



UNIVERSITY *of* ST. THOMAS

BUSH FOUNDATION PROGRAM GRANT:  
COLLABORATIVE INQUIRY

**Inquiry at UST:  
A Poster Session with the Results of  
Faculty/Student Collaboration  
at the University of St. Thomas**

**Abstracts**

**Vol. 6  
September 29, 2005**

## Introduction

The abstracts published in this volume reflect the value we at the University of St. Thomas place on faculty/student collaboration.

Students who have recently done collaborative work with a faculty member present that work in these abstracts and at this poster session for purposes of dissemination and scrutiny by their peers, their professors, and the academic public.

The University of St. Thomas expresses its deep gratitude to the Bush Foundation, who funded this event through a three-year Program Grant. The grant seeks to increase the use of inquiry-based teaching methods, so that students experience the real work of the professions, working on real problems often taken from outside the university, in the ways they will be called upon to employ their disciplines after they leave the university.

A second theme of the Bush Program Grant is to increase faculty/student collaboration. We believe that one of the very best ways to teach is to have professors work with students collaboratively. Students see how work is really accomplished in their chosen professions, and professors have the chance to share their work as it is being created.

We hope this event and this volume gives visibility and credibility to the ideas represented in our Bush grant



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September 2005

As president of the University of St. Thomas, I am both pleased and proud to welcome you to the sixth annual poster session devoted to faculty/student collaboration projects developed as part of our grant from the Bush Foundation, *Focus on Inquiry: Faculty/Student Collaboration at the University of St. Thomas.*

I believe that one of the most effective ways for students to learn is through collaborative inquiry: students and faculty working together on research that can have real-world consequences. This is completely in keeping with our mission as a Catholic university grounded in the liberal arts tradition. We strive to provide a high degree of personal attention in a challenging campus environment that is engaged with the complexities of our urban community and the world beyond.

Collaborative inquiry gives our students the opportunity to experience first-hand how their professors approach research questions in a given discipline. It also gives our faculty a better opportunity to understand how our students think, and helps them develop new ways of looking at research problems. Collaborative inquiry enables our students and faculty to experience their disciplines in action, deepening students' academic experience while simultaneously increasing career competency.

I am very proud of what our students and faculty are doing and I hope the work represented here will illustrate the importance of collaborative inquiry at St. Thomas.

Sincerely,

A handwritten signature in black ink, appearing to read "Dennis Dease".

Reverend Dennis Dease  
President

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*Danielle Anderson*

## **MINNESOTA SURVEY OF CONSUMER WELL-BEING**

*Faculty Collaborator: Dr. Stephan Grzeskowiak*

The impact of communities' commercial infrastructure on the quality of life of its residents is of increasing importance to community planners and policy makers. The community commercial infrastructure, such as the quality of products and services available to residents, spills over to other life domains, thus affecting residents' overall satisfaction with life (Sirgy 2001). In this study we analyze the effect of community consumer well-being on community life satisfaction and in conjunction with other life domains, overall life satisfaction. Here, community consumer well-being can be defined as residents' satisfaction with the acquisition, preparation, consumption, maintenance, and disposal of goods and services in their community.

Fifty mall-intercept surveys were administered across the twin-cities asking residents about their consumption experiences within their local community. The results of this study suggest that shopping experiences (e.g. quality and selection of stores), performance of service providers (e.g. satisfaction with services received), and assistance with selling unwanted goods are the primary determinants of residents' satisfaction with community commercial infrastructure. Overall life satisfaction in our sample was determined by social and health life.

In summary, the results of our study can be used to aid community planners and policy makers in developing and managing commercial infrastructures, as well as to monitor its contributions to residents' quality of life.

*Jennifer S. Anderson, Ashley E. Keller*

## **“WIRED”: ANALYZING THE PORTRAYAL OF ADHD IN THE JOEY PIGZA BOOK SERIES**

*Faculty Collaborator: Dr. Jean Giebenbain*

Attention-deficit/hyperactivity disorder (ADHD) is one of the most frequently diagnosed disorders among children today. With increasing prevalence rates currently ranging from 4 to 12% in school populations, the need for a clear understanding of this diagnosis seems critical for parents, teachers and students (Rinaldi, Parisi, Poscente, Calvani & Grammatico, 2004).

The Joey Pigza series, by Jack Gantos, is an award-winning, popular, three-book series chronicling the life of Joey Pigza; a fictional character diagnosed with ADHD. The present study sought, through analysis of this three-book set, to examine the novels' overall representation of ADHD and to determine whether the author presented an accurate or inaccurate, positive or negative rendering of this common childhood disorder.

The methodology for this project required that each of the three books composing the Joey Pigza series be read thoroughly. Therefore, each book was read twice by all three researchers. After the first read through, group members each wrote brief summaries of the novel's characters, and rated the portrayal of ADHD from 1 (extremely negative portrayal of the disorder) to 5 (extremely positive portrayal), and composed a brief rationale for the rating. During the second reading, researchers were required to note specific passages pertaining to ADHD and to mark them as either positive/negative and accurate/inaccurate portrayal of the disorder. Analyses from the three raters were then compared.

Results indicate that this popular series' depiction of ADHD is less than favorable. Analyses consistently revealed that, in particular, the first installment of this series, Joey Pigza Swallowed the Key

(the book presumably most likely to be read in a series), presented a particularly exaggerated and negative portrayal of ADHD. The follow-up novels presented a more positive depiction. Implications of the possible impact of these renderings are discussed.

*Randy C. Anderson, Brittany A. Mrosak, and Patrick G. Tsai*

## **REPRODUCTIVE ALLOCATION STRATEGIES AND THE MATING SYSTEM OF A NATIVE PERENNIAL PLANT SPECIES, PRAIRIE LARKSPUR DELPHINIUM VIRESCENS**

*Faculty Collaborator: Dr. Simon K. Emms*

The Prairie Larkspur *Delphinium virescens* is an insect-pollinated hermaphroditic Angiosperm native to dry prairies of the upper midwest. Like other such species, reproductive fitness is likely to be dependent on when and how plants distribute resources to their floral structures. Male structures (stamens) produce pollen; female structures (pistils) produce ovules; petals and nectar attract and reward the pollinators that distribute pollen. Allocation of resources to these structures changes during the blooming season according to the blooming rank of flowers on a plant. Data from previous years (2000, 2001, and 2003) indicate that Prairie Larkspurs usually decrease resource allocation to female structures and increase allocation to male structures in later blooming flowers on a plant. In 2005 we collected additional data on trends in male, female, and petal allocation and obtained for the first time data on nectar production. Pollinator exclusion cages were set up around 40 plants at each of three sites in southeastern Minnesota: McKnight Prairie, St. Croix Savanna and Cedar Creek Natural History Area. Sites were visited daily throughout the blooming season. Two early-blooming flowers and two late-blooming flowers were collected from each plant two days after they had begun to open. Nectar was extracted to estimate 48 hr nectar production rates, stamens and ovules were counted, and petals were dried and weighed for each flower. So far the data collected has confirmed and complemented results from previous years, but nectar production rates have yet to be measured and analyzed. In the lab we are currently refining the technique of allozyme electrophoresis for use with Prairie Larkspurs. Genetic information obtained from this work will help us determine whether the plants in our three populations are reproducing through self-fertilization, outcrossing, or a combination of the two.

*Trina M. Arola*

## **INTERMOLECULAR INTERACTIONS IN PHENYLHYDRAZONE CRYSTALS: LEWIS ACID-LEWIS BASE VS. HYDROGEN BONDING**

*Faculty Collaborator: Dr. William J. Ojala*

This research project is intended to find ways to make new crystalline organic compounds. This information can then be used both in the design of materials with new and useful properties and also in the design of new and effective drugs. These crystalline materials will be prepared by co-crystallizing molecules we have designated “bridge-flipped isomers.” These are molecules in which two major parts of the molecule are joined by a chain or bridge of atoms; the exchange of atoms between positions within the bridge relates one isomer to the other. The bridge-flipped isomers we describe here are organic compounds called phenylhydrazones, in which the bridge-flipped isomerism is  $\text{Ar-NH-N=CH-Ar'}$  vs.  $\text{Ar-CH=N-NH-Ar'}$  (where Ar = aryl). The chances that these isomers can be co-crystallized are

improved if the isomers assume the same molecular packing arrangements in their respective crystals, forming isostructural crystals. We have prepared a series of phenylhydrazones and have determined their crystal structures by single-crystal X-ray diffraction in order to identify isostructural pairs of these compounds for co-crystallization experiments. If intermolecular interactions in the solid state were to link molecules into similar chains in the two isomers, those crystalline isomers might be especially likely to be isostructural, so we have prepared phenylhydrazones substituted with halogen atoms and nitrile groups to determine whether any chain-forming Lewis acid-Lewis base interactions might occur in the crystal between the halogen atom of a given phenylhydrazone molecule and the nitrile group of a neighboring phenylhydrazone molecule. As described in this poster, the Lewis acid-Lewis base interactions we have sought can be outweighed by a competing interaction, hydrogen bonding involving the bridge N-H group. Obtaining isostructural phenylhydrazones in future work will depend on overcoming the differentiating effect of this H-bonding interaction.

We thank the Young Scholars Program for financial support of this work.

*Anne Bainbridge*

## **FORMATION OF LIGHT EMITTING ANTIGEN CONTAINING POLYMERS**

*Faculty Collaborator: Dr. J. Thomas Ippoliti*

Ring-opening polymerization (ROMP) using the second generation Grubbs catalyst was used to synthesize a polymer to which antigen and luminal derivatives were then attached. This molecule could then be applied in an assay to detect levels of real antigen based on relative light units from the luminescent moiety. Polymers with luminal and either estradiol or Vitamin D were successfully synthesized. Analysis by chemists at DiaSorin showed strong luminescence in all polymers, weak binding of the estradiol, and strong binding of the Vitamin D.

*Matthew Behrns and Adam Urness*

## **POLARIZED LIGHT IMAGING OF SIMULATED SKIN CANCER**

*Faculty Collaborator: Dr. Adam Green*

Our experiment investigates the effectiveness of Polarization-Difference Imaging (PDI) for the detection of cancerous lesions in human tissues. This type of imaging is useful when targets in turbid (random) media reflect polarized light asymmetrically. In addition to its biomedical applications, PDI is also useful for robotics, underwater exploration, environmental sensing, and understanding how certain animals can navigate and communicate using polarized light.

We have completed the first stage of this project, which was to construct a PDI apparatus and test it on a system that simulates a tumor imbedded in tissue. Our “tumor” was a block of aluminum with two square patches comprising orthogonal scratches that produced polarized light with perpendicular orientations. The block was submerged in milky water so that the scratches were largely invisible to the unaided eye. Our optical system was able to acquire high-contrast images of these scratched patches, particularly after an appropriate signal processing algorithm was employed.

*Mark Bussey*

## **C.P.E. BACH CONCERTO FOR GUITAR AND STRING ORCHESTRA**

*Faculty Collaborator: Dr. Christopher Kachian*

The project entails producing a guitar transcription of a concerto by Carl Philippe Emmanuel Bach (1714-1788). The primary basis for this project is the existence of three parallel concerti by C.P.E. Bach written for Flute, Violoncello, or Harpsichord each accompanied by string orchestra. In each concerto, the orchestra accompaniment is identical; the solo parts, while idiomatic for each instrument, all share recognizable melodic features. Had the modern concert guitar been available in his time, one can easily imagine C.P.E. Bach producing a setting of the concerto for this instrument.

The existence of multiple versions of the solo part makes this a particularly attractive transcription project. Different characteristics of each of the solo settings help inform the final transcription: overlap of the flute's musical range, tonal characteristics similar to cello, and bright attack and rapid decay of the harpsichord. One of the frequent challenges for guitar transcription is determining musically appropriate ways to address long sustained notes typical for flute and cello. Typically in baroque and classical-era music, the solution involves subtly embellishing, or ornamenting, the melody. In this transcription, C.P.E. Bach's own theoretical and technical writings greatly inform this process.

*Jay Christenson*

## **THE SYNTHESIS OF THE STARTING MATERIALS FOR A LEUKOCYTE ESTERASE SUBSTRATE**

*Faculty Collaborator: Dr. J. Thomas Ippoliti*

The first two steps in the synthesis of a leukocyte esterase substrate, N-tos-Alanyloxy Indole, were successfully completed several times resulting in ~140g of pure Indoxyl Diacetate. The Diacetate is then reacted in several more steps to form a Leukocyte Esterase test molecule.

*Michael Cook*

## **ELECTRICAL PROPERTIES OF LOW PRESSURE GASES**

*Faculty Collaborator: Dr. Martin Johnston*

Paschen's law describes the characteristics of gases at low pressures. It states that the breakdown potential,  $V_b$ , of a gas at low pressure is a function of the pressure of the gas times the distance between the two electrodes. More generally,  $V_b$  can be derived from the mean free path and number density of the gas, which are products of the pressure, temperature, and velocity of the gas and the gap distance. This function will generally have a minimum value generally on the order 10 Torr-mm, for example air has a minimum  $V_b$  of 327 volts at 5.67 Torr-mm. We have set up a system to test  $V_b$  experimentally in various gases, and began testing the breakdown properties of He. Then we will test the properties of other gases, such as N<sub>2</sub> or Ar. Eventually we will use our system to test a gas mixture similar to the composition of the atmosphere of Mars. This research has applications to many technical and scientific fields, especially planetary research.

*Lauren Edge*

## **COMPUTER MODELS OF CHARGE DISTRIBUTION ON A 1-DIMENSIONAL SURFACE**

*Faculty Collaborator: Dr. Paul Ohmann*

How does charge spread on a one-dimensional metal wire? The equilibrium charge distribution on a three-dimensional conducting sphere is uniform. However, for “simpler” objects with fewer dimensions, the validity of this assumption is questionable because of the boundaries of the object. In our study of the one-dimensional wire, we investigate an analysis of the equilibrium charge distribution by Griffiths and Li (Am. J. Phys. 64, 706-714, 1996), noting that the numerical results they present do not agree with the analytical solution (in the appropriate limit). Subsequent work by Jackson (Am. J. Phys. 68, 789-799, 2000) and Griffiths and Bonfim (Am. J. Phys. 69, 515-516, 2001) help clarify the issue.

*Robert Ertel*

## **TIME-OPTIMAL SKIING**

*Faculty Collaborator: Dr. Michael Hennessey*

Over January 2005, in Kinematics & Mechanism Design (ENGR 225) students studied the problem of minimum-time skiing. Using a 4th-order state-space model derived from application of Newton’s second law, students attempted to “ski” down the mountain from a start point to a finish point across the mountain in minimum time. Based on a pure guess and some mechanics intuition a constant body yaw rate was assumed for the skier such that the skier traverses through the finish. As it turns out, this approach yields the minimum time (to within a few milliseconds) when compared to the minimum-time solution determined from a curve-based calculus of variations approach. Could this be the theoretically correct answer? The answer, it turns out, is yes, and it took all summer to prove it (through a CAM project)! Mathematically, the problem involves the calculus of variations and use of the 4th order state-space formulation. Beyond proving the conjecture, summer 2005 yielded some exciting results, as an entire framework for solving more important practical but yet difficult problems was developed. It will now be possible to solve related problems such as incorporating coulombic friction, accommodating fairly arbitrary slope geometries, different end conditions, examining different optimization criteria, and so forth. There is even interest in the professional ski coaching community over these results. I am very excited about continuing this successful line of research and solving several of these more general problems as mentioned in addition to performing MATLAB dynamics simulation that will likely be of interest to the skiing engineering analysis, and applied mathematics communities.

*Sean Ewen*

## **BEHAVIOR OF POTASSIUM CHANNELS IN NEURON AXONS**

*Faculty Collaborator: Dr. Mikhail Shvartsman*

The nervous system is responsible for transmitting information incredibly fast. Billions of neurons interconnect to form the network of the nervous system. Signals of information must pass through one of the most important parts of the neuron, the axon. At first glance the axon resembles a cable, both having current and potential (voltage). But the axon transmits information through active differences in

potential between the outside and inside of the axon that are caused by ions entering and leaving the axon through specialized channels. This is called the action potential and is responsible for the transmission of signals throughout the axon. The potassium channel allows for ions to leave the axon once the action potential reaches a certain voltage. If the potassium channel fails to open, the signal cannot proceed.

We were able to take a first order differential equation that applies to the change in concentration of open potassium channels over time, and model it after data calculated from experimentally derived numbers. By keeping all variables except the order of equation stable, we were able to find that our data was actually modeled better when the equation was to the 1/8 order. By using this new found order while integrating the equation and solving for time, we were able to find an inverse relationship between time and voltage. As voltage increases, it takes much less time for all potassium channels to become open. As voltage decreases, it takes more time for all of the potassium channels to become open. The next step in our research will be to use our calculated data to model the time it takes for the action potential to pass through any given point in the axon.

*Christopher M. Flynn*

## **PHOTO-INDUCED ELECTRON TRANSFER IN 9-CYANOANTHRACENE AND 9,10-DICYANOANTHRACENE**

*Faculty Collaborator: Dr. Joseph Brom*

The dynamic quenching characteristics of the photo-luminescent molecules 9-cyanoanthracene (9-CNA) and 9,10-dicyanoanthracene (9,10-DCA) by anisole, 1,4-dimethoxybenzene, and trans-stilbene were examined. For all the substances studied, the  $k_q$  increased as  $E_{ox}$  of the quencher became more positive. The  $k_q$  of the 9-CNA solution quenched by anisole ( $E_{ox} -1.64$  V) was  $3.96 \cdot 10^6$  M<sup>-1</sup>s<sup>-1</sup>, while that of trans-stilbene ( $E_{ox} -1.51$  V) was  $5.00 \cdot 10^9$  M<sup>-1</sup>s<sup>-1</sup>, and the  $k_q$  of 1,4-dimethoxybenzene ( $E_{ox} -1.34$ ) was found to be  $1.00 \cdot 10^{10}$  M<sup>-1</sup>s<sup>-1</sup>. This data is consistent with the Rehm-Weller model for an electron transfer reaction between fluorophores and quenchers. Molecular energetic calculations indicate that 9-CNA and 9,10-DCA are both excited state electron acceptors, while the quenchers studied are electron donors. Based on this information, the mechanism of fluorescence quenching of 9-CNA and 9,10-DCA by the quenchers anisole, trans-stilbene, and 1,4-dimethoxybenzene is an electron transfer reaction.

*Christina Freiberg*

## **RESTAURANT LOCATION PROBLEM IN THE TWIN CITIES**

*Faculty Collaborator: Dr. Robert Werner*

A client plans to open four New York style deli restaurants in the Twin Cities over the next few years. The client anticipates that the customers will have a demographic profile like that of two successful D'Amico restaurants, one in Minneapolis and the other in St. Paul. The client also expects customers to be affluent females at home.

The authors constructed a demographic profile of people living 1, 1 1/2, and 2 miles from the two successful D'Amico restaurants. The values of relevant demographic attributes were then used to search for similar areas of the Twin Cities. These variables include the size of the population surrounding the sites; income, education, age, and family size.

Competing restaurants were downloaded from ReferenceUSA, then culled by the client to identify those restaurants he thinks would compete with his. Likely areas for his new restaurants are those with the right demography and little existing competition.

*Brandon Goblirsch*

## **CHARACTERIZATION AND ANALYSIS OF A AU PARTICLE ARRAYED G-WIRE SCAFFOLD**

*Faculty Collaborator: Dr. Thomas Marsh*

Colloidal Au nanoparticles were arrayed on a DNA self-assembled scaffold. The DNA scaffolding consisted of a two component system with one ten base pair oligonucleotide. Sequences used were Tet1.5 d(5'-GGGGTTGGGG-3') and TM1-6DSP d(5'-GGGGTT\*GGGG-3') with the \* marking the site of a disulfide modified thymine nucleotide to attach the Au nanoparticles. Thermal self-assembly of the of the two oligonucleotides results in a non-Watson and Crick scaffolding known as the G-wire which was then decorated with the Au nanoparticles at a organic/aqueous interface. PAGE assays, TM AFM data, and TEM analysis show successful G-wire formation and subsequent decoration of the resulting G-wire with Au nanoparticles. These results demonstrate the use of DNA to coordinate a Au nanoparticle moiety having a potential application in molecular electronics.

*Matt Gorman*

## **FISH COMMUNITIES VERSUS WATERSHED USE AS DRIVERS OF ALGAL ABUNDANCE IN SHALLOW LAKES**

*Faculty Collaborator: Dr. Kyle Zimmer*

Past research has shown that nutrient loading from human activities in the watershed can influence the abundance of algae in deeper lakes. However, the strength of this relationship has not been tested in shallow lakes. We measured turbidity (an index of algae abundance) in 18 shallow lakes in western Minnesota during the summer of 2004 and 73 shallow lakes during the summer of 2005. We also sampled the fish communities in each lake to determine the type of fish community present, or whether the lake was fishless. Lastly, we measured the percentage of land used for agriculture in a 500 meter buffer surrounding each lake. Data analysis using a model-selection approach showed that the presence/absence of fish explained 29% of the variance in algal abundance, and was 19 times better supported by the data compared to the proportion of the surrounding landscape used for agriculture. Our preliminary findings for the 18 lakes we sampled during the summer of 2004 indicate that management of Minnesota's shallow lakes should expand beyond the current focus of anthropogenic effects on watersheds to include the management of fish populations within these systems. Installation of culverts and ditches that connect shallow lakes and increase the distribution of fish will likely influence the water quality characteristics of these ecosystems.

*Nathan J. Greiner*

## **OPTIMAL ROUTING OF A SAIL BOAT IN STEADY WINDS**

*Faculty Collaborator: Dr. Mike Hennessey*

From crossing an ocean to modern day sail boat races, people have always been looking for the quickest way to get from one point to another. By applying concepts of calculus of variations and a numerical ordinary differential equation solver, this research project strives to find an optimal route for a sail boat through a steady wind field with constant direction but varying speed.

This project is a continuation of a research project Dr. Hennessey took on where he attempted to find the optimal route of a sail boat through a steady wind field with the speed of the wind being constant and the direction varying with position.

The dual simulation to Dr. Hennessey's previous work (this project) pertains to a sail boat traveling down the center of a channel with steady winds, and this sail boat wants to get to a point on the shore down stream in the minimal time possible. As in many fluid mechanics, the flow of a fluid is slower at the edges than in the center, as is the case in this simulation. There is a linear decrease in the speed of the wind in the center of the channel to a smaller speed at the shore of the channel. This project will apply many different methods to attempt to find the minimum time route including simple integrals, Using derivatives to find a minimum, and finally using calculus of variations to find the optimal smooth curve through the given wind field.

*Katy Hanson and Ben Bauer*

## **SYNTHESIS AND SPECTROSCOPY OF IRIIDIUM COMPLEXES AS POTENTIAL ORGANIC LIGHT EMITTING DIODES (OLEDS)**

*Faculty Collaborator: Dr. David Boyd*

Organic Light Emitting Diodes (OLED) have been investigated for more than a decade. Recently digital camera and cell phone screens have been created using OLED technology. Prototype televisions and computer screens have been created but not sold. Our research investigates Iridium compounds as potential OLEDs because of their known emission at room temperature. Many different ligands have been investigated to encourage Iridium to donate its electrons; which is required for light emission. Currently, we have yet to observe an emission from any of the observed complexes but we plan to change the ligands bound to the Iridium atom.

*Chelsi D. Harrell*

## **DETERMINATION OF REDDENING AND EXTINCTION DUE TO DUST IN TULLY GALAXY CLUSTERS**

*Faculty Collaborator: Dr. Joshua G. Nollenberg*

Existing observations suggest that rich galaxy clusters are largely dust-free, but smaller galaxy groups may have dust. We have created a technique that will determine the degree of reddening or extinction due to substantial amounts of dust in nearby moderately rich and poor galaxy clusters. We are comparing the colors and magnitudes of background APM galaxies located on the same sight-line as foreground Tully galaxy clusters which may contain dust. The sizes of the 371 Tully test positions range

from  $\approx 0.6$  to  $\approx 36.1$  arcmin and distances range from 0.1 to 48.6 Mpc. An extension of our analysis will allow us to determine the distribution of the dust (uniform, non-uniform, or clumpy). The research may also then be applied to any and all sets of galaxy clusters or groups which are of two-color galaxy catalogs.

*Chelsi D. Harrell*

## **GALAXY-QSO CROSS-CORRELATIONS BETWEEN SDSS GALAXIES AND 2DF QSOS**

*Faculty Collaborator: Dr. Joshua G. Nollenberg*

This project deals with the angular correlation between galaxy clusters and quasars (light sources) on the sky. This correlation is thought to be due to gravitational lensing. Gravitational lensing in this context is the idea that gravity from a galaxy cluster located between our line of sight and a distant quasar (QSO) distorts the path of light emitted by the QSO, thus causing a shift in the position of the QSO on the sky. We measure the magnitude of the effect using QSO-galaxy cluster cross-correlations. Cross-correlations measure how often QSOs are near galaxies in comparison to how many we would expect from a random sample on the sky. A long standing problem is that the amount of QSOs measured near galaxies far exceeds the amount we would expect from the classic model, which assumes a standard linear collapse for gravitational interacting material in the universe.

One source of the discrepancy could be due to systematics within individual data sets. I have worked toward resolving this discrepancy by investigating systematics such as selection effects in galaxy and QSO catalogs. I have compiled a computational code which performs an analysis of different data sets and uses a variety of masks. This involves performing the analysis to the same portion of the sky under explicit selection effects. I then compared the results with those from other studies that have used different catalogs to compare the systematics. We should yield similar results compared to other catalogs as long as the QSOs are selected from the same brightness range and all systematic effects are small. With future applications of this computer code we will be able to determine the magnitude of the effect that systematics play in regard to the discrepancy.

*Anja Holter*

## **ARCHAEOLOGICAL SURVEYING IN LORON (POREC), CROATIA: SEARCHING FOR STRUCTURES OF A ROMAN MARITIME VILLA**

*Faculty Collaborator: Dr. Vanca Schrunk*

Land transformation occurred in ancient Istria due to the expansion of the Roman Empire, most prominently between the reigns of Caesar and Augustus. The Romans established power through military intervention, which oversaw landscape transformation and veteran colonization. The colonies of Parentium and Pola (modern Porec and Pula) were examples of the dramatic shift from rural to urban, where Roman structures and monuments formalized the landscape. The urbanization of Porec and Pula included the colonization of high-ranking military veterans, who used their plots of land to build maritime villas. Many maritime villa sites that have been excavated along the Istrian coast have shown luxurious architecture, mosaics, and decorative sculptures.

One such villa was located on a large senatorial estate at Loron near Porec, which produced amphorae and terra sigillata from the 1st to the 4th century C.E. In the summer of 2005, our archaeological research included ground and gradiometric (magnetometric) surveys, in order to

document unexcavated archaeological resources for future research and preservation. The gradiometer measures abnormalities approximately up to a meter under the surface. These anomalies are seen as magnetic noise. The data readings can show overall trends in the landscape, such as plowed areas, the possibility of walls, or other structures, or a buildup of other geologic anomalies. This method is particularly helpful to archaeologists in locating structures without the high cost of excavating. We dug a test trench to check our findings by gradiometry where we expected remains of the villa's residential complex.

*Kumiko Ijichi*

## **EFFECT ON RUNNING WHEEL IN INVESTIGATION OF CIRCADIAN RHYTHM IN C57BL/6J**

*Faculty Collaborator: Dr. Dwight Nelson*

Mammalian circadian rhythms of physiology and behavior are thought to be controlled by the suprachiasmatic nucleus located within the anterior hypothalamus. C57BL/6J mice are a "lab mouse" and apparently breeding for large number of mice over many generations has resulted in an animal that does not possess responses to photoperiod or day length (which might reduce reproductive activity in some photoperiods). Our lab has recently been examining the influence of day length on basic activity rest. Initial experiments suggested that C57BL/6J mice do alter their circadian system in response to changes in day length (such as changing from L:D 12h:12h to L:D 18h:6h. Additional data from other labs suggested that access to a running wheel and the intense activity associated with a running wheel caused some changes in photoperiodic responses in other animals. In my experiments we are following up on this initial finding with C57BL/6J mice. Since prior experiments have demonstrated that running wheel activity did not significantly alter the circadian system in mice, we hypothesized that running wheel would have no effect in terms of endogenous length of day (Tau), length and amount of activity (alpha), and the magnitude of steady state phase shifts due to light stimulation.

In our experiment, 24 male C57BL/6J mice (12 had wheel access, and the rest didn't) were entrained in 6:18 LD cycle for one month, and released into constant darkness (DD). On 7th day of DD, the light pulse (~500 lux) was given for one hour to see the response to the light stimulus and shift their circadian time. To collect data, we utilized infrared camera device to track mouse activity during entire experiment. In a second phase of the experiment the entrainment LD cycle altered to 18:6.

We found that wheel access and use did not cause significant differences in Tau, Alpha, and Phase Shift following short day light entrainment (LD6:18), and also didn't show any effect on Alpha and Phase Shift in LD18:6. However, Tau following long day treatment became significantly shorter in wheel group (mean = 23.27 and mean = 23.65). We speculate that intense running activity may have an influence on Tau in longer light entrainment due to the intensity of running activity giving some alteration to multiple (perhaps non-SCN) oscillators which are still unknown. In future research, we could duplicate this experiment in different photoperiod as well as track mice activity and analyze what activity they actually engage in with / without wheel access.

*Andrea Johnson*

## **DOES THE SMALL G-PROTEIN RAP1 HAVE AN EFFECT ON THE MAMMALIAN CELL CYCLE?**

*Faculty Collaborator: Dr. Jennifer L. Cruise*

The small G-protein Rap1 has been linked to a number of signaling pathways involved in the cell cycle, but its exact role is unknown. Prior research has demonstrated that endogenous Rap1 expression is regulated in a cell-cycle-dependent manner; more specifically, it is down-regulated prior to the onset of DNA synthesis. This led to the hypothesis that Rap1 activity regulates the cell cycle. We are testing the predictions that increasing active Rap1 in cells would decrease DNA synthesis and cell proliferation, and decreasing active Rap1 would increase DNA synthesis and cell proliferation, using mammalian MRC-5 (fibroblast) and MDCK (epithelial) cells. These cells were transfected transiently or stably with either an activated Rap1 gene, a control plasmid, or a dominant-negative Rap1 gene. The cell cycle was then monitored through flow cytometry, BrdU labeling index assays, and cell counts using a hemacytometer. Flow cytometry experiments and BrDU labeling studies thus far have suggested that active Rap1 reduces baseline DNA synthesis in both cell types. Flow data also indicated that it reduces responses to growth factor stimulation. Dominant-negative Rap1 appears to have the opposite effect, increasing DNA synthesis in response to growth factors in MDCK cells. BrdU labeling index assays in MDCK cells suggest that dominant-negative Rap1 increases baseline DNA synthesis. In addition, MDCK cell counts reveal a higher overall proliferation rate in cells expressing dominant-negative Rap1, and a lower rate in cells expressing increased active Rap1, when compared to controls. This preliminary data supports our hypothesis that Rap1 has a regulatory effect on the mammalian cell cycle, but further, more specific experimentation is necessary to confirm our results. In particular, we seek to use immunofluorescent labeling to track plasmid expression in transient transfections, allowing us to limit data acquisition to cells expressing the plasmids in which we are interested.

*Austin Johnson*

## **A MORE EFFICIENT SYNTHESIS OF A QUINOLINE BASED INDICATOR**

*Faculty Collaborator: Dr. J. Thomas Ippoliti*

A more efficient synthesis for 1,2,3,4-tetrahydrobenzo[h]quinolin-3-ol has been proposed and successfully completed. This compound can now be produced more efficiently and less expensively.

*Tucker F. Johnson*

## **THE ROLE OF PHOSPHATASES IN NATURE'S TIMEPIECE**

*Faculty Collaborator: Dr. Jayna L. Ditty*

Cyanobacteria are among the oldest organisms on Earth. The cyanobacterium *Synechococcus elongatus* PCC 7942 uses a circadian clock to regulate gene expression and complex biological processes as a function of time. At least three proteins have been identified that are central to the circadian clock mechanism in *S. elongatus*, KaiA, KaiB, and KaiC. Previous research has found that the phosphorylation state of KaiC protein is integral to the timekeeping capabilities of the circadian clock. Cyclic phosphorylation and dephosphorylation of KaiC has been shown to be responsible for maintaining the

pacemaker function of the circadian system. This research project investigated whether phosphatases—enzymes that remove phosphoryl groups from proteins—are important for the circadian mechanism in cyanobacteria. Genome wide homology searches identified several serine and threonine (Ser/Thr) and tyrosine (Tyr) phosphatases that may potentially play a role in the circadian mechanism. Successful mutation of the 1501 Tyr phosphatase and subsequent transformation resulted in preliminary data demonstrating either arrhythmic bioluminescence traces or low amplitude bioluminescence oscillation. Replication of these data and future growth curve analyses will determine whether this is the result of the direct influence of the 1501 phosphatase on the circadian mechanism or some indirect influence.

*Melissa Jones*

## **EXTRACTION OF GAS PHASE ANALYTES FROM AQUEOUS SOLUTIONS USING MICRODIALYSIS MEMBRANES**

*Faculty collaborator: Dr. Tony Borgerding*

The goal of our study was to develop a probe for in vivo sampling of volatile analytes. The probes were developed as a “side-by-side” design with staggered fused silica capillary. The end was inserted into a hollow regenerated cellulose microdialysis membrane (200 mm i.d.). Dialysis membranes were utilized because of their small dimensions, which allowed rapid permeation of analytes through the thin membrane walls. Typically dialysis membranes are used for extraction between two liquid phases. The probes were tested for their effectiveness in extracting ethanol from aqueous solution using a flame ionization detector (FID). Ethanol was extracted from water in less than 10 seconds, as shown by monitoring FID signals. We are utilizing the fast extraction capabilities of these probes by combining them with fast gas chromatography (GC) for the monitoring of volatile organic compounds (VOCs) like ethanol and acetaldehyde present in the metabolizing of ethanol in a biological system. We are also investigating the use of the probes to extract nitric oxide (NO), an important neurological compound, and detect using chemiluminescence.

*Matthew Jungwirth*

## **THE ORIGIN OF A SECOND-ORDER PHASE TRANSITION FOR PROS<sub>4</sub>SB<sub>12</sub>**

*Faculty Collaborator: Dr. Daniel Agterberg, University of Wisconsin, Milwaukee*

The first of two second-order phase transitions of PrOs<sub>4</sub>Sb<sub>12</sub> under a constant magnetic field has been successfully modeled using MatLab. Previous experiments have proven the existence of two second-order phase transitions, an anomaly in nature, in the superconducting metal PrOs<sub>4</sub>Sb<sub>12</sub>. A theoretical study of these transitions would reveal their properties for use in further research or industry. Derived from the Ginzburg-Landau free energy expansion, the macroscopic wave function describing the system includes terms for a constant magnetic field, to match the induced field from moving electrons in a metal. A MatLab program solves the wave function to find the eigenvalues under low field conditions, where coupling of spin and orbit for the electrons appears as cubic symmetry, and under high field conditions, where spin and orbit are decoupled appearing as spherical symmetry. The cubic symmetry is weakly broken by combining two closely related components and increasing the field, forcing the symmetry of the system to be spherical. This reveals the properties of the transition itself, the details of which are compiled in a later project.

*Brian Kjersten*

## **DEVELOPMENT OF A GUIDANCE ALGORITHM FOR AN AUTONOMOUS ROBOT**

*Faculty Collaborator: Dr. Chris Greene and Dr. Jeff Jalkio*

The University of St. Thomas chapter of the Institute of Electrical and Electronics Engineers has built a robot to be used to experiment with robotics. The robot had reached a stage of development in which it is possible to create a guidance algorithm to control it. This is a high-level algorithm in the MATLAB language that calculates a near-optimal path between two points in a room, considering the location of obstacles. We determined that it is effective to represent a map as an array of numbers, and save maps as images. Good paths can be found quickly using a “square value” method.

*Abraham Langseth*

## **THE USE OF 2-PHOTON CONFOCAL MICROSCOPY TO ASSESS DAILY RHYTHMS OF MPER1 PROTEIN EXPRESSION**

*Faculty Collaborator: Dr. Dwight Nelson and Dr. Paulo Kofuji (University of Minnesota)*

All mammals have a major circadian clock which controls daily timing of physiology and behavior within the suprachiasmatic nucleus (SCN) which is located in the hypothalamus just above the optic chiasm. The neurons in the SCN express genes involved in controlling the clock. The products of these genes are translated into proteins, and these proteins interact and eventually turn off their own transcription. This negative feedback cycle and the subsequent degradation of the proteins to release the inhibition takes approximately twenty-four hours, and is the basis for daily rhythms of physiology and behavior. Our laboratory has acquired a genetically modified mouse from Vanderbilt University which has the gene for green fluorescent protein (GFP, which fluoresces when excited) coupled to the circadian gene Period 1, both controlled by the Period 1 promoter. The product of these genes is a fusion protein, which functions normally in the cell and plays an important role in the circadian clock mechanism just as wild-type Period 1 protein would. Our experiments seek to quantify the relative amount of Period 1 protein produced in neurons of the SCN at various times during the circadian day through the use of 2-photon confocal microscopy. Since expression of the GFP gene and Period 1 gene are driven by the same promoter, the amount of GFP in the cells, and therefore the amount of light they give off, is directly proportional to the amount of Period 1 protein present at that time. Our initial project goal is to incubate SCN neurons for 12 – 24h in vitro while recording the GFP fluorescence. Future experiments will look at the rhythms of subpopulations of neurons within the SCN and the factors that can change the expression of Period 1 protein, such as light reaching the eye of the mouse during the subjective night.

*Nicole Lanie and Amanda Thompson*

## **GEMS (GIRLS EXPERIENCING MATHEMATICS IN THE SUMMER) CAMP 2005**

*Faculty Collaborator: Dr. Lisa Rezac*

The University of Saint Thomas hosted its fourth annual summer math camp for high school girls from June 26th to July 1st, 2005. GEMS (Girls Experiencing Mathematics in the Summer) Camp is an opportunity for mathematically talented high school girls to explore interesting math topics not typically covered in high school math courses. The goal of this camp is to motivate high school girls in the

traditionally male dominated field of mathematics. The methods used to motivate the participants were based on structured activities, group work, interacting with women in mathematics, and fun.

Two mini-courses were presented to the participants in an interactive and lecture based environment. These two mini-courses featured geometry, iterations, and fractals as the core components. As a compliment to these courses, the participants prepared project presentations on a topic of their choice. With the guidance of the staff, the participants underwent a hands-on research experience that required self-motivation and creativity. Additional activities included a mathematical field trip to the Science Museum, a discussion panel of female speakers from the field of mathematics, and recreational activities.

Amanda Thompson and Nicole Lanie co-directed this program as camp counselors. Dr. Lisa Rezac and Dr. Jeffery McLean are faculty in the Department of Mathematics who led the mini-courses. Amanda worked closely with Dr. Rezac on preparing the material for the mini-course Iterations and Fractals. She researched the basics of Mandelbrot and Julia sets before the camp and during the camp prepared a mini-lecture on spherical geometry. Nicole worked closely with Dr. McLean on preparing materials and lectures for the mini-course Going Round in Circles. She also presented mini-lectures on patty paper and modular arithmetic.

*Shirdi Letran*

## **OPTIMIZING TRANSFECTION CONDITIONS FOR SELECTED MAMMALIAN CELL LINES**

*Faculty Collaborator: Dr. Jennifer Cruise*

Transfection is a technique that introduces foreign DNA into a cell, which results in changes in a cell's protein production. Using the lipofection transfection method, we transfected eight different cell lines with a bacterial plasmid called GFP. This plasmid caused the cells to express a green fluorescent protein, visible under UV light, allowing us to find each cell line's optimal transfection conditions. In order to find the optimal conditions, we varied the ratio of Lipofectamine 2000 reagent to DNA, as well as the presence or absence of serum. We also monitored cell toxicity and GFP expression by fluorescence microscopy. We discovered that a ratio of 0.5 to 1.0 microliters of lipofectamine to 1 microgram of DNA gave optimal results for MDCK, 3T3, A7r5, EcR-CHO, HEK 293, MrC-5 and H1299 cell lines. McF-7 cells required a 0.25 microliter to microgram ratio for optimal conditions. With our results, we are now able to transfect cells in a more efficient manner, using the required minimum amount of lipofectamine reagent while avoiding toxicity and maximizing the number of cells expressing a desired protein.

*Jennifer Lombardi*

## **DIGITAL IMAGING**

*Faculty Collaborator: Dr. Michael O'Donnell*

With the advancing technologies that surround us, the world of communication has become a landscape of change. Preparing for it requires a constantly growing set of skills and expertise, both in using the technology and in understanding how best to apply it.

As the industry advances, the very nature of how the media are perceived exists in a state of flux. While the idea of understanding all the ways in which these changes are occurring is a daunting one, I

spent the past semester diving into the world of the Digital Image in an effort to harness some of this new technology for myself.

There were two sides to this independent study. On one end of the spectrum, I was analyzing the effects of the Digital Image on society, and vice versa. The photograph has always held an inherent power in the world of information, and new technologies have had a variety of effects on that power.

The new ease with which an image can be manipulated, the speed of the digital “darkroom”, and the size limitations of new digital technologies are all examples of some of the sources of these effects. My research focused on trying to understand these changes and thus trying to figure out where the Digital Image fits into mass communications.

The other end involved the practical use of digital imaging technologies. I learned to take digital photos, and to edit and adapt them for a variety of uses. I did several projects over the course of the semester: a picture slideshow to be displayed via the internet, a large poster advertising an event on campus, and a couple of photo montages and manipulations.

I hope to use the skills and understanding I developed and take them further through another independent study this fall.

*Erin Lorence*

## **SYNTHESIS OF A CHROMATIC POLYDIACETYLENE WITH A LEUKOCYTE ENZYME SUBSTRATE**

*Faculty Collaborator: Dr. J. T. Ippoliti*

Leukocyte Esterase is one enzyme that is detectable in human urine and its presence indicates a urinary tract infection. The current detector for this enzyme is unstable in the atmosphere. The objective of this project is to synthesize a stable polydiacetylene sensor molecule to detect the presence of the enzyme by changing color. Currently, seven different reaction schemes have been performed in an effort to synthesize the desired sensor product. The starting carboxylic acid was converted into an acid chloride and reduced with two different reducing agents, this pathway lead to no product. A novel method using sodium borohydride and iodine produced an unknown compound with an NMR similar to the alcohol; however, other reaction properties conflicted with the NMR data. Only the aminoethanol alcohol has a promising future to yield the final product. More trials with the aminoethanol alcohol will be needed to test its possible success.

*Rachel Lundeen*

## **ANALYTICAL IDENTIFICATION AND CHARACTERIZATION OF PAHS IN AQUEOUS ENVIRONMENTS BY MEANS OF FAST EXTRACTION AND AROMATIC SELECTIVE LASER IONIZATION DETECTOR (ARSLID)**

*Faculty Collaborator: Dr. Anthony Borgerding*

Characterization of the aromatic selective laser ionization detector (ArSLID) by means of a fast extraction injection system was conducted. Well-known environmental pollutants at low concentrations called polycyclic aromatic hydrocarbons (PAHs) were screened using the ArSLID. Several experiments gave calibration data that was effective in characterization and identification of PAHs using the ArSLID at concentrations ranging from 0.05  $\mu\text{M}$  to 5000  $\mu\text{M}$ . Calibration results obtained through this study show

increased sensitivity and selectivity of the ArSLID to aromatic compounds without generating ionization signals from non-aromatic compounds or solvents. The fast extractor allows for rapid analysis by bypassing unnecessary chromatography, and due to the simplistic nature of the injector design, screening of PAHs can be done in less than 5 seconds. Concentration limitations are beginning to be identified, ultimately leading to potential determinations of concentration ranges of different types of aromatic compounds. Novel results were seen with previously undetected higher boiling point compounds such as benzenanthracene (boiling point 437.6 °C) at concentrations of 0.0005 µM (or 0.5 nM). Standard errors of slope (range from 3.64149E-06 to 0.001124567) were calculated from each compound's linear regression analysis equation indicating that the smaller the standard errors of slope, such as dichlorobenzene at 3.64149E-06, the more precision and certainty the data points correlate to the linear regression line. The relative sensitivity of the ArSLID to that particular compound is then based on the slope of the calibration equation assuming a low standard error of slope.

*Christian R. Lytle*

## **SIMULATION OF THE EFFECTS OF MULTIPLE-PLANE GRAVITATIONAL LENSING ON THE GALAXY-QUASAR ANGULAR CROSS-CORRELATION**

*Faculty Collaborator: Dr. Joshua Nollenberg*

Angular cross-correlations between galaxies and high redshift ( $z > 2$ ) quasars have been linked to a gravitational lensing effect known as magnification bias, which affects visual sky density and apparent brightness of the lensed object. Current theoretical models for galaxy-quasar cross-correlations predict magnitudes far below observationally measured magnitudes. We are attempting to resolve this magnitude discrepancy by a computational simulation of the effect of several gravitational lensing planes on a light ray. We are currently testing Monte-Carlo code which simulates a single lens of  $10^{14}$  solar masses. This will soon be extended to several lensing planes. We have calculated strong and weak Einstein deflection angles for light rays impacting our lens plane within a 5 megaparsec radius of the lens. Once we receive results from the fully three-dimensional multiple plane simulation, we will compare these with the integrated cross-correlations calculated for linear, fully-evolved non-linear, and quintessence models of mass distribution evolution. Resolution of this discrepancy will assist in efforts to test general relativity on large scales and refine mass distribution theories.

*Leo McNamara*

## **PHOTOPERIOD-INDUCED CHANGES IN THE MOUSE CIRCADIAN PACEMAKER**

*Faculty Collaborator: Dr. Dwight Nelson*

As the day length changes from season to season, the behavior and physiology in many organisms adjust to the changing light durations. In many mammals, a number of changes in both behavior and physiology occur as seasonal adjustments to changing environmental conditions. Examples of these 'photoperiodic' changes include coat color, activity levels, reproductive system changes, metabolic changes, even hibernation. Many of these changes are caused by seasonal changes in the secretion of pineal melatonin. We have been studying changes in the mouse circadian system that are associated with different durations, or photoperiods. In particular we have been measuring the effect of photoperiod on duration of activity, free-running period, and photic responsiveness.

C57BL/6 mice entrained to different photoperiods showed changes in several functions of the circadian system including free-running period, duration of activity, and photic responsiveness. Mice entrained to 17 hours of light per day displayed a compressed duration of activity. On average they were active 11.6 hours (SEM = 0.60h) per day rather than 14.9 hours (SEM = 0.58h) for mice that were entrained to a photoperiod of seven hours of light per day. Mice entrained to long days also displayed a free-running period 23.56 hours (SEM = 0.03h). This was significantly shorter than the 23.89 hour (SEM = 0.04) photoperiod of the mice entrained to long days. These effects persisted for at least 56 days after mice were released into constant conditions.

These results are significant because they suggest that some circadian changes in behavior and physiology are a direct function of photoperiod – rather than changes mediated by pineal melatonin than the pineal gland. These results are also intriguing because they open the door to ideas the possibility that day length may influence the behavior and physiology even in animals that have not been thought to be ‘photoperiodic.’

*Matt Moen*

### **NOVEL SYNTHESIS OF (-)-“WINE LACTONE” IN RACEMIC AND ENANTIOMERICALLY PURE FORM**

*Faculty Collaborator: Dr. J. Thomas Ippoliti*

Two synthetic routes were developed in an attempt to synthesize (-)-“Wine lactone” in a more efficient and less costly manner. One synthesis was developed to allow for the formation of “Wine lactone” in racemic form (Scheme 1). A second synthesis was attempted in order to form enantiomerically pure (-)-“Wine lactone” (Scheme 2). In Scheme 1, the kinetic enolate of 3-methyl-2-cyclohexen-1-one was formed using lithium diisopropylamide; whereby, alkylation was attempted using various alkylating groups. Alkylation with iodoacetic acid gave 2-(4-methyl-2-oxocyclohex-3-enyl) acetic acid, however, purification was unsuccessful. Alkylation with ethyl bromoacetate was also attempted. This resulted in the formation of pure ethyl-2-(4-methyl-2-oxocyclohex-3-enyl) acetate. Reduction with sodium borohydride and methylation with iodomethane were then attempted as the final steps in synthesizing racemic “Wine lactone.” Scheme 2 utilized a 6 step synthesis to obtain enantiomerically pure (-)-“Wine lactone.” Thus far, progress has been made in the formation of both racemic and enantiomerically pure “Wine lactone.”

*Adine S. N. Momoh*

### **THE NEED FOR INTERNATIONAL ENVIRONMENTAL LAW: AN EXAMINATION OF THE RATIFICATION OF THE KYOTO PROTOCOL BETWEEN THE UNITED STATES AND CANADA**

*Faculty Collaborator: Dr. Susan J. Marsnik*

Global climate change, the increase in the average temperature of the atmosphere, oceans, and landmasses of Earth, is a global problem. Although most countries admit that global warming is occurring and are working towards protecting and restoring the environment, nations frequently disagree about what to do to ameliorate the situation. The lack of agreement concerning this issue is

illustrated by national responses to the Kyoto Protocol to the United Nations Framework Convention on Climate Change. In order for the Treaty to be enforced, the Protocol had to be ratified by 55 industrialized nations responsible for at least 55 percent of carbon dioxide emissions. The United States alone is responsible for 35 percent of the carbon dioxide emissions; thus, the involvement of the United States was crucial to the initial enactment of the Protocol. However, in March 2001, President George W. Bush announced the United States' formal withdrawal from the Kyoto Protocol. Since the Canadian economy is strongly linked to that of the United States, the United States' withdrawal from the Protocol was one of the biggest factors that increased the risks and uncertainty associated with Canada's implementation costs of the Protocol. Despite these concerns, Canada ratified the Kyoto Protocol. This report has two main objectives. The first objective is to describe the Kyoto Protocol while assessing the difficulty countries have faced when trying to implement the Kyoto Protocol's greenhouse gas emission commitments. The second objective is twofold. The first part of the objective is to show that the United States' participation in the Kyoto Protocol will not guarantee the Protocol's ultimate success. The second part of the objective is to show that it is no longer necessary for the United States to ratify the Kyoto Protocol. Both the first and second objective of this report require examination of the economic and legal impact of the Kyoto Protocol within the United States and Canada.

*Austin Nelson*

## **MODELING AND PREDICTING CHAOS: A STUDY IN NON-LINEAR DYNAMICS**

*Faculty Collaborator: Dr. Marty Johnston*

By definition, one might be quick to claim that it is impossible to model and predict the motion of a "chaotic system". Indeed one could spend a lifetime trying to predict the behavior of a chaotic system without success. However, chaotic motion is governed by the same physical laws as periodic motion, and when examined from the proper perspective, we find that there is an underlying order and structure that is characteristic of deterministic systems.

Our objective this summer was to model and characterize a chaotic physical pendulum with sufficient precision that we could investigate the synchronization of chaotic systems. My job was to handle the experimental side of the problem: taking data on chaotic runs, obtaining the coefficients for the equation of motion, and handling any engineering and design issues with the system. My partner, Aubrey Overson, handled the theoretical side of the problem by modeling the second order differential equation of motion.

We used two primary methods for finding a "match" between experimental and theoretical data: the Poincaré section and the bifurcation diagram. The Poincaré section shows what states of position and velocity the system is "allowed" to be in at a given phase of the driving cycle; it does not predict motion sequentially, but instead shows where the system can be at any time. The bifurcation allows us to examine which settings produce chaotic or periodic motion. By the conclusion of the summer, we had successfully matched scaling, general shape, and specific line structure between Poincaré sections and were able to match the predictions of bifurcation diagrams to experimental results. These steps will pave the way for future research in matching data for the current system, adding complexity via a magnetic dipole interaction, and ultimately investigate the synchronization of chaos.

*Maureen E. O'Connor*

## **SYNTHESIS OF BIPHASIC POLYMERS USING RING-OPENING OLEFIN METATHESIS POLYMERIZATION**

*Faculty Collaborator: Dr. J. Thomas Ippoliti*

A 7-oxonorbornene based monomer was prepared by using a Diels-Alder reaction. This monomer was then converted into a one hundred chain unit polymer by means of Ring-opening Olefin Metathesis Polymerization (ROMP) through the use of Second Generation Grubbs catalyst. The polymer was characterized using <sup>1</sup>H-NMR Spectroscopy. It was then reacted with a long fluorinated alcohol and ammonium hydroxide in order to form carboxylic acids and amide functional groups along the polar backbone of the polymer. The addition of the fluorinated chain creates a hydrophobic nature, while the functional groups on the polymer stick well to cellulose by the use of hydrogen bonding. Characterization proved to be difficult at this point, but will be done in future work.

*Rick Ollmann, Stan Busman, and Dan Everson*

## **SYNTHESIS AND TESTING OF NEW ORGANIC MEDIA DYES**

*Faculty Collaborator: Dr. J. Thomas Ippoliti*

Synthesis of a new organic media dye began with two different starting materials, 2-mercaptothiazoline and 2-methylbenzothiazole, that followed parallel reaction schemes before being brought together. Both a dialkene, and a derivatized final product were synthesized. Each was tested for UV absorbance and stability when coated on PET films. The derivatized product was synthesized to enhance desired optical properties, which were observed through several tests. In addition, both final products exhibited proper absorbance at 405 nm and proved to be stable under prolonged exposure to UV light.

*Angela Osmolak, Laura Suurmeyer*

## **SEASONAL CHANGES IN RELATIVE ABUNDANCE AND PHOSPHORYLATION STATUS OF LIGHT HARVESTING AND REACTION CENTER PROTEINS IN PINUS STROBUS AND ABIES BALSAMEA**

*Faculty Collaborator: Dr. Amy Verhoeven*

In evergreens exposed to seasonally cold environments, there is strong evidence that the light harvesting complexes of photosystem II functionally change from energy harvesting to energy dissipating centers. Here we report preliminary data from an ongoing study examining seasonal changes in relative abundance and phosphorylation status of light harvesting and reaction center proteins in the evergreens *Pinus strobus* (growing in the sun) and *Abies balsamea* (growing in sun and shade environments) in the seasonally very cold climate of Saint Paul, Minnesota. Thylakoids were isolated in summer, fall, spring and winter and western analysis of thylakoid fractions using antibodies to specific light harvesting and reaction center proteins were performed. Antibodies were tested in each conifer, and concentration curves were generated for each antibody in order to ensure that increasing protein content correlated with increased antibody signal. Phosphorylation status of photosynthetic proteins was assessed in three light environments using the conifers in order to compare with previous studies. Results of control experiments indicated that most of the antibodies will work in conifers, and there is fluctuation in

phosphorylation status of photosynthetic proteins with light intensity that is consistent with other studies. Preliminary results from the seasonal analysis indicate that the majority of the light harvesting proteins (PSI and PSII) decrease in relative abundance during winter, although winter increases in some of the Lhcs were observed (e.g. Lhcb2). Changes in the phosphorylation pattern of the photosynthetic proteins were observed in tissue collected both predawn and midday in winter relative to summer. Additionally, shade plants showed a dramatic increase in phosphorylation of photosynthetic proteins during winter, relative to summer, and relative to winter sun plants. The results are discussed in the context of specific changes in the composition of the light harvesting apparatus as a component of the reconfiguration of the photosynthetic apparatus from light harvesting to dissipating centers during winter.

*Aubrey Overson*

## **CHASING CHAOS: CORRELATION OF EXPERIMENTAL RESULTS WITH THEORETICAL SIMULATION**

*Faculty Collaborator: Dr. Martin Johnston*

Many would scoff or snicker at the idea of predicting chaotic behavior since the common definition of the word conjures up synonyms like ‘unpredictable’ and ‘disorderly’. However, with a bit of mathematical analysis and abstraction there are ways to see order and beauty in the mess. Examples of such analysis are 2D and 3D Phase Space diagrams, Poincare Sections, and Bifurcation diagrams. The goal of the project was develop a computer program written in Matlab to generate the same results as our experimental apparatus. The heart of this program lies in the integration of second order differential equation which describes our physical chaotic pendulum. The constants for the system’s equation were obtained through careful physical measurements done in parallel by my research colleague Austin Nelson. Overall, the summer relinquished encouraging results, new techniques, and intriguing problems to investigate. First, the energy scale, size, and overall shape of the Poincare Sections were strikingly similar. Secondly, the new program allowed us to predict at what frequencies and at what value for constants, chaos would occur. Thirdly, a new technique for characterization called Bifurcation diagrams was developed which allowed us to explore a great number of chaotic modes and again compare them to experimental results. Although the summer yielded many improvements, it also leaves us with more areas to explore. Looking ahead, we would like to add in magnetic field interactions into both the physical system and the computer model. We hope to not only maintain correspondence, but also explore synchronization of chaotic systems.

*Amanda Plourde*

## **THE EFFECTS OF RAP1 ON CELL SIGNALING PATHWAYS**

*Faculty Collaborator: Dr. Jennifer Cruise*

Rap 1 is a small G-protein which may act as a tumor-suppressor gene. However, most of the effects of Rap1 on cell signaling pathways are still unknown. We know from previous research that active rap decreases cell proliferation, and that it inhibits Cdc42 and Rac1, two proteins that regulate the cytoskeleton. Recent research suggests that in MDCK epithelial cells, active Rap may inhibit Akt, a protein kinase involved in cell survival, and Jnk, a protein kinase involved in cell proliferation. We found that the over-expression of active Rap in the MDCKs caused a decrease in the amount of active Jnk and

Akt. Knocking down active Rap levels had the reverse effect. Akt, Jnk, Rac1, and cdc42 are all downstream of PI3K. These results suggest that the small G-protein Rap1 may be acting at the level of PI3K regulation.

*Laurie N. Rice*

## **POSTTRANSLATIONAL REGULATION OF RAD51 OVEREXPRESSION IN TETRAHYMENA THERMOPHILA**

*Faculty Collaborator: Dr. Thomas C. Marsh and Dr. Daniel Romero*

RAD51 is a protein required for DNA repair. RAD51 is required to repair double-strand breaks during homologous recombination, a DNA repair mechanism required to maintain genomic stability. Previous research has shown constant overexpression of RAD51 has severe consequences for cell viability. Overexpression of RAD51 can lead to genomic instabilities, which may alter the interactions with tumor suppressors, such as BRCA2, and lead to hereditary breast cancers. Genomic DNA clones of constitutively overexpressed RAD51 have shown missegregated macronuclear phenotypes in *Tetrahymena thermophila*. Complementary DNA clones, while overexpressing RAD51, show a normal wild-type phenotype. This research explores the molecular basis for these varying phenotypes to broaden the understanding as to how RAD51 expression is controlled. Furthermore, this research seeks to learn how genetic instabilities become phenotypically expressed in eukaryotes as a consequence of malfunctioning RAD51.

*Benjamin Roby, Benjamin Struthers*

## **FUBAR (FILE SHARING FOR BUSINESS AND RECREATION)**

*Faculty Collaborator: Dr. Patrick Jarvis*

Client-server and peer-to-peer are the two major approaches for implementing resource sharing. Client-server implementations are quite common and include applications ranging from the print servers to web sites. Peer-to-peer applications are generally more challenging to implement but result in a more robust environment since there is no single machine in charge. Our project involved the design and implementation of a peer-to-peer file sharing application. Each peer contains a cache of files that can be accessed by any other peer via search requests. There is no limit to the number of peers and, therefore, no limit to the number of files available for sharing. This approach works well in collaborative environments where redundant document storage is discouraged.

*Janet B. Rollefson*

## **IDENTIFICATION OF TOLUENE METHYL-ACCEPTING CHEMOTAXIS PROTEINS (MCPS) IN PSEUDOMONAS PUTIDA F1**

*Faculty Collaborator: Dr. Jayna L. Ditty*

*Pseudomonas putida* F1 is chemotactically attracted to toluene in its environment, using this compound as its sole carbon source. Methyl-accepting chemotaxis proteins (MCPS) are receptors that bind

molecules, such as toluene, initiating signaling cascades which direct movement of bacteria towards or away from a chemical gradient. Two possible toluene MCP genes (3987, 4307) have been identified in *P. putida* F1. Modified capillary assays have been performed, demonstrating the chemotactic attraction of this organism to toluene in the environment. To determine the role of putative toluene MCP genes, each gene will be mutated, and resulting phenotypes will be observed through capillary assays. Gene 3987 has been PCR amplified and is in the process of being cloned into an *E. coli* cloning vector. An antibiotic resistance cassette (KmR) will then be introduced into the reading frame to disrupt gene 3987. The mutated allele will then be reintroduced in the *P. putida* F1 genome through transformation and double recombination. The same process will be used to mutate gene 4307, and phenotypes of each mutant determined.

*Brandon Rowekamp*

## **FRACTAL MODELING AND THE STOCK MARKET**

*Faculty Collaborator: Dr. Chehrzad Shakiban*

Fractal geometry, in contrast to the more familiar geometry of circles and other simple geometric shapes, is a geometry which describes sudden changes and infinite complexity. Fractals are so complex that their dimensions are between two numbers, so for example a fractal curve would have a dimension between 0 and 1. Another important feature of fractals is that of self-similarity which, roughly speaking, means that the fractal is composed of pieces that resemble itself, only smaller. Though fractals seem to be a mathematical curiosity at first, a large number of applications for fractals have been found in diverse fields. In particular, the stock market seems to have a fractal nature, since it is characterized by constant and sometimes drastic change. Additionally stock market data taken over long periods of time resemble data taken over shorter periods of time, suggesting self-similarity. In this project we give concrete reasons to believe that the stock market follows a fractal pattern (such as approximations of stock market dimension) and then present various modeling techniques that use fractals to model the stock market.

*Krista Sandford*

## **RAMSEY COUNTY RESIDENTIAL PROPERTY VALUES AND ENVIRONMENTAL AMENITIES, 2004**

*Faculty Collaborator: Dr. Paul Lorab*

Environmental amenities can promote growth by attracting high wage workers, retirees and tourists. Past research demonstrated that the presence of national parks is associated with population growth in the Rocky Mountains, while the presence of wilderness is associated with economic diversification and employment growth in Vermont. While most studies on the economic value of amenities focus on federal lands and regional economies, this research explores the relationship between real estate values and environmental amenities in Ramsey County. It hypothesizes that proximity to lakes and parkways is positively and significantly correlated with relatively high residential property values.

This analysis was conducted using ArcGis 9.1. Multiple data sets were used, including the 100k Rivers and Lakes layer from the Minnesota DNR and the most recent versions of the Regional Parcel Datasets and the Generalized Land Use for the Twin Cities Metropolitan Area from MetroGIS. After controlling for variables including housing type, housing density, square footage and year built, Pearson's

Correlation Coefficient was used to quantify the relationship between property values and distance from lakes and parkways.

This analysis demonstrates that, in addition to being valuable for open space and recreational opportunities, lakes and parkways in Ramsey County enhance the value of adjacent housing stock. Associated benefits may include a strengthened tax base, relatively stable urban neighborhoods, and may also suggest one way for urban areas to limit the loss of high income households to the suburbs.

*Emily Schupp*

## **THE MAKINGS OF A SAINT: PAINTINGS OF TERESA OF AVILA'S MYSTICAL EXPERIENCES AND THE PROGRAM OF THE COUNTER-REFORMATION CHURCH**

*Faculty Collaborator: Dr. Susan V. Webster*

St. Teresa of Avila lived and worked during the Counter-Reformation in Spain (1515-1582). She dedicated herself to the Church at an early age, but her true conversion came in 1554 when she began to experience a series of mystical apparitions. These visions eventually led Teresa to begin her own program of reform within the Carmelite order and to begin writing about her experiences. Although Teresa's life and her mystical doctrine has been the subject of much scholarly attention, particularly in the last two decades, no one has undertaken a systematic study of the visual images that represent her mystical visions.

The research in "The Makings of a Saint" examines the paintings of St. Teresa and her visionary experiences in Counter-Reformation art created by Spanish and Mexican artists in an attempt to demonstrate the role and significance of painting as a physical affirmation of the validity and sanctity of Teresa and her visions. Since nearly all of the paintings of Teresa are representations of her religious visions, the events that inspired these images are examined in conjunction with formal and iconographical analyses to determine how her mystical experiences were physically translated into pictorial form. To fully understand these images, the reasons for the commission and production of these paintings were also explored.

*Zach Simmons*

## **AHARONOV-BOHM EFFECT: MICROSCOPIC COILS / MACROSCOPIC ANALOGIES**

*Faculty Collaborator: Dr. Marty Johnston and Dr. Herman Batelaan, UNL*

The Aharonov-Bohm (AB) effect is a much debated phenomena arising from quantum mechanics which obliges us to reinterpret electromagnetic theory. The AB effect, specifically the magnetic effect, predicts that coherent electrons passing on either side of an infinitely long solenoid, i.e. in the region of zero magnetic field, will still experience a phase shift because of the magnetic vector potential surrounding the coil. This is significant as it would establish the magnetic vector potential as more fundamental than the magnetic field. This is interesting because in classical EM the E and B fields are seen as more fundamental as the Lorentz force acts through them. However, there are opponents to this quantum interpretation, namely Boyer, which argue that the effect can be explained within classical EM theory as resulting from a force.

This work consisted of two tasks relating to an experiment that would definitively determine if the effect was a quantum phase shift or a quasi-classical force: 1) devising a method to produce  $\sim 50 \mu\text{m}$

diameter solenoids, and 2) evaluating macroscopic AB analogy experiment ideas that would demonstrate the force nature of the phenomena.

*Matt Sindt and Anja Holter*

## **ROMAN MILITARY POWER: CONTROLLING OTHER'S TERRITORY AND MANPOWER**

*Faculty Collaborator: Dr. Vanca Schrunk*

The conquest of Istria, like many other areas, was a gradual process of interference, alliances, conquests and finally acculturation and assimilation. The Roman presence in Istria started as a response to organized piracy, which was rampant in the Adriatic at the time. The true Roman conquest of the peninsula occurred as a result of the Second Histrian War of 178-177 BCE. The second Histrian war erupted in 178 when the Histrians took up arms under the leadership of Epulon. Of all the major towns in the Histrian League only Nesactium dared to challenge the Roman onslaught. The Romans invested the city and took it after a long siege full of actions and counteractions. The final result was the death or enslavement of all the city's inhabitants. Before the Romans could take the town King Epulon took his own life.

The Roman presence in Istria was not significant for at least another one hundred and thirty years after the second Histrian War, when veteran colonies were set up primarily by Julius Caesar and his successor, Augustus during and after the Civil Wars. The result of the colonization was that atop the remnants of old Histrian hillforts, new cities of several thousand Roman soldiers were formed. Inter-marriage led to assimilation to some extent, but more prominently, a blending of Italian and Histrian customs and beliefs. The Army was central to the Roman expansion and control over a vast expanse of land. In addition to subduing conquered peoples, it supplied slaves for the plantations, built bridges, aqueducts and fortifications.

*Jill M. Spude*

## **INTERMOLECULAR INTERACTIONS IN THE BRIDGE-FLIPPED ISOMERS OF A BENZYLIDENEANILINE**

*Faculty Collaborator: Dr. William H. Ojala*

Benzylideneanilines, organic compounds having the formula  $\text{Ar-CH=N-Ar'}$  (where Ar = aryl) have useful anticancer and anti-inflammatory properties and are often used in stereoselective organic synthesis. They also show high potential for co-crystallization, which is a way to make new solid materials. Pairs of benzylideneanilines that we have designated "bridge-flipped isomers" differ only in the orientation of the chain or bridge of atoms connecting the two aryl groups, so that the isomerism is  $\text{Ar-CH=N-Ar'}$  vs.  $\text{Ar-N=CH-Ar'}$ . The respective crystals of benzylideneaniline bridge-flipped isomers can have very different properties (such as color or melting point) even though their molecular structures are quite similar. Our overall goal is to prepare new solid materials in which these properties can be controlled or modified; this will be done by co-crystallizing various proportions of bridge-flipped benzylideneaniline isomers to obtain both isomers in the same crystal. The chances that this will occur are enhanced if the bridge-flipped isomers have the same molecular packing arrangement in their respective crystals, so we are preparing a series of benzylideneaniline bridge-flipped isomeric pairs and determining their crystal structures in search of these isostructural pairs that would be especially suitable

for co-crystallization. We have recently discovered our first such pair of isostructural bridge-flipped benzylideneanilines: 2-trifluoromethyl-N-(2-methylbenzylidene)aniline and 2-methyl-N-(2-trifluoromethylbenzylidene)aniline. Unlike the only other isostructural bridge-flipped benzylideneanilines of which we are currently aware, 4-chloro-N-(4-methylbenzylidene)aniline and 4-methyl-N-(4-chlorobenzylidene)aniline, our compounds form ordered crystals, crystals in which only one orientation of the molecule is observed at a given site in the crystal. In future work we will attempt to obtain co-crystals of our two isomers by dissolving them together in an appropriate solvent and growing crystals by the slow evaporation of solvent from this mixture.

We thank the Petroleum Research Fund of the American Chemical Society for financial support of this research project.

*Jeremy Stubblefield*

## **RESPONSIVENESS OF MPER2 DEFICIENT MICE TO VARYING PHOTOPERIODS**

*Faculty Collaborator: Dr. Dwight Nelson*

The mammalian circadian clock is thought to be controlled by the cycling expression of “clock” genes. Among these are mPer1, mPer2, and mPer3. These genes are typically found in wild-type mice and their resulting period is about 23.7 hours. Mice deficient in the mPer2 gene (mPer2  $^{-/-}$ ) display a period of about 22.9 hours and a high percentage of arrhythmicity in total darkness.

In the original study, mPer2  $^{-/-}$  mice were reared in a 24h LD cycle and given light pulses to determine the responsiveness of the circadian system to light. Results revealed that mPer2  $^{-/-}$  mice became arrhythmic more often than normal mice and often this arrhythmicity was associated with the light stimulation. In addition, mice appeared to display two types of circadian phase shifts: large shifts (as large as 6 h) and smaller, more normal shifts (~1.5 h).

A follow-up pilot experiment was conducted to test whether a rearing in 23h LD (more closely matching the endogenous period for these mice) would normalize the abnormalities. Results suggest that similar abnormalities were observed despite differences in rearing.

Finally, we are conducting a pilot study to test the ability of the mPer2  $^{-/-}$  mice to entrain and respond to different photoperiods. We are exposing the mice to photoperiods ranging from 23h equivalents of L:D 12:12 to L:D 20:4. Preliminary data suggest that mPer2  $^{-/-}$  mice are able to entrain and respond to different photoperiods in a fairly normal manner.

mPer2 mutant mice have a different endogenous circadian period, responsiveness to light, and a somewhat higher degree of arrhythmicity. These differences do not appear to be associated with differences between the period of LD and animal. They also do not appear to significantly alter the ability of mice to entrain and alter their circadian system in response to changes in photoperiod.

*Sean Sweeney*

## **MUST SUCCEED, TRY TO SUCCEED, OR TRY TO AVOID FAILING: THE EFFECTS OF GOAL ORIENTATION, COMPETITION, AND COOPERATION ON MOTIVATION**

*Faculty Collaborator: Dr. John Tauer*

Imagine a teacher gives you a goal of not failing on your test. Now, imagine another teacher encouraging you to try for a perfect score on your next exam. Which goal, avoiding failure or

approaching success, will lead to higher levels of motivation? The purpose of our study was to investigate the effect of different types of goals in different contexts on intrinsic motivation.

We conducted a field study in a naturalistic athletic context, a setting rarely employed within the field of motivation. Approximately 330 participants in an instructional basketball camp volunteered to participate in the study. They were randomly assigned to one of twelve conditions in a 3 x 2 x 2 design. The conditions combined one of three contexts, competition (where a participant competed against one other camp member), cooperation (two participants working together), or intergroup competition (two participants cooperating together in competition against another team). Participants were also put in one of two goal orientations (approach or avoidance). In the approach condition, participants were instructed to try to make a certain number of free throws, whereas participants in the avoidance conditions were told to try to miss fewer free throws than this goal (e.g. make 6 out of 10 versus miss fewer than 6 out of 10). Finally participants were given one of two types of direction (controlling or non-controlling). Controlling instructions provided participants with an added emphasis on meeting their goal. This design allowed us to simultaneously examine the unique and interactive effects of goal orientation (approach/avoidance and controlling/noncontrolling), cooperation, competition, and success/failure on motivation. Intrinsic motivation was assessed using a self-report measure of task enjoyment.

Replicating previous research, preliminary results indicate that intergroup competition produced more task enjoyment than cooperation or competition. More task enjoyment was also found in participants who met their goal. Contrary to our predictions, controlling instructions actually increased task enjoyment. Results of our findings and implications for future research will be discussed.

*Paul Synhavsky*

## **CONTIGUOUS RELATIONS FOR SPECIAL FUNCTIONS AND DIRICHLET SPLINES**

*Faculty Collaborator: Dr. Patrick Van Fleet*

Special functions play an important role in various areas of applied mathematics. One of the most well known and researched special functions are Gauss' 2F1 hypergeometric functions. It has been shown that there exist contiguous relations between these functions and moments of Dirichlet splines.

Dirichlet splines are generalizations of standard polynomial splines used to approximate functions. The unique and useful aspect of Dirichlet splines is recurrence formulas of their moments are dimension-free. The initial research conducted in this project consisted of writing recurrence formulas for the 2F1 functions as moments of Dirichlet splines. For these formulas, it was possible to match them to previously defined moments. The next step was to investigate higher dimensional functions. Appell's hypergeometric functions are the 2D extension of Gauss' functions. When constructing recurrence formulas for these functions it became clear that they did not all match up to previously known moment formulas.

Initially, the goal of the research was to find patterns in the lower dimensional moment formulas to be able to generalize recurrence relations for higher dimensional special functions and eventually construct n-dimensional formulas for the Lauricella functions. However, our results from Appell's functions yielded new moment formulas, not previously known. Although this does not follow with initial presumptions, it gives way to further research and new directions of exploration in the study of contiguous relations on special functions, and their relationships to Dirichlet splines.

The poster will demonstrate how contiguous relations are applied to Gauss 2F1 and Appell's functions, and how they relation to moment formulas. There will also be detailed derivation of recurrence

equations from the moment formulas, first in the general case and then on the special functions. In addition, an explanation of interesting change of variables on Appell's F2 function from the unit cube to the standard simplex on which all the moment formulas are passed will be outlined.

*Jimmy Thielen*

### **A VERSATILE MUELLER MATRIX POLARIMETER**

*Faculty Collaborator: Dr. Adam Green*

We have constructed a Mueller matrix polarimeter that will be employed in a variety of optics experiments in the Physics Department. This device comprises two liquid crystal variable retarders and other high-quality polarization optics. We have written sophisticated LabVIEW software that controls the voltage applied to the retarders, reads light intensities from three photodetectors, manipulates two translation stages, and calculates complete Mueller matrices for any target that we place in the system. These matrices contain complete information about the sample's polarization properties.

Our polarimeter will initially be used to characterize a 50-nm diffraction grating to see if it can be employed as a high-quality linear polarizer for visible light. Such gratings have applications that range from electron interferometers to liquid crystal displays. We will also use our apparatus to characterize the polarization properties of quartz samples for the Geology Department.

*Michael Tholen, Kathryn Keller and Karen Pults*

### **ECONOMIC POWER IN ROMAN ISTRIA**

*Faculty Collaborator: Dr. Vanca Schrunk*

This study was based on an application of Michael Man's model for social power, specifically focusing on economic change in Roman Istria (a Mediterranean region of Croatia). The study provides an overview of Istria from the 3rd century BCE through the 1st century CE, while also analyzing the implications of archaeological evidence from specific sites in the region. The study looks at the effects of Roman dominance of the region on: land division, through the analysis of the remains of villas and inscriptions; agricultural production, through the remains of storage materials and production equipment; natural resources, through the location of the resources and the disbursement of these commodities throughout the region; labor, and how it relates to the previous areas. Where little archaeological evidence exists, information is compared from contemporary provinces to gain insight on change within the region.

*Stephanie Vaske*

### **PRE-CHRISTIAN JEWISH MESSIANIC EXPECTATION AND THE SON OF MAN**

*Faculty Collaborator: Dr. John W. Martens*

How did the modern Christian conception of the Messiah come to be what it is today? Starting with Christianity's roots in Judaism, this paper proposes places where ancient Jewish expectation and/or scripture passages and the Christian understanding of the "Messiah" overlap, particularly in the expected person of the 'Son of Man'. Based in the historical expectation of the Jewish people, before the influence

of Christianity, for the coming messiah, this paper seeks to ascertain common points of expectation between Christian and Jewish understandings of the “Messiah”. It follows the development of Jewish messianism from its foundations in David to later Jewish visions found mainly in the prophetic books and other apocalyptic literature. These texts are not only an important source for current understanding of the Messiah; they are a blueprint for the messianic expectation of the people around the time the books were written. The later prophetic books of Hebrew scripture are filled with visions and hopes for fulfillment of God’s promise to restore Israel by a man Judaism has by now accepted as a single, divinely appointed, “anointed one”. The emphasis on the ‘Son of Man’ along with the development of eschatology influenced all aspects of the Messiah and is the particular focus of this paper. Although the basis for the Christian interpretations can legitimately be found in these scriptures and in some sects’ messianic expectations, mainstream Judaism does not appear to have put any importance in them.

*Maria C. Wiering*

### **ST. MICHAEL’S CHURCH: THE BUILDING OF AN ICON**

*Faculty collaborator: Dr. Victoria Young*

Completed in 2005, the Church of St. Michael in St. Michael, Minnesota is the newest church in the Archdiocese of Minneapolis and St. Paul. Unusual to the Western world, the church’s design is influenced mainly by Eastern Catholic rite architecture, such as the Hagia Sophia in present-day Istanbul, Turkey. As such, the building is a visual testament to the universality of the Catholic Church. A universal design approach is also favored by the Church, one that utilizes documents such as *Built of Living Stones* (2000) and the *General Instruction of the Roman Missal* (2003) among others. However, many architects are in disagreement over the documents’ correct architectural and artistic interpretations. Traditionalists believe the church’s style should reflect the Church’s rich history while modernists argue that design should represent present or future culture. Because the Church of St. Michael incorporates both traditional and modern elements, it is destined to become a player in the contemporary debate on sacred space and its implications for the Catholic faithful. Through a reading of church documents, interviews with the makers of St. Michaels, and documenting the building itself, I evaluated the balance of not only tradition and modernity in present debate and the church’s design, but also the cross-cultural architectural and artistic notions present in this twenty-first century religious space.

*Tyler Winkelman*

### **SYNTHESIS AND TESTING OF NOVEL ANTIMICROBIAL AGENTS**

*Faculty Collaborator: Dr. Jayna L. Ditty and Dr. J. Thomas Ippoliti*

Multi-drug resistant bacteria are rapidly becoming a major concern for the health care industry. A new synthetic class of antimicrobials, known as oxazolidinones, are a promising combatant against drug resistant bacteria. Two novel oxazolidinone microbial agents were prepared via a six step syntheses, with each of the final steps utilizing high yielding “click chemistry.” One of the antimicrobials has been tested against the Gram-positive bacterium *Staphylococcus aureus*. Preliminary findings suggest the antimicrobial tested has little activity against the organism.

## **ATTENTIONAL CAPACITY**

*Faculty Collaborator: Dr. Britain Scott*

Fredrickson and Roberts (1998) found that trying on a swimsuit before taking a math test hurt women's performance but not men's. According to Objectification Theory (Fredrickson & Roberts, 1997), women's math performance suffered because their attention was divided between the math task and self-appearance monitoring, a form of cognitively detrimental self-objectification. A potential problem with this interpretation is that the dependent measure of attentional capacity was related to the common stereotype that women are worse than men at math. It may be that, instead of appearance monitoring, women's attention may have been taxed by fears of confirming the math gender stereotype (a concept known as stereotype threat). Trying on a swimsuit on a swimsuit, as in the Fredrickson et al (1998) article, could have conceivably primed the salience of women's own femininity and produced stereotype threat. In fact, Fredrickson et al (1998) even mentioned stereotype threat as a potential confound, but no studies have investigated the matter further. In the present study, female participants' attentional capacity is being tested in two domains – mathematical and logic skills – one of which is associated with a gender stereotype and on which is not, in order to determine whether stereotype threat or objectification is a more likely antecedent to decreased math performance. As a result of having no formal participant pool during the summer



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