balloons represent an ideal way to engage students (middle school – university) in the study of the vertical structure of our atmosphere. Two of the most measured quantities are pressure and temperature as they have very predictable characteristics as altitude changes. While these variables are easily measured with readily available commercial products, a major drawback to these devices is that they operate individually and log their data via time. To relate this information to altitude requires computation of altitude from the pressure data or the use of a GPS to acquire altitude data. The end result is a series of independent measurements, each typically in a different time base, which makes the analysis of how temperature and pressure changes versus altitude difficult. While the university student may find the exercise of interpolating the different data sets onto the same time base stimulating so that pressure/temperature can be plotted directly versus altitude, middle or high school students typically don't possess these skills. A simple solution to this problem is to have a data logger that simultaneously records all of the data. We present here a module based on the ATmega32A microcontroller that contains an on-board GPS system and sensor inputs for the measurement of temperature, pressure, and outputs from other sensors. The module is flight compatible, and the data output is inherently all on the same time base which facilitates the examination of how temperature, pressure, and other experimental variables change as a function of altitude.

Session: Poster
Undergraduate from a Small Institution
Noel Stewart
Salish Kootenai College - Hydrology

Storm and Climate Impacts on Seagrass Habitat Suitability

This project analyzes storm and climate changes in the Mobile Bay and adjacent estuaries that affect sea grass habitat suitability and speciation. Storm and climate changes that affect sea grass habitat suitability and speciation are important, because fisheries are key, to the Mobile Bays economy. By analyzing the impacts of five storms' temporal and magnitude affects when storms occur, we will be able to determine which storm had the greatest impact on salinity changes. Then we will be able to determine sea-grass habitat suitability and spec by comparing habitat thresholds to climate data for 2025 and 2050. This research may provide a better understanding of how storm occurrence affects environment; which in turn could have detrimental effects on economic prosperity.

Session: Poster
Undergraduate from a Research Institution
Hannah Susorney
Montana State University-Bozeman – Earth Science
David Lageson

Displacement History in the Wedges Region of Europa

Europa, a moon of Jupiter, is of great interest to planetary scientists and astrobiologists due to the presence of a liquid ocean under its icy crust. The tidal forces due to the interaction of the other Galilean Satellites and Jupiter provides the energy needed to sustain a liquid ocean. The tidal forces also create a tectonically active crust, overlying the ocean, with ridges, chaos terrain, domes, pits, bands and relatively few craters. The Wedges Region (approximately 200 by 300 km in size) is located in the trailing anti-Jovian quadrant and is crisscrossed with both ridges and bands. These features show displacement from one another, when crossed by a younger ridges or bands. The bands are believed to be areas of spreading, while the ridges are believed to represent cracks caused by changing tidal stress fields. These features were mapped using Adobe Illustrator to show their relative ages with respect to each other. The ages were divided into seven arbitrary categories and the displacements were mapped within each age group and displayed using rose diagrams. Understanding the displacement history of Europa can assist in understanding the stress history the crust has undergone. This can reveal important information about the crusts' degree of activity, which can assist in understanding the behavior of the liquid ocean below.

Session: Poster
Undergraduate from a Research Institution
Wade Wilkison
Montana State University-Bozeman – Mechanical and Industrial Engineering

Characterization of Initial Flight Path by Optical Applications and Sensor Technology

Initial rocket flight movements, although small, are crucial and can significantly impact the overall flight path and chances for success. In small rockets, powered by various model engines, there is large variability in construction and performance that can have disastrous effects without caution and adherence to recommended standards. These flight movements and associated safety issues were studied previously resulting in the current model rocket regulations defined by the National Association of Rocketry (NAR). The focus of this research project was to determine whether current standards are adequate for safely maintaining and monitoring amateur rocket projects. Four test status categories were established to examine launch and safety conditions for n=16 rocket launches. First, all initial preparation was categorized as "setup stage follows regulation". Secondly, the launch environment itself was analyzed in terms of personnel safety. All 16 launches followed these basic regulations and therefore met organizational or specific personnel regulations. The third safety category was the flight path, which ranked each path based on the angles of deviation from vertical. "Safe flight" was defined as 0 to 10 degrees, and "moderate concern" was defined as 10 to 30 degrees. Optical images were gathered using a Canon 60D and angles were determined using image analysis with Image J software. All flight paths of the first 8 launches were categorized as "safe flight" with mean difference of 2.856+/-1.322. In the second flight series only 2 flight paths fell outside the "safe flight" range at values of 10.48 and 10.79 degrees. This series averaged 7.37 ± 3.09 degrees. Finally, the fourth testing category included the deployment of a parachute or drag inducer and landing implications. Two launches did not fully deploy a drag inducer but all 16 launches resulted in safe and undamaged landings. In conclusion, the NAR regulations appear sufficient: there were no injuries or damage during this study and almost all launches (14/16 = 87.5%) were defined as "safe flight." These data emphasize the benefits of defining and using well-established protocols for rocketry safety. Proper adherence to NAR regulations can result in research, education, and enjoyment.

Session: Poster
Graduate Student
Kathryn Williamson
Montana State University-Bozeman – Physics
Shannon Willoughby

Student Understanding of Gravity in Introductory College Astronomy

Understanding gravity is foundational for astronomy students to understand planetary and star formation, the motion of satellites, and the general behavior of bodies in space. Investigations of student understanding of gravity have mainly focused on young children, and the few studies of college students are limited to one or two questions in Physics-specific contexts. The present study is the first comprehensive study tailored specifically to introductory college astronomy students' understanding of gravity. Twenty-three free-response questions and fifteen student interviews were used to explore student understanding of gravity in a variety of contexts, including the strength of gravity in and around Earth, throughout the solar system, and in hypothetical situations. The exploratory, open-response format allowed themes to emerge naturally, and in addition to the typical documented misconceptions about gravity, previously undocumented misconceptions were observed. The breadth of questions allowed for descriptions of possible student mental frameworks, including alternative models that will guide distractor choices in the future development of a multiple-choice Gravity Concept Inventory.