COLLEGE OF SCIENCE

BIOLOGICAL SCIENCES  ■  CHEMISTRY  ■  MATHEMATICAL SCIENCES
PHYSICS & SPACE SCIENCES  ■  SCIENCE & MATH EDUCATION

April 9, 2010
11:00am — 4:00pm
Clemente Center for Sports & Recreation
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Tell me, and I forget; show me, and I remember; let me do and I understand. “Chinese Proverb”. Undergraduate research has been a cornerstone of undergraduate majors in the College of Sciences for decades. Its value as an educational component in the undergraduate experience was enhanced by the university-wide Quality Enhancement Program (QEP). All majors must complete a senior-level project as a graduation requirement for their Bachelor of Science degree. Students work with faculty to conceive, conduct, and present their projects at a local, state, or national meeting. Many of our departments have embraced the traditional single faculty mentor-student apprentice model of undergraduate research. Anecdotal information suggests that many students choose to pursue graduate work in the sciences or related disciplines as a result of their undergraduate research experiences.
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A Comparative Analysis of DBH & Angle of Lean in Old Growth Trees of a Sand Pine Plot

Megan Lizotte, Stephanie Rewitzer, Jacob Zehnder

Faculty Advisor: Dr. Mark B. Bush

Forestry management requires mathematical models in order to properly predict and prepare for events that can cause severe damage to the forests. In areas prone to high winds or hurricanes, these models take on a very specific role. These models must accurately predict not only the extent of the damage that is likely to happen but also which stands or species of tree will be most affected. These models work on both the stand level and individual tree levels of organization, but the models make large generalizations in order to function: such as uniform stand composition or a generic type of tree structure. If these models are to continue to increase in accuracy and usefulness they must be applicable to more specific habitats and ecosystems. Using a simple methodology, the influence of tree diameter at breast height (DBH) will be tested for a correlation with wind-induced angle of lean. This study will attempt to address the importance of DBH and how it needs to be included in these models in a species and habitat specific approach and not a generic common tree approach. This will also be a building block for further studies into the significance of various tree factors and how they relate to stability damage resistance in high wind events.
COS - 2
An Analysis of the Effect of Canopy Cover on Seedling Growth and Germination
A.C. Hannon III, K.M. Heckman, T.K. Man
Faculty Advisor: Dr. Mark B. Bush
The study and understanding of the relationship between sunlight and the number of germinating seedlings is of vital importance for forestry management and sustainability. The amount of sunlight that is available to photosynthesizing plants is one of the driving forces in determining the species makeup of a forest. In the study that was conducted, we aimed to analyze how the percentage of light that breaks through the canopy effects germinating seedling on the forest floor. We hypothesized that an increased amount of sunlight exposure would increase the number of seedlings. The statistical tests ran indicated that there was no strong correlation between the number of seedlings and the amount of light penetrating the canopy within each plot, but that there was an ideal relationship between the two plots when compared against one another.

COS - 3
Effects Of Prey Type On The Prey-Capture Kinematics Of The Cryptic Coral-Reef Fish Taenianotus triacanthus
A.C. Hannon III, B.M. Compton
Faculty Advisor: Dr. Ralph G. Turingan
The ability of fishes to capture different types of prey depend on their ability to modulate their feeding behavior depending on the size, morphology, escape response and swimming ability of their prey. This phenomenon is seldom tested in cryptic predators, such as Taenianotus triacanthus. This study was designed to examine the prey-capture behavior and to determine the effects of prey type on the prey-capture kinematics of T. triacanthus. Fish were filmed using a Red Lake high-speed video camera while feeding on live fish, Gambusia affinis, live ghost shrimp, and dead G. affinis. Results indicate that prey does have an effect on the kinematics of prey capture in T. triacanthus. T. triacanthus rapidly opened and closed its jaws when feeding on elusive prey compared to their strike behavior when they feed on non-elusive prey. This study provides information that helps us understand how predators adapt to changing environmental conditions, particularly the availability of prey resources.
Formation and Growth of Vertebrae In Brittlestars: Do Ossicles Ever Fuse?

Helen M. Croce

Faculty Advisor: Dr. Richard L. Turner

It has long been thought that vertebral ossicles in brittlestar arms evolved by fusion of paired ambulacral ossicles. Researchers examining the development of ophiuroids often focused on external rather than internal features, and, due to the presence of the ventral and lateral arm plates, development of the vertebrae has not been well studied. Here, the development of vertebral ossicles in *Ophiophthalmus filograneus* (Echinodermata: Ophiuroidea) near the growing tip of the arm was examined. Arm tips, cleaned of soft tissue with bleach, were studied using scanning electron microscopy. It was found that vertebral ossicles originate under the terminal plate in halves of unequal size, suggesting alternated development. These two halves grow towards one another with much branching of the stereom, eventually interdigitating in the manner of a three-dimensional jigsaw puzzle. As the vertebrae grow, their halves interlock more tightly, creating a suture line, which before has been taken as evidence for the incomplete fusion of the halves. Some evidence of fusion is found in more mature vertebrae, in which the suture line on the distal face was sometimes not visible. Further study is needed to determine conclusively whether fusion, either partially or in full, occurs between the two halves of vertebral ossicles in ophiuroids, or if, as this study suggests, interdigitation forms an immobile joint, here referred to as the rigid ambulacral joint, between the halves.
COS - 5
Stress Catecholamines Regulate Vascular Cell Communication
Alejandro Chavarriaga, Lindsay Pisani and Mikaela Devaux
Faculty Advisor: Professor Lisa Moore
Elevated catecholamine levels are cardiotoxic and the pathologic effects have been attributed to adrenaline. This syndrome has been called stress cardiomyopathy or Takotsubo syndrome. Clinically patients with stress cardiomyopathy exhibit symptoms similar to a heart attack, such as low blood pressure and an irregular heart rhythm. The direct cause of these symptoms is unknown, but it is thought they are induced by microvascular spasm. Gap junctions are specialized ion channels that are ubiquitously expressed in most tissues and responsible for coordinating blood pressure tone and cardiac synchronicity. We have shown that modulation of expression of the two key cardiovascular gap junction proteins occurs when exposed to adrenaline and its metabolites at high concentrations. Alteration of the expression of one or both of the key gap junction proteins (connexins, Cx) has been demonstrated to result in aberrant vessel and cardiac function. In this study, primary rat aortic smooth muscle cells expressing Cx40 and Cx43 were treated with catecholamine and evaluated for changes in the expression of Cx protein, level of p38 MapK activity and effect of an inhibitor of p38 MapK, SB203580 on the cellular response to catecholamine. We have used several techniques to evaluate gap junction protein expression, including western blotting, immunohistochemistry and dye tracer scrape-load techniques with Lucifer Yellow, a dye which moves through gap junction channels but does not cross the membrane. Our preliminary results indicate that the signaling molecule, p38 MapK may play a role in modulating the expression of both Cx40 and Cx43, thus maintaining protein expression at a level similar to that seen in control conditions. Future studies will examine the relationship of p38MapK to the catecholamine response.

COS - 6
The Effect of Increasing Distance From Turkey Creek On The Diameter At Breast Height of Sabal palmetto
Katherine Burton, Shelby DeNeice, Cecilia Finch, Michelle Luce
Faculty Advisor: Dr. Mark B. Bush
In this study, a complex ecosystem was broken down by investigating a specific relationship within Turkey Creek Sanctuary. The interaction studied was the influence that the distance from Turkey Creek had on the diameter at breast height (dbh) of the Sabal palmetto. To perform this study, three quadrats were measured at increasing distances from Turkey Creek. Each quadrant was 15m by 45m. In each quadrant, all sabal palm trees were located with the assistance of a GPS and were measured for dbh using a dbh tape in centimeters. It was hypothesized that the dbh of the sabal palm trees would decrease as their distance from the creek increased. The results were analyzed using an ANOVA test on the log-transformed data. The results of this study showed that there is no significant difference between the mean dbh of the sabal palm trees based on their distances from the creek. These results are supported by the findings of Holbrook and Sinclair (1992) that sabal palm trees are very drought resistant which may be a reason that these trees can grow the same at varying distances from a water source such as Turkey Creek. [Holbrook, N.M., and T.R. Sinclair (1992). Water balance in the arborescent palm, sabal palmetto. i. stem structure, tissue water release properties and leaf epidermal conductance. Plant, Cell and Environment, (15), 393-399.]
The Effect of Predator Presence on the Feeding Behavior of the Indian River Lagoon Fish Gobiesox stumosus Larvae

Amanda Spitery, Joseph E. Kenyon

Faculty Advisor: Dr. Ralph G. Turingan

Predation and starvation are key factors that influence the rate of mortality in marine fish larvae. This hypothesis has rarely been tested on estuarine fishes. This study was designed to examine the stage-specific effects of the presence of a fish predator on the feeding performance of the larvae of the IRL fish Gobiesox stumosus. Three, seven and 11 days post-hatch (DPH) G. stumosus were allowed to eat (rotifers, Brachionus sp.) for 2 hours under two feeding regimes: one in the presence of a fish predator and the other in the absence of the fish predator. Gut contents of the larvae were subsequently examined and compared between the two treatments. Larvae fed in the absence of a predator ate more prey compared to those that were fed in the presence of a predator. Interestingly, the magnitude of the difference in feeding performance between treatments increased with age of the larvae; older G. stumosus larvae were more sensitive to the presence of the predator compared to younger G. stumosus larvae. This study concludes that not only does the presence of a predator affect the feeding performance of fish larvae, but, this effect is magnified with increasing age of the fish larvae.

The Presence of Water Current Influences the Feeding Performance and Growth of Amphioprin ocellaris larvae

David B. Burguet

Faculty Advisor: Dr. Ralph G. Turingan

The ability of marine fish larvae to capture prey plays an important role in their survivorship, especially during the very early stage in their life history. Feeding performance in fish larvae is affected by a number of factors such as prey availability, swimming and feeding behavior, and physical properties of the environment, including water movement. This study attempts to establish a correlation between current speed and the feeding performance, as well as growth in the larvae of Amphioprin ocellaris. A. ocellaris larvae were hatched and reared in different current speeds: 0cm/sec and 1cm/sec. From each rearing environment, 2-day old (2DPH; first-feeding stage) and 4-day old (4DPH) larvae were taken for measurement of gape and examination of food habits. Area of mouth opening was significantly larger for individuals reared in a current compared to those reared in still water (z = -3.165; n = 47; α = 0.002). Larvae reared in moving water also consumed more prey relative to those reared in still water. Notochord length of larvae reared in moving water also were significantly longer compared to conspecifics reared in still water (z = -2.134; n = 93; α = 0.033). These results have important implications for our understanding of the factors that influence the rate of survivorship (or mortality) in marine fish larvae, both in the wild and in captivity.
COS - 9

The Search for Proteins that Interact with the Src Homology Domains of PLCγ at Fertilization

Brooke A. DeRosa

Faculty Advisors: Drs. Mitch Rotenberg and David Carroll

Upon sperm-egg contact, a series of molecular events occur that lead to release of calcium from the egg endoplasmic reticulum. This release of calcium is essential to the development of the embryo. For this to occur, phospholipase Cγ (PLCγ) must hydrolyze PIP2, a membrane phospholipid, into two active molecules: DAG and IP3. While DAG is significant in other metabolic events (such as protein synthesis), IP3 is the molecule that specifically triggers the release of calcium from the endoplasmic reticulum. The influx of calcium is required for egg activation, but it is unclear how these events are set into motion by sperm-egg interaction. Studies have been conducted that explain the mechanism from trigger of calcium release by IP3 back to the generation of this molecule by PLCγ. However, the specific protein that’s responsible for the activation of PLCγ is still a mystery, as is the means by which sperm-egg contact initiates this chain of events. This research addresses the issue of what protein(s) are responsible for the activation of PLCγ. Results from studies of sea urchin eggs suggest that PLCγ is activated after binding of its SH2 (Src Homology) domains to a tyrosine kinase. The goal of this study is to identify what specific tyrosine kinases, or other proteins, are interacting with the SH2 and/or SH3 domains of PLCγ, thereby leading to its activation. To accomplish this, plasmid DNA was engineered to contain the genes for GST, PLCγ SH domains, and GFPR. Bacterial clones transformed with the engineered plasmids were used to produce the translated recombinant proteins. These proteins were then reacted with glutathione sepharose beads to yield GST-fusion beads. These fusion beads are being used in affinity interaction experiments to investigate what protein(s) are binding to and thus activating PLCγ.

COS - 10

Visualization of MAPK Enzymes in the Starfish

Christine Chater, Maxime Michel

Faculty Advisor: Dr. David Carroll

The enzyme Mitogen-Activated Protein Kinase (MAPK) is involved in the regulation of cell growth and differentiation in response to external signals. It is found in almost all cells, including oocytes. MAPK functions in a biochemical pathway that includes the upstream kinase known as MAP Kinase/ERK kinase 1 (or MEK). These enzymes are regulated by tyrosine phosphorylation events, when phosphorylated, they are activated. However, little is known about the exact interaction between the phosphorylated forms of MAPK and MEK in oocytes. Therefore, in the present study, the localization of several proteins of the pMEK-pMAPK pathway was examined using oocytes and sperm from Asterina miniata. Phosphorylation of MEK was stimulated at 30 minutes after addition of the maturation hormone 1-methyladenine. It remained high until fertilization. MEK phosphorylation rapidly decreased following fertilization. The phosphorylated MEK appears to be present in both the cytosol and plasma membrane. Future experiments will confirm this localization and refined the time period of phosphorylation and dephosphorylation of MEK.
Artificial Neural Net Model of PLCγ-dependent Calcium Release and Growth after Fertilization in the Starfish Asterina miniata

Cristina Mazzone, Erin Zingarelli, Adam Hernandez

Faculty Advisors: Drs. Semen Koksal and David Carroll

During fertilization in all plants and animals, there is an increase in the concentration of intracellular free calcium due to the production of inositol 1,4,5-trisphosphate (IP3) by a member of the phospholipase C (PLC) enzyme family. In several animal phyla, including echinoderms, PLCγ is the isoform responsible for calcium release. Furthermore, inhibition of PLCγ activity inhibits both the calcium increase and the initiation of embryonic growth. However, the relationships between these molecules at fertilization has never been tested in a rigorous quantitative manner. To address this issue, an artificial neural net (ANN) was developed to model fertilization, focusing on the contribution of PLCγ, its products (IP3 and diacylglycerol), and downstream effectors (protein kinase C and calcium) to embryonic growth. This is a multilayer hybrid ANN that combines both the perceptron and back-propagation training algorithms. The ANN is currently being tested in the laboratory by inhibition of PLCγ enzyme activity in living eggs via microinjection of a competitive PLCγ-inhibitor followed by microscopic imaging of intracellular free calcium at fertilization. Thus far, only 1/11 eggs injected with between 4.75 – 19 μχρομολαρ PLCγ-inhibitor exhibited any calcium release, compared to 5/5 control-injected eggs. This suggests that there is a threshold level of PLCγ activity that is required to initiate the fertilization-induced calcium increase. Future experiments will focus on testing lower concentrations of the PLCγ-inhibitor to determine if a threshold exists for calcium release and/or for cell growth.
COS - 12
Coral Growth, Partial-Colony Mortality and Whole-Colony Mortality: In Search Of Primary Functions Governing Population Dynamics
K. Llera\textsuperscript{1}, E. Demirci\textsuperscript{1}, L. Roth\textsuperscript{2}, J. Gulbranson\textsuperscript{1}, S. Koksal\textsuperscript{1}, R. van Woesik\textsuperscript{2} \\
\textsuperscript{1}Department of Mathematical Sciences, \textsuperscript{2}Department of Biological Sciences

Faculty Advisor: Drs. Semen Koksal and Robert van Woesik

One of the primary goals of marine ecology is to understand population dynamics by quantifying key processes that govern populations through time. This study sought to quantify coral growth, partial mortality, and coral-colony mortality and determine whether we could estimate some universal constructs. We focused on corymbose \textit{Acropora} colonies, and tracked colonies at windward and leeward sites, at three depths (1 m, 3-4 m, and 6-7 m), on Akajima Island, southern Japan. Our objectives were to: (1) ascertain whether universal probability functions exist for coral growth, partial mortality and (whole) coral-colony mortality, and (2) quantify the dynamics of these three parameters. Coral-colony mortality $p_m(x)$ best fitted a piecewise linear function. Since the sum of probabilities of mortality and survival is one, the function that gives the most accurate survival probability was $p_s(x) = 1-p_m(x)$, at all depths. The probability of relative growth followed a function in the form $p_g(x) = e^{-ax}$, where $a$ was the fitting parameter, suggesting that the smaller the coral colony the higher the relative growth rate. The probability of partial mortality ($p_p$), therefore, was given by the function $p_p(x) = 1-p_m(x) - e^{-ax}$, which showed partial-mortality rates were incorporated within a distinct envelope dependent on colony size. In summary, small colonies did not undergo partial mortality, the highest probability of mortality was when corals were < 10 cm, and partial mortality was greatest at around 20 cm, after which whole coral mortality increased.
A Study of the Fluorescence Characteristics of Betaxanthins

Julie Gama

Faculty Advisor: Dr. Clayton Baum

Fluorescence has recently been recognized as a potential pollinator attractant in plants. Betaxanthins are responsible for fluorescence in certain flowers; these compounds are naturally yellow and lack toxicity so they also are of interest in the food industry. Betaxanthins are found in the roots, fruits and flowers of Caryophyllales plants. Betaxanthins absorb in the blue visible (463-474 nm peak) range and emit in the green (509-512 nm peak) range. Fluorescent patterns are created when surrounding betacyanins, which are violet in color, absorb some of this emission. The purpose of this study is to better characterize the spectroscopic properties of betaxanthins. Pigment from Beta vulgaris (common beet root) was extracted by puréeing half a small beet root in a food processor. Pigment from Bougainvillea was extracted by crushing colored leaves with a mortar and pestle. Both were dissolved in distilled water and diluted so as to obtain maximum useful absorbance values below 0.5. Absorption spectra were obtained of each diluted solution using a Jasco UV/Vis spectrophotometer. Exciting the solutions at their absorbance maxima, fluorescence spectra were obtained using a Fluoromax fluorometer. Initial laser experiments employed a PTI dye laser pumped by a PTI nitrogen laser. The absorption and fluorescence spectra closely resemble those in the literature and display a notable decrease in intensity over days. This is most likely due to the decomposition of betaxanthins in solution. Initial laser experiments examined the decay of fluorescence. The more intense peak at 20 ns is partially due to Raman scattering of water. The second, less intense peak at 150 ns implies an unusual delay between when the molecule is excited and when it fluoresces. Laser excitation of flower pigment fluorescence will be further investigated. Solutions will be purified to some extent and the fluorescence characteristics of various purities will be studied.

A Theoretical Study of Tryptanthrin interaction with DNA

Theresa Kummerer, Mark Novak

Faculty Advisor: Dr. Mark Novak

Density Functional Theory molecular modeling is being used to examine how tryptanthrin may intercalate into the DNA of e-coli and other bacteria through π-π stacking. It is being explored as to whether the intercalation is random or nucleotide specific.
COS - 15
The Oxidation of L-Proline by a Green Chemistry Compound (Ferrate): An Example of an Environmentally Friendly Disinfection Alternative
Meagan Strouse
Faculty Advisor: Dr. Virender K. Sharma

Amino acids are nitrogen-containing compounds which may form harmful disinfection byproducts during the chlorination. They are introduced into the environment through natural occurrence in organisms and through the pharmaceuticals that contain them. Oxidation and therefore removal of amino acids from the environment by the use of ferrate (VI), an environmentally friendly oxidant was examined by studying the oxidation of L-proline, a secondary amino acid, as a function of pH. Primary amino acids kinetics with ferrate have been observed in previous studies, while secondary amine kinetics are not well known with ferrate(VI). The second-order kinetic of the reaction of ferrate(VI) with L-proline was determined as a function of pH. Ferrate(VI) successfully oxidized L-proline. Future studies will include understanding the mechanism of the reaction of ferrate(VI) and L-proline and studying the reaction between ferrate(VI) and proline derivatives.

MATHEMATICAL SCIENCES – 1

COS - 16
Self-Similar Solution Of The Free Boundary Problem For The Nonlinear Parabolic Equation Arising In Laser-Ablation Of The Biological Tissue
Osarhieme Osarenkhoe¹,²
Department of Mathematical Sciences¹, Department of Mechanical Engineering²
Faculty Advisor: Dr. Ugur Abdulla¹

Laser ablation of biological tissues is an important problem of bioengineering. Understanding short pulse laser-tissue interaction is essential in view of a growing number of biomedical applications, such as laser-based therapeutic or surgical procedures, tumor ablation, dermal remodeling etc. In this project, we investigate the free boundary problem for the nonlinear heat equation in an unknown region arising in short pulse laser ablation of the biological tissues. The free boundary problem consists of finding an unknown temperature function along with the unknown free boundary-ablation depth, subject to initial and boundary conditions. Standard mathematical models used in bioengineering are based on the linear heat equation. The novelty of this project is that it is the first time mathematical modeling through nonlinear heat equation is suggested. We look for the self-similar solution of the free boundary problem. The method is based on using scaling properties of the nonlinear heat equation and reducing the partial differential equation to a nonlinear ordinary differential equation. By integrating the latter, we derive a nonlinear integral equation along with transcendent equation for finding the solution. Algebraic necessary and sufficient condition is found for the existence of the solution. Method of successive iterations is used to solve the coupled integral/transcendent equations.
A Case Study: Search for Terrestrial Gamma-Ray Flashes in Thunderstorms Using the Thunderstorm Energetic Radiation Array (TERA)

Crystal L. Latham
Faculty Advisers: Drs. Joseph R. Dwyer and Hamid K. Rassoul
Collaborators: Meagan M. Schaal, Eric S. Cramer

A hot topic in the field of atmospheric sciences is the source of terrestrial gamma-ray flashes (TGFs). TGFs are short powerful bursts of gamma-rays that are observed by low earth orbiting spacecraft like the Compton Gamma Ray Observatory. The BATSE instrument on this observatory has measured these strong bursts of gamma-rays which have had measured energies of up to several tens of MeV. In 2004, Dwyer et al. reported a gamma-ray burst at ground level that exhibited the characteristics of a TGF during the first stages of a rocket that triggered lightning. Over the past five years, the Thunderstorm Energetic Radiation Array (TERA) at the International Center for Lightning Research and Testing (ICLRT) at Camp Blanding, FL has been making ground based observations of thunderstorms as well as rocket-triggered lightning events in the search of TGFs. Analysis of the TERA data measured on June 30, 2009, has been done using a number of IDL programs to determine what the probability, based on a Poisson distribution, of the measured events being background noise is. The lower the probability the more likely the event was a TGF. Using data specifically from events on June 30, 2009, I shall report some initial results of the data analysis.

Automated Detection and Analysis of Bright Points in the Solar Transition Region

Lauren J. Preuss, N. Brice Orange, Hakeem M. Oluseyi
Faculty Advisor: Dr. Hakeem M. Oluseyi

The study of solar atmospheric features has become a hot topic within space sciences today, and the first step in understanding how our sun works is being able to identify its features. We are writing an automated program in IDL that will classify bright elements within the transition region (TR). Being able to identify these features is important for studying space weather and will assist in understanding how the plasma is accelerated within the TR. This is done through three major steps: event detection, event analysis, and event classification. Currently we are using data from Hinode’s Extreme Ultraviolet Imaging Spectrometer (EIS) and the Michelson Doppler Imager (MDI) aboard the Solar Heliospheric Observatory (SOHO). The detection begins by looking for pixels that are significantly brighter than the background, and these pixels are grouped into their proper features. The analysis starts by creating a variety of submaps for each feature that show properties such as line of sight velocity, intensity, and line widths. Once these characteristics have been determined, we can use them to classify the brightenings. In the transition region we are looking for blinkers, explosive events, spicules, and other bright points. In the future this work will be expanded upon to include time series to deduce movement and lifetimes of the features. The program will also include other instruments, such as EIT and TRACE, and this will allow us to model the different brightening events.
COS - 19
Design, Testing and Results of Gas Electron Multiplier Detectors for Muon Ray Tomography Imaging
Alfred Menendez, Michael Abercrombie, Amilkar Quintero, Kondo Gnanvo
Faculty Adviser: Dr. Marcus Hohlmann
Gas electron multiplier (GEM) detectors are a type of micropattern particle detector being developed for 3-D image reconstruction utilizing muon tomography. Muon tomography is a passive imaging process which has applications in detecting contraband nuclear material which could be hard to detect using current methods, such as x-ray imaging or radiation detection. Muons are sub-atomic particles produced by collisions between cosmic rays—which are usually either high energy protons or nuclei from distant galaxies—and the nuclei of our upper atmosphere. In this poster I present the design of a GEM detector, several performance test results, and some preliminary results from our detector here at Florida Tech.

COS - 20
Exoplanetary Atmospheric Composition Detection Method
Kristie Llera
Faculty Advisor: Dr. Joseph R. Dwyer
How can we expand our techniques in determining exoplanetary atmosphere compositions? For one, by applying pre-existing theories in a new light; relating transit elapsed time and frequency dependent light curve dips to optical depth and spectral characteristics through the atmosphere. Light curve dips from an exoplanet transiting the much brighter host star, are obtained by frequency in real time. If that exoplanet supports an atmosphere, then the light curve is different by frequency. Analyzing elapsed times in the ingress, in-between, and egress stages, as well as, the relative magnitude dip, vary with frequency. Using this time-lapse data in conjunction with spectroscopy, the composition of the atmosphere can be determined, or at least be able to narrow the possibilities. My ultimate goal was to first create one-molecule atmosphere transits producing emitted spectra and light curve data to compare opacity inferences to the spectra for the modeled interaction. So far in theory, I should be able to match some characteristics of the light curve to calculate optical depth of a frequency. The interacting cross section through the atmosphere increases with the elapse time of the ingress stage. When max optical depth is reached, the delayed ingress should begin at this time since the path length is increasing. The simplified optical depth calculation is dependent on radius and line-of-sight overlap width from the exoplanet and star.
COS - 21
Geothermal Energy: From the Earth to Your Outlet
Laurel Borgias
Faculty Advisor: Dr. Joseph R. Dwyer
One of the world’s leading concerns is the production of energy. Currently, the leading source of energy comes from non-renewable, and quickly diminishing, fossil fuels. Great efforts are being made to research and develop other sustainable and renewable energy sources. One such sustainable source, geothermal energy, has been a neglected field for many years due to logistical difficulties in harvesting it. Developments in science and industry have made large scale production of geothermal energy more practical than ever before. To properly utilize this source, it is important to understand the theory behind production.

COS - 22
Gravitational Wave Propagation
Andrew Gibson
Faculty Advisor: Dr. Joseph R. Dwyer
The purpose of this research is to determine the propagation speed of gravitational waves. The research begins with Einstein’s theory of general relativity and proceeds first by understanding the math used in Einstein’s field equations. The equations are then solved in a linearised form under a weak-field limit to show that gravitational waves propagate at the speed of light. Having shown the conclusion to the main problem, this research then expands to the proof of gravitational waves’ existence and the consequences of the propagation speed of gravitational waves. The only proof of the existence of gravitational waves is indirect as first shown in the observations of the Hulse-Taylor binary system. Efforts for direct detection include the LIGO and LISA projects, which if successful would open up a new field in observational astronomy. This new field would open up new areas of the universe which are currently unreachable to astronomers using electro-magnetic radiation due to the non-interacting nature of gravitational waves with matter and the phase coherence of the waves.
Investigating LSST’s Sensitivity to Periodic Stellar Variability Using RR Lyrae Stars

K. Hoadley\textsuperscript{1}, Hakeem Oluseyi\textsuperscript{1}, I. J. Allison\textsuperscript{2}, A. Becker\textsuperscript{3}, C. S. Culliton\textsuperscript{1}, M. Furqan\textsuperscript{1}

\textsuperscript{1}Florida Institute of Technology, \textsuperscript{2}Alabama A&M University, \textsuperscript{3}University of Washington

Faculty Adviser: Dr. Hakeem M. Oluseyi

We have investigated the Large Synoptic Survey Telescope’s (LSST) capability to recover RR Lyrae lightcurve periods, shapes and Fourier parameters as a function of apparent magnitude and LSST survey length. An LSST simulation tool was used to sample authentic ugriz RR Lyrae lightcurves as observed in Stripe 82 data from the Sloan Digital Sky Survey. A subset of 30 RRab and 10 RRc lightcurves, which fully sampled the template and period-amplitude space, was placed in 1007 locations on the sky to obtain a statistically relevant sample of the sky and LSST’s observing cadences. The period and lightcurve recovery capability was investigated for LSST survey lengths of 1, 2, 5 and 10 years, and the simulation tool returned each lightcurve with realistic photometric errors based on historic seeing and weather data at the LSST site. A period was considered successfully determined if it was within 0.1\% of the input value. We found that two years of data were sufficient to recover periods for 90\% of RR Lyraes with mean g-magnitudes brighter than mag-23 in the deep survey data, while closer to six year of data were required for the main-survey fields to recover the periods at the same efficiency.
Lunar Soil Erosion Physics For Landing Rockets On The Moon

Ryan N. Clegg\textsuperscript{1}, Philip T. Metzger\textsuperscript{2}, Stephen Huff\textsuperscript{2}, Luke B. Roberson\textsuperscript{2}
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To develop a lunar outpost, we must understand the blowing of soil during launch and landing of the new Altair Lander. Based on simulations from the Apollo missions, blowing lunar soil particles have velocities up to 2000 m/s at low ejection angles relative to the horizon, reach an apogee higher than the orbiting Command and Service Module, and travel nearly the circumference of the Moon [1-3]. The low ejection angle and high velocity are concerns for the lunar outpost. We performed a series of low-velocity impact experiments in a modified sandblasting hood using lunar soil simulant impacted upon various materials that are commonly used in spaceflight hardware. The velocities of individual soil particles of different diameters were calibrated with a high-speed video camera that recorded their trajectories through the chamber. Their velocities were in the range of 30-85 m/s, depending on the particle size and the experiment settings. We also exposed five different sheets of glass to the equivalent of between one and five lunar landings at 200 m distance. After one landing equivalent of spray, the glass was severely eroded and unusable. Candidate materials that may be used as a lunar fence impact barrier [3] were blasted with 1 landing equivalent JSC1A. This abstract discusses results of our findings and potential future work. Future work includes quantifying the damage that lunar outpost hardware will experience, and functionally testing thermal control blankets for loss of reflectivity and solar cells for loss of received power.

\textit{Figure 1}: Glass impacted with the equivalent of one lunar landing of JSC-1A
COS - 25
Monitoring ‘Hot Jupiter’ Exoplanets Using the Ortega 0.8-M Telescope

Crystal L. Latham

Faculty Adviser: Dr. Samuel T. Durrance

The Florida Tech exoplanets group has an ongoing project monitoring 64 of the brightest known transiting exoplanet systems. Exoplanet transits have been successfully measured using the Ortega 0.8-m telescope. This is done by taking photometric measurements beginning before the exoplanet transit occurs until after the transit has ended. The investigation of known transiting planets is important in the continued discovery of new exoplanets. ‘Hot Jupiters’ are a specific type of exoplanet that closely resembles Jupiter and has a very short orbital period around its parent star. Monitoring any variations in the transit time of an exoplanet can help determine if an exomoon, non-transiting planet, or Trojan may exist within the system.
Monte Carlo Simulations of a First Prototype Micropattern Gas Detector System Used For Muon Tomography

J. B. Locke, K. Gnanvo, M. Hohlmann

Faculty Advisor: Dr. Marcus Hohlmann

Muon tomography is a versatile technology and can be used, for instance, to detect shielded nuclear threat material in shipping containers. Muons are particles, similar to electrons, created naturally by cosmic radiation striking the Earth’s atmosphere. Many of these muons survive long enough to reach sea level with average energies of about 4 GeV and a flux of about 10,000 muons per square meter per minute. A muon tomography system is made of at least two stations consisting of micropattern gas electron multiplier detectors. The top station detects the incoming path of a muon and the bottom station detects the outgoing path. A simple algorithm is used to find the point of closest approach and the angle between the incoming and outgoing paths. Using the scattering angle and the point of closest approach, the type and the location of the material which scattered the muon are determined. The muon tomography system currently under construction has a tomography volume of 30x30x10 cubic centimeters. However, due to limited electronic instrumentation, only 5x5 square centimeters of the XY plane will be used for the initial hardware tests projected for early 2010. Monte Carlo computer simulations using the GEANT4 utility for a muon tomography system with this configuration are presented. The simulated scenarios consist of the tomography system with cubes of tungsten of various sizes placed in the tomography volume. The primary factors considered are the ability and speed of the system to reconstruct a target. The results from these simulations will be compared to actual results from the muon tomography system currently under construction.

Observation of TGFs (Terrestrial Gamma Ray Flashes) from the Fermi Gamma-ray Space Telescope

Mary E. Cwikla; Joseph R. Dwyer; Eric S. Cramer; Michael E. Splitt; Hamid K. Rassoul

Faculty Advisors: Dr. Joseph R. Dwyer and Hamid K. Rassoul

Terrestrial gamma-ray flashes (TGFs) are short bursts of gamma-rays observed by satellites in low Earth orbit that come from the atmosphere with energies extending up to several tens of MeV. In the field of atmospheric science, one of the great unknowns is the source of these gamma-ray bursts. The FERMI spacecraft is equipped with the Gamma-Ray Burst Monitor (GBM) that has detected more than 40 TGF events since its launch in 2008. The GBM detector utilizes twelve sodium iodide scintillators and two bismuth germinate scintillators. The RHESSI spacecraft has also recorded TGF data which have been analyzed in order to determine the characteristics of possible TGF-producing storms. In this study, the same type of analysis is done on a smaller scale, focusing on fewer isolated events. By comparing flash rates and the density of the flashes within the storm, it becomes clearer which storm produced the event. The flash rate analysis for two Fermi events has been conducted in order to give us a better determination of the possible TGF origin within the storm system. For future studies, we will use these source locations to fully model the nature of these TGFs.
Observations of Sprites, Elves, Blue Jets, and Gigantic Jets from Florida

Guillermo Naranjo

Faculty Advisors: Drs. Ningyu Liu, Joseph Dwyer and Hamid K. Rassoul

Transient luminous events (TLEs) are a group of large electrical discharges of air occurring in a planetary upper atmosphere. In the Earth’s atmosphere, they are driven by thunderstorm activities at tropospheric altitudes. Currently, there are four identified classes of TLEs. They are: Blue Jets, Sprites, Elves, and Gigantic Jets. Using low-light cameras and the complementary electromagnetic detectors at the Florida Tech’s Observatory on the roof of the Olin Physical Science building, we have recorded several large TLE events. This research poster reports on our recent observations as well as the theoretical modeling effort for understanding these electrical discharges in our atmosphere. The long term goal is to understand the physics of TLE’s generation, energy content, and propagation.
COS - 29
Observing Radon Washout and Terrestrial Gamma-Ray Flashes from Background Radiation and Thunderclouds
Hunter Mehrens
Faculty Advisor: Dr. Joseph R. Dwyer

Radon Washout and Terrestrial Gamma-Ray Flashes (TGF) are phenomena that are observable during thunderstorms and are directly related to activity in thunderstorms. We find that Radon Washout is the depositing of radioactive material on the ground by rain water. This process occurs when rainwater falls from the clouds to the ground collecting all the radioactive isotopes in the air. This process amplifies the amount of natural radiation at ground level and can be monitored by a NaI detector. The goal of this research is to observe Radon Washout and attempt to model the data relative to the natural background radiation and the weather conditions present at the time of the thunderstorm. The data were collected through four NaI detectors and processed through a Producer/Consumer Labview Program that counted the peaks of data (a high energy photon) in 100 ms intervals. These data were compiled in different timescales (100ms, 1 second and 1 minute), using an IDL program; the data provided several examples of Radon Washout decay. TGF were first discovered by 1994 by Compton Gamma-Ray Observatory (CGRO) and are classified as a short-lived, intense burst of gamma rays that come from thunderstorms. Usually caused by Relativistic Runaway Electron Avalanche, TGF come in two waves: hard gamma-rays are observed within tens of microseconds and then softer gamma-rays arrive at hundreds of microseconds. Due to this nature of TGF, a search for two separate peaks inside our data, that are far more intense then the natural background, could establish the detection of a TGF. This data then could be correlated to lightning data.

COS - 30
Performance of a USCMS Tier-3 Computing Cluster at Florida Tech
Xenia Fave, Patrick Ford, Johanna-Laina Fischer
Faculty Advisor: Dr. Marcus Hohlmann

The Tier-3 High Performance Computing Cluster at Florida Tech is being used for data production of the CMS experiment at the CERN Large Hadron Collider as well as for local analyses and has undergone significant changes during the course of the semester. The system software has been upgraded to include the latest version of the Virtual Data Toolkit, the Grid User Management System (GUMS), and the Physics Experiment Data Exports system (PhEDEx). A development node was converted into a separate Storage Element with 64GB of RAM to replace our previous Berkley Storage Manger System configuration. Performance tests of the cluster were conducted to ensure maximum efficiency and speed and it is now achieving 941 Mbits/sec data transfer between the frontend and the Network Attached Storage (NAS). Currently the cluster is being used by several faculty members for their projects, which include the modeling of accretion flows from binary stars and the studying of propagation of solar energetic particles, as well as to run our own Muon Tomography simulations.
**COS – 31**  
**Quarknet Muon Data Analysis with Shower Array Studies**  
**J. L. Fischer, A. Citati, M. Hohlmann**  
**Faculty Advisor: Dr. Marcus Hohlmann**  
In collaboration with Fermilab, the Florida Institute of Technology’s Quarknet Project captures and collects data from cosmic ray muons. We use plastic scintillator paddles, photomultiplier tubes, a DAQ card, and a computer to detect these muons. We measure the muon flux with different orientations of detectors configured for quadruple coincidence in which the plastic scintillator paddles are stacked on top of each other. For time-stamping our data, we use GPS systems atop our building. Using Fermilab’s Cosmic eLabs, we analyze the data from our data collections and measure flux and lifetime. Using muon shower array orientation, in which the paddles are oriented side-by-side, we performed muon shower array studies.

**COS - 32**  
**The Analysis of Auroral Events and Mechanisms Within Our Solar System**  
**Chase Mueller**  
**Faculty Advisor: Dr. Joseph R. Dwyer**  
“...a whirlwind came out of the north, a great cloud, and a fire unfolding itself, and a brightness was about it, and out of the midst thereof as the color of amber, out of the midst of fire.” (Ezekial 1:4). The Aurora’s of Earth have drawn the curiosity of humans for millenniums. To some, the lights brought fear. To others, they were the highest level in the afterlife. Today, we know the lights on Earth are created by a team of forces involving the Earth’s core, and solar particles from the sun. Finding answers to why auroras exist, how the colors are emitted, and how this auroral system could be applied to other systems in our universe lead me to research some of the more unique systems in our solar system. Of those systems, I focused my research on Mars and Jupiter.
COS - 33
The Changing Rotation Period of Comet Tempel 2
E. Schwieterman, T.L. Farnham, M.M. Knight, D.G. Schleicher
Faculty Advisors: Drs. T.L. Farnham, M.M. Knight and D.G. Schleicher

Thirty-one nights of broadband R and narrowband photometry were obtained of 10P/Tempel during its 1999/2000 apparition using Lowell Observatory 1.1 and 1.8-m telescopes. Early emphasis was placed on obtaining rotational lightcurves, while narrowband measurements later in the apparition were intended to study coma morphology. From our 12 nights of broadband measurements we determine a double-peaked rotation period of 8.938 hrs with an uncertainty of ±0.002 hours. Mueller and Ferrin (1996) suggested a possible change in Tempel 2’s rotation period from the 1988 to the 1994 apparitions, comparing five possible rotation periods from data obtained in October and December of 1994 to Sekanina’s (1991) period of 8.932 hours determined for the 1988 apparition. We can conclusively rule out four of Mueller and Ferrin’s five periods, leaving their period of 8.939, which is within the uncertainty of our period. It is important to note that Mueller and Ferrin’s data were obtained post-perihelion during the 1994 apparition, and our 1999 data were obtained pre-perihelion. (If one presumes any change in period would be caused by gas jet-induced torques, it is reasonable to assume the period remains relatively unchanged between perihelion passages.) Two perihelion passages occurred between the 1988 and 1994 and 1999 data sets, suggesting a spin-down of Tempel 2’s rotation rate of about 10 seconds per apparition. We phase several authors’ photometry results from the 1988 apparition to the previously determined period and ours to confirm the period change. We present these results and others.

COS - 34
Tidal Heating On Io
Amanda Kunos
Faculty Advisor: Dr. Joseph R. Dwyer

Io is Jupiter’s closest Galilean moon. The combination of Jupiter’s mass and Io’s short distance from Jupiter produces a strong gravitational pull on Io from Jupiter. The other three Galilean moons also have a gravitational influence on Io. The combination of these forces causes tidal deformations on Io. Normally, this tidal dissipation would cause Io’s elliptical orbit to become circular. In reality, the tidal dissipation causes heating within Io’s interior. This happens because Io, Europa, and Ganymede orbit in resonances. The resonances maintain Io’s elliptical orbit, and so the work done by the tidal dissipation needs another outlet: tidal heating. The tidal heating has made Io a spectacular display of volcanic activity and unique dust plumes.
How Can I Modify Teaching Strategies to Increase Student Engagement During Lectures?

David Thompson

Faculty Advisor: Professor Debra S. Blenis

This action research targeted high school mathematics classes with students ranging from tenth to twelfth grade. During my first few weeks of student teaching I observed that my supervising teacher had students go up to the board to work math problems. I began to wonder if there was a correlation between the students’ grades and the amount of in class voluntary participation. The analysis of this data indicated there was a correlation: the lower achieving students were participating least. However, the high achieving students participated less than the “average” students. Students whose grades were “average” tended to volunteer to work problems at the board the most. I implemented strategies that would motivate more students to voluntarily participate in board work. By having the students continually working math problems at the board, they are able to see mistakes right away – both theirs and other students. This helps to create a strong foundation to delve into the higher level thinking and problem solving. Individual students made impressive gains with a strong correlation between their participation and test scores. I plan to continue this further when I am a classroom teacher because I feel that I can positively affect student performance by getting more students involved in board work.
COS - 36
Improving Critical Thinking Skills in a High School Classroom
Nicole Aia
Faculty Advisor: Professor Debra S. Blenis
The objective of my research is to aid high school students in developing and enhancing their critical thinking skills. While teaching at two different public high schools at both the regular and honors levels, I noticed that many of the students did not even attempt critical thinking questions on assignments. On assessments containing mostly multiple choice questions followed by a few higher-order questions, students will finish the multiple choice and completely skip the higher order questions. My main concern is that the students are simply not getting past the basic levels of thinking. As the saying goes, “If you don’t use it, you lose it.” The thinkers of today will be the leaders of tomorrow. I feel that it is my goal as a teacher to help my students be as prepared for the future as possible.

The students’ critical thinking skills were pre-assessed by making observations on a number of attempted critical thinking questions. I counted the number of questions attempted by students and recorded how many were answered correctly. I then began to implement critical thinking strategies. I began by asking higher order questions during class discussions and providing handouts with some critical thinking questions on them. The next step involved hands-on activities that challenged the students to think critically. These involved group activities where they taught each other and playing logic and strategic games as time allowed. Within eight weeks I observed that a majority of the students were attempting higher order thinking questions. The percentage of questions unanswered decreased from 18% to 9%. I believe this is due to decreased anxiety over critical thinking type questions since I increased their exposure to them.
COS - 37
The Effects of Positive Parental Contact on Student Academic Achievement and Behavior
Ashley Sicard
Faculty Advisor: Professor Debra S. Blenis

Although I am an academically driven student and have always been relatively successful in my endeavors, what about students who may be less focused and struggle with self motivation? What happens to the students who need positive reinforcement to keep them academically motivated? Positive parental contact from teachers is one method that has been proven to help enhance the quality of secondary students’ education (Beekman, 1989). Research has shown that if teachers work as a team alongside their student’s parents, the student will be more likely to have greater learning gains in the classroom (Rosenthal & Sawyer, 1996). Students need to feel support and structure in their lives and if their two main focuses, school and home are working separately then how can success be prevalent? These observations lead to the main focus of my action research project, how might positive parental contacts affect secondary student academic achievement and behavior within the classroom? Over the course of six weeks, observations were recorded from four different science classes of 9th and 10th graders within a local public high school. These observations consisted of behavioral and academic achievement. As the weeks progressed, I made 42 positive parental contacts in the form of emails, telephone calls, parent conferences and letters home. When parents were contacted directly, such as a phone call, most expressed sincere gratitude for the positive feedback. Students also seemed to appreciate the positive parental contact. In this short period of time, slight improvements in behavior were evident and academic achievement also improved. I will continue these strategies throughout my student teaching with the hope of continued improvement.

Forms of Parental Contact

<table>
<thead>
<tr>
<th>Method of Correspondence</th>
<th>Number of Direct Parent Contacts*</th>
<th>Number of Indirect Parent Contacts**</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>18</td>
<td>18</td>
<td>5 parents responded to my emails</td>
</tr>
<tr>
<td>Telephone</td>
<td>21</td>
<td>12</td>
<td>More messages were left on machines</td>
</tr>
<tr>
<td>Parent Conference</td>
<td>2</td>
<td>2</td>
<td>These were scheduled meetings</td>
</tr>
<tr>
<td>Letter Home</td>
<td>1</td>
<td>0</td>
<td>Sent home in an envelope with student</td>
</tr>
<tr>
<td><strong>TOTALS:</strong></td>
<td>42</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

* Direct Parent Contact is a form of correspondence where teacher and parent are face to face or talking on the phone to one another.
** Indirect Parent Contact is a form of correspondence where teacher and parent are not face to face, but rather communicating indirectly.
What Effect Will The Use Of Teacher-Generated Critical Thinking Questions Have On The Quality Of High School Student Work?

Charlane Browne

Faculty Advisor: Professor Debra S. Blenis

When I first began student teaching, I noticed a pattern in the quality of the work turned in by the students. Many students did not complete assignments; skipping any critical thinking or higher-order questions presented in their assignments. They also experienced difficulties when performing critical thinking activities. These occurrences were reflected in the assignment grades as well as in the overall grades of the students in the classes. The purpose of this action research was to improve the quality of student work by helping the students become more familiar with critical thinking questions and how to approach them. My approach included gradually increasing the number of teacher-generated critical thinking questions in their assignments. This approach helped them see success along the way. I conducted my research in the four science classes of high school students at a public school where I student taught. I used several teaching strategies to encourage students to think creatively to solve problems without the fear of losing points by giving the “wrong” answer. The numbers of students completing the critical thinking questions on assignments, as well as the average grade received on assignments were recorded in my reflective teaching journal with anecdotal observations. According to the data collected, both the quality of student work and the students’ attitudes towards critical thinking improved. The percentage of students completing critical thinking questions increased from 58% to 85%, and the number of C, D, and F students decreased while the number of A and B students increased. I was really pleased to see such a drastic improvement in such a short period of time.
What Instructional Strategies Can Improve Middle School Student’s Academic Independence?

Deirdra O’Donnell

Faculty Advisor: Professor Debra S. Blenis

When I first began student teaching, observations of students recorded in my reflective teaching journal indicated students required a high amount of instructional repetition. This behavior is indicative of students’ lack of self-confidence in their own academic abilities. The goals of this study were to increase middle school students’ confidence in their own academic abilities so to reduce the amount of repetitive instruction. This process will also provide the students with improved analytic skills and will increase their ability to deal with new information and draw independent conclusions. The design of this study was carried out as normal classroom activities and procedures. I began each class by explaining the standards I expected of the students every day. These expectations were presented to them both verbally and visually. When giving directions, I would announce to the class “I expect you to listen carefully as I will only say the directions once, you should follow along with your written directions.” After giving the days instruction, I would only answer questions dealing with clarification and told students to refer to their written directions for any procedural questions. Students need for repetitive instruction has decreased by 17% and students work quantity of assignments has increased by 10%. However student’s quality of work has decreased. Decreasing the number of students questions is good, but not at the risk of quality of work and student grades. I will continue to record data until the end of my student teaching. I anticipate that students will continue to gain more confidence in their academic abilities and their quality of work will begin to improve.