#1 - SURVIVAL OF INVASIVE AQUATIC PLANTS AFTER AIR EXPOSURE AND IMPLICATIONS FOR DISPERSAL BY RECREATIONAL BOATS. Lindsey Bruckerhoff, Susan Knight, and John Havel, Biology. Faculty Advisor: Dr. John Havel

Recreational boating is widely recognized as an important vector for overland transport of invasive aquatic plants. Since their dominant form of recruitment is vegetative reproduction, entangled fragments on boats and trailers can establish new populations. The effectiveness of recreational boats as a transport vector relies on the resistance of macrophytes to air exposure. During the summers of 2011 and 2012, we conducted nine field experiments in northern Wisconsin to assess air tolerance of Eurasian water-milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). We simulated conditions these plants would experience when ensnared on boats and trailers by testing both single stems and coiled plants. Each experiment involved hanging macrophytes to dry for varying amounts of time and assessing viability based on positive growth rates after rehydration. Single stems of *M. spicatum* and *P. crispus* were viable for up to 24h and 18h of air exposure, respectively. Coiling extended the viability of *M. spicatum* to 72h of air exposure. Vegetative propagules, such as the turions of *P. crispus*, may also be carried by boats. A preliminary experiment indicated turions can survive at least 2 weeks air exposure. The fact that boaters can easily travel among many lakes within a few days suggests that most lakes are susceptible to introduction of viable plants, and so management should continue to focus attention on boat cleaning, especially at lakes known to have populations of invasive species.

#2 - EFFECTS OF GLOCHIDIA AGE ON JUVENILE CONDITION IN FRESHWATER MUSSELS. Amy Maynard and Rowena Woode, Biology. Faculty advisor: Dr. Chris Barnhart.

Toxicologists are increasingly using freshwater mussels (clams) to investigate the effects of pollution. The mussel larvae (glochidia) are briefly parasitic on fish where they metamorphose to the juvenile stage, which is used for toxicology. We compared juveniles derived from glochidia differing in age by 1 year. We measured larval viability and metamorphosis success on host fish and observed the time to 50% mortality (LT50) of the juveniles during starvation as a measure of their condition. Older larvae were less likely to metamorphose. The LT50 of starved juveniles was similar at 24 or 26 days for juveniles from 4, 6, 16 and 18-mo old larvae. We also exposed the larvae to concentrations of salt (NaCl) to test their tolerance of this stress. Juveniles from 4-mo old larvae were slightly more tolerant of salt than juveniles from 16-mo old larvae. Interestingly, NaCl lengthened juvenile survival in starvation at concentrations less than 4.5 g/L and shortened survival at higher levels. These data suggest that aging of Lampsilis glochidia over 1 year has minor effects on juvenile quality for propagation and toxicity testing.

#3 - TRANSGENIC PLANTS TO SILENCE SIRTUIN GENES. Dresden Whitehead, Balazs Kalapos, Daniel Pap, Biology. Faculty Advisor: Laszlo Kovacs

Sirtuin proteins are histone deacetylase enzymes that have become a focus of interest in scientific research. While functions of sirtuin proteins in mammal and fungi are being identified as regulating stress tolerance and longevity, little is known about the role they play in plants. Plant genome encodes two sirtuins, AtSIRT1 and AtSIRT2, which are histone deacetylase enzymes that appear to protect the plant from oxidative stress. The molecular mechanism of plant sirtuins however is unknown. The goal of this work is to better understand sirtuin function in plants through the down-regulation of the expression of these genes. In our study, silencing constructs were made to produce dsRNA molecules homologous to each gene, and the DNA from these constructs was inserted into the genome of *Arabidopsis thaliana.* Through a series of self-fertilizations and selections using Kanamycin, homozygous lines for each silencing construct have been generated and confirmed.

#4 - ENERGETIC COST OF LOCOMOTION IN PANCAKE TORTOISES, A SPECIES WITH A UNIQUE BODY PLAN. Brooke McWherter, Megan Smith and Hillary Kozeny, Biology. Faculty Advisor Dr. Day Ligon.

The pancake tortoise (*Malacochersus tornieri)* is a small tortoise that is native to Tanzania and Kenya and is found on hillsides with rocky outcrops. These outcrops provide little cover in the way of vegetation with the habitat consisting mostly of thorn scrub and grasses. As a result, these tortoises have developed a unique morphology, including a flattened profile and flexible shell that allows them to wedge into rock crevices for shelter. However, their softer shells make them vulnerable to predators, and unlike many tortoises that withdraw into their shells to avoid predation, pancake tortoises more often make a dash for rock cover. This unique antipredator behavior, combined with their shell shape, leads to the possibility of unique adaptations for improved locomotor efficiency. We measured the energetic cost of walking by measuring tortoises' rates of CO_2 production while walking on a treadmill. Walking trials lasted for intervals ranging 22–32 minutes. Our results show that pancake tortoises are able to endure relatively long periods of time walking and produce 41.5–44.5 ml/g/min CO_2 when walking XX m/min. Further studies should compare the cost of locomotion of pancake tortoises with similar sized, but more traditionally high-domed, tortoise species.

#5 - PANCAKE TORTOISES: A STUDY IN BURROW SHARING BEHAVIOR. Brooke McWherter, Biology. Faculty Advisors Dr. Alicia Mathis and Dr. Day Ligon.

Understanding animals' space use and social behavior is important to wildlife management decisions. The pancake tortoise is a crevice dwelling testudinid native to eastern Africa; this small tortoise has been observed sharing crevices with up to two conspecifics. Using a captive group of tortoises, I tested whether female social preferences influenced group composition. I placed individual females in an arena and offered the choice of two crevices that either contained an unfamiliar male, a female, or was unoccupied and monitored behavior and crevice selection. Females exhibited a statistically non-significant trend for choosing male-inhabited crevices (Fishers Exact Test two-sided p-value of 0.1534). A limited number of animals were available for my study, and increasing the sample size could help discriminate social preferences. Alternatively, social patterns could be ascertained in wild populations.

#6 – LANDMARK LEARNING BY JUVENILE SALAMANDERS (*AMBYSTOMA MACULATUM*). Whitney Heuring. Biology. Faculty Advisor: Dr. Alicia Mathis.

We tested whether juvenile spotted salamanders (*Ambystoma maculatum*) could learn to associate foraging patches with landmarks. Training occurred in square containers with a plastic feeding dish in each corner. The food (a piece of earthworm) was placed in a randomly-selected feeding dish (the other three dishes remained empty), and the landmark was always placed beside the feeding dish with the food. A control group was exposed to the same set-up and procedures, but the landmark was placed beside a randomly-selected feeding dish, and so was not a reliable indicator of the presence of food. Each salamander was trained once every 2 days for 30 days. To determine whether learning had occurred, salamanders were placed in the arena with empty feeding dishes in each corner. Significantly more landmark-trained salamanders than control salamanders entered the landmark area first, and landmark-trained individuals had faster latencies to enter the landmark area and longer stay-times. These results suggest that spotted salamanders may be able to locate resources like food patches, breeding ponds, burrows, and shelters in their home ranges by associating their positions with visible landmarks.

#7 - EMBRYONIC LEARNING IN FRESHWATER SNAILS? SUPPORT FOR THE NULL HYPOTHESIS. Courtney Heuring. Biology. Faculty Advisor: Dr. Alicia Mathis.

Embryos of a few aquatic species have been shown to be able to detect chemical cues in their environments and alter post-hatching behavior in ways that appear to be adaptive. We tested the effects of embryonic exposure to cues from a predator on post-hatching anti-predator behavior in pond snails (*Physa acuta*). The embryos were exposed to chemical cues from crayfish (predator), mussels (non-predator control), and plain water (blank control), and juveniles were tested for post-hatching activity when exposed to crayfish (predator), cricket (novel scent), and blank (control) cues. Juvenile snails responded to the chemical stimuli from crayfish predators with more activity (a fright response) in comparison to the other two stimuli. However, there were no significant differences among the embryo treatments. Our failure to find effects of embryonic exposure to predator cues on post-hatching behavior differs from findings for some other aquatic species, bur few species have been tested. The results suggest that anti-predator behavior may be innate in *Physa acuta*.

#8 - HERITABILITY OF ANTHESIS TIMING IN *RUELLIA HUMILIS* Ben Smith, Biology. Faculty Advisor: Dr. John Heywood

Ruellia humilis is a flowering plant species adapted for pollination at night by Hawk moths. Extensive habitat destruction has led to significant declines in Hawk moth visitation rates, potentially jeopardizing the future persistence of this species. I estimated the heritability of the time of anthesis (flower opening) in order to assess the potential for this species to evolve in response to the activity schedules of alternative potential pollinators. Anthesis was observed via an infrared trail camera, mounted above benches of potted *Ruellia* in the Temple Hall greenhouse. The camera captured images at 5 minute intervals overnight, with each image displaying the time and ambient temperature. A total of 3,456 images were taken over 32 nights from 10 families. Ambient temperature had a significant effect on anthesis time, with flowers opening earlier on warmer nights. After controlling for this temperature effect there was significant variation among families in mean anthesis time, suggesting that this trait is heritable. In contrast, the amount of time required for a flower to open completely was not significantly affected by either ambient temperature or family of origin.

#9 - DIVERSITY OF CARBONATE-BORING ALGAE: MORPHOLOGY AND MOLECULES. Lauren Bansbach, Biology, and Dr. Charles O'Kelly, University of Washington Friday Harbor Laboratories. Faculty Advisor: Dr. John Havel.

Despite the name, carbonate-boring algae are in fact quite interesting. These marine algae bore into calcium-carbonate surfaces such as shells, barnacles, and corals. Through this $CaCO_3$ dissolution process, CO_2 is released into the biosphere, equivalent to one fifth of all human-contributed CO_2. With such broad-reaching ecological impacts, surprisingly very little taxonomic work has been completed on these algae. This research used morphological and molecular identification techniques to test whether these algae exhibit tidal height species zonation similar to several intertidal organisms. Morphological analysis of five genera of carbonate-boring algae found at Argyle Lagoon, San Juan Island, WA, along with analysis of 3-dimensional resin casts of the bore holes showed that using morphology to study diversity tells an incomplete story. Phylogenetic analysis of laboratory algal cultures of cool-temperate carbonate borers revealed a strong genetic difference between subtidal and intertidal species studied, suggesting that these algae possess some degree of tidal height zonation.

#10 – IDENTIFICATION OF MICRORNAS INVOLVED IN THE IL-10-INDUCED ANTI-INFLAMMATORY RESPONSE. Leah Cardwell, Srinivas Reddy Doma, Biology. Faculty Advisor: Dr. Brian Weaver.

Interleukin-10 (IL-10) mediates a unique anti-inflammatory response to dampen immune responses and limit tissue damage in infectious disease. In response to bacterial lipopolysaccharide (LPS), macrophages express an array of pro-inflammatory mediators. IL-10 serves to deactivate these cells and inhibit their expression of pro-inflammatory genes. IL-10 works through activation of the transcription factor STAT3 and induction of a set of anti-inflammatory genes (IL-10-induced genes). In this study, we addressed whether IL-10's anti-inflammatory effect is due in part to the induced expression of one or more miRNAs. MiRNA genes encode for small RNA products that negatively regulate expression of protein-encoding genes in various systems. Since IL-10 acts to suppress inflammatory gene expression, we hypothesized that it may do so through a miRNA-mediated mechanism. We used low-density qPCR-based arrays to screen 135 miRNAs with putative roles in inflammation. Our preliminary results revealed 5 miRNA candidates induced in macrophages in response to LPS and IL-10. Thus far, we have confirmed that miR-207 and miR-455 expression is increased in response to IL-10. Although, the specific role each of these miRNAs may be playing remains to be defined, the results suggest that a miRNA-driven pathway may be part of the IL-10-induced anti-inflammatory response.

#11 – EFFECTS OF PRESCRIBED FIRE ON CARBON INPUT AND OVERSTORY PRODUCTION OF OAK-HICKORY FORESTS AND WOODLANDS. Tasha Jacobson and Micayla Kiepert, Biology. Faculty Advisor: Dr. Alexander Wait.

Fire is essential in Ozark forests and woodlands to maintain a relatively open canopy, which allows light into the understory and purportedly increases species diversity. We examined the amount of leaf litter inputs of oak, hickory, and other tree species in three different woodland sites at the Bull Shoals Field Station. “Burn” sites received prescribed fires every 2-4 years since 1999, “reference” sites have been burned since 1980 every 2-4 years, and “control” sites have not been burned in 50 years. Leaf litter, which represents both seasonal over story production and carbon inputs to the soil, has been collected every fall since 2000. I took these data and correlated them with precipitation and ambient air temperature data for each month in those years. Years with higher overall average temperatures appeared to be negatively correlated with oak-hickory production while greater overall average precipitation amounts were positively correlated with oak-hickory production. The greatest production over this time period has been in “burned” woodlands, with the lowest production in “reference” woodlands. These data confirm that prescribed burns open the canopy and may stimulate carbon inputs into soil.

#12 - POTENTIAL FUNCTIONAL CONNECTION BETWEEN DYNAMIN AND THE COAT PROTEIN CLATHRIN. Michelle Williams, Hyoeun Ahn, Courtney Hofstetter, Jeff Sletto. Biology. Faculty Advisor: Dr. Kyoungtae Kim.

Vps1 (Vacuole protein sorting 1) is a GTP binding protein that has been shown to be a multifunctional and multi-localized protein. Vps1 works collaboratively with other proteins at the plasma membrane, vacuole and peroxisome to promote membrane invagination and pinching-off. It is well known that Vps1 functions together with clathrin, a vesicle coat protein which forms a triskelion made up of three heavy chains and three light chains, based on the fact that Vps1 and clathrin genetically interact. Here, I show for the first time that Vps1 and clathrin colocalize, according to my sub-cellular localization assay. Consistently I recently found that clathrin localization is disturbed in cells lacking Vps1, suggesting that Vps1 is required for clathrin to be targeted to the Golgi membrane. Currently I am investigating whether or not clathrin is required for Vps1 localization to the Golgi. Interestingly, I found that Vps1 does not function together with Vps15 and Vps34, which are implicated in membrane trafficking from the Golgi to endosomes. In the future we plan to determine if Vps1 and clathrin physically interact. We will also investigate the spatial temporal recruitment of clathrin and Vps1 in relation to other Golgi proteins.

#13 – CLASSICAL CONDITIONING IN THE OZARK ZIGZAG SALAMANDER (*Plethodon angusticlavius*). Kendell Loyd, Biology. Faculty Advisor: Dr. Alicia Mathis.

Numerous aquatic species can use associative (Pavlovian) conditioning to learn to recognize the scent of unfamiliar predators, but studies of terrestrial species are rare. We trained terrestrial Ozark zigzag salamanders by pairing the scent of the predator with a chemical alarm cue from earthworms (salamanders are known to use the alarm cue of earthworms (Family: Lumbricidae as one way of determining if a potential predator is nearby)). During training, I exposed salamanders to the earthworm alarm cue paired with cues from Whitetail Shiners (*Cyprinella galactura*), a species that a fully terrestrial salamander would never have encountered; control salamanders were exposed to the shiner cue paired with plain water. After training, I exposed all salamanders to the shiner cue only. Salamanders trained with the alarm cue showed a stronger fright response (less distance travelled) than control salamanders, indicating that learning had occurred. The ability to learn to recognize unfamiliar predators through associative learning should increase survival of salamanders in their terrestrial forest habitats.

#14 - HISTORICAL PATTERNS OF RECRUITMENT IN TWO POPULATIONS OF POST OAK (*QUERCUS STELLATA*). Abby Holloway, Joey Michalski, Biology. Faculty Advisor: Dr. John Heywood.

In an effort to maintain the natural populations of old growth post oaks at Drury Point (Drury Wildlife Conservation Area, Taney County, MO), and Turkey Pen Hollow (Ha Ha Tonka State Park, Cambden County, MO), the state of Missouri conducts frequent controlled burns. The absence of small trees at these sites suggests that the short interval between prescribed burns prevents new recruitment. In order to determine conditions under which recruitment has occurred in the past, we used tree core data from these two sites to reconstruct the historical pattern of recruitment and examine its relationship to climatic conditions. We collected and digitized core samples from over 300 trees. Both sites show a flush of recruitment 80-120 years ago, and virtually no new recruitment has occurred in the last 50 years. While both sites are being maintained as old growth populations, their age distributions suggest both sites were harvested at least once. Future recruitment will require increased burn intervals or periodic burn holidays.

#15 - EFFECTS OF LARVAL AGE AND PERIOD OF PARASITISM ON JUVENILE FRESHWATER MUSSEL QUALITY. Grant Bolton and Alexander Linan, Biology. Faculty Advisor: Dr. Chris Barnhart

Freshwater mussels are used by toxicologists to test effects of water pollution. The mussel life cycle includes a parasitic larva that attaches to a host fish and metamorphoses into a juvenile. The juvenile stage is preferred for toxicology. We are studying the effects on juvenile quality of 1) age of the larvae and 2) duration of the parasitism on the host fish. We used larvae of two ages (4 or 16 months). We controlled the period of parasitism by chilling the fish for 0, 2, or 4 weeks at 10C to slow the rate of metamorphosis, before warming them to 23C so that development could continue. After metamorphosis, juveniles were exposed to salt (NaCl) as a stressor to test juvenile quality. Metamorphosis success was not affected by the age of the larvae or duration of parasitism. However, juveniles from old glochidia were killed by lower salt concentrations than younger individuals. Juveniles that had been on the host fish for a longer period were much more tolerant of salt, and the difference between age groups was reduced. We conclude that both age of mussel larvae and duration of the parasitic period are important in determining juvenile quality for toxicology.

#16 - AMYLASE, CALCITONIN GENE-RELATED PEPTIDE, CORTISOL, ESTRADIOL, AND VASOACTIVE INTESTINAL PEPTIDE LEVELS IN TREXIMET TREATED AND UNTREATED MENSTRUAL MIGRAINE PATIENTS. Evan Clark, Ryan Cady, Biology. Faculty Advisor: Dr. Paul Durham.

Amylase, calcitonin gene-related peptide (CGRP), cortisol, estradiol, and vasoactive intestinal peptide (VIP), are present in saliva of patients with inflammatory disorders, and thus, may be useful as biomarkers of progression or treatment response. However, biomarker concentrations are not yet fully understood in some disorders, such as menstrual migraine attacks. We hypothesized that saliva could be used as a diagnostic tool to better understand the levels of biomarkers in menstrual migraine patients. To test my hypothesis, saliva samples were obtained from 27 menstrual patients with one group receiving a placebo and the other TREXIMET, which is a combination of sumatriptan and naproxen sodium. Samples were taken at various points before and after the attack and treatment. Samples were analyzed for the level of amylase, CGRP, cortisol, estradiol, and VIP by radioimmunoassay or ELISA. Patients treated with TREXIMET were found to have increased levels of amylase and CGRP compared to placebo patients. In contrast, VIP and estradiol levels were found to decrease in TREXIMET patients compared to placebo patients during an attack. Results for cortisol were inconclusive. Data from this pilot study demonstrate changes in the expression of salivary biomarkers during a menstrual migraine attack.

#17 – QUANTIFICATION, ISOLATION, AND 16S IDENTIFICATION OF BACTERIAL SPECIES FROM A COMMERCIALLY-AVAILABLE DIETARY SUPPLEMENT Andrew Millar, Rhy Norton**,** Biology. Faculty Advisor: Paul L. Durham

Dietary supplements are not currently regulated by the U.S. Food and Drug Administration (FDA) and given their growing popularity it is critical for both manufacturers and consumers to be aware of any associated product risk. An unfortunate epidemic in 1989 led to the death of 37 individuals and left nearly 1,500 permanently paralyzed resulting from a supplement of the amino acid L-Tryptophan containing a poisonous substance. The objective of this study was to characterize the bacterial load of a popular dietary supplement to better understand the possible risks associated with consuming unregulated dietary products. Bacterial levels were quantified using a standard plate count. Unique bacterial isolates were then selected using a battery of selective and differential microbiological culture media. Once selected, a fragment of the 16S rRNA gene was amplified using colony PCR and sequenced. The resulting sequences were identified using BLASTn and then classified according to their potential pathogenicity. Two concerning isolates were identified to be potentially pathogenic: *Bacillus cereus/Bacillus anthracis* and *Bacillus cytotoxicus*. Further testing is needed to definitively decide the risk associated with this product. This evidence may shine light on the need for tighter regulations of commercially available dietary supplements as their use becomes more widespread.

#18 - THE CASTROPHIZING EFFECTS OF MUSCLE PATHOLOGYAND SLEEP DEPRIVATION ON THE TRIGEMINAL SYSTEM. Brittany N. Thurman, Jennifer E. Denson, Jordan L. Hawkins, Biology. Faculty Advisor: Dr. Paul L. Durham

Migraine is a painful neurovascular pathology that affects approximately 9% of Americans and is characterized by severe headaches. There are many environmental risk factors implicated in initiating a migraine attack such as neck muscle pathology and sleep deprivation. Clinically, neck muscle pathology and sleep deprivation are prevalent in most migraine patients. Migraine is characterized by peripheral and central sensitization of trigeminal nociceptive neurons. Sensitization is mediated by inflammatory signaling proteins such as PKA, and activated microglia and astrocytes. In this study, I investigated the catastrophizing effect of neck muscle pathology and REM sleep deprivation on trigeminal neurons utilizing von Frey techniques and immunohistochemistry. Data from this study provided evidence that neck muscle pathology and sleep deprivation on their own were not sufficient to produce substantial increases in nocifensive behavior or increased levels of PKA and Iba1 in spinal trigeminal nucleus. However, animals experiencing the combination of muscle pathology and sleep deprivation exhibited increased nociceptive behavior, as well as elevated levels of PKA and Iba1. Results of my study demonstrate that the sum effect of several environmental risk factors can lead to activation of pain signaling neurons in the spinal trigeminal nucleus known to be involved in migraine pathology.

#19 - REGULATION OF PROMOTER EXPRESSION OF PRO-INFLAMMATORY GENES IN RESPONSE TO NATURAL PRODUCTS. David R. Miley, Ryan Cady, Biology. Faculty Advisor: Dr. Paul L. Durham

Natural products are an often-overlooked as a means to modulate inflammatory pathways. Calcitonin gene related peptide (CGRP) and nuclear factor kappa-light-chain-enhancer of activated B cells (NFkB) are two proteins known to play important roles in the initiation and maintenance of an inflammatory response. These proteins have been implicated in diseases ranging from migraine to cancer. The goal of this study was to screen for natural products that decrease NFkB and CGRP promoter activity. One way to study inflammatory pathways is through monitoring the transcriptional activity of a gene. In my study, I used a human neuronal-like cell line, DMS 153 cells. Cells were transfected with either NFkB or hcal, the human CGRP promoter, and treated with various natural products. After overnight incubation, promoter activity was measured using a luciferase assay and a luminometer. Of the products tested, cocoa showed the greatest inhibitory effects on both promoters. Results of this type of analysis will be used to determine which natural products have the greatest anti-inflammatory effects and will therefore be used for future in vivo testing.

#20 - INVESTIGATION OF VPS1 FOR THE ASSEMBLY OF RETROMER IMPLICATED IN THE PATHOLOGY OF ALZHEIMER'S DISEASE. Katie Schmelzle, Brandon Tenay, Josh Lukehart, Biology. Faculty Advisor: Dr. Kyoungtae Kim

The retromer plays an essential role in the recycling of proteins from a membrane bound sack-like structure called the endosome to the Golgi. It is comprised of two sub-complexes, cargo recognition and vesicle initiation sub-complex. The former is comprised of Vps35 (Vacuolar protein sorting 35), Vps26, and Vps29. It recognizes cargo found in the endosomal membrane and grabs it. The vesicle initiation sub-complex, including Vps5 and Vps17, assembles around the cargo and initiates pinching off of the endosomal membrane to begin its journey to the Golgi. Vps10 is a cargo protein and is implicated in the delivery of carboxypeptidase Y (CPY), a peptidase targeted to the vacuole for degradation of waste molecules. Vps1 is involved in the recycling of Vps10. I hypothesized that upon the loss of Vps1, the assembly of the retromer complex might be affected. In order to examine that Vps1 is required for targeting of the retromer complex, I am investigating the localization of the retromer components in *VPS1* knock out cells. It has been studied that Vps35 levels are low in Alzheimer's disease. In the future, I hope to discover the relationship between the retromer and Vps1 to better characterize their pathological significance in Alzheimer's disease.

#21 - ANALYSIS OF CONFORMATION CHANGE IN DNA DOUBLE HELIX BY 8-oxoG SINGLE BASE MODIFICATIONS. Juliano D. O. Silveira, Chemistry. Faculty Advisor: Dr. Gary Meints.

Deoxyribonucleic Acid (DNA) contains all genetic information of living beings and some viruses. This information is saved as a nucleotide sequence format, readable by enzymes and transcription factors. The products of the genes within the molecule provide the cell with structural (proteins and enzymes) and functional (regulatory RNAs and RNAs involved in post-transcriptional modification) substrates. It is important that the molecule remains intact; for a modification on its sequence or contents can result in cell malfunction, lead to cancerous modifications or cause cell death. DNA damages, however, are very frequent, occurring on average about 10,000 times a day per cell of the human body. Repair enzymes are the endogenous machinery used to extract modified or misplaced bases from a DNA strand and replace them for unmodified bases in the correct sequence. Reactive oxygen species are the main prompters of Guanine oxidation into 8-oxoGuanine. In order to elucidate how DNA modifying enzymes recognize damaged bases stacked in the DNA helix, the local conformation modifications caused by 8-oxoG in different sequence positions have been measured through solution-state NMR. The results from those analysis can provide information on the exact mechanism by which repair enzymes recognize their binding sites.

#22 - RADICAL AND CATIONIC MECHANISTIC PATHWAYS IN ROTENONE BIOSYNTHESIS. Ty McMurry, Chemistry. Faculty Advisor: Dr. Matthew R. Siebert.

The atomic-level inner-workings of biological systems are of general interest. Rotenone, a known pesticide and piscicide and cancer chemo preventative, is the focus of the study herein. The mechanism for the biosynthesis of rotenone is largely unknown with both ionic and radical pathways proposed. We use computational methods (B3LYP/6-31G*) to assess the likelihood of both pathways in hopes of gleaning new information about how rotenone is synthesized by Nature.

#23 - CHEMICAL OPTIMIZATION OF NANOPARTICLE QUANTUM DOTS FOR SINGLE MOLECULE IMAGING OF CELLULAR NUCLEIC ACID DELIVERY. Robert Reeves, Michelle Butts, and Jason Davis, Chemistry. Faculty Advisor: Kayte M. Fichter

Recent discoveries in nanobiotechnology have shown that CdSe nanoparticle quantum dots (QDs) demonstrate unique fluorescent properties that allow for highly detailed and quantitative imaging of cellular trafficking mechanisms. In this study we activated the carboxylate groups on the surface of the QDs for conjugation to diamine moieties to impart a positive charge. This functionality allows the electrostatic condensation of negatively charged nucleic acids onto the surface of the QDs. The resulting products and DNA conjugates were characterized using gel electrophoresis. We anticipate that these optimized QD-nucleic acid vehicles will facilitate cellular delivery in gene therapy applications.

#24 EVALUATION OF HALOGEN BONDING FOR CRYSTAL ENGINEERING. Shalisa Oburn & Lisa Kirchner, Chemistry. Faculty Advisor: Dr. Eric Bosch.

To successfully engineer crystals, and other assemblies of organic molecules, non-covalent interactions are used to bring molecules together in a predictable fashion. Halogen bonds have recently been recognized as important synthons in crystal engineering and supramolecular chemistry. In addition, halogen bonds are now recognized to play a role in binding and recognition of biomolecules and have been used in the design of enzyme inhibitors. This pilot study is focused on the formation of large planar polyaromatic assemblies using carefully designed aromatic molecules. The molecules contain a halogen bond donor atom and a halogen bond acceptor atom which are positioned so that the molecules will dimerize in solution and solid state with two halogen bonds. The success of the project will be evaluated using X-Ray crystallography. In subsequent studies, molecules capable of halogen bonding will be prepared with specific goals. For example, some halogen bonded structures will be designed to have liquid crystalline properties while other substituents will be chosen to form porous networks for selective entrapment/separation of small molecules.

#25 - DEVELOPMENT OF PROGRAMMABLE LOGIC CONTROLLER CODE TO OPERATE A BATTERY HIGH POTENTIAL TEST MACHINE. Marvin W. Tulla, Justin D. Kosar, Joshua S. Holcomb, Dylan T. Underwood, Electrical Engineering. Faculty Advisor: Dr. Robert I. Egbert. Technical Advisor: Dr. Kelvin T. Erickson.

Northstar Battery designs and manufactures a wide range of engine and telecommunications batteries. Often, a problem develops in the manufacturing of batteries when two or more internal lead plates are shorted together. Current final product inspection is performed manually and at random resulting in poor efficiency. The project's goal is to integrate an automated High Potential (Hipot) test unit into the existing production line to perform a Dielectric Withstanding Voltage (DWV) test. Automating and integrating testing, into production, will improve production efficiency and reduce waste. During the DWV test, high voltage is applied to the lead plates and resulting current between the plates is measured. Automated testing is performed by interfacing the Hipot test machine with an Allen Bradley programmable logic controller (PLC). The PLC will control an automated robot that delivers batteries to the Hipot test machine. Six individual tests will be conducted on the six cells of lead plates within the battery. Each test result will be conveyed to the PLC, which determines whether to pass the battery down the production line or indicate any failures to the operator. The automation portion is completed and will be integrated into the current system upon delivery of the testing equipment.

#26 - MECHANICAL DESIGN AND CONSTRUCTION OF A HIGH-POTENTIAL TESTING STATION FOR INDUSTRIAL BATTERIES. Jordan Keene, Elliott Hankison, Nathan Minor, and Wayne Spencer, Electrical Engineering. Faculty Advisors: Dr. Kelvin Erickson, Dr. Robert Egbert

A battery manufacturer, NorthStar Battery Company, requires an automated high-potential testing station within the battery assembly process for industrial sized batteries. The test will check for the integrity of the materials within each battery cell, thereby, ensuring quality control. The company already owns the high-potential testing equipment, but needs an automated station that will allow for efficient testing. The existing test is done manually, much later in the assembly process, and a negative test renders the battery useless. The anticipated new testing procedure will be within the assembly line, where a negative test will result in salvageable components. Furthermore, the automated process will allow the tester to detect imperfections quickly, via an integrated Programmable Logic Controller (PLCs), which will be implemented by a third party. Implementing the proposed station will improve production numbers by reducing testing time and waste. This project concentrates on the mechanical design of a high-potential testing station following the guidelines set forth by the company. The final prototype was designed to function in the corrosive environment of the production facility, over a long period of time. Using interchangeable trays, the design will allow for testing the various battery models produced by the facility.

#27 – HEATING OIL BY FOCUSING SOLAR ENERGY USING AN INWARD FACING COMPOUND PARABOLIC TROUGH. Daryl McConnell, Brad Mothersbaugh, Kennedy Kiptanui, Zach Yarger. Electrical Engineering. Faculty Advisors: Dr. Robert Egbert, Dr. Steve E. Watkins.

The designed system's goal is to heat oil, with active monitoring, up to the desired temperature, using solar insulation which will at a later stage become part of a bigger system, where the heated oil reactive force is captured and mixed with water through a retrofitted engine that drives an alternator intended to provide electrical power to areas that may not have access to grid power. Using an inward facing parabolic trough, solar energy is focused onto a pipe carrying 5W-30 synthetic oil to achieve a desired temperature. The trough will be placed axially East to West to avoid solar tracking so as to maximize solar insulation capture efficiency. Gravity feed will be used at this time for fluid flow. System components were selected to withstand high temperature, and facilitate remote operation. A Programmable Logic Controller (PLC), running on 12 VDC, will monitor the oil's temperature. PLC inputs will be the temperature sensors installed at the start, 1/3, 2/3, and end of the trough system. The developed system will be used to demonstrate the feasibility of collecting energy through the proposed technique and serve as a platform for further research and development.

#28 - HIGH RESOLUTION GRAVITY SURVEY TO DETERMINE LOCATION AND EXTENT OF FAULTING, JANE, MO. Mark O. Larson. Geography, Geology, and Planning. Faculty advisor: Dr. Kevin Mickus.

Mapping of the Jane Quadrangle in SW MO was undertaken by a group at Missouri State University in 2012. The area is composed of Lower Ordovician and Early Mississippian limestone, dolostone, and shale. Numerous low amplitude structural features and faults were found. A high resolution gravity survey, including a number of profiles at 0.1 mile spacing, was conducted in order to constrain and identify faults in the region. 2-D profiles and a Bouguer gravity anomaly map will be used to show the subsurface geometry and extent of faulting.

#29 - ARCHAEOLOGICAL GEOPHYSICS AT NATHAN BOONE HOMESTEAD STATE HISTORIC SITE, SW MO. Mark O. Larson. Geography, Geology, and Planning. Faculty advisors: Dr. Elizabeth Sobel, and Dr. Kevin Mickus.

The Nathan Boone Homestead was established by Nathan Boone, his family, and enslaved African Americans in Ash Grove, Missouri in the 1830s. Nathan Boone was the son of famed frontiersman Daniel Boone and was a significant figure in Euroamerican settlement of the trans-Mississippi west. Previous archaeological excavations and geophysical studies indicated a number of cultural features (both identified and anomalous) at the site. In this study, we synthesize the results of new and previous geophysical research at the site including GPR, resistivity, magnetic, and electromagnetic surveys. These findings will aid management and research at the site by the Missouri Department of Natural Resources.

#30 – GRAVITY AND MAGNETIC ANALYSIS OF PLUTONS, RING PLUTONS AND MAFIC BODIES IN THE ST FRANCOIS MOUNTAINS, SE MISSOURI. Mark O. Larson. Geography, Geology, and Planning. Faculty Advisor: Dr. Kevin Mickus.

The St. Francois Mountains of Missouri are a Proterozoic volcanic complex composed of felsic bodies, mafic intrusions and is the largest exposure of Proterozoic lithologies in the region. The origins of the St. Francois Mountains is not well understood, but subduction volcanism is the leading hypothesis. The region has been faulted in the Cambrian with reactivation in the Cretaceous, and continuing today. Our research focuses on analyzing gravity and magnetic data to determine the upper crustal structure of the region in order to relate these data to the location of proposed caldera rims, as well as mafic bodies, and to better understand their nature and origin. Gravity (Bouguer anomaly maps) and magnetic data (residual magnetic maps) identified anomalies that agreed with existing structural data of the region. Detailed gravity data were collected along profiles. We modeled these with 2D forward modeling to determine the subsurface geometry of the calderas constrained by surface density measurements and surface features. Additionally, a series of residual, regional and derivative gravity and magnetic anomaly maps have been constructed to aid in interpretation. Collection of rock samples at the surface and from drill core have granted density data to constrain our models

#31 - SEASONAL VARIATIONS IN RAINFALL-DISCHARGE RELATIONSHIPS FOR MISSOURI WATERSHEDS. Joshua D. Elson, Geography, Geology, & Planning. Faculty Advisor: Dr. Bob Pavlowsky.

Watershed hydrology exerts major influence on the ecological and geomorphic processes within a river. In this study, long-term monthly discharge trends are evaluated to investigate changes in flow conditions related to seasonal weather patterns, climate change, and land use conditions. Hydrologic records were generated from historical records from eight USGS surface water monitoring stations in different Missouri river basins. Monthly discharge data was divided into the four seasons to investigation seasonal variation. Generally, stations share two distinct trend lines found within the seasons that can be explained by seasonal vegetation coverage. Summer and fall share a trend line that have lower discharge values that are explained by an increase in evapotranspiration due to maximum vegetation cover and air temperature. Spring and winter share similar trend lines with relatively higher discharge totals per unit depth of precipitation which indicates less water loss to evapotranspiration due to cooler temperatures, less foliage interception, and lower rates of soil water uptake. Hydrological variations of Missouri basins are also impacted by topographic relief, latitude, urbanization, deforestation and climate change. Winter has recently seen less variability, which might be explained by warmer winters seen over the last couple decades.

#32 - WATER TEMPERATURE VARIATIONS OVER MULTIPLE SCALES IN THE JAMES RIVER, SW MISSOURI POWER STATION. Sara Cheek, Geography, Geology, and Planning. Faculty Advisor: Dr. Robert Pavlowsky.

Thermal pollution is a consequence of utilizing a water body as cooling water discharge for a power plant. Heated water released by power plants puts aquatic organisms at risk due to reduced dissolved oxygen levels. In 2002, approximately 200 fish were found dead near the dam at Lake Springfield that serves as cooling water for the James River Power Station. This study evaluates influence of thermal releases to the main stem of the James River within the context of daily, seasonal, and annual temperature variability. Temperature records were evaluated from ambient water quality stations, TMDL, and a study by the authors that monitored water temperature changes above and below a coal-fired power plant discharge point. Water temperature data was collected with a Horiba U-22XD multi-parameter probe weekly from October to December 2012. Average temperatures increased by 7^{o}C in the James River from 13.8^{o} C above the plant to 20.8^{o} C below the plant outfall. Long-term and current temperature and dissolved oxygen data were analyzed to examine if levels fell below Missouri guidelines of 5.0 mg/L.

#33 - CAVE SINUOSITY OF SOUTHWEST MISSOURI AND SOUTHEAST MISSOURI. Matthew Butler, Geography, Geology, and Planning. Faculty Advisor: Douglas Gouzie

Cave sinuosity is the geomorphologic phenomenon that occurs when cave passages meander similar to that of alluvial rivers. Cave maps from the Southwest and Southeast regions of Missouri were obtained by a randomized system with criteria set similar to that of George H. Deike III and William B. White with their work on sinuosity of caves in Kentucky and Missouri against stream passages. Cave passages that displayed predominant sinuosity were used and compared from both regions. Measured was the wavelength of crest to crest distance (L) and the channel width (W; both in feet), two graphs were then set up with a power function of (L) x (W) for each region individually. The wavelength of cave passages on all maps is found by the equation $L = 2/N \sum l$ (N being the number of crests measured, and l being the measured distance in feet). It is found that there is: 1) a significant difference in sinuosity within caves of Southeast and Southwest Missouri 2) there is a moderate difference in data comparison against Deike and White's work on caves from both Missouri and Kentucky.

#34 - EFFECTS OF SLOPE ANGLE AND FLOW TIME ON FLUVIAL GEOMORPHOLOGY USING A STREAM TABLE. Michael Jahnke, Geography, Geology, and Planning. Faculty Advisor: Dr. Bob Pavlowsky.

Stream formation is a complex process, but when broken down into simpler studies, can prove powerful to understanding the geomorphic and hydrologic processes involved in rivers and related landform development. Using a stream table, several hypotheses regarding fluvial geomorphology were studied: what is the chronology of landform development and how does slope angle influence the degree and speed of landform development. In this study, trials were run at three different slope angles, 2 degrees, 5 degrees, and 10 degrees, allowing water to flow for 5-minute intervals. The resultant stream forms were photographed and analyzed to show that the sequence of landform development is the same, regardless of slope. Flume results also showed that as the slope of the stream table increases, fluvial landform development occurs more rapidly. A final outcome is that as time increases, more pronounced landforms form due to prolonged erosional work. From these results, a chronologic sequence of stream development can be created, allowing greater understanding of fluvial processes.

#35 - RIVER INFLUENCE ON MARINE WATER QUALITY AND CORAL REEF CONDITION, SOUTHWEST JAMAICA. Aaron T. Pavlowsky, Geography, Geology, and Planning. Faculty Advisor: Dr. Judith L. Meyer

Marine fisheries and coral reefs in Jamaica have degraded over the past three decades due to over-exploitation, coastal development, and river pollution by nutrients and sediment. This study evaluates the influence of river discharge and pollution loads on coastal water quality along the southwest coast of Jamaica. Water and sediment quality were measured along three offshore transects associated with inputs from the Bluefields and Sweet Rivers in the Bluefields Bay Fish Sanctuary, the Black River Bay, and Galleon Beach Fish Sanctuary. River mouth mixing zones were identified with temperature and salinity profiles. Nutrient levels in the bay were evaluated using phosphorus concentrations in the water column and fine-grained bottom sediment. In addition, sediment metals were also evaluated. Sampling points were located with a global positioning system and mapped with ArcGIS software. Under low flow river conditions, freshwater influence usually extended <500 m offshore in Bluefields Bay. However, in the Black River Bay, brackish water extended a few kilometers offshore. The highest nutrient concentrations were found in bays fed by larger rivers draining urban and agriculture land use. Coral reef conditions declined with excess sediment deposition and higher nutrient levels in the Black River Bay.

#36 – CLASTIC DIKES WITHIN THE SWAN CREEK SANDSTONE, SOUTHWEST MISSOURI. Joshua D. Elson, Mark O. Larson, Joe M. Talarico, Brandon Ives, Geography, Geology, & Planning. Faculty Advisor: Dr. Charles Rovey II.

The Swan Creek sandstone is a member of the Cotter dolomite, which intermittently appears within the top 50' of the Cotter. It is Ordovician silica rich and is typically 2-10' thick. It frequently shows herringbone cross-bedding that indicates a near-shore environment. Outcrops of the Swan Creek sandstone are found along Swan Creek near Sparta, MO. At this location unique features of clastic dikes and boxwork like veins are found. The dikes are composed of the same quartz arenite as the Swan Creek, and do not intrude into the Cotter above or below. The dikes cut across the herringbone cross-bedding and have laminae that indicate that the sand originated from within the unit. Preliminary investigations suggest that the dikes are oriented N-S. The boxwork like veins are primarily composed of silica cement, but also have a fair amount of quartz grains. The veins are oriented sporadically within the unit and range from 5cm to 2 meters in length and 1/2-2 cm wide. These features are likely linked to some tectonic event. Perhaps the Oauchita trough and rifting occurring during the Ordovician. The events had to have occurred during or just prior to lithification. Thin section analysis might reveal enough evidence to accurately describe these features.

#37 - CLUSTERING BASED FAST SUPPORT VECTOR REGRESSION. Joshua Smith, Mathematics. Faculty Advisor: Dr. Songfeng Zheng.

Multiple Linear Regression (MLR) is a well-established and useful method of fitting a model, but it is not the only method. In this research, I explore the method of Support Vector Regression (SVR) and highlight its unique features when compared with MLR. The preliminary topics of regression and loss are reviewed. Then, the goals of the SVR problem are stated, which lead to a convex optimization problem. Finally, I explore the use of predictor variable clustering to reduce the run-time complexity of the SVR problem.

#38 - KRYLOV SUBSPACES AND ADAPTIVE ARNOLDI METHODS FOR COMPUTING PAGERANK. Alex Thomson, Mathematics. Faculty Advisor: Dr. Jorge Rebaza.

Since Google released its PageRank algorithm, a common approach for computing PageRank vectors has been the power method. This simple approach effectively computes the eigenvector associated with the dominant eigenvalue of a large, stochastic, primitive matrix which is the PageRank vector. However, a disadvantage is that it tends to converge slowly. This presentation proposes implementing a generalized Arnoldi algorithm that can reduce the size of our problem by mapping the web matrix into an orthonormal basis of its Krylov subspace with a much smaller and more manageable dimension. This orthonormal basis is used to form an approximate similarity transformation to find approximate eigenvalues of the web matrix. It will also be discussed how a combination of the generalized Arnoldi algorithm and SVD factorization is used to ensure the convergence of the PageRank vector. Along with the generalized Arnoldi algorithms matrix reorderings can be implemented to speed up computations. Numerical tests will be displayed to show the superiority of the generalized Arnoldi methods when compared to power method and other related algorithms recently studied by researchers for the problem of web page ranking.

#39 - EIGENVECTOR RANKING OF SPORTS TEAMS. Brittany Street, Mathematics. Faculty Advisor: Dr. Matthew Wright.

The project attempts to establish a ranking system among professional football teams using the same techniques Google employs to rank web pages. This is achieved by using a 32x32 probability matrix comparing the 32 teams in the NFL to each other. The eigenvector corresponding to the largest eigenvalue of this matrix will produce a ranking of teams. Teams were ranked based on methods incorporating home-field advantage, won/loss record, win percentages, scores, and point differentials. After several models were explored various combinations of models were tested in hopes of getting an improved ranking. The math behind the use of eigenvector ranking as well as the development and testing of various models has been explored in this project in the framework of professional football teams.

#40 – SUBGROUP LATTICES OF GENUS ONE. Jeremy Berry, Mathematics. Faculty Advisor: Dr. Les Reid.

Extending the work of Bohanon and Reid in their paper titled “Finite groups with planar subgroup lattices”, one might ask when does a group have subgroup lattice that is embeddable in a surface of genus equal to one? That is to say, which subgroup graphs can be drawn in the surface of the torus (orientated surface of genus one) or in the projective plane (non-orientable surface of genus one)? We completely investigate and classify subgroup graphs of cyclic, abelian and non-abelian groups of the latter with partial results for the former. After introducing the necessary background information, we discuss the process and techniques which were used to classify said subgroup lattices.

#41 – PHOTOMETRIC ANALYSIS OF NINE YELLOW SUPERGIANT STARS. Philip E. Crouse, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Robert S. Patterson.

From September to December 2012 a group of yellow supergiant and bright giant stars was observed with the 14-in. telescope and Apogee Alta u77 CCD camera at the Missouri State University Baker Observatory. The CCD images were calibrated to obtain the brightness of the program stars using a technique called differential photometry. To be certain of the variability, stars presumed to be constant stars of like spectral class were observed concurrently. Three of the nine yellow supergiants were recovered as known variable stars, five were observed to be non-variable at a 1% precision measurement level, and one star, HD 199290 is suspected to be variable with an amplitude of 0.1 magnitude and period on the order of 60 days, which would make it a newly-found Cepheid variable star. These Cepheid variable stars are all important distance indicators which allow astronomers to measure the vastness for space.

#42 – CONTINUING THE SEARCH FOR PULSATING M DWARF STARS USING *KEPLER* DATA. Amanda Winans, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Andrzej Baran

M dwarfs stars account for a significant part of our Galaxy's population and the measurement of their properties would help in determining cosmological values. More specifically, measuring the masses of these stars would greatly assist the calculation of the total mass of the Galaxy. Current models of M dwarfs suggest that these stars should pulsate with a frequency of about 36 cycles per day. We processed *Kepler* data for stars with temperatures below 5000 K and searched for an amplitude at that frequency. Of the 544 stars that were looked at, only eight showed potentially close peaks though none of them strong. These stars will be spectroscopically classified in the future. Since we assume that most of the stars that were looked at are M dwarfs due to *Kepler*'s planet hunting nature, finding only a few weak possibilities suggests that current M dwarf models may need to be looked at again.

#43 - CONSTRUCTION OF AN INITIATED CHEMICAL VAPOR DEPOSITION REACTOR AT MISSOURI STATE UNIVERSITY. Hayley R. Osman, V. S. Sandeep Akkanapragada, and Edgar Kosgey, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Saibal Mitra.

Initiated Chemical Vapor Deposition (iCVD) is a well-known method for depositing polymers for use in chemical, biological, and electrical applications. By utilizing a variant of hot filament deposition we can produce conformal coatings of polymer films at relatively low reaction temperatures. The iCVD method is a solventless technique in which thin polymeric films are deposited by introducing controlled ratios of monomer and initiator gasses into the reaction chamber. Low temperatures in the reaction chamber allow the deposition of polymer films on a wide variety of substrates that include biological substrates. In collaboration with Massachusetts Institute of Technology (MIT) we have demonstrated the ability to deposit copolymers with different compositions, coat curved surfaces, pattern various substrates, and create chlorine-resistant antifouling coatings. The construction of the iCVD reactor will give us at Missouri State University (MSU) the ability to develop bio-compatible coatings, antibacterial coatings, and electrically conductive coatings for biomedical and electronic applications. In this part of the presentation, we will discuss the challenges and design problems we faced and are overcoming to complete the project. These challenges include extra safety precautions to accommodate MSU undergraduate researchers and alternative reactor components to utilize our small lab space.

#44 – MEASURING THE MASSES AND SIZES OF STARS AND PLANETS USING KEPLER SPACECRAFT DATA. Kate Hargis, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Mike Reed

The Kepler spacecraft has been searching for extrasolar planets since its launch in 2009. The spacecraft measures the brightnesses of stars with unequaled precision which benefits us in two ways. When a planet transits in front of a star, it blocks a small amount of the light. Repeated transits can be used to determine many properties of the planet, including orbital period, orbital distance, relative size (compared to the host star), and possibly mass and therefore density. The second is benefit is determining precise properties of the host star. If the star is pulsating (dimming and brightening periodically) we can use those properties to determine properties of the star, including the mass and size of the star. Once we know the mass and size of the star and the duration of a planetary transit, we know the size of the planet. In this manner, we can characterize the densities of extrasolar planets and, along with the distances from their parent stars, estimate their surface conditions- especially those which may be suitable to harbor life.

#45 – INVESTIGATIONS OF Fe-DOPED MESOPOROUS SILICA FDU-12 TREATED UNDER HYDROTHERMAL CONDITIONS. Adam Brandt, Steven Harrellson, Scott Maasen. Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Robert A. Mayanovic.

Modifying the physical and chemical properties of periodic mesoporous silica FDU-12 by surface-doping with metal ions such as Fe^{3+} using hydrothermal treatment has potential applications in the energy and chemical industry. In this research project, we are investigating the structural, vibrational and optical properties of Fe-surface-doped periodic mesoporous silica FDU-12. A reactor vessel built out of Hastelloy C-276 material was used to react Fe(III) with mesoporous silica FDU-12 under hydrothermal conditions at temperatures ranging from 160 to 370 °C. Our results show that the higher P-T conditions used in the hydrothermal treatment result in considerable degradation in the stability of the pore structure of FDU-12. Raman spectroscopy shows that the TO/LO symmetric transverse and longitudinal optic network modes are diminished whereas the localized n-member (n = 3,4) siloxane ring vibrational modes are generally broadened in Fe-doped vs. undoped FDU-12. Photoluminescence spectroscopy shows that the features at photon energies ranging from ~1.4 to 1.7 eV are enhanced in Fe-doped relative to that of undoped FDU-12.

#46 – INVESTIGATING THE PULSATIONS OF AN EVOLVED COMPACT PULSATING STAR USING KEPLER SPACECRAFT DATA. Heather Foster, Physics, Astronomy and Materials Science. Faculty Advisor: Dr. Mike Reed.

The Kepler spacecraft was launched into an Earth-trailing orbit of the Sun in 2009. Its primary mission is to detect planets. Fortuitously, Kepler is doing that by taking repeated images of stars, allowing us to study the host stars. Many of the stars Kepler is observing are pulsating; that is getting brighter and fainter in a periodic fashion. Those pulsations describe the internal structures of the stars, allowing us to probe their interiors. Over two years of continuous observations have been released by Kepler and these data are used to examine the pulsation structure of a compact star revealing a rich pulsation structure that is also examined for time-dependence.