Ohio Wesleyan University

RESEARCH SYMPOSIUM

Patricia Belt Conrades Summer Science Research Symposium

September 21, 2009

Heather Costello, ’05 >>

Current PhD candidate in the Integrated Biomedical Science Graduate Program at The Ohio State University

> *“My experience at Ohio Wesleyan prepared me well for the rigors of graduate school. It allowed me to develop, at an early stage in my career, the passion and perseverance necessary to succeed in research.”*

The Patricia Belt Conrades Summer Science Research Symposium

Science, mathematics, and technology touch all of our lives. Through ongoing research and discoveries concerning worldwide problems such as infectious diseases, air pollution, gene therapy, and global warming, we can tackle such issues and train today's students to be tomorrow's accomplished scientists.

Now in its 17th year at Ohio Wesleyan, the Patricia Belt Conrades Summer Science Symposium encourages engaged research and learning within a 10-week period. This culminates in a symposium allowing students to proudly present their research in poster format at a gala event in the atrium of our Conrades•Wetherell Science Center.

Contents >>

Atrium, Conrades•Wetherell Science Center

Monday, September 21, 2009 at noon

Opening remarks by President Rock Jones followed by student poster presentations

Thoughts from the Director

Ohio Wesleyan is an institution that strives to meld classroom knowledge with practical experiences. The Summer Science Research Program does just that. There is no better way to learn how to be a scientist than through the doing of science. In science classes this is often accomplished in the accompanying laboratory. However, experience in student research goes beyond the class laboratory experience by empowering students to take control of their learning. Student participation in the Summer Science Research Program goes a step beyond research conducted during the normal academic year by totally immersing students in the research experience. This immersion allows students to focus and hone their intellectual skills through investigating questions of import to not only their research group but the wider national and international academic community. With careful guidance from our science faculty, the students in this program have had that unique experience of possessing a piece of new knowledge prior to adding it to the greater body of scientific understanding. Today is a very proud day for the students who conducted research, their faculty mentors, and our institution as we celebrate the work of these students during today's Patricia Belt Conrades '63 symposium. We are deeply grateful to Dr. Nancy Schneider '64 for providing the endowed funds for this community celebration of our science students' successes.

In addition to the one-day symposium in the fall, students present their research findings to one another at luncheons throughout the summer program and are encouraged to present their research to other students and faculty who are not part of the program in podium talks at departmental seminars throughout the academic year. Many of our students also present their research along with that of their faculty mentors at professional scientific meetings and have their work published in major scientific journals. This provides further opportunities for our students to gain critical experience in presenting data at scientific venues and to become recognized by the larger scientific community

While our Summer Science Research students receive small stipends and supply budgets for their work, it is the one-on-one contact with faculty mentors and fellow student researchers from Ohio Wesleyan as well as elsewhere that is of ultimate value and importance as our students' science educations develop and unfold.

In the following pages, you will also be introduced to several of our Symposium researchers and students who conducted science research at off-campus locales during this past summer, as well as students from other colleges who conducted research on our campus under a National Science Foundation (NSF) Research Experiences for Undergraduates (REU) Grant awarded to our faculty in physics, astronomy, computer science, and mathematics.

Celebrate with us the accomplishments and new discoveries of our students — the innovative leaders and scientists of tomorrow.

Chuck Stinemetz
Summer Science Research Program Director
Dean of Academic Affairs

The Making of a Scientist

A person must "do science" in order to truly learn science. The Ohio Wesleyan Summer Science Research Program is an excellent opportunity for students to put the theory they learn in the classroom into practice in the lab and in the field. Research is so much more than a classroom lab — more challenging, more creative, more frustrating, and more rewarding. This program offers students the opportunity to "do science" by conducting research in conjunction with OWU professors over a 10-week period in the summer.

As a research mentor, I am always impressed at the enthusiasm and resourcefulness with which my students approach research. As the summer progresses, I see the students learning about background information, working on the experiments, and eventually taking ownership of the project. During this time, students are thinking, acting, and speaking like scientists — actually becoming scientists.

While 10 weeks might sound like a long time, research students soon find that it is not. By the end of the summer program, many students have just gotten to that "Ah, ha!" moment, the moment when the experiment finally works and the data begin to address the initial research question. Therefore, many students continue their research during the academic year through Independent Study courses and may even develop their projects into honors projects. But the science doesn't stop there. In the past 2 years, over 40 OWU students attended national and international scientific meetings to present their research. Research is an essential part of being a scientist, and Ohio Wesleyan's strong reputation for developing excellent young scientists is growing.

During the Symposium this afternoon, you will have the opportunity to interact with 19 students who performed research at OWU this summer mentored by OWU faculty members, 9 students from schools other than OWU who worked on campus with OWU faculty, and 15 OWU students who performed research off-campus at other universities or in other countries. There is no doubt that the research results presented here today are exciting and novel. However, equally as exciting is the opportunity for you to speak with and interact with these young scientists.

Enjoy the Symposium and be sure to learn something new!

Laura Tuhela-Reuning
Department of Botany-Microbiology, Department of Zoology
Scanning Electron Microscopist
Summer Science Research Program Events Coordinator

The Patricia Belt Conrades Summer Science Research Symposium Endowment

In 2006, Dr. Nancy Reynolds Schneider ’64, established an endowment to name the Summer Science Research Symposium after her good friend and fellow OWU alumna, Patricia Belt Conrades ’63.

Mrs. Conrades is a volunteer registered nurse and homemaker, and a member of Ohio Wesleyan’s Board of Trustees. She regularly assists in the operating room of Boston’s Mt. Auburn Hospital. Dr. Schneider is a highly regarded Professor of Pathology and Director of the Cytogenetics Laboratory on the faculty of the University of Texas Southwestern Medical Center in Dallas. She is also a member of Ohio Wesleyan’s Board of Trustees.

Mrs. Conrades and Dr. Schneider share a commitment to the sciences, and are both examples of individuals who have enjoyed successful careers in science. The support of Mrs. Conrades and her husband, George Conrades ’61, a member of the OWU Board of Trustees, and Dr. Schneider and her husband, John Schneider, continues to strengthen the science and mathematics programs at OWU.

Special Acknowledgements

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Marcia Kunstel ’69

Support for the Patricia Belt Conrades Summer Science Research Symposium

Dr. Nancy Reynolds Schneider ’64



Board 1

Alex R. Howe

Faculty Mentor: Robert A. Kaye
Department of Physics and Astronomy

The "proton-rich" nucleus selenium-71 appears qualitatively to show a strong competition between the individual and collective motions of its constituent protons and neutrons. Nuclei near this mass generally show rapidly increasing collectivity with the number of neutrons. The goal of the project was to measure how quickly the excited energy states in selenium-71 radiate energy, from which the degree of collective behavior can be inferred. This work confirmed the predictions made by theory and the suspected intermediate collectivity of selenium-71, as well as improving the known energy level structure of this nucleus.

Lifetime Measurements in ^{71}Se

Despite a number of similarities, the existing level structures for the light (proton-rich) selenium isotopes near mass A=70 show marked differences. For example, the level scheme of ^{73}Se indicates strong collective behavior in the form of clear, strongly coupled rotational bands, while that of ^{69}Se shows strongly reduced collectivity. ^{71}Se appears to be a transitional nucleus, showing signs of competing single particle and collective structures, but less is known about its level structure. The goal of the present work was to measure as many lifetimes as possible in ^{71}Se in order to quantify the degree of collectivity as a function of spin and across multiple intrinsic configurations of the unpaired neutron. ^{71}Se nuclei were produced at high spin by a ^{54}Fe(^{23}Na,αpn) fusion reaction at 80 MeV conducted at Florida State University. Fifteen lifetimes were measured from the resulting gamma-ray coincidence data using the Doppler-shift attenuation method. Experimental Qt values were inferred from the lifetimes and found to be in agreement with the predictions of cranked Woods-Saxon calculations. Comparisons with neighboring nuclei confirmed that ^{71}Se exhibits properties of a transitional nucleus with an intermediate degree of collectivity. Based on coincidence relations and systematic arguments, the level scheme was enhanced and extended to higher spin. A band that was previously assigned positive parity was reassigned as the "missing" signature partner of an existing negative-parity band.

Board 2

Greg Stull

Faculty Mentor: David Johnson
Department of Botany and Microbiology

I surveyed all the trees on the Ohio Wesleyan campus to determine the different types of trees represented on campus and their locations. I also measured the sizes of a subset of the more than 1800 trees documented to generate estimates of the total amount of tree matter (biomass) present on campus. The information generated can be used to maintain or promote biodiversity on campus and to guide land-use practices and future development on campus to decrease the university's overall environmental impact.

Tree Diversity and Carbon Sequestration on the Ohio Wesleyan University Campus

Urban ecology, which examines ecosystem processes in urban and suburban areas, is often used to inform urban and suburban development and land-use practices to promote greater environmental health. To generate base-line data for urban ecology studies on the Ohio Wesleyan campus, I determined the species identification and GPS location of all trees on campus, making permanent herbarium specimens of each species represented. I found approximately 1,800 trees on campus, including more than 95 different species. For a subset of approx. 550 of these individual trees, I also measured the height and diameter at breast height, data that can be used to estimate the amount of carbon sequestered by campus trees. These data can be used to manage the campus arboretum such that biodiversity is maintained or enhanced and to guide campus land-use practices and future development plans to decrease the university's overall environmental impact.

Board 3

Kristin Kovach

Faculty Mentor: Jennifer Yates
Department of Psychology/Neuroscience

Loss of motor and sensory function due to spinal cord injury can be increased by the body's immune response to the injury. Two different pharmaceutical interventions, methylprednisolone and 6-Cl tryptophan, can each be used mitigate separate pathways that lead to this secondary decline. These two drugs were tested simultaneously in the guinea pig model of spinal cord injury to determine whether the drugs will work additively to show greater improvement than either drug alone.

The Effects of Simultaneous Intervention in Two Mechanisms of Secondary Pathology on Behavioral Functional and Tissue Integrity in the Guinea Pig Model of Spinal Cord Injury

Traumatic spinal cord injury damage can be exacerbated by secondary pathological mechanisms that cause further destruction and increase the severity of motor and sensory functional deficits. Activation of macrophages and microglia as part of the innate immune response produces the tryptophan metabolite quinolinic acid (QUIN), which accumulates at the injury site in proportion to the severity of initial functional deficits. 4-Cl-3HAA attenuates QUIN production, reduces accumulation at the injury site, and reduces the severity of functional loss by sparing axons and myelin. Reactive oxygen species, also produced in response to inflammation, cause lipid peroxidation of cell membranes in the central nervous system, damaging cells that had been spared by the injury. These oxidative processes can be attenuated using the steroid methylprednisolone, resulting in functional improvements after injury. Female Hartley guinea pigs were injured by lateral compression of the spinal cord at the twelfth thoracic vertebra. They were treated thirty minutes after the injury and at two, four, and six hours with intraperitoneal (IP) injections of methylprednisolone or vehicle. Starting five hours post-injury, they were given IP injections of 6-Cl tryptophan (which is internally metabolized into 4-Cl-3HAA) or vehicle every twelve hours. To assess motor and sensory function, placing, toe spread, and the *cutaneus trunci* muscle reflex were evaluated at five hours, one day, two days, three days, seven days, and twelve days post-injury. The spinal cords will be sliced, stained, and measured to analyze the area of surviving white matter at the injury site.

Board 4

Lindsey Aurora

Faculty Mentor: Dave Markwardt
Department of Zoology

Gene expression, the process by which the information in a gene is converted into proteins, is controlled at numerous levels. One point of control is an mRNA surveillance pathway that eliminates certain transcripts before they can be translated into proteins. This pathway was found to control the expression of aly-3, a gene in *C. elegans* important for nuclear transport processes.

The mRNA Export Adaptor *aly-3* is a an Alternatively Spliced Target of the Nonsense Mediated Decay (NMD) Pathway in the Soil Nematode, *C. elegans*

Gene expression, the conversion of DNA to RNA to protein, is regulated at different points in the pathway. A post-transcriptional mechanism known to control gene expression at the level of the RNA message is Nonsense Mediated Decay (NMD), a cellular quality control mechanism that selectively degrades mRNAs with a premature stop signal. NMD targets two populations of transcripts: abnormal mRNAs that arise due to mutations and physiological targets: those mRNAs that are targeted as part of the regulation of gene expression. *aly-3*, a nuclear export factor found in the nematode *C. elegans*, is an example of a physiological target. Primarily nuclear, Aly-3 binds to RNA transcripts, transporting them from the nucleus to the cytoplasm. Using RT-PCR, the *aly-3* transcript was shown to be alternatively spliced. Our results revealed the presence of an alternative splice form of aly-3 in worms that could not perform NMD. This same species is absent in wild-type animals, suggesting that the pool of *aly-3* transcripts is being regulated by the NMD pathway. There are a number of testable models that explain the functional utility of this kind of NMD-dependent splicing. For example, Aly-3 may control its own levels through a homeostatic feedback loop in which the Aly-3 protein drives spicing in an unproductive direction. Another explanation is that there are certain cellular or environmental conditions which may lead to NMD-dependent splicing of this transcript (and others). Future goals of the lab are to test predictions made by these different models.

Board 5

Tiffany Elsea

Faculty Mentor: Vicki DiLillo
Department of Psychology

Influenza (the flu) is responsible for more than 200,000 hospitalizations and over 36,000 deaths annually in the US, making it a significant public health problem. Although most college students are young and healthy, crowded living conditions put them at high risk for contracting the flu and annual vaccination is recommended for this population. Despite this recommendation and the availability of an effective vaccine, relatively few college students are vaccinated. This study was designed to 1) identify predictors of intent to be vaccinated for the flu and 2) test a health communication intervention designed to enhance vaccination intent in a college population.

The Flu and You: Predictors of College Students' Intent to be Vaccinated for Influenza

Influenza (the flu) is a significant public health problem. Because of crowded living conditions, college students are at high risk and annual vaccination is recommended. However, there is little research concerning flu vaccination in this population. Furthermore, there has been little research investigating health communication interventions to increase vaccination of any sort in this population. The current study was designed to 1) identify factors related to intent to vaccinate and 2) test a message framing intervention to enhance vaccination intent among college students. Fifty college students (*M* age=20 years, 66% female, 88% white) participated. Vaccination intent was assessed. Participants then completed questionnaires developed for this study assessing general knowledge about, beliefs, and attitudes towards the flu and flu vaccine. After completing the questionnaires, participants received a flu-focused educational intervention and were randomly assigned to receive either a gain- or loss-framed flyer promoting vaccination. Vaccination intent was assessed again post-intervention. Results reveal that participants were moderately knowledgeable about the flu and vaccine (*M*=74%). Of a variety of variables examined, only past vaccination behavior was related to intent to vaccinate (r=.82, p<.0001 pre-intervention, r=.56, p<.0001 post-intervention). Initially, 30% of participants reported being somewhat or extremely likely to receive the vaccine, compared with 70% post-intervention. Post-intervention intent to vaccinate did not differ by framing condition (t=-.67, p=.50). Agreement with more flu-related misconceptions predicted change in vaccination intent from beginning to end of the intervention (r=.39, p<.01). The factors rated most important in a decision not to be vaccinated were forgetting and lack of perceived seriousness of the flu; the factors rated least important were influences of family and friends. Results suggest that vaccination behavior may be driven by habit rather than conscious health decision making processes. Additional research is needed to determine whether intent to vaccinate predicts actual vaccination behavior in this population.

Board 6

Jessie Miller

Faculty Mentor: Robert Harmon
Department of Physics and Astronomy

Digital images of LO Pegasi were taken during May, June, and July 2009 at Perkins Observatory. By processing these images, the brightness of the star can be determined. Lightcurves are then created by plotting the brightness of LO Pegasi vs. the star's rotational phase (fraction of a rotation through which the star has turned) at the time the image was taken. These lightcurves can be inverted to reconstruct the stellar surface, showing the locations of starspots. Starspots are cooler, darker regions on the surface associated with areas where the magnetic field is thousands of times greater than that of the spot's surroundings and are analogous to sunspots on the Sun. When starspots are in view of the telescope, they decrease the observed brightness of the star. Studying starspots provides greater insight into the magnetic properties and processes of stars.

Stellar Surface Imaging of LO Pegasi via Light-Curve Inversion

The purpose of this research was to map the starspots on LO Pegasi (HIP 106231), a K8 main-sequence star, in order to create an image of the star's photosphere (surface). An indirect method was required to map the starspots due to the fact that stars other than the Sun are so far away from Earth that even the Hubble Space Telescope images show stars as featureless pinpoints. Starspots are believed to be analogous to sunspots; they are associated with regions of the star that have a greater magnetic field than the surrounding photosphere. Starspots allow the magnetic activity on the stellar surface to be mapped. A star's magnetic field is linked with various stellar phenomena such as X-ray emissions and flares, so studying starspots provides a better understanding of stellar magnetic phenomena. By studying starspot formation and movement on the surface of the star, greater insight into the dynamo process which generates the magnetic field of the star can be gained as well as further insight into the magnetic activity of the Sun.Digital images of LO Pegasi were taken during May, June, and July 2009 through B, V, R, and I photometric filters using a 0.2-m Meade Instruments LX200 Schmidt-Cassegrain telescope and Santa Barbara Instruments Group ST-8XE CCD camera at Perkins Observatory. Differential aperture photometry was performed on the images to determine the magnitude of the star. Using these measurements, the intensity of the star is plotted vs. the rotational phase to create a lightcurve. The lightcurves are fed into the Matrix Light-Curve Inversion (MLI) algorithm. This algorithm creates a reconstructed image of the star's surface showing the location of starspots. The location of the spots visible on the 2009 image combined with the overall dimming observed in LO Pegasi since 2008 imply that there is a spot on the visible pole. The current MLI program does not image polar spots, but future work will include changing the code to view these spots.

Board 7

Jianchao Wang

Faculty Mentor: Ramon Carreno
Department of Zoology

Understanding the seasonal dynamics of different parasites may help explain how environmental changes affect parasite communities and thus their hosts. Four species of sunfish were being surveyed in a local stream called Delaware Run. Different parasite communities were present, including two species of acanthocephalans, trematodes, nematodes, and cestodes. Comparison with parasites collected in other seasons from the same locality revealed that acanthocephalans are more prevalent in the summer than in any other season. Their massive number and ferocious thorny head caused some major infections on the intestinal wall of some sunfish. The relationships between the two acanthocephalan species are subjects of future studies.

A Survey of Sunfish Parasite Communities from a Local Stream

Studies on parasite communities and their dynamics are helpful in understanding the ecology aspect of Parasitology. Four species of sunfish- Green Sunfish, Bluegill, Northern Rockbass, Central Longear Sunfish were found in Delaware Run, Delaware, OH. Are certain parasites more prevalent on a seasonal basis? If so, what causes the differences, if any? These questions were addressed by comparing summer samples collected in this study with those from other seasons in the same locality. Different parasites were present in the fish. Among them, the most common ones are acanthocephalans (2 species), followed by trematodes, nematodes, and cestodes. Comparison with parasites collected in other seasons from the same locality revealed that acanthocephalans are more prevalent in the summer than in any other season. In particular, the majority of acanthocephalans presented in the fish intestine were adult form; rarely its juvenile form- cystacanth were seen in this study. In addition, the yellow tissue being found on the intestinal wall of its vertebrate host is believed to be the infection caused by the invaginable proboscis of acanthocephalans. One of the two acanthocephalan species- *acanthocephalus dirus* were more commonly found in *Lepomis Cyanellus* than the other, *Leptorhynchoides Thecatus*. However, what are the relationships between the two is still the subject of future studies. Nematodes, trematodes, and cestodes were so rare in number that we have to rely on more data to make any comparisons.

Board 8

Chloe Hamrick

Faculty Mentor: Laura Tuhela-Reuning
Department of Botany and Microbiology

Some bacteria such as *Bacillus* are able to move toward chemicals they can use for energy sources. In addition, some *Bacillus* species also degrade feathers, thus releasing protein fragments and amino acids, such as glycine and alanine, into the surrounding environment. A feather-degrading strain of *Bacillus* isolated from a common yellowthroat, a wild songbird, was shown to move toward the amino acids asparagine and alanine and away from glycine. This suggests that *Bacillus* may be able to move toward areas of feather damage on birds.

Characterization of the Motility and Chemotaxis of *Bacillus* spp. Isolated from Songbird Plumage

The plumage of songbirds is not typically thought of as an ecosystem, yet the plumage provides a habitat for a variety of microorganisms including bacteria. Within the plumage, several species of *Bacillus* were isolated that degrade feathers by breaking bonds in the beta-keratin complex of feathers, thus utilizing the feathers as the sole carbon and nitrogen source. *Bacillus* species are also known to be motile by peritrichous flagella and can move toward optimum concentrations of attractant compounds by chemotaxis. To investigate how motility can affect the bacteria in the plumage, we screened several feather-degrading *Bacillus* spp. isolated from songbird plumage for motility. The most motile strain was isolated from a common yellowthroat (*Geothlypis trichas*), and the chemotactic response was tested in this isolate. Because amino acids, including glycine and alanine, are released into the surrounding environment as feathers are degraded, we chose to use glycine and alanine as possible chemoattractants. Asparagine was also chosen as a possible chemoattractant because it is an attractant for at least two other *Bacillus* species. We tested possible attractants at concentrations of 0, 100, 250, 500 and 750 µM for each amino acid, and response ratios were calculated. A response ratio greater than 2 indicates a chemotactic response toward the amino acid. The *Bacillus* isolate was chemotactic toward asaparagine with the highest response ratio of 89.41 at a concentration of 750 µM asaparagine. Alanine was also a chemoattractant but to a lesser extent with a maximum response ratio of 2.91 at a concentration of 250 µM alanine. Glycine acted as a repellent at the concentrations tested because the response ratio never was higher than 0.5532 (at 100 µM glycine). This provides evidence that bacteria in songbird plumage can exhibit chemotaxis and may be able to move toward areas of feather damage.

Board 9

Chloe Hamrick

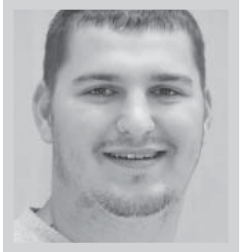
Faculty Mentors: Edward Burtt, Jr. and Laura Tuhela-Reuning
Departments of Zoology and Botany and Microbiology

The plumage of songbirds is home to an ecosystem of a wide variety of microorganisms, some of which can degrade feathers. Two feather-degrading bacteria, *Bacillus licheniformis* and *Streptomyces fradiae*, have different optimal growth temperatures. We found that at lower temperatures (28°C and 37°C), *S. fradiae* degrades faster and that *B. licheniformis* degrades faster at higher temperature (55°C). This shows that the rates of feather degradation on songbirds may be affected by external temperatures, which affect the microbial ecosystem on the bird.

Feather Degradation by *Bacillus licheniformis* and *Streptomyces fradiae* at Different Temperatures

Several species of bacteria, including *Bacillus licheniformis* and *Streptomyces fradiae*, degrade feathers. These bacteria produce keratinase enzymes, which break peptide bonds in the beta-keratin structure of feathers, resulting in a release of oligopeptides into the surrounding media. Oligopeptide concentration can be quantified to determine the overall rate of feather degradation. Activity of each species' keratinase is influenced by conditions in the surrounding environment, including other microorganisms and temperature. The rates of feather degradation by *B. licheniformis*, *S. fradiae* and an equal combination of both were tested at 28°C, 37°C and 55°C. At 28°C and 37°C, S. fradiae was the most active degrader while *B. licheniformis* was the most active degrader at 55°C. An equal combination of each microbe showed rates of degradation similar to the dominant degrader at each temperature. Activity of the feather-degrading enzymes from different bacteria is affected differently by temperature.

Board 10



Seth Young

Faculty Mentor: Amy Downing
Department of Zoology

In order to explore how freshwater ecosystems respond to human disturbances, we constructed 20 miniature pond ecosystems using 300 liter plastic tanks. We then simulated 3 common disturbances of freshwater ecosystems: decreases in pH, increased turbidity, and reduction in oxygen levels. The pH treatment caused the largest decrease in abundance and diversity of organisms, but different groups of species reacted differently depending on the disturbance.

Freshwater Community Response to Increased Turbidity, Reduced Oxygen, and Decreased pH

The health of freshwater ecosystems is important for the life of the planet, but with continued human growth, a variety of complications have endangered these delicate systems. In order to study the effects of human disturbances on freshwater pond ecosystems, we created twenty medium sized replications (mesocosms) of a source pond at Kraus Reserve (owned by Ohio Wesleyan) using 300 liter cattle tanks. After adding filtered pond water to each tank, we then added sediment, macroinvertebrates, and plankton from the source pond in concentrations similar to the natural pond. After the 20 replicate ecosystems had been established for 3 weeks, we implemented 4 treatments with 5 replicates each which included the control, increased turbidity, low pH, and low oxygen conditions. After the disturbances had been implemented for 1 week, the mesocosms were disassembled and macroinvertebrates and zooplankton were counted. The pH treatment had significantly lower species abundance, species richness, and Shannon's index number for most macroinvertebrate groups and and zooplankton. Snails and amphipods were particularly sensitive to the decreased pH and generally went extinct. The turbidity treatment increased zooplankton abundance, especially for *Daphnia laevis*. The low oxygen treatment did not decrease oxygen at the level expected, but the treatment did significantly decrease the abundance of *Diaphanosoma* zooplankton, one of the most abundant species of zooplankton in the control and turbidity treatments. Our results indicate that different groups of species respond immediately and differentially to common human disturbances. Longer term experiments may result in even more drastic changes, and future experiments should explore how intact freshwater ecosystems will respond to increasing pressure from humans.

Board 11

Kate Ball

Faculty Mentors: David Johnson
and Nancy Murray
Department of Botany and Microbiology

Once upon a time artists went on ships with botanists to unexplored lands far far away. On the lands, they explored. and drew new species. Now we do not have ships, at least not with large sails or parrots. Now, actually since early medieval times, we have things called herbariums. In herbariums, there are many species of plants, which are all flat and dried. Now, most artists do not get captured by pirates, but instead, they sit safely in climate controlled science centers and don't even have swords. They draw from many different samples, and make them not look crunchy.

Botanical Illustrations of the Genus *Xylopia*

The plant family Annonaceae is a primitive group of flowering plants with approximately 2500 species found in tropical America, Africa, and Asia. About 180 species in this family belong to the genus *Xylopia*, which is the only genus in the family that is pantropical in distribution. By comparing individual characteristics of the species, the evolution and geographic dispersal of the genus may be better understood. Descriptions of the physical traits of species are often complemented by visual aids in a publication, which help to clarify important details. Different forms of visual representation include scans of dried herbarium specimens, artistic illustrations (drawn either in the field or herbarium), and actual photographs of the plant. Although photographs and scans may seem like the best choices for accurately representing a species, illustration remains the preferred method of botanical visual representation. Things such as color and environmental conditions are expressed in a photograph, but these details often distract from taxonomic comparisons. Photographs are inconsistent and therefore challenging to use in a comparative analysis. Herbarium specimens, although more uniform, must be interpreted as raw information by the viewer. Botanical illustration allows for a greater level of control in representing the plant. Details characteristic of the species may be highlighted, and unnecessary details edited out. In addition, specific parts of multiple species may be juxtaposed in a single image, simplifying comparisons. Ten pen-and-ink plates showing 23 species of *Xylopia* from Africa and Madagascar were prepared this summer to illustrate a forthcoming manuscript.

Board 12

Mats Nordbø

Faculty Mentor: Sarah Leupen
Department of Zoology

As a means to confront the rising rate of extinction among amphibians, this experiment aims to further develop our knowledge regarding the reproductive physiology of amphibians. By determining the presence of a negative feedback mechanism in the production of axolotl (*Ambystoma mexicanum*) sex hormones, we can better help prevent the continued reduction of amphibian populations due to a greater understanding of the factors that may be influencing the amphibian reproductive axis. Specifically, this project aimed to determine whether testosterone, produced in the testes, inhibits the production of gonadotropin-releasing hormone, produced in the hypothalamus.

Evidence for Sex Steroid Feedback on Gonadotropin-Releasing Hormones in Urodele Amphibians

In recent years the rate of extinction of amphibians the world over has greatly increased. Our knowledge of amphibian reproductive physiology is incomplete, and therefore this study examines whether or not the reproductive axis of amphibians mirrors that of mammals and birds, in which the hypothalamus secretes gonadotropin-releasing hormone (GnRH) into the hypophyseal portal system, which stimulates the production of luteinizing hormone (LH) and follicle stimulating hormone (FSH) from the anterior pituitary. These hormones enter the bloodstream and reach the gonads where sex steroids are released into the blood and travel to the brain, operating by negative feedback to prevent further production of GnRH. This study examines GnRH protein levels in three groups of axolotls (*Ambystoma mexicanum*). Control animals were untreated. The second group had their testes removed (orchidectomy, ORX) and the third group had their testes removed followed by a testosterone replacement treatment (ORX + T). The testosterone is replaced by adding a capsule filled with testosterone acetate and sealed at the edges with silica gel to allow for a slow diffusion rate. After three weeks, animals were sacrificed, and the brains were fixed and sliced. GnRH neurons were detected on the slices using a fluorescent immunohistochemistry (IHC) procedure and counted using confocal microscopy. We found a mean of 14 neurons in the control group, 35 neurons in the ORX animals, and 0 in the ORX + T group, which is consistent with the operation of negative feedback in the axolotl. Loss of some brain tissue during the experiment prevented sufficient numbers of animals being included in the final analysis, which will be rectified with the continuation of this project in the fall semester.

Board 13

Sarah Bonnet and Ahlam Awad

Faculty Mentor: Danielle Hamill
Department of Zoology

Cell division is a complex and highly conserved process. What is learned about cell division in the *C. elegans* model can give insights in other organisms, including humans. An embryonic-lethal cell division mutant in *C. elegans* was characterized. The gene possibly responsible for the mutant phenotype was sequenced and potential genetic suppressors were analyzed.

Characterization of a Cell Division Mutant in *C. elegans*

We are studying an embryonic-lethal cell division mutant in *C. elegans* called *or452ts* that when grown at the restrictive temperature produces embryos that fail to make a bipolar mitotic spindle in the early cell divisions. Consequently, the chromosomes fail to segregate, the cells become multinucleated, and the embryos die prior to differentiation. In an effort to identify the gene that causes this mutant phenotype, a candidate gene was sequenced in the mutant as well as in wild type and in *lin-5* (the genetic background in which the mutant was generated), but no mutation was found. More candidate genes will be sequenced. We are also attempting to identify genetic suppressors of *or452ts* using RNA interference (RNAi); RNAi allows us to knock down the function of a gene of interest. Of the twenty-one candidate genes tested, approximately ten appear to improve the viability of the mutant worms, suggesting that these genes may be suppressors. These results need to be replicated, quantitated, and confirmed. Additional candidate suppressors also need to be tested. The underlying mechanisms of cell division are conserved. Therefore, what is learned from a model organism like *C. elegans* can provide insight into cell division in other organisms, including humans. We believe that characterization of this mutant, identification of the gene responsible, and identification of genetic suppressors will provide new insights into the process of mitotic spindle assembly and cell division.

Board 14

Virginia Jaquish

Faculty Mentor: Ramon Carreno
Department of Zoology

A Study of Nematodes Parasitic to Millipedes

Nematode parasitism is thought to have evolved independently more than once resulting in multiple lineages from the same ancestral outgroup of soil dwelling nematodes. Within this group there is a comparative deficit of information available regarding the pinworm families Thelastomatidae and Rhigonematidae which parasitize arthropods. Millipedes are an ideal study organism because they are the only known hosts of rhigonematid species but are also parasitized by species of thelastomatids. Millipedes from both wild and captive lab populations were surveyed for previously undescribed thelastomatid and rhigonematid pinworms to improve the understanding of pinworm phylogeny and the evolution of parasitism in nematodes. Of the ten species of millipedes sampled three were found to host potentially undescribed species of pinworms. Several thelastomatid and rhigonematid species were found in each of the captive millipede populations from the OSU Entomology Collection. The millipede *Apheloria virginiensis* was collected from the local Bohannan preserve and found to host a thelastomatid species that closely resembled *Thelastoma krausi*, a pinworm found in a local population of *Euryurus leachii* millipedes from the Kraus preserve. Sequencing of 28S LSU rRNA gene revealed a base pair difference of 54 out of the 503 analyzed, indicating the presence of a distinct, cryptic species in *A. virginiensis*. Further morphological and molecular studies are necessary in order to clarify this relationship.

Board 15

Michael Sarap

Faculty Mentor: Kim Lance
Department of Chemistry

Current water purification methods are effective, but they also produce byproducts that can cause multiple health issues from illness to birth defects. The Chlorine used currently is left behind in the environment while the complexes produced in this experiment can be used continuously without harmful byproducts being produced. These catalytic complexes also mimic already occurring reactions in nature, which means they do not disturb the chemistry of nature that has been occurring on its own forever.

Preparation of Complexes as Robust Catalytic Oxidants

Green Chemistry is an extremely relevant field to today as the world grows more and more conscious of its actions and their reactions within the environment. Catalytic Oxidation is one field of many within the vast branch of Green Chemistry. Catalytic oxidants are important as they are ways in which a laboratory can purify water sources while reproducing the same useful catalyst. The oxidation process that occurs with such complexes mimics the processes that happen naturally in the environments that have no harmful byproducts or side reactions. Current water purification techniques implement chemicals such as chlorine that can produce harmful byproducts with benzene complexes that exist in the environment. The oxidant in this case was a robust macrocyclic complex with an iron oxidation center. The complex of interest initially was a 12 member macrocycle which was produced from multiple organic reactions. 1.2-phenylenediamine and Acetone Cyanonhydrin were initially reacted at to produce a Dinitrile. The Dinitrile was then stirred with concentrated Hydrochloric acid to produce a Diacid which could finally be reacted with more 1,2-phenylenediamine to complete the large macrocycle. The macrocycle was then reacted with anhydrous Iron(III) to give it an oxidation center. All organic reactions were run at room temperature and in a neat fashion to reflect the Green Chemistry goals of the experiment. Once the original 12 member complex was produced, variations in macrocycle size were examined using 1,8-naphthalenediamine as the starting material. A 12,13, or 14 member ring could then be produced to test the stability and effectiveness of the variations.

Board 16

Meredith S. Palmer

Faculty Mentor: Shala J. Hankison
Department of Zoology

In animal behavior, personalities or "syndromes" are defined as correlations between different types of behavior. For example, a fish that is consistently both very inquisitive as well as very bold would be said to possess a behavioral syndrome. We tested stickleback fish to determine whether exposure to the threat of predation would elicit behavioral syndrome.

Effects of Predation on Developing Behavioral Syndromes in Stickleback Fish

We examined the development of behavioral syndromes, correlations between different behavioral traits, in three-spined stickleback, *Gastersteus aculeatus*, exposed to the threat of natural predation. Three sets of 15 individually marked fish were tested to quantify boldness and exploration. Variables tested included the distance a fish traveled, the number of unique objects encountered in a new environment, and the amount of time it took for a fish to resume feeding after a 'predation scare', among others. We placed fish in enclosures at different depths (~1m, ~2m) in a pond stocked with bass at Ohio Wesleyan's Kraus Preserve, while one group remained in the laboratory. Individuals were re-tested after 16 days. There were no significant differences between fish placed in pond enclosures at different depths. Fish from pond enclosures developed two behavioral correlations, whereas lab fish developed five behavioral correlations — essentially, correlations between all variables tested. The conclusion that lab fish under no threat would spontaneously develop syndromes while fish exposed to new predators would undergo little behavioral modification is unexpected based on previous research.

Board 17

Yan Dong and Sarah Marous

Faculty Mentors: Harry Bahrick, Melinda Baker, Lynda Hall
Department of Psychology

This study examined stability of recall when young and older adults were asked to recall the names of famous people on two separate occasions. Past evidence suggests older adults have more situations in which they can recall an answer on one occasion but not on a different occasion. Some test questions provided little information to cue the name (e.g., a picture of the person); other questions provided more information (e.g., a picture, a description, and the person's initials). We will examine the impact of amount of cue information on stability of recall for each age group.

The Effect of Number of Cues and Age on Stability of Recall

Several studies suggest that a primary memory problem for older adults is accessing information that they know. We've all experienced situations in which we are confident we know an answer but we can't recall it; these situations are encountered more frequently by older adults. Anecdotal evidence suggests that the problems are more pronounced when one attempts to recall names of people than when one attempts to recall other types of information. The goal of this study is to explore the effect of the amount of contextual support on stability of recall. When one is provided with more cue information (i.e., a more supportive context), the probability of correct recall increases. However, we don't know if the stability of successful recall is influenced in a systematic way or if the effect of amount of cue information on stability of recall varies with age. Participants were given an exam with 204 questions about the names of famous people. One third of the questions were prompted with a single cue (either a picture or a written description of the individual), one third were prompted with two cues (both a picture and a written description), and one third were prompted with three cues (a picture, a written description, and a hint about the name such as the individual's initials). Participants were asked to return for a second session either 1 day or 1 week later in which they were asked to recall answers for the same questions cued in the same format. We will examine the stability of recall for young and older adults as a function of the time interval between tests and the amount of cue information provided.

Board 18

Devinda Hiripitiyage

Faculty Mentor: Laura Tuhela-Reuning
Department of Botany and Microbiology

Despite containing antimicrobial compounds, cosmetic products can be an ideal site for microbial growth as they are rich in nutrients. Some microbes that grow may be harmless while others could be quite harmful resulting in eye and skin infections. This study looks into the types of microorganisms growing in cosmetic products that have been used by the consumer for three to five years. Results show that there is bacterial contamination in these cosmetic products such as eye liner, eye shadow, mascara, foundation cream and lipstick in older, used cosmetics.

Post Consumer Contamination of Cosmetic Products in the United States

Although commercially available cosmetic products contain antibacterial compounds to increase shelf-life and protect the consumer, cosmetics are excellent substrates for the survival and development of a wide array of microorganisms such as *Klebsiella*, *Enterobacter*, *Serratia*, and *Pseudomonas* spp. These microorganisms can cause eye and skin infections in consumers. To investigate the microorganisms contaminating used cosmetics, samples including eye liner, eye shadow, mascara, foundation cream, and lipstick that were between three and five years old were collected and bacteria were isolated from these cosmetic samples. Isopropyl myristate was used to extract the bacteria from the oil-based cosmetics, and Tween 80 was used to neutralize antibacterial compounds present in the cosmetics. In order to search for any microbial contamination present in the cosmetics, the extracts were plated onto tryptic soy agar (TSA) medium and plates were incubated at 28oC for seven to ten days. After incubation, colonies were isolated and subcultured onto TSA slants. Gram stains indicated all isolates were Gram positive with cell morphologies of both bacilli and cocci. Critical point drying was done to prepare the samples for scanning electron microscopy (SEM). SEM was used to study cell morphology and surface features on the bacterial isolates.

Board 19

Rebecca J. Sisson, Morgan N. Waddles, Jenna E. Sroka, and Brittany V. Coss

Faculty Mentors: Faculty Mentors: Gerald Goldstein[1] and Edward H. Burtt, Jr.[2]
[1]Department of Botany and Microbiology,
[2]Department of Zoology, Ohio Wesleyan University

Identification of Gram Positive Feather Degrading Bacilli on Birds and in Soil and Calculation of Feather Degradation Rates

Beta keratin, the structural protein of feathers, is unusually resistant to microbial degradation, yet many species of microorganisms exhibit feather degrading activity. Birds acquire their plumage microbiota from the environment after they hatch with soil being one of several possible sources. In this study, gram positive feather degrading bacilli cultured from the plumage of birds and from soil samples were identified by polymerase chain reaction, specifically amplifying DNA fragments of the bacterial keratinase gene. Of 112 strains of gram positive feather degrading bacilli isolated from feathers, 73.2% of the isolates were identified as *Bacillus subtilis*, 25.9% as *B. licheniformis*, and 0.9% as *B. pumilus*. Of 43 strains of gram positive feather degrading bacilli isolated from soil samples, 76.7% of the isolates were identified as *B. subtilis* and 23.3% were identified as *B. licheniformis*. These results support the conclusion that plumage bacteria originate from bacteria present in the soil. A method for calculating the rate of feather degradation of respective bacterial isolates was also derived. Feather degradation by bacterial isolates was monitored over a period of five days. The final measurements of absorbance were divided by the number of hours of incubation and multiplied by 10,000. Feather degradation rates greater than 100 are considered fast, less than 50 are considered slow, and between 50 and 100 are considered intermediate. The respective feather degradation rates make it easy to compare the speed at which different cultures of microbes degrade feathers.

Board 20

Tina L. Graver

Faculty Mentor: Kendra McLauchlan
Department of Geography, Kansas State University

The Flint Hills region of Kansas is home to approximately 600 prairie plant species which use different functional traits to thrive in this environment.135 plants were collected and examined for functional trait differences (leaf angle, density and thickness) against areas of different land management techniques (burning and cattle grazing), their ecological abundance and their functional group (grass, forb, legume). It was found that the functional group and land management technique do have predictable functional traits which may be used to determine the plants ecological importance and relative abundance.

Investigation of Plant Functional Traits in the Flint Hills of Kansas

Plant functional traits are used to investigate a plant's ecological importance and relative abundance. Land use practices such as burning and grazing are thought to have an impact on these functional traits and, in return, a plant's ability to compete and thrive. In addition, ecologists commonly use functional group characteristics (i.e. forb, grass, legume) to investigate prairie dynamics, such as dominance. Functional groups were investigated to determine whether land management and dominance could be used to predict plant functional traits. In the Flint Hills region of Kansas, 135 plants were collected from twelve sites. For each plant, leaf angle, thickness, area and mass were measured. From these, leaf volume and density were calculated. On average, grasses had a lower leaf thickness and a higher leaf density value than the forbs and legumes. It was also found that grazing caused a lower leaf angle and higher leaf density for both forbs and grasses. Unburned sites produced a higher leaf angle and leaf density but produced a less thick leaf for both grasses and forbs. Species that were more dominant tended to have denser, less thick leaves with a higher leaf angle than the least dominant species. These results indicate that ecological factors such as functional group and dominance are better factors for predicting functional traits than management techniques are.

Board 21

Andrew White

Faculty Mentor: Angus MacDonald III
Department of Psychology, University of Minnesota

Schizophrenia patients often show deficits in context processing, the ability to represent and maintain task relevant behavior. Current imaging techniques, although extremely helpful in studying schizophrenia, can't tell us much about the cellular mechanisms that underlie this disorder. If visual tasks that tap into context processing deficits can be developed, we can learn about the cellular mechanisms involved by training nonhuman primates to do the tasks and recording from them. This data can then be used to improve the current treatment options for schizophrenia patients, which are all currently just symptom relief and occasionally have very adverse side effects.

Establishing Visual Tasks Sensitive to Context Processing Deficits in Schizophrenia

Deficits in context processing, the ability to represent and maintain behavior relevant information, is one of many debilitating effects of schizophrenia. Tasks have been developed that elicit a double dissociation between individuals with intact context processing and those without. Not only do schizophrenia patients frequently fail to use appropriate information to guide behavior, but extraneous information often impairs their performance. The current study investigated the validity of two potentially translational tasks to study cognitive deficits caused by schizophrenia, the Spatial AX and DYSC Shift Tasks. Consistent with previous work in the field, error rates were increased in trials in which participants had to overcome a prepotent response to a stimulus in the Spatial AX Task and for incongruent trials in the DYSC Shift Task. These findings warrant testing these tasks in schizophrenia patients as well as nonhuman primates in an attempt to further our understanding of this devastating disorder.

Board 22

Duy Hua

Faculty Mentor: David H. Thompson
Department of Chemistry, Purdue University

Polyethylene glycol (PEG) was bifunctionalized with tris-nitrilotriacetic acid (tris-NTA) and lipid to form lipid-PEG-tris-NTA. This compound was combined with phospholipid in various ratios to form a self-assembled lipid monolayer that was deposited onto the transmission electron microscopy (TEM) grid to modify its surface. It is anticipated that such alteration to TEM grid surface can enhance imaging efficiency and thereby, accelerate the protein structure determination process.

Development of a Functionalized Lipid Monolayer for Protein Capture to Accelerate Structure Determination

Cryogenic Transmission Electron Microscopy (C-TEM) is an important tool of growing importance for 3-D reconstruction of proteins, protein complexes and whole viral particles at near atomic resolution (3-5 Å). In utilizing C-TEM, the samples are applied to a TEM grid prior to vitrification in liquid propane and transferred to a liquid nitrogen-cooled stage where they are imaged via TEM. Since most biological samples are quite dilute prior to vitrification, they are often very sparsely distributed across the TEM grid. In order to enhance sample localization on the TEM grid, we are developing methods to produce a self-assembled lipid monolayer with protein capture capability on the grid surface. The protein capture chemistry we are utilizing is based on tris-nitrilotriacetic acid (tris-NTA) that is known to possess high affinity for histidine-tagged proteins ($K_b \geq 10^9\ M^{-1}$) in the presence of Ni^{2+}. Tris-NTA was synthesized on the 100+ mg scale prior to the lipid-polyethylene glycol-amine (lipid-PEG-NH_2) coupling step to make the lipid-PEG-tris-NTA target. Lipid-PEG-tris-NTA was combined with phospholipid in 1:9 ratio to form a self-assembled functionalized lipid monolayer that was deposited onto TEM grids via Langmuir-Schaffer transfer. Protein capture experiment indicated that self-assembled lipid-PEG-tris-NTA: Ni^{2+}/lipid monolayer was capable of specific capture of his-tagged protein. It is anticipated that monolayers of this type will improve imaging efficiency via enhanced protein distribution and orientation on the vitrified C-TEM grids. Materials development approaches of this type can enable substantial improvements in protein structure determination to provide a more detailed knowledge about the activity of biologically active molecules.

Board 23

Heather Derry

Faculty Mentor: David Hovda
Department of Neurosurgery, University of California-Los Angeles

Mild traumatic brain injury (mTBI) is sustained in alarming numbers in the juvenile and athletic populations, and receiving one concussion puts the brain at increased risk for a second injury. While recovery from a single injury may be rapid and complete, an additional head trauma may introduce the possibility for cumulative effects of injury and permanent damage. Nevertheless, repeat head injury is rarely studied, and the need for an accurate animal model of the condition is apparent. The effectiveness of a new model of repeat mTBI in rats was evaluated by examining the behavioral and anatomical damage resulting from the injuries.

Axonal Injury and Behavioral Deficits Associated with repeat Mild Traumatic Brain Injury and Ketogenic Diet in Rats

Mild head trauma is a significant injury, especially as it relates to juveniles and sports-related concussion. Sustaining one mild traumatic brain injury (mTBI) increases the risk of experiencing an additional concussion, and the damage from a second injury may be more deleterious and permanent than that from a single impact. The current study evaluated the effectiveness of a new repeat mTBI model in rats by examining both behavioral and anatomical outcomes. In addition, a ketogenic (KG) diet was examined as a protective measure against subsequent injury. Juvenile male Sprague-Dawley rats were assigned to sham, single injury, repeat injury, and ketogenic repeat injury groups. Single injury animals received one mTBI using the model at hand, while repeat TBI rats received a second impact 24 hours after the first injury. KG repeat TBI animals were given the KG diet immediately following the primary injury, and resumed normal diet following the second impact at 24 hours. Following injury, rats underwent behavioral testing to evaluate the presence of deficits similar to those that mark human complaints after concussion. Behavioral testing evaluated performance prior to injury then reevaluated behavior on post-injury days 1, 3, and 5. Stress and anxiety were evaluated by examining exploratory behavior in an open field task. A novel object recognition task was used to assess short term memory function. Rats were perfused on post-injury day 7 for tissue analysis. Anatomical measures of neurological damage utilized histological markers for axon disruption. Immunohistochemical analysis examined glial fibrillary acidic protein (GFAP), β-amyloid precursor protein (β-APP), myelin basic protein (MBP), and neurofilament protein (NF). The anatomical and behavioral deficits observed in repeat TBI and KG animals were compared to those of single impact animals to evaluate the effectiveness of the model and KG diet intervention.

Board 24

Sean M. Williams

Faculty Mentor: Edward H. Burtt, Jr.
Co-authors: Taylor S. Bliss and Jack M. Stenger
Department of Zoology, Ohio Wesleyan University

Dark Bills to Reduce Glare is a Widespread Adaptation Among Birds

Because the bill projects into the bird's visual field, its hard, polished surface can reflect light into the eyes. Such glare can be minimized by dark coloration. North American wood warblers with dark bills forage in sunlight more often than wood warblers with pale bills. Willow Flycatchers (*Empidonax traillii*) whose bills were painted white increased their use of shade. These data strongly support glare reduction as the selective force behind dark bills in warblers and Willow Flycatchers. We studied the correlation between bill color and foraging behavior of neotropical and North American birds. Bill color was determined from museum specimens. We observed birds throughout the United States and Costa Rica from 1991-2009. Birds that forage in sunlight are significantly more likely to have dark bills than those that forage in shade. Those that forage on aerial insects are significantly more likely to have dark bills than those that glean or probe for insects or eat fruit or seeds. We suggest that glare reduction is an important selective force on bill color in all birds.

Board 25

Rita E. Cook

Faculty Mentor: Gwénaël Rapenne
Department of: CEMES of the CNRS, Toulouse, France; chemistry

The movement of the most simple mechanical working units such as wheels, motors, and gears can be mimicked by single molecules whose structures resemble those of the full-sized objects. These molecules are made in much the same way as any complex object is: by taking parts and putting them together in the right configuration to form the working unit. In this project, we worked to make a nanocar: a molecule that has four "wheels" and can roll on a surface.

From the Rotation of Nanowheels to Single Molecular Nanovehicles

A nanowheelbarrow was successfully synthesized in the *Nanosciences group* of Toulouse, France, and studied on a metallic surface using the STM. However, this study has shown that the triptycene wheels were not rigid enough and that there were too many interactions of the chassis with the surface to allow the wheelbarrow to roll. Work is currently being done to create a nanocar that will consist of three main parts: the chassis, the four wheels, and the axles to link the two previous parts. First, the chassis is a polyaromatic platform that has been chosen for its rigidity. This gives the molecule fewer degrees of freedom and makes it easier to manipulate. Similarly to the chassis, the axles haves been chosen for their rigidity, but also because they are linear. This allows a free rotation around the C-B bond between the wheels and the axles and the C-C bond between the wheels and the chassis. Two convergent retrosynthetic strategies were carried out for the realization of the chassis using both Scholl coupling and Sonogashira catalyzed coupling conditions.

Board 26

Anthony Wong

Faculty Mentor: Søren Meibom
Optical and Infrared Division,
Harvard-Smithsonian Center for Astrophysics

A star's spectrum is a measure of how much light we observe from the star at different wavelengths, and is determined by properties of the star, including effective temperature, surface gravity, metallicity, and rotational and radial velocities. Many non-astrophysical effects contaminate observed spectra, however, and we have developed a data reduction "pipeline" to correct for these. Once reduced, we compare the spectra to template spectra with known properties to find the best-fitting parameters for each star.

A Spectroscopic Study of Stars and Star Clusters

Spectroscopy makes use of the most readily observable property of stars — their spectra — to deduce their true characteristics, including effective temperature, surface gravity, metallicity, and velocity, both rotational as well as radial. This is complicated by non-astrophysical effects such as cosmic rays, pixel sensitivity, spectral dispersion, the presence of a background continuum spectrum, and the blaze function of the spectrograph instrument. These contribute to the raw shape of the observed spectra, and must be removed in order to obtain the most accurate cross-correlation with synthetic template spectra. Furthermore, analysis of hundreds of spectra at a time provides valuable data for models of stellar evolution, determination of stellar membership in clusters, measuring the three-dimensional relationship between stellar color, rotation period, and age (which is not well-known), and useful applications in the search for exoplanets. Our data is collected from the Hectochelle multi-object echelle spectrograph, using the post-conversion Multiple Mirror Telescope (Mount Hopkins, Arizona). We have experimented with different corrections for the continuum and blaze shapes and have developed a data reduction pipeline and stellar classification procedure which accurately corrects for these contaminations and cross-correlates the corrected object spectra with templates. Additionally, we find that omitting 3 wide absorption lines, the Magnesium-B triplet, from the cross-correlation process yields more accurate results.

Board 27

Kristen M. Lear

Faculty Mentors: Elizabeth Braun de Torrez[1], Thomas H. Kunz[1], and Edward H. Burtt, Jr.[2]
[1]Department of Biology, Boston University;
[2]Department of Zoology, Ohio Wesleyan University

As the environmental impact of agricultural chemicals are being revealed, alternatives to chemical methods of pest control are being investigated. One such method is the use of insectivorous bats. This study monitored general activity and foraging activity at specified distances from a bat house on a pecan orchard in Texas to determine if bat houses provide beneficial effects on pest control. Results show that bat activity and foraging activity are higher near the bat house, suggesting that attracting bats to agricultural lands through the installation of bat houses increases the benefits to pest control. This is important to farm owners as they seek alternatives to chemical-dependent pest control methods.

Bat Foraging Activity Increases Near Bat Houses

Agriculture often employs the use of chemicals for insect pest control. Alternative methods, such as the use of beneficial insects, have also been used. Insectivorous bats can be used as a biological method of pest control. One way of attracting bats to farms is by installing bat houses. I set out to determine if bat foraging activity increases near bat house roosts, thereby increasing the beneficial effect of bats on maintaining pest populations. General bat activity and foraging activity was monitored with an Anabat II acoustic detector at 15 sites along four transects radiating from a bat house occupied by Mexican free-tailed bats (*Tadarida brasiliensis*). Sites were chosen at 15, 95, 175, and 255 meters from the bat house located in an organic pecan orchard in central Texas. Total bat passes and feeding buzzes were recorded for 4 minutes at each site between 2200 and 0100. Preliminary results show that general bat activity and foraging activity are higher at sites closest to the bat house. These findings suggest that attracting bats to agricultural lands through the installation of bat houses increases the benefits to pest control, which is important to farm owners as they seek alternatives to chemical-dependent pest control methods.

Board 28

Anne Worth

Faculty Mentors: Maroun Mhanna and Ajith Mathew
Department of Neonatology, MetroHealth Medical Center, Cleveland, OH

Survival of infants considered Very Low Birth Weight (≤1500 grams) continues to improve with improvements in technology. However, there have been no significant increases in survival without long term morbidity, including the use of a tracheostomy. A tracheostomy is a surgical procedure that opens a direct airway to the trachea in order for oxygen to reach the lungs. This study sought to identify the risk factors associated with the need for a tracheostomy in order that these factors can be reduced or eliminated.

Risk Factors Associated with the Need for a Tracheostomy in Very Low Birth Weight Infants.

Survival of Very Low Birth Weight infants (VLBW) continues to improve with recent improvement in technology. However there have been no significant increases in survival without neonatal and long term morbidity. We sought to determine in a retrospective case control study the prevalence, risk factors, and outcomes of VLBW infants with tracheostomies. Nine VLBW infants who were admitted to MetroHealth's neonatal intensive care unit (NICU) and required a tracheostomy were included in the study. All medical records were reviewed for patients' demographics, characteristics, potential risk factors for tracheostomy and outcome. There were no differences in patients' gestational age or birth weight between infants with a tracheostomy and their controls [26.5 ± 1.7 wks vs. 26.5 ± 1.5 wks (p=0.93) and 893.1 ± 187.6 grams vs. 878.7 ± 189.4 grams (p=0.85) respectively]. There were also no differences in patients' characteristics. Patients with a tracheostomy had a higher rate of non congenital upper airway obstructions, broncho-pulmonary dysplasia (BPD), multiple intubations, and more days of mechanical ventilation than their controls [55% (5/9) vs. 0% (0/18; p=0.001), 89% (8/9) vs. 0% (0/18; p<0.0001), a median of 13 intubations/patient (interquartile range of 11-15) vs. a median of 3 intubations/patient (interquartile range of 2-5; p< 0.001), and 87.2 ± 32.3 vs. 27.3 ± 19.1 days (p<0.001) respectively]. Also patients with a tracheostomy had an increased mortality, days of mechanical ventilation and severe BPD [44% (4/9) death vs. 0% (0/18) death (p=0.007), and 99.2 ± 46.9 days vs. 28.1 ± 20.5 days (p=0.001), and 100% (9/9) BPD vs. 0% (0/18) BPD (p<0.0001) respectively]. In conclusion, BPD, non congenital upper airway obstruction, number of intubations, and days of mechanical ventilation are possible risk factors associated with the need of a tracheostomy in VLBW infants. Also tracheostomy is associated with increased mortality and morbidity among VLBW infants.

Board 29

Kevin McGowan

Faculty Mentor: Gary Keck
Department of Chemistry, University of Utah

Bryostatin 1 has been shown to be a potential therapeutic agent for the treatment of Alzheimer's disease as well as some cancers. During the 10-week fellowship significant amounts of the substituted stannane was synthesized. This material is to be used in the scale up of synthetically important intermediates as well as the total synthesis of bryostatin 1 and its structural analogs.

Synthetic Efforts towards the Total Synthesis of Bryostatin 1 and its Structural Analogues

Bryostatin 1, a marine natural product isolated from the bryozoans *Bugula* neritina, has been shown to be a potential therapeutic agent for the treatment of some cancers as well as Alzheimer's disease. Bryostatin 1 is a highly oxygenated 20-membered macrolactone that also contains three 2, 4, 6 substituted pyran rings. Efforts were made towards synthesizing useful amounts of advanced intermediates used in the synthesis of the bryostatin A-ring pyran. The A-ring can be obtained from the coupling of a substituted stannane and a highly functionalized chiral aldehyde. Multi-gram quantities of the substituted stannane were synthesized through a 4-step process from available starting materials. Further synthetic efforts were made towards synthesizing the highly functionalized chiral aldehyde coupling partner. With the substituted stannane in hand, Lewis acid catalyzed 1,3 chelation controlled coupling with the chiral aldehyde was performed with excellent diastereoselectivity. These materials will be used in the large-scale preparation of A-ring subunits for the total synthesis of bryostatin 1 and structural analogues of this intriguing natural product.

Board 30

Randi Amstadt

Faculty Mentors: Wasim Khasawneh, Deepak Kumar, and Sharon Groh-Wargo
Department of Neonatology, MetroHealth Campus of Case Western Reserve University School of Medicine, Cleveland, Ohio

Osteopenia of prematurity is a condition frequently affecting very low birth weight infants that leads to a decrease in bone density. Common causes include low birth weight, prematurity, and inadequate calcium and phosphorus intake. Medical records were reviewed to determine the incidence and factors associated with this condition in extremely low birth weight infants admitted to MetroHealth Medical Center between January 2006 and December 2008.

Osteopenia of Prematurity in Extremely Low Birth Weight Infants

Osteopenia of prematurity is a condition marked by decreased bone mineralization that commonly affects very low birth weight, preterm infants. Retrospective chart review was conducted to investigate incidence and factors associated with osteopenia of prematurity in extremely low birth weight (ELBW; ≤ 1000 g) infants admitted to MetroHealth Medical Center (MHMC) Neonatal Intensive Care Unit (NICU) between January 2006 and December 2008. From a potential 175 ELBW infants admitted during the study period, data was abstracted for 106 infants. From this sample, 33 (31.1%)infants had osteopenia. Of these 33 infants, 10 infants had associated spontaneous fractures. After 5 weeks of age, all infants with osteopenia had remarkably decreased nutritional intake (e.g. calories, protein, calcium, and phosphorus) and significantly higher levels of alkaline phosphatase ($p=0.0022$) and direct bilirubin ($p=0.0126$). Compared to controls, infants with osteopenia were associated with significantly greater number of days on Lasix ($p=0.0003$), antibiotics ($p=0.0012$) and assisted ventilation ($p<0.0001$).

Board 31

Chris Gong

Faculty Mentor: Claud Lacy
Department of: Physics and Astronomy, University of Arkansas

Analyzing the periodic light variation of eclipsing binary stars is the only way that enables astronomers to accurately determine fundamental properties of stars such as mass and size. In this study, these properties of the eclipsing binary LV Her put the most recent theory about how stars evolve to the test. An accurate stellar evolutionary model is essential in our understanding of the evolution of the Sun and astronomical processes in general.

A Photometric Study of Algol Type Eclipsing Binary LV Her

Analyzing eclipsing binary stars' photometric data is the only way that enables astronomers to accurately calculate fundamental properties of stars such as mass and size. In this project, we use photometric light curve to determine the absolute dimensions (mass, radius, absolute magnitude, luminosity and surface gravity) of Algoltype eclipsing binary star LV Her. We test our results against the stellar evolutionary model Y2 Isocrhones and find no difference within the observational uncertainties. Photometric observations were made in V filter with a CCD sensor from 2001 to 2009 at the University of Arkansas. The light curve is solved using EBOP program (NDE model). The results demonstrate that LV Her is a detached system (Algoltype), with high orbit eccentricity (0.6142 ± 0.0001) and relatively long orbital period (18.43595 days). Two components are similar in mass and size and also to those of the Sun. To calculate the temperatures of the two stars, instead of using spectral class determined by Popper, we calculate directly from color indices obtained from three surveys: TASS, 2MASS, TYCHO, and the observation made by Hilditch and Hill. The effect due to interstellar reddening is determined using the comparison between the color indices of the theoretical model and the observed values from the surveys. This consideration increases the intrinsic temperatures by about 200K. The temperature for the primary star is $6215K\pm25$ and for the secondary $6195K\pm25$. To test the Y2 Isochrones theory, we plot LV Her's positions on HR diagram along with the isochrones tracks. Within the uncertainties of both luminosity and temperature, two stars of LV Her overlay a same range of isochrones, proving that the theory successfully predict the same age for both stars. Therefore we cannot reject this theory. The average age for the primary is 2.67 billion years and for the secondary 2.42 billion years.

Board 32

Jack Stenger

Faculty Mentors: Matthew J. Stuber and Jay D. Carlisle
Department of Biology, Idaho Bird Observatory, Boise State University

Flammulated Owl Survey Results from Three Study Areas in Southern Idaho in 2009

In order to improve our current understanding of the distribution and abundance of Flammulated Owls in Idaho, we conducted standardized nocturnal surveys from mid-May to mid-July across three disjunct study areas in southern Idaho: the Owyhee Mountains in southwestern Idaho, the south portion of the Sawtooth National Forest (NF) in south-central Idaho, and the Caribou-Targhee NF in eastern Idaho. We examined patterns of detections based on survey date, habitat type, and study area. We found generally high abundance of Flammulated Owls in the Sawtooth NF and low to moderate abundance in the Owyhee Mountains and on the Caribou-Targhee NF. Preliminary results suggest that presence of mature aspen was an important factor affecting Flammulated Owl presence in all three study areas. In general, detectability was higher early in the summer (mid-May to mid-June) with detections tailing off in late June and early July; however, detections on the Sawtooth NF were more consistent between early and late summer. These data will add important information to our state-level and regional understanding of this enigmatic species.

Board 33

Patricia Troy

Faculty Mentors: Karen Overstreet and Dirk Bucher
Whitney Laboratory for Marine Bioscience, University of Florida

The axon is generally thought to act as a telephone wire, merely transmitting the signals of a neuron from one place to another. However, it has been discovered that dopamine can change and alter signals as they travel along the axon. By applying different drugs to the axons of neurons dissected out of lobsters, I was able to mimic or inhibit this dopamine effect to gather support for the pathway through which dopamine acts on the axon to alter the signal. I also used *in situ* hybridization to show which cells were expressing dopamine receptors and were therefore susceptible to signal alteration by dopamine.

Dopamine Signaling Pathway in the Stomatogastric Ganglion of *Homarus americanus*

Dopamine can alter the signaling of the pyloric dilator (PD) neuron in the stomatogastric ganglion (STG) of the lobster, *Homarus americanus*. When applied to the quiescent axon, dopamine elicits peripheral spike initiation. In addition, during normal ongoing centrally generated activity, dopamine modulation of the axon can alter the temporal pattern of spikes during axonal conduction. Previous research has shown that dopamine initiates peripheral spiking by increasing current through HCN (hyperpolarization-activated, cyclic nucleotide-gated) ion channel, increasing an inward rectifying current that depolarizes the cell. Therefore, the dopamine should bind to a D1 type receptor, resulting in an increase in cAMP, increasing the current through HCN channels. Here, we used a pharmacological approach to test this hypothesis. We applied drugs to the axon that are either activators/agonists or blockers of different steps of the pathway to either mimic or inhibit the response to dopamine. There are three different dopamine receptors in *H. americanus* so *in situ* hybridization was used to map which cells in the STG are expressing which receptor. The different pathway drugs tested support that the peripheral spiking is initiated via an increase in cAMP which causes the HCN channel to open. The *in situ* protocol has been optimized such that mapping of the cells can now be done to show that the PD cell is expressing a D1 type receptor.


HAMILTON

Lawrence E. Young '35 Award Projects >>

Established in 1994, this award is presented to students interested in health-related careers.

Board 34

Raksha Adhikari

Faculty Mentor: Omprakash Mittapalli
Department of Entomology, OARDC/ Ohio State University

The Orange Blossom Wheat Midge (*Sitodiplosis mosellana*) is a destructive insect that infests on wheat and have been causing severe damage to the wheat cultivars in countries mostly in the Northern hemisphere like Canada, Russia, China and USA (North Dakota and Idaho). The most destructive stages are the first and second instars/larvae since they are actively involved in feeding. Despite crop losses worth of thirty million pounds in an outbreak during 1993, to date, knowledge on the level of molecular biology of this insect is minimal. So far, only one resistance gene, "Sm1", has been identified in wheat.

Differential Gene Expression Pattern in Orange Wheat Blossom Midge

We characterized the first detoxifying enzymes, glutathione S-transferase: GST-1 (delta) and GST-2 (sigma) in wheat midge and analyzed the gene expression pattern in different tissue and development stage samples. Annotations of the two GST sequences (GST-1 and GST-2) using blast confirmed that GST-1 was delta-like and GST-2 was sigma-like. GST-1 sequence had the highest similarity with delta-like GST from *M. destructor* with an e-value of 2e-68 and an amino acid identity of 65%. GST-2 sequence showed the greatest similarity with sigma-like sequences from species such as *A. aegypti*, *C. quinquefasciatus*, and *M. destructor* with an e-value of 7e-79, 2e-78 and 1e-66 respectively. Analysis of the results obtained from quantitative-PCR showed that GST-1 expression was highest in the fat-body and second instar. In contrast, GST-2 was constitutively expressed in the fat body and midgut among the tissue samples and was highest in the second larvae-pupae stage. We concluded that GST-1 was tissue-specific while GST-2 maybe constitutively expressed. GST-1 could play a direct and indirect detoxification function in counteracting insecticides and plant allelochemicals while GST-2 could play an important role during critical physiological changes (e.g. molting) and in general detoxification function.

Board 35

J. David Gatz

Faculty Mentor: Amanda Garner
Department of Chemistry, The Scripps Research Institute

Nearly one billion people on this planet are either overweight or obese. Such health conditions are commonly the precursors to additional and more serious afflictions such as type 2 diabetes and heart disease. Current research suggests that inhibiting the actions of the hormone ghrelin could potentially prevent obesity and stabilize insulin levels in diabetes. We synthesized ghrelin mimics that might stimulate the production of antibodies capable of deactivating true ghrelin, and also worked on developing an assay to detect inhibitors of the enzyme responsible for activating ghrelin.

A Vaccine for Obesity? Diabetes?

Ghrelin is a 28 amino acid long peptide, secreted by several groups of select cells throughout the human body. Ghrelin is unique among known human peptides because of a *n*-octanoyl post-translational modification, facilitated by the enzyme ghrelin O-acyltransferase (GOAT). It is believed this modification activates ghrelin for many of its roles, including stimulating appetite and insulin secretion. Thus, removing or preventing the attachment of this fatty acid might inactivate the hormone. A "two-prong" approach was pursued in attempting to inhibit active *acyl*-grehlin. The first route sought to improve upon previous success with catalytic antibodies. Ghrelin mimics, containing various transition state analogs were synthesized to determine the optimal transition state analog and side-chain length for eliciting catalytic antibodies. These antibodies will eventually be raised in mice, and tested for their catalytic efficiency. The second route sought to inhibit the enzyme responsible for adding the Serine-3 octanoyl group, GOAT. Attempts were made to isolate the GOAT enzyme, after viral transfection to Sf9 cells. Additional ghrelin transition state mimics were synthesized as potential small molecule inhibitors of the enzyme's active site.

The NSF-funded REU/RET (Research Experience for Undergraduates/Teachers) program at Ohio Wesleyan makes it possible for students from universities across the country, as well as one or two high-school science teachers from central Ohio, to do research in the fields of astronomy, computer science, mathematics, and physics on the OWU campus.

Board 36

David Carpenter

Delaware Hayes High School

Faculty Mentor: Barbara Andereck
Department of Physics and Astronomy,
Ohio Wesleyan University

Three of the four large moons of Jupiter orbit in a synchronized manner. We studied a simplified model consisting of only two satellites and Jupiter, to see how their 2:1 orbital period relationship might have originated. We found intricate patterns for the locations of the closest approach to Jupiter, depending on starting conditions and the mass of Jupiter used.

Orbit Synchronization

The synchronization of the orbital periods of the natural satellites of planets resembles the synchronization of mechanical oscillators. When two satellites are of comparable mass, each gravitationally influences the orbit of the other satellite. Eccentricities of the orbits cause nonlinear oscillations. The satellites can therefore modulate each other's periods slightly through altering each other's eccentricities.

In this study, *Mathematica 7* was used to model a planet with only two satellites, based on the orbital properties of Jupiter and two of its satellites, Io and Europa. This was chosen because Io, Europa and Ganymede actually are synchronized with orbital periods in ratios of 4 : 2 : 1. The orbits are also phase-locked, with conjunctions between Io and Europa always occurring at Io's perijove, and Europa's apojove. No tidal influences were modeled, and eccentricities were exaggerated by a factor of 10.

By deliberately displacing the phase of Europa's orbit, we observed that the phase angle between Io's orbit and Europa's orbit would librate. The libration pattern would itself precess at a rate that was fairly steady (at least at early times). The rate of this precession was shown to increase with improved coupling, achieved by decreasing the mass of the model Jupiter.

Board 37

Andrea Richard

Muskingum College

Faculty Mentor: Robert O. Harmon
Department of Physics and Astronomy,
Ohio Wesleyan University

Digital images of LO Pegasi were taken in order to analyze the variations in the star's brightness. From these variations, light curves can be made that are then inverted through the use of Matrix Lightcurve Inversion (MLI). Once the light curves are inverted, MLI creates reconstructed star surfaces that show visible starspots. Studying starspots then allows us insight into the magnetic activity of the star.

Stellar Surface Imaging of LO Pegasi via Light Curve Inversion

LO Pegasi or star HIP 106231 was observed for the purpose of mapping its starspots. An eight-inch Meade Schmidt-Cassegrain Telescope was used in conjunction with a Santa Barbara Instruments Group ST-8XE CCD Camera in order to obtain digital images of LO Pegasi and its surrounding sky region. Observation of the star occurred during the months of May, June, and July. Starspots, analogous to sunspots, on the surface of the star are caused by intense magnetic fields. Aperture photometry was performed on the images of LO Pegasi using *Mirametrics* Mira Pro 7 in order to determine the magnitude of the star. From the photometry, light curves could be produced using the brightness of the star versus its rotational phase. The light curves were then analyzed by the use of Matrix Light Curve Inversion, which is an algorithm that produces an image of the surface of the star and its starspots based on the changes in the brightness of the star as it rotates in and out of the field of view of the telescope.

Board 38

David Kamensky
University of Virginia

Faculty Mentor: Todd Krause
Department of Physics and Astronomy,
Ohio Wesleyan University

This research adapts the non-relativistic astrophysical simulation code GADGET-2 to model black hole mergers. We automated the generation of simulation inputs and began work on modifying GADGET-2 to include the relativistic effects necessary for the full study of black holes.

Numerical Relativity and Black Hole Mergers

This research adapts the Newtonian cosmological simulation code GADGET-2 to model black hole mergers. First, initial conditions (ICs), consisting of positions and velocities of particles representing black hole accretion disks, must be generated for use as input to GADGET-2. The automated generation of large numbers of such positions and velocities requires optimization, while the diversity of possible physical distributions requires modularity and extensibility. A pre-existing, C++ solution was optimized to shorten both source code and running time, and we continue to develop a Python-based implementation. With a working IC generator in hand, we will modify GADGET-2 itself to include relativistic effects.

Board 39

Lisa Brodsky
Hampton University

Faculty Mentor: Bob Kaye
Department of Physics,
Ohio Wesleyan University

Like the electrons of a molecule that is burning releasing a photon as it moves to a relaxed state, the nucleus releases energy in order to reach a relaxed low energy state by releasing electromagnetic energy in the form of a gamma ray. Because these states are discrete the energies of the gamma ray from an individual state to the next will always be the same, and if the ray is released while the nucleus is moving Doppler shifting may be observed and utilized to find the lifetime of the state, which in turn is similar to the concept of half life of a radioactive atom. Lifetimes may then be related to deformations of the nucleus from the spherical, which allows for greater understanding of other nuclei, like ^{70}As, which exist in a special region of the chart of nuclides called the “wild west” where deformations change rapidly from one nuclide to the next.

Lifetimes and Deformations in Odd-Odd ^{70}As

The collectivity and deformation of ^{70}As are of particular interest due to the odd-odd nature of ^{70}As and its location in the “Wild West” region of the nuclear landscape where deformation and structural behaviors change rapidly with the number of nucleons, as well as with the evolution of excitation energy and angular momentum (spin). Therefore, the positive-parity high-spin states of ^{70}As were studied in a ^{54}Fe(^{23}Na, α2pn) reaction at 80 MeV utilizing the John D. Fox superconducting accelerator at Florida State University. Gamma-ray coincidences were measured with 10 Compton-suppressed Ge detectors divided into angular positions of 35°, 90°, and 145° relative to the beam axis.The lifetimes of five excited states with spin-parity $I^{\pi} = 10^{+}$, 11^{+}, 12^{+}, 13^{+}, and 15^{+} were measured using the Doppler-Shift Attenuation Method (DSAM) applied to the experimental line shapes measured at both 35° and 145°. The transition quadrupole moments (Q_t) of these states were inferred from the lifetimes using the rotational model, which indicated moderate collective behavior associated with these states. These experimental Q_t values were then compared to those predicted by cranked Woods-Saxon calculations, resulting in a general agreement with the expected trend of increasing collectivity and deformation with spin in the lowest positive-parity band.

Board 40

Sean Quigley
University of Michigan

Faculty Mentor: Sean McCulloch
Department of Mathematics and Computer Science, Ohio Wesleyan University

If two or more individuals want to find the shortest paths on the same graph or network, it often helps to collaborate and share the cost for some common portion of the path. We analyzed this problem using techniques in game theory, and devised an algorithm that lowers the total cost of all individuals, while simultaneously results in a routing where no individual has incentive to leave the solution and find a cheaper path elsewhere.

Shared Shortest Paths in Graphs

The shortest path between two points in a weighted graph can be found with Dijkstra's algorithm. We have been investigating a similar problem in which multiple source and destination pairs (called journeys) must be routed within a graph, and these journeys equally share the costs of edges that they mutually traverse. Because each journey's individual cost can depend on the routings of other journeys, we view each journey as an individual strategically choosing a path that minimizes its cost and employ game theory to analyze the problem. We have developed multiple variations of a program that attempts to find the Nash equilibrium solution of minimal total cost for all journeys. Our most recent algorithm generally results in solutions of lower total costs than previous algorithms. In our tests, we have yet to find a situation in which a Nash equilibrium is not reached. Recently we have also been investigating the importance of the order in which journeys are routed on the graph, and preliminary results show that routing journeys of least cost first may result in better equilibrium solutions. In future work we hope to refine our algorithm and investigate ways to find strong Nash equilibrium solutions.

Board 41

Christopher Brodkin
Hampton University

Faculty Mentor: Brad Trees
Department of Physics and Astronomy, Ohio Wesleyan University

Synchronization of coupled nonlinear oscillators is common in nature, having applications in biology, chemistry, and physics. This work studies a new mathematical model of coupled oscillators that allows for analytical solutions of the underlying differential equations. Analytic results are always more complete predictors of system behavior than numerical solutions, but analytical solutions are usually much more difficult to obtain.

Study of a Linear Reformulation of Synchronized Oscillators

Systems of coupled oscillators for years have sparked curiosity and a desire to develop mathematical models to describe their behavior. Recently, Roberts [1] has introduced a linear model of coupled complex oscillators. Unlike the well known nonlinear Kuramoto model of coupled oscillators, the linear model can be solved analytically for the phase order parameter for a finite oscillator number N. Solving Roberts' linear model is similar to solving a normal mode problem where the oscillators are set in the complex plane. We created several Mathematica notebooks to solve the Roberts model and the Kuramoto model for the phase order parameter, and the oscillator's positions and angular velocities. Each notebook has different settable parameters e.g. the manner in which the oscillators are coupled, local or global, how strongly they are coupled, and the distribution of the natural angular frequencies.

1. David Roberts, Phys. Rev. E **77**, 031114 (2008).

Vivek Sampathkumar
Georgetown University

Faculty Mentor: Scott Linder
Department of Mathematics and Computer Science, Ohio Wesleyan University

In many applied settings (pharmaceutical, biomedical, industrial, etc.), data is subjected censoring. For example, a researcher begins with 100 electronic components, and stops the experiment after the 30th failure (so 70 failure times are censored). Although censoring is commonplace, methods appropriate for the analysis of such data are not well developed because sampling distributions in these settings are mathematically intractable. Here we examine the properties of a statistic (Fisher's Z-transformation, commonly used for non-censored samples) when censoring occurs. We demonstrate that the impact of censoring is systematic and predictable in terms of experimental conditions. Using this, we propose a "modified" transformation which accounts for presence of censoring.

Modified Fisher Z-Transformation and Inference for Correlation in a Bivariate Normal Model Subjected to Type II Censoring.

When data in a bivariate normal model has been subjected to Type II censoring, the sampling distributions of ordinary statistics are typically intractable mathematically. This renders statistical inference for model parameters difficult if even possible. For full samples (no censoring), Fisher's Z-transformation has long been commonly used to make inferences about the correlation between two random variables. Here, we demonstrate that the quality of inferences made using Fisher's Z-transformation erodes under even light censoring. However, the impact of censoring on Fisher's Z-transformation is predictable as a function of experimental conditions. Based on this systematic impact, we propose a simple modification to Fisher's Z-transformation. We demonstrate that this modification enables researchers to greatly improve the quality of inference about correlation when their data has been subjected to Type II censoring.

Elizabeth Segelken
Kenyon College

Faculty Mentor: Brad Trees
Department of Physics and Astronomy, Ohio Wesleyan University

Superconducting electromagnetic oscillators known as Josephson junctions have many uses, including potentially as bits in quantum computers. The governing equation describing these junctions is equivalent to that of a microscopic pendulum. This work uses quantum mechanics to study the behavior of a damped, driven microscopic pendulum, with the future goal of looking for the synchronization of two coupled pendula.

Quantum Dynamics of Nonlinear Oscillators

Motivated by an analogy to Josephson junctions, we studied the dynamics of a damped, driven pendulum in the quantum limit. We model the effects of damping by means of the quantum state diffusion method, in which the Hamiltonian in Schrödinger's equation is augmented by terms constructed from combinations of Lindblad operators. The dynamics were observed by looking at the time dependence of the expectation values of the pendulum's angular momentum and mechanical energy. We present our results. The next step is to couple two damped, driven quantum pendula and search for evidence of synchronization. This would suggest that it is possible to synchronize coupled small-area Josephson junctions, which must be treated in the quantum limit.

Anne L. Benjamin
Wellesley College

Faculty Mentor: Barbara S. Andereck
Department of Physics and Astronomy,
Ohio Wesleyan University

When two metronomes of nearly identical frequency are started oscillating in opposite directions on a board that is free to move sideways, the metronomes gradually adjust their oscillations until they are in sync. During the process of synchronization the amplitudes of the metronomes change noticeably and in a periodic fashion. We studied the nature of this process and how it depends on key characteristics of the system.

Long Timescale Behavior During Synchronization in Two Coupled Nonlinear Mechanical Oscillators

The phenomenon of synchronization has been found in many, widely diverse arenas, some harder to study than others. While synchronization can be described satisfactorily by the Kuromoto model, specific systems differ in important ways that may shed insight on how synchronization works. One such easy-to-study system is two coupled nonlinear mechanical oscillators, eg. two metronomes with nearly identical frequencies on a board with two degrees of freedom of motion. The main advantage of this particular system is that the equations of motion are well known and have been shown to be accurate. This study used the numerical solutions of these equations to explore the behavior of the system for parameters that would be impractical or impossible to examine physically.

As metronomes synchronize, they exhibit two types of behavior: short timescale oscillations of pendulum positions and long timescale oscillations in the amplitudes. Due to nonlinearity, these amplitude variations change the frequency of the metronomes, leading to synchronization. This long timescale behavior is itself analogous to a nonlinear oscillator that has been damped. The frequencies of both metronomes oscillate 180 degrees out of phase with the other. Synchronization occurs when the frequency oscillations decay to a common final value. We found how the strength of the coupling of the metronomes, the relative strength of the escapement mechanism, and the ideal pendulum amplitude all affect the period of frequency alternation and how quickly the frequency oscillation damps.

Departmental Honors 2008-2009

Graduation with Departmental Honors requires an independent project, an oral exam on the project, and a comprehensive exam in a student's major department during his or her senior year. This program is open to students who have attained cumulative grade point averages of 3.5 in their majors after fall semester, junior year, as well as overall grade point averages of 3.0 or the support of their academic major departments, and have successfully petitioned the Academic Policy Committee at OWU.

Student Name	Department	Supervising Professor	Title
Laura Coonfield	Philosophy	Scott Calef	A Sound Mind with a Sound Body: The Case for Substance Dualism
Grant Geib	Physical Education	Nancy Knop	Developing a Periodized Training Program for OWU Football
Victoria Lee	Physical Education	Nancy Knop	Case Study in Childhood Cancer
Kyle Martin	Physical Education	Nancy Knop	The Effects of Mental Training in Sports and the Use of these Methods at OWU
Tov Nordbø	History	Mark Gingerich	How did Joseph Stalin politically react to the American monopoly of the atomic bomb between 1945-49 and how did this affect the early Cold-War tensions?
Scarlett Rebman	History	Xiaoming Chen	From the Manchurian Incident to Pearl Harbor: The Escalating Tensions between the United States and Japan
Lauren Smith	Zoology	Jed Burtt	The Geography of Parrot Coloration

2008 SSRP Participants

Rob Anthony, OWU '10
Presented Research: American Physical Society Conference – Denver 2009
Currently: Working with Incorporated Research Institutions for Seismology (IRIS) this summer at the University of Miami, Ohio to study seismic waves along Mexico in order to gain a better understanding about Tsunamis; involves installing seismographs in the Cascades

Valerie Sloboda, OWU '09
Currently: Beginning nursing school at Xavier University to obtain an MSN degree to become a nurse practitioner

Beth Mayers, OWU '10
Presented Research: Mid-Western American Society of Plant Biologists Meeting – Peoria, IL 2009
National American Society of Plant Biologists Meeting – Honolulu 2009
Currently: Summer research position at the University of Georgia, Athens working in a lab focusing on sunflower habitats

Evan Bai, OWU '11
Presented Research: Mid-Western American Society of Plant Biologists Meeting – Peoria, IL 2009
Currently: Awarded a Summer Undergraduate Research Fellowship (SURF) from the American Society of Plant Biologists to do research on how phosphate availability affects the architecture and gravitropic responsiveness of the roots of *Arabidopsis thaliana*

Andrew Riley '10
Currently: Conducting summer research involving synthetic chemistry at the University of Kansas

Lauren Smith, OWU '09
Presented Research: American Ornithologists Union Meeting – Portland, OR 2008
Wilson Ornithological Society Meeting – Pittsburgh, PA 2009 (awarded the Wilson Prize for Best Poster Presentation)
Currently: Working on NSF sponsored research at Arizona State University, applying to graduate school in ornithology

Jenna Sroka, OWU '09
Currently: Beginning graduate school at Case Western Reserve University

Emily Turner, OWU '09
Currently: Beginning Medical School at the University of Louisville School of Medicine, awarded a 50% tuition scholarship

Randi Amstadt, OWU '10
Currently: Conducting summer research in the Edward M. Chester, M.D. Summer Scholars Program at MetroHealth Hospital in Cleveland, OH

Nick Baker, OWU '09
Presented Research: American Physical Society Meeting, Wright State University
American Physical Society Division of Nuclear Physics Meeting, Oakland, CA 2009
Currently: applying for research jobs

Megan Evans, OWU '09
Currently: Beginning a position with City Year in Miami, Florida. City Year is an AmeriCorps program.

Alex Friedman '10
Presented Research: Mid-Western American Society of Plant Biologists Meeting – Peoria, IL 2009
Currently: continuing research at OWU, shadowing physicians in Ohio Health System

Rachel Decker, OWU '09
Presented Research: Ohio Region Section of the American Physical Society – Wright State University 2008
Currently: Beginning job with AmeriCorps VISTA program

Caitlin Willet, OWU '09
Currently: Working at Harding Hospital and beginning graduate school in Public Health specializing in Health Behavior and Health Promotion at The Ohio State University

2007 SSRP Participants

Britta Buchenroth, OWU '09
Currently: Beginning Medical School at the Boonshoft School of Medicine at Wright State University

Nalin Vutisalchavakul, OWU '09
Currently: Beginning graduate school in astronomy at the University of Texas-Austin

Sara Nienaber, OWU '09
Currently: Beginning graduate school in Interdisciplinary Environmental Studies at University of Oregon

Sahar Mazhar, OWU '09
Currently: Beginning graduate school at Mount Sinai School of Medicine

Tov Nordbø, OWU '09
Currently: Accepted to veterinary school in Scotland, working this summer in a national park in Jackson Hole, WY

Tiffiny Rye, OWU '09
Currently: Beginning graduate school in biochemistry at The Ohio State University

Scott Williams, OWU '09
Currently: Beginning graduate school in entomology at Purdue University

Kelly E. Haines, OWU '09
Currently: Beginning graduate school in chemistry at the University of Cincinnati

Caitlin Chesnut, OWU '09
Currently: Teaching high school chemistry in Columbus Public School System

Index >>

Campus and Off-Campus Researchers

NSF-REU/RET Researchers

Special Thanks

Rock Jones
David Robbins
Charles L. Stinemetz
Karen McNeal
Laurie Patton
Ohio Wesleyan University Buildings and Grounds Staff
Chartwells Dining Services
Faculty supervisors and student volunteers
Parents and guardians of student researchers

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