Friday, April 19, 2013
10:00am – 4:30pm
Clemente Center for Sports & Recreation

Florida Tech
COLLEGE OF SCIENCE
Where Knowledge Meets Discovery
“Tell me, and I forget; show me, and I remember; let me do and I understand” (Chinese Proverb). Undergraduate research has been a cornerstone for 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 local, state, or national meetings and conferences. 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.

What Is The College of Science STUDENT DESIGN SHOWCASE?

STUDENT DESIGN SHOWCASE Provides Opportunities To...

- Participate In Goal Setting
- Develop A Plan to Attain Goals
- Learn To Think & Work As A Scientist
- Gain Advanced Laboratory, Field & Computational Skills
- Enhance Career/Graduate School Preparation

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Temperature Induced Modulation of Feeding Kinematics in a Nonnative Florida Species (*Pterois volitans/miles* complex): A Comparison of Feeding Profiles

Brian Bement, Kayla Chapman, Matthew Sonnefeld, and Tyler Sloan

Department of Biological Sciences, Florida Institute of Technology

Faculty Advisor: Dr. Ralph Turingan

Efficacious species invasion relies upon physiological and behavioral traits appropriate to an invaded ecosystem. Contemporary environmental gradients, such as temperature, have been seen to influence performance when marine species are put under physiological stress. By augmenting preferred ecological gradients, the Indo-Pacific lionfish (*Pterois volitans/miles* complex) continues a trend of northerly invasion at alarming rates outside of the species’ natural range, being one of the first Indo-Pacific species to establish in the Western North Atlantic. While it is known that the capacity of a species to thrive is greatly dependent on its ability to effectively capture prey, little is known about the integrated effects of body size and temperature across variations in the feeding-episodes of Indo-Pacific lionfish. This study was designed in order to gain a logistical interpretation of the feeding events in the non-native lionfish by testing the following hypothesis: (1) Temperature has a significant effect on performance in the feeding episodes in lionfish. Thirteen lionfish, divided into three size classes, were collected from a Florida population and fed live *Gambusia* spp. while being filmed using high-speed video. A frame-by-frame analysis of kinematic variables: gape, hyoid depression, cranial rotation, and jaw displacement were profiled through size and temperature regimes. A two way MANCOVAR was used to determine significance of each profile. Examination into the breakdown of prey capture events gives insight into the occurrence of modulation and at what loci these changes are occurring. Manifestation of modulation could conceivably impact trophic communities where lionfish now reside.
Effects of Temperature on the Scaling of Feeding Kinematics in Non-Native Florida Populations of Lionfish (*Pterois volitans/miles* complex)

Kayla Chapman, Brian Bement, Matthew Sonnefeld, Tyler Sloan

Department of Biological Sciences, Florida Institute of Technology

Faculty Advisor: Dr. Ralph Turingan

The introduction of invasive species to non-native systems is a platform of study that is becoming extensively monitored. Within the last decade, the Indo-Pacific native *Pterois volitans/miles* complex has become the juggernaut of one of the largest marine invasions in history. The pervasive presence of this species in the Western Atlantic and Caribbean is driving efforts to better understand the nature of their success. The current documented distribution of invasive lionfish indicates their exposure to different temperature regimes. With this knowledge it is important to investigate if temperature can act as an ecological barrier to their continued spreading. It is known that the physiology of living systems is influenced by variations in temperature; however, minimal information has been acquired regarding effects of temperature on feeding performance in fish of different sizes. This study was conducted to test the hypothesis that scaling of prey capture kinematics will vary across different temperature regimes. Using 13 lionfish, kinematic variables including cranial rotation, hyoid depression, peak gape, and jaw displacement were studied using high-speed videography. Linear regression analyses and Student’s t-tests revealed little deviation in the measured variables across temperature regimes and standard lengths. Although temperature is known to affect physiology of poikilotherms, it does not produce significant change in prey capture kinematics across sizes in the invasive lionfish. This means that temperature increases may not act as ecological barriers to the spreading of this invasive fish.
Characterization of the Diets of Juvenile Bonefish *Albula sp. cf. vulpes* in the Indian River Lagoon, Florida

Mary Christine Draghetti

Department of Biological Sciences, Florida Institute of Technology

Faculty Advisor: Dr. Jonathan Shenker

Bonefishes support very valuable recreational fisheries in the Florida Keys, Bahamas, Caribbean Islands, and around the Gulf of Mexico. Recent genetic research has shown that the well-known *Albula vulpes* is actually a multi-species complex, with at least 3 morphologically similar species of bonefishes co-occurring throughout the region. In fall 2012, large numbers of juvenile bonefish were found for the first time in the middle Indian River Lagoon, far north of their typical habitat. Genetic analysis identified these fish as the as-yet undescribed *Albula* sp. *cf. vulpes*. Little is known about the feeding habits, behavior, or ecology of any juvenile species of bonefish. Gut content analyses of the juvenile *Albula* sp. *cf. vulpes* from the Indian River Lagoon showed that these 29–105 mm juveniles fed primarily on benthic harpacticoid copepods and opportunistically on larger invertebrates such as mysids, cumaceans and cirriped larvae. Unusual gill raker morphology appears to influence their ability to winnow their prey from sandy substrate. Hypotheses about the reason for the occurrence of juvenile bonefish outside their traditional habitat include natural recruitment variability, variation in thermal regimes, and loss of sea grass in the Indian River Lagoon.
Modeling Processes Driving Coral Population Persistence in a Time of Rapid Environmental Change

Kevin Hoover

Department of Biological Sciences, Florida Institute of Technology

Faculty Advisor: Dr. Robert van Woesik

Contemporary coral populations are under tremendous stress, both locally and globally. While changes in coral populations are driven by a suite of processes, acting on individual colonies at all life-history stages, we know little about how these vital processes will vary under rapid climate change. This study asked two main questions: (1) what probability distributions are most suitable to model the processes that influence change in coral populations? and (2) which processes are most sensitive to environmental change? This study focused on the probability of four processes: (i) recruitment (new offspring), (ii) colony growth (transition into a larger size class), (iii) partial mortality (transition into a smaller size class), and (iv) total-colony mortality (loss of entire colonies). We determined the most appropriate distributions using field data to compute maximum likelihood estimates. Recruitment and environmental stress followed a Poisson random variable. Mortality followed exponential distributions, whereas colony growth and partial mortality were drawn from a normal distribution, with the sign determining either growth or shrinkage. Coral colony mortality was drawn from an exponential function that scaled for coral colony size. During thermal-stress events, recruitment declined and large coral colonies were more likely to die than small coral colonies, changing the sign of the mortality fitting parameter. Persistence only occurred when recruitment was greater than total-colony mortality. This new process-level model increases the accuracy of predictions of change in coral populations in rapidly warming oceans.
Holocene Dynamics of Coral- Reef Associates: Implications for the Long-Term Productivity of Eastern Pacific Coral Reef Ecosystems

Allison Randolph

Department of Biological Sciences, Florida Institute of Technology

Advisors: Dr. Richard Aronson and Lauren Toth

Geological records from coral-reef frameworks provide valuable archives for understanding the environmental, climatological, and ecological histories of reef ecosystems. In the tropical eastern Pacific, where coral populations collapsed for 2500 years beginning 4000 years ago, a multi-proxy approach to paleoecological reconstruction provides a comprehensive picture of past reef dynamics. We analyzed the abundance of spines of the sea urchin Diadema mexicanum and sponge spicules in cores from Pacific Panamá to reconstruct temporal changes in the relative abundance of herbivores and suspension-feeders. The abundances of both urchin spines and sponge spicules were variable over the last 6000 years. They generally tracked each other, likely reflecting changes in sedimentation rates. After accounting for changes in sedimentation, our results suggest that sea urchin populations were fairly constant during the Holocene, despite the millennial-scale hiatus in coral growth. Conversely, the abundance of sponge spicules was significantly higher during the middle Holocene (6000–4000 yrs ago). This pattern is consistent with other regional paleo-productivity records, which suggest that enhanced upwelling boosted oceanic primary productivity during the mid-Holocene, relative to the interval from 2000 years ago to present. Reef cores contain diverse ecological proxies that can provide important insights into the history of coral reef ecosystems.
Congruence Between Feeding Functional Morphology and Food Habits in Florida Marine Fishes

Matthew J. Sonnenfeld

Department of Biological Sciences, Florida Institute of Technology

Faculty Advisor: Dr. Ralph G. Turingan

In fishes, the mechanics of the feeding apparatus serves as the main constraint in their ability to capture prey, regardless of which feeding mode they portray. Fishes use three major modes of feeding: ram, suction, and manipulation. A central question in organismal biology is, “How related are form and function of the feeding apparatus in fishes?” This study was designed to address a more specific and relevant question, “Which of the metrics of functional morphology determines the food habit of Florida fishes?” Five species representing the range of feeding morphology and mode found in the assemblage of Florida marine teleosts were included in this investigation: *Lutjanus synagris* (ram; n=6), *Centropristis striata* (suction; n=10), *Calamus bajonado* (manipulation; n=5), *Haemulon aurolineatum* (ram-suction; n=11), and *Calamus penna* (manipulation-suction; n=9). Two hypotheses were tested: (1) there is a difference in the mechanical traits among species, and (2) These mechanical traits will be representative of feeding style defined by prey use. Analysis of Covariance and subsequent Tukey post-hoc tests revealed that interspecific variation in all biomechanical traits was evident. Furthermore, of these traits, the mechanical advantage of the jaw, jaw mass, and the force-generating capability of the adductor mandibulae best represent feeding mode. In the fully integrated feeding system in fishes and other organisms, some and not all of the component parts contribute substantially to organismal performance.

Buccal Expansion

Lower Jaw Movement
Detecting Citrus Greening in Florida’s Orange Trees

Daniel DeLellis and Peter Cohen

Department of Chemistry, Florida Institute of Technology

Faculty Advisor: Dr. Nasri Nesnas

Citrus greening, or Huanglongbing, is a disease destroying citrus crop yields. Early detection of infection is essential to maintaining a healthy crop. The polymerase chain reaction (PCR) is the benchmark technique for diagnosis. Our aim is to develop a more rapid and definitive method of diagnosis using Direct Analysis in Real Time Mass Spectrometry to identify molecules (biomarkers) associated with diseased trees. Experimental parameters of temperature, voltage, and ionization were adjusted to fully explore samples. Solvent extracts were performed on midrib samples before analysis to target particular classes of biomarkers. Spectral integration was used to differentiate between diseased and healthy samples. The methanol and hexane extracted samples provided spectra with greater consistent differences between the healthy and diseased samples compared to toluene and non-extracted sampling. The analysis of the spectra demonstrated significant relative differences in several suspect peaks which could be used to differentiate between healthy and diseased samples.
Barrier Height Spectroscopy of HOPG in Air and 1-Phenyloctane Using STM

Teresa Esposito, Melissa Mitchell

Department of Chemistry, Florida Institute of Technology

Faculty Advisor: Dr. Joel A. Olson

Scanning Tunneling Microscopy can be used in order to obtain images of the topography of surfaces on the atomic scale. Barrier height of the surface can also be obtained simultaneously. Barrier height is highly dependent on the medium in which it is imaged in, so imaging was performed in air and 1-phenyloctane, a nonpolar solvent. The current range where images with good atomic resolution can be collected in air is 0.1-2.0 nA, and for 1-Phenyloctane, it is significantly lowered to 0.04-0.02 nA. A lower tunneling current means that the tip is further away from the surface, meaning that the tunneling barrier breakdown will be small. However, in 1-phenyloctane there is a large increase in the barrier height under 0.14 nA, This is a much higher current value than previously thought for barrier breakdown, so an alternate reason for this increase is noise. To the right of the barrier, the barrier height also rises, this can be due to interaction between the tip and the molecules in the solvent, so more experiments should be performed with solutions of different sized non-polar molecules and over a longer range of currents.
Computational Elucidation of Energetic Trends for DNA Intercalation

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Faculty Advisor: Dr. Mark Novak

The prediction of general energetic trends from intercalation of polycyclic aromatic compounds with DNA can provide insight into these pertinent interactions, as well as improve synthetic drug design. Compounds chosen for this study are nucleoside base pairs (AT, GC) and 4-azatryptanthrin. Our computational methods utilize SPARTAN and GAUSSIAN software, a Ground State Density Functional Theory (DFT) LSDA method, and a 6-311++G** basis set for the energy calculations. We use both a systematic approach of aligning planes based on center of mass (COM) and several 20° rotations and a visual alignment of the interacting moieties’ electrostatic potential (ESP) maps. Each pose is then evaluated energetically at varying separation distances. The simplicity of the ESP method could lead to a significant decrease in the time cost and the consideration of dispersion forces increases confidence in the resulting insight. Results indicate a slight preferential intercalation of 4-azatryptanthrin with the GC base pair over an AT base pair. Identification of trends such as this can be valuable in designing future experimental studies targeting GC or AT rich regions associated with genetic disorders such as Myotonic Dystrophies, Fragile X, and Friedrich’s Ataxia.
Atomic Force Microscopy Studies of Surface Activity of Amphiphilic Molecules at Nanoscale

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Faculty Advisor: Dr. Boris Akhremchey

Understanding the energetics of electrolytes in aqueous solutions is important in understanding the control of electron transfer in biological processes. On this small scale, the dielectric properties of water behave in a manner different from theory. The structure of water causes the dielectric properties to change near non-polar interfaces. This phenomenon has been supported through spectroscopic evidence. Doing direct electrostatic measurements on these interfaces may give insight to the length scale of these phenomena. This can be measured using an Atomic Force Microscope (AFM) by Force Modulation technique by creating a stable air bubble inside a water bubble. The electrostatic interactions at the water-graphite, water-molybdenum disulfide, water-HOPG, and water-surfactant interfaces will also be sampled. This data will then be analyzed using continuous and layered structure models. These results will be compared to results of flexible and rigid interfaces.
Scanning Tunneling Microscopy of 2,8-dinitrotryptanthrin

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Tryptanthrin molecules are of great interest to researchers because of their medicinal properties as antitrypanosomal, antifungal, and antimalarial agents. It has been observed that the addition of nitro functional groups onto the tryptanthrin molecule occur in a certain order. This addition can be further studied using scanning tunneling microscopy (STM), a chemical imaging technique used to image surfaces at the atomic level. It has been previously used to study the structure of tryptanthrin molecules. This presentation concentrates on the imaging of 2,8-dinitrotryptanthrin. The topographical images collected by STM show the electron density resulting from electrons tunneling from the molecular orbitals of the molecule to the tip; the image resembles the density functional theory calculation of the highest occupied molecular orbital for the molecule. Rows of 2,8-dinitrotryptanthrin molecules were able to be identified from the topographical images collected in this experiment. This successful identification will allow researchers to move forward and begin to collect barrier height images and perform calculations to see if the reasons for the observed order of functional group addition can be identified.
Selective Deuteration of Retinoids and Solid-State $^{2}H$ NMR Analysis

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Rhodopsin is a visual pigment protein that is stimulated by light via its ligand molecule retinal. Retinal exists in the dark state as 11-cis-retinal. Upon photo excitation, a conformation change about the C11 double-bond produces all-trans-retinal, and thus provides the chemical basis of vision for life. Solid-state NMR provides a novel tool to study the mechanism of action by quantifying orientational changes about the polyene structure of retinal. Selectively deuterated retinal molecules are synthesized in the Florida Institute of Technology Bioorganic Chemistry lab for $^{2}H$ NMR analysis at the University of Arizona, Tuscon. $^{2}H$ NMR can analyze the quadrupolar couplings present in $CD_{3}$ groups. Deuterations of the C5, C9, C13, and both C1 methyl groups provide distinct measurement locations along the rotational axes of the molecule. The syntheses were accomplished by dividing the molecule into subsections that can be individually deuterated, followed by a recombination into retinoids. No finished molecules have been produced yet, but the major components for the C9 and C1 deuterations have been synthesized. Upon completion, $^{2}H$ NMR will proceed.
Synthesis of 2,18-Dithia[3](1,8)carbazolo[3](3,5)pyridinophane for Study of Fluorescence Properties

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Carbazole fluoresces in many environments and can be quenched by the presence of pyridine. The molecule will continue to fluoresce in the presence of any other quenching agent, if the amino hydrogen of carbazole is substituted with an ethyl group. There are two reasons that may show this. One, the hydrogen acts a hook to bring in the pyridine. Two, there is some hydrogen bonding interaction from the carbazole to the pyridine nitrogen. Large compounds called carbazolopyridinophanes were made to test these theories. The compounds force the pyridine into close proximity to the carbazole, causing the compounds to quench. One molecule has the pyridine nitrogen facing the carbazole, while the other has it facing away from the carbazole. The two molecules should give an idea if proximity of the molecule quenches the fluorescence or if hydrogen bonding is the cause of the quenching. The quench occurs with the pyridine nitrogen facing the carbazole in 2,18-Dithia[3](1,8)carbazolo[3](3,5)pyridinophane. The other molecule, with the pyridine nitrogen facing outward, has not been synthesized yet, but should prove that the hydrogen bond is needed to quench.
An Optimized Åkermark Cyclization for Diethyl-2,2’-Iminodibenzoate

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Used as a precursor for a novel hydrazine sensor, diethyl-1,8-carbazoledicarboxylate may be produced by an oxidative cyclization reaction, known as Åkermark cyclization. This process uses stoichiometric amounts of palladium(+2) salts that are rather expensive. Therefore, it would be economically beneficial if more product could be generated while using equal or lesser amounts of palladium. The Wacker process is known to regenerate palladium to its (+2) oxidation state by means of a co-oxidant, namely copper(+2) salts. In doing this, more starting material may be converted to product, increasing the reaction’s efficiency. In the present work, the effectiveness of the Wacker process was demonstrated by an approximate increase of 14% yield for the reaction of interest. Though more reactions and data are needed to identify a truly optimized process, the reaction has been made more cost effective and therefore, economically beneficial, in the synthesis of the hydrazine sensor.

![Figure 1. Wacker-Assisted Åkermark Cyclization Reaction](image-url)
The Effect of Reading Accountability on Classroom Performance

Victoria Savosh

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Faculty Advisor: Dr. Kastro Hamed

The overall goal of this Action Research project was to increase students' test scores by holding them accountable for reading the required material from the textbook. In order to hold the students accountable for reading the required material a reading accountability handout, called a Directed Reading, was introduced at the start of each new unit of instruction during the third term of the school year. Each Directed Reading handout consisted of 12 Bloom's level 1 and 2 questions that could be answered by reading the corresponding chapter in the textbook. Mean test scores before and after the introduction of the reading accountability handouts were compared. The mean test scores of the class that did not receive the handouts were also compared to the mean test scores of the class that did receive the handout. Statistical analysis revealed p values larger than 0.05 for both t-tests, which are not statistically significant. In the future I plan to continue the use of Directed Readings. I will increase the duration of time that the Directed Readings are used, which may have a more substantial impact on the students test scores and thus overall classroom performance.
Increasing Homework Completion Rates in Middle School Math Students by Self-Regulation

Courtney N. Williams

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Through student teaching in two middle grades mathematics classes, it has been observed that there are a number students who consistently do not do their homework or just forget to bring it to class when it is due. As a result of this, the student will receive a zero on the assignment and will score low on assessments based on the homework. The consistent zeros and low grades in the grade book significantly affect the student's grade. A new trend in education is self-regulation, a proactive process whereby individuals consistently organize and manage their thoughts, emotions, behaviors, and environment in order to attain academic goals. The goal of the study was to increase the number of homework assignments completed and to increase the self-regulation skills in the students so they will be prepared for high school. At the beginning of the second nine weeks, students had twenty to twenty five homework problems daily. During the third nine weeks, the number of homework problems was decreased to five to ten daily and instead of grading for right or wrong answers, homework was graded for completion providing detailed feedback, when necessary. The rationale behind decreasing the number of homework problems was to encourage more students to complete the homework. After collecting data over 8 weeks, there was no statistical significance to the study. For some assignments, there was an increase of up to 30%, but other assignments there was no change or even a decrease in homework completion. Even though the percentage of homework completion was not consistent, with a few changes to the study, self-regulation could have a positive effect on students in increasing homework completion.
Combinatorics of Periodic Points on Wehler K3 Surfaces

Joao Alberto de Faria

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Faculty Advisor: Dr. Benjamin Hutz

The study of dynamical systems involves the study of orbits of points under iteration by a function. In the case of reversible (i.e. has a time-reversing symmetry) maps on the plane, Roberts and Vivaldi conjectured a distribution for the cycle lengths over finite fields. Our research aims to see if the conjecture will hold for reversible maps on a certain class of K3 surfaces. Using the computational algebra software SAGE, we wrote code to analyze the cycle lengths of randomly generated surfaces. The data supports the generalized prediction of Roberts and Vivaldi, and we believe that the conjecture holds for K3 surfaces. Moreover, since our maps are the composition of two involutions, we continue to investigate the dynamical and combinatorial implications that arise from this type of time reversing symmetry.
Fundamental Solutions of the Kolmogorov Equation

Joao Alberto de Faria

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Faculty Advisor: Dr. Jay Kovats

In this case study of a well-known Partial Differential Equation, we are seeking to derive the fundamental solution to a linear parabolic equation in n dimensions. Such equations have a multitude of applications, modeling situations from varying fields, stretching from physics, chemistry, engineering to even the financial markets. In order to derive this solution, we begin with the fundamental solution to the heat equation and then use the fact that both of these equations are linear to extend further fundamental solutions to several interim equations before we finally reach the solution to our desired equation.
Multispectral Landsat Image Fusion for Contrast Enhancement

Juan Johnson

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Faculty Advisor: Dr. N. Nezamoddini-Kachouie

Numerous studies have been conducted to categorize the effects of global warming on climate change. Global warming shrinks glaciers and will have a significant impact on water supply (Edenhofer 2011; Nick 2009). Over the past decades, the shrinkage of mountain glaciers has become apparent as it is primarily caused by the rising temperatures. Quantification of mountain glacier variations helps us to better understand glacier water contribution, potential global hydrologic changes, and the influence it has on the anthropogenic society. Therefore, there have been many studies to quantify mountain glacier shrinkage (Bjork 2012). Traditionally, ground measurements have been used to quantify glacier variations, but there are many glaciers with no available ground measurements. To this end and because of technological advancements, new methods depend on remote sensing for estimation of glacier change. Estimation of glacier variation through available multispectral satellite images relies on the detection of mountain glacier features such as glacier terminus. In this project we fuse Landsat multispectral images using wavelets to improve the glacier feature detection.
The Game of Volleyball: A Mathematical Analysis

Nicole M. Johnson

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Faculty Advisor: Dr. Munevver Mine Subasi

Ever wonder how likely a team is to win a game when they are down by a few points, or possibly how important it is to win the 20th point? The game of Volleyball is very mathematical, from the best angle to attack a ball, to the statistics behind the sport. Initially, we consider two main questions: (1) when is the most crucial time to call a timeout? And (2) what is more important, offence or defense? These questions have led us to calculate the probability a team wins given a specific score. There have been two dominant teams in the sport in the last 20 years. To answer the second question we choose to analyze Penn State, who made history in 2010 by winning four consecutive titles. We conjecture that offence would prove to be more statistically crucial than defense. The hypothesis is that there are three influential statistics that indicate and best predict the winner of a match: (a) Hitting Percentage, (b) Serve/Serve-Receive, and (c) Minimal Unforced Errors. Using regression analysis, we develop an equation to predict a team’s season win percentage based on its statistics. Our statistical analysis shows that this hypothesis is true.
Delayed Differential Equations Applied to Stellar Evolution

Katie Kosak

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Faculty Advisor: Dr. Gnana Tenali

The project was to use delay differential equations as an application for stellar formation. DDEs have been previously used to model blood flow. The beauty behind DDEs for stellar formation is the ability to create a function based off of given parameters while considering a time delay. Our model used the density of gas in a galaxy available to form stars. In the study, we concluded that the best description for stellar formation is a periodic function with a given time delay.
The Fractional Schrödinger Equation

Erik Maki

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A study of the fractional Schrödinger equation and related topics is presented. A generalized version of the path integral to Schrödinger Equation method is shown to develop fractional quantum mechanics. Methods for generalization and simplifications of the equation are examined. Notable results including the wavefunction of a free particle are considered as well.
Mathematics: Music to My Ears

Matthew Callan Malczyk

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Advisors: Dr. Munever Mine Subasi and Kshetrajna Raghavan

Markov chains have proven to be surprisingly accurate in predicting how the world works. In this project we propose a complex algorithm that can be used to create pleasant musical compositions. Our algorithmic approach learns from input compositions and generates sophisticated output compositions by using Markov Chain Monte Carlo method. In our system all transitions between notes and rhythms with their relative frequencies are represented by the $n^{th}$ order transition probability matrices of Markov chains. The novelty of our probabilistic model which makes it different from the existing models in literature is the use of note transitions as well as note durations as random variables. As a byproduct of this research effort we hope to develop a software package with a user interface that can be adopted by musical composers and producers in the music industry. The software will also enable non-experts to produce pleasant musical compositions.
Magnetic Levitation: Superconducting Applications

Kristen Brockway

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Faculty Advisor: Dr. Joseph Dwyer

Magnetic Levitation is the product of flux exclusion and flux trapping. This occurs when the field lines produced by the magnetic field do not penetrate the superconducting magnet. As the superconductor gets trapped between the field lines, it cannot fall to the ground with gravity nor lift into outer space, but is rather trapped in a “levitated” state. The current uses of this technology are present in the transportation and shipping industries, but the consequences of such a technology can reach much further – into mechanical bearings and manufacturing, rocketry and launch technologies, and even construction related purposes. Current maglev technology is presently being researched and developed in Japan and Germany where high speed rail systems can reach upwards of 350 km/h, superconducting magnetic levitation despite high production costs could increase travel speeds to nearly 500 km/h reducing commute times and increasing possible living distances from dense urban centers.
Optimization of Laser Soldering for Through Hole Components

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In many cases, through-hole components of PWB’s assemblies need to be soldered in specific locations without damaging the previously soldered SMT components. Laser Soldering is the process that is most similar to manual soldering in terms of heat application. The objective of this project was to develop an algorithm that generates laser-soldering parameters using predetermined conditions and an accompanying flowchart that performs parameter optimization through experimental solder joint observation. This finally led to a more cost-efficient procedure to ‘debug’ the program. The algorithm was finally constructed using established empirical observation and finite element analysis of the laser soldering process.
Search for the Higgs Boson Decaying to Tau Pairs at Compact Muon Solenoid (CMS)

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In the Standard Model, the Higgs boson breaks electroweak symmetry, and allows $W$ and $Z$ to have mass. The masses of the fermions in the SM are generated via the Yukawa couplings between the fermions and the Higgs field. This is the famous Higgs mechanism which is built on the union of Gauge Invariance and spontaneous symmetry breaking. On July 4, 2012, CERN announced the discovery of a new boson, with mass around 125 GeV and with properties compatible with those of a SM Higgs boson. Among all the decay channels of the Higgs boson, the tau channel has the largest branching ratio for low mass Higgs and along with $b$-quarks is the only direct coupling mode of Higgs to fermions which make it an ideal channel to discover or constraint models beyond standard model. This presentation gives a brief overview of the analysis techniques used in Tau reconstruction as well as the recent results from the CMS Higgs to tau working group.
Dark Matter vs. Dark Energy

Peter Solenski

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Advisor: Dr. Joseph Dwyer

Dark matter and dark energy are two opposing forces that make up the majority of our universe, yet the two are still relatively new concepts and are barely understood. Dark matter appears to be the force holding the universe together, while dark energy is pulling it apart. During the early universe, dark matter was the dominant force, but over time dark energy has become more abundant and is causing our universe to expand at an accelerating rate. This poster presents what information is known about the discovery, formation, and composition of these two mysterious universal forces.
Imaging High-Z Materials Using Compact Muon Tomography Station

Christian Zelenka

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Muon tomography uses multiple coulomb scattering of muons, from naturally occurring cosmic rays, off High-Z materials to detect and image them. As the size of the nucleus of the object you are trying to image increases the scattering of the muons also increases. Using Gas Electron Multiplier (GEM) detectors you can map the paths the muons take both before and after the target you are imaging and therefore calculate the scattering angle of the muon. Due to the strong penetrating qualities of muons muon tomography is very useful in order to differentiate between lower-Z shielding material and high-Z nuclear contraband. This poster looks at the applications of muon tomography in imaging both uranium shielded by lead acid batteries normally used in uninterruptible power supplies used in our cluster and imaging the same batteries in order to see our MTS' (muon tomography station) bias toward the center of the station.
Quantum Entanglement

Virginia Ziwei Zhang

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As the name itself suggests, quantum entanglement is a quantum mechanical phenomenon. It involves the entanglement of two separated quantum systems due to an interaction of the two. It was first investigated in the 30s in a famous paper by Einstein, Podolsky and Rosen, in what is now commonly known as the EPR paradox, and after in several papers by Schrödinger. At the time, Einstein used entanglement as an exemplary case to critique the Copenhagen interpretation and to demonstrate the incompleteness of the new-born Quantum Mechanics, but the term “Entanglement” was actually coined after by Schrödinger. The attitude towards entanglement has changed a lot since it was first hypothesized. It can be used as “a quantum information channel to perform computational and cryptographic tasks”, impossible to recreate in purely classical systems. It is largely studied also towards the creation of a quantum computer, and its manipulation methods in new superconductive materials. The very means by which entanglement can be created are of vital interest in current researches. Not to mention its importance, especially in experiments using weak-measurements, on better understanding and maybe even bending Quantum Mechanics. Lastly is not to underestimate the importance of philosophical questions that entanglement brings up on the limits of scientific knowledge and explanation.
Simulation of High-Energy Collisions at the LHC

Virginia Ziwei Zhang

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Simulation of main physics processes in proton-proton collisions have been studied to describe the kinematics of the particles produced. The simulation is done under conditions of experiments at the Large Hadron Collider (LHC). The LHC was first built to seek for relations between Quantum Mechanics and General Relativity, but it has opened a window into new energy scales, allowing us to study events and particles nor reproducible before. Detailed simulation helps us, in the analysis of data, to reduce background processes, this is particularly important in the search of rare events, such as those involving the Higgs boson.
Study of the Cosmic Microwave Background Radiation and its Anisotropies

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Faculty Advisor: Dr. Joseph Dwyer

Throughout history, mankind has been wondering about its origins and speculating where everything came from. There is a lot of research being done on the cosmological evolution of the universe, and this project focuses on the study of the beginning of the Universe, with a special focus on the cosmic microwave background radiation and the theory of the inflationary universe. The inflationary theory of the formation of the universe refers to the rapid expansion of the universe by a factor of \(10^{75}\) after the Big Bang. On the other hand, the cosmic microwave background radiation is the light from the "Surface of the Last Scattering", which means when matter and light decoupled from one another. Different observations have seen some anisotropies in the distribution of this radiation, which gives hints to the large-structure of the early universe at a redshift of about \(z \sim 10^{89}\). This is crucial for the understanding of how everything formed after the Big Bang.
Spectroscopic Survey of Ultra Luminous Infrared Galaxies

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Ultra Luminous Infrared Galaxies (ULIRGs) provide excellent constraints for models of galaxy evolution. They emit high velocity ($v_{out} > 400 \text{ km s}^{-1}$) outflows that have been detected using [OIII] emission as a result of interactions with the interstellar and intracluster medium. However, not much is known about these interactions. In order to investigate feedback mechanisms, four ULIRGs have had their emission regions imaged by the Hubble Space Telescope (HST). Using these initial images, the roll angles and required slit locations for the four galaxies were computed for follow-up observations with the Space Telescope Imaging Spectrograph. The emission regions show complex morphologies with one possibly being a “Voorwerp”. The forthcoming spectroscopic data of these regions may determine the dominant mechanism for the regulation of galaxy evolution by the central supermassive black hole.
Rotation Ages of Wide Binary Candidates in the Kepler Field

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Faculty Advisor: Dr. Terry Oswalt

We present a study of stellar ages using Kepler field data limited by the Washington Double Star catalog (WDS) and containing binaries wider than five arcseconds. Sydney Barnes' gyrochronology method was used to determine stellar age. A literature search of the Kepler Mission’s analysis procedures was applied to create an analysis tool written in Python. We will continue to refine this tool and use it with the binary candidates found in our search to ultimately determine the ages in the dataset.
Evidence of Multi-Scale Self-Similarity in Solar Sigmoids

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Solar sigmoids are “S”-shaped magnetic structures observed on the solar corona. These structures are important because their strong correlation to coronal mass ejections makes them an invaluable tool for predicting these events. In addition, studying these structures furthers our understanding of stellar dynamics. In order to understand these structures better, it is important to determine whether recently discovered “S”-shaped structures are, in fact, solar sigmoids. If these new structures are sigmoids, then this is evidence of multi-scale self-similarity, because these structures are a magnitude smaller than known sigmoids. Furthermore, multi-scale self-similarity would indicate that sigmoids might also exhibit self-organized criticality, and that more research should be performed to determine this. One step toward determining if these new structures are true sigmoids is discovering if they have a similar magnetic field line structure. Using CMS, the magnetic field line structures of a sigmoid and a “miniature sigmoid” were mapped. Both of these structures share shallow “S”-shaped magnetic field lines that appear between the highly positive and highly negative regions. This evidence supports the theory that these smaller structures are sigmoids. However, more sigmoids and “miniature sigmoids” need to be modeled to determine if this similarity is uniform. In addition, more research on the formation and evolution of these new structures needs to be performed before it can be confirmed that these smaller structures are sigmoids. Therefore, while this research is not comprehensive enough to confirm that these structures are sigmoids, it supports this theory and shows that further research needs to be performed.
Self-organizing fibers are affected by gravitational settling. This halts growth and creates a tangled network of fibers in the bottom of the growth container, thus creating a need for a testing platform in a weightless environment. This is the reason for the Self-Assembly in Biology and the Origin of Life (SABOL) experiment proposed by the Florida Institute of Technology for the 2012 Space Florida International Space Station Research Competition. The SABOL experiment has several important scientific elements dedicated specifically to:

- Developing an improved understanding of the origin of life on our planet
- Increasing our understanding of Alzheimer’s disease, and
- Providing an opportunity to apply this new understanding for the betterment of humanity.

In addition to these scientific aims, the SABOL proposal also includes an educational outreach component to inspire and involve America’s next generation of scientists and engineers.
Upper Transition Region Heating and Loop Energizing

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Minimal observational evidence exists for fast transition region (TR) upflows in the presence of cool loops, however, such results challenge notions of standard solar atmospheric heating models as well as their descriptions on the origins of bright TR emission. Using Extreme-ultraviolet Imaging Spectrometer (EIS) observations, we observe fast upflows \((v \geq 10 \text{ km s}^{-1})\) over multiple transition region temperatures \((0.63 \text{ K} \leq T_e \leq 1.0 \text{ MK})\) at the footpoint sites of a cool loop \((T_e \leq 1.0 \text{ MK})\). Prior to cool loop energizing, asymmetric flows of \(+5 \text{ km s}^{-1}\) and \(-60 \text{ km s}^{-1}\) are observed at the footpoint sites and occur simultaneously with both magnetic flux cancellation (at the site of upflows only) & \(\approx 30\%\) mass in-flux at coronal heights. The loops heating and cooling times are \(~\text{equivalent}\), while maintaining a non-isothermal state. We conclude that the TR acts as the site heating for the cool loop, with both wave-heating and magnetic reconnection acting as energy conversion mechanisms.
Classification and Analyses of Eclipsing Binary from LINEAR Survey

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We are continuing an Eclipsing Binary (EB) survey of eclipsing binary candidates from the LINEAR survey probing a magnitude $14 < V < 18$. In this project, we classified the EBs and strived to develop orbital solutions for these orbital solutions and to study proto-systems and secondary pulsators. The first round of classification completed and stored in SQLite database. The EB systems were sorted by magnitude of color. A population density was identified.
First-Time Analysis of Restored Apollo 14 and 15 DTREM Instrument Data

Marie McBride

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Advisors: Dr. Niescja E. Turner and Dr. David R. Williams

When the Apollo Astronauts were on the surface of the Moon, part of their mission was to deploy the Apollo Lunar Surface Experiments Package (ALSEP). One of the instruments deployed with the ALSEP on Apollo 11, 12, 14, and 15 was the Dust, Radiation, Thermal, Engineering Measurement (DTREM), also known as the Lunar Dust Detector. The DTREM is a small fiberglass box that has 3 thermometers and 3 solar cells. The solar cells were used to determine the degradation from dust, temperature, and radiation on the lunar surface after the astronauts returned to Earth. A set of microfilm at the National Space Science Data Center (NSSDC) is the only archived information from the instrument. The only other existing data are the raw binary counts returned in the communications stream. All other data were lost over time. Combined with the communications stream, the microfilm was used to translate the raw data into a calibrated digital format. Now the full 40-year-old data sets for Apollo 14 and 15 are being properly archived and are in the process of being analyzed with modern technology. The initial analysis reveals evidence of the effects of radiation and dust on the lunar surface as well as the effects of a solar proton event.
The Big Bang Theory

Sara Munoz

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The purpose of my research paper is to gain some insight about how the Universe began and what could be its possible outcomes. By doing research online and reading books on the subject, I’ve compiled a paper about the Big Bang theory, including the origin and history of the Universe, also some of the observational experiments that prove this theory and final about the possible outcomes of the Universe. The Big Bang theory is an effort to explain what happened at the very beginning, how was the Universe, as we know, it created? Astronomers believe that our Universe did indeed have a beginning, prior to it, there was nothing. According to the various sources I have read, the Universe began in a big Cosmic explosion 15 billion years ago, called the Big Bang. It apparently inflated, began its expansion, cooled down, to create for the elementary particles, then the basic atoms, hydrogen and helium and finally the galaxies and stars. There are major evidences that support this theory. First of all, galaxies appear to be moving away from us, which can be seen in their spectrum. And also their recession speed is directly proportional to their distance from us. This is called Hubble’s law. There are 3 possible outcomes to the Universe: the flat Universe, the open Universe, and the close Universe, which they depend on the initial amount of mass and energy, the expansion rate and also, it has been discovered recently that it depends on the dark matter and energy.
Heliophysicists have searched for an explanation to the coronal heating problem since the 1930’s. The Sun’s atmosphere, the corona, fluctuates between 1-10 million Kelvin, while its surface is a mere 6000K. One way of approaching this problem is by examining the heating of coronal loops. Coronal loops form when heated plasma travels along closed magnetic flux tubes. Previous studies using TRACE (Transition Region and Coronal Explorer) data have shown that the evolution of Extreme Ultraviolet (EUV) coronal loops can provide clues to the coronal heating mechanism (Mulu-Moore, et al. 2011). However these studies are done by manually selecting loop pixels by hand, which may introduce observer bias and systematic error. The Atmospheric Imaging Assembly (AIA) on the Solar Dynamics Observatory (SDO) provides high-spatial and temporal resolution and therefore a special opportunity to observe, analyze, and differentiate the loop properties and derive important constraints to the coronal heating mechanism. In this research we have developed an automatic detection algorithm that extracts loops by analyzing the evolution of pixels in high-cadence AIA images. When complete, this algorithm will be able to identify loops in multiple wavelengths without introducing biases and errors associated with manual methods. In this poster we discuss the current state of the algorithm and its success detecting loops visible in AIA 171Å and 193Å images.
Energy Conservation in Cosmological Redshift Photons

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Cosmological time dilation proposes a paradigm in the current understanding of the Universe as it conflicts with the Law of Conservation of Energy. As the Universe expands, space expands and so does the wavelength of a given photon. A longer wavelength represents a smaller energy which is not accounted for at a first glance. We explore possible explanations, including another cosmological phenomenon known as Cosmological Redshift.

![Figure 1 – Illustration showing an expanding wavelength together with an expanding Universe.](image)
Discovery and Analysis of Extrasolar Planets: A Follow-Up on KELT Survey

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The discovery of extrasolar planets (also known as exoplanets) is important because finding new planets means that there could be other worlds with life. This is a follow up on the KELT Survey in order to confirm or deny the new discovery of exoplanets; this study also characterizes the exoplanets by finding orbital parameters. The Ortega and Sara North telescopes are used to observe these planets, and then the planets can be confirmed or not confirmed with the KELT Survey. These observations can also provide orbital parameters such as the mass, radius, distance to the parent star, and orbital period. The results produced show that if there is an ingress or egress then we are able to see if there is an exoplanet or if there is nothing, but care must be taken to determine whether it is an exoplanet and not just a really small star orbiting another one; this is why the mass of the smaller object is so important. With the KC04C006953 star, there is a ingress that shows an object passing in front of the star. More research will be able to tell if that object is an exoplanet.
The Single Degenerate Model of Type 1a Supernovae

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A type 1a supernova occurs when a white dwarf accretes mass from a companion star in a semi-detached binary star system and approaches the Chandrasekhar mass limit. When this limit draws near, extreme temperature and density drive convection within the star. Eventually, a burning front is generated and rips through the star and detonates within seconds. These explosions all occur in the same way and, therefore, their luminosities are nearly identical. This allows for them to be used as distance indicators. By comparing the luminosities with redshifts, a survey found that the universe was expanding at an accelerating rate and led to the discovery of dark matter.
Determining the Ages of 36 Main Sequence Stars Using Gyrochronology

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The age of a star is an important property that can help scientists deduce more aspects of stellar evolution. We are attempting to determine the ages of 36 main sequence stars using gyrochronology in order to compare them to their stellar ages. Once a sufficient amount of data has been collected, we will find a mathematical fit that will tell us the rotation period. So far our results have been inconclusive due to lack of data; however BD-03 2935 and LP684-1 are two target stars that seem promising.
EBTEL Modeling of Solar Coronal and Transition Region Loops

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The existence of the solar corona and the solar wind emanating into interplanetary space implies a mass input from lower atmospheric levels. The source of this mass input is a long-standing problem in astrophysics. The transition region (TR) and the overlying corona are predominately comprised of magnetic loop structures, in which plasma fills and drains continuously. The formation, heating, and evolution of these loops is widely believed to be cause by nanoflares. Here, we test a specific nanoflare model against the observations obtained by the space-based Hinode satellite. We were able to reproduce the temperature profile and lifetime of multiple cycles of filling and draining of a loop with transition region and coronal signatures. These results reproduce some features of a TR loop, which supplies mass to the corona.
RECENT COLLEGE OF SCIENCE GRAND CHAMPIONS

Northrop Grumman Science Champions

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Kimberly Rigano
“Visual Capabilities of Yellow Ratsnakes as Predators of the Endangered Florida Scrub-Jay”
Advisors: Dr. Michael Grace and Angela Munoz, Department of Biological Sciences

2011
Judson Locke, William Bitner and Leonard Grasso
“Detecting Shielded Nuclear Contraband Using Muon Tomography”
Advisor: Dr. Marcus Hohlmann, Department of Physics & Space Sciences

President’s Cup Award Winners

2012
Roby Poteau
“A Mathematical Approach to Predict the Rate of Progression of Chronic Kidney Disease”
Advisor: Dr. Munevver Subasi, Department of Mathematical Sciences

2011
Dawn McDonald, Christina Mazzone and Christine Chater
“How Sensitive is Your MAPK?”
Advisor: Dr. David Carroll, Department of Biological Sciences

2010
Cristina Mazzone, Erin Zingarelli and Adam Hernandez
“Artificial Neural Net Model of PLC gamma–Dependent Calcium Release and Growth After Fertilization in the Starfish”
Advisors: Dr. David Carroll, Department of Biological Sciences and Dr. Semen Koksal, Department of Mathematical Sciences