

Members of the Holy Cross Community,

We welcome you to the 2002 Undergraduate Summer Research Symposium. Now in its ninth year, the symposium is a college-wide event that brings faculty and students together from all disciplines at Holy Cross, and provides an opportunity to celebrate their accomplishments as well as those of their friends and colleagues. It also provides an opportunity for students to witness the breadth of research possibilities on campus, and to open a dialogue with a faculty member about conducting research during the upcoming academic year and summer. We hope you enjoy the impressive collection of research on display today.

*Professor Kenneth Mills
Professor Timothy Roach
2002 USRS Organizing Committee*

We would like to recognize those who contributed to make this research and this day possible, including:

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Poster 1

Determining the Depletion Layer of the Gold Plated CZT Detector for the Hard X-Ray Band

F. Niestemski and T. Narita

Department of Physics, College of the Holy Cross

Since the emission of black hole binaries primarily radiates power at 100 keV, a more sensitive telescope is needed for an all sky survey in this hard X-ray band. We are working to develop a detector using CZT for such a telescope. The focus of this research is to measure the size of the non-depleted region within an Au coated CZT detector. The primary task to achieve this is the engineering of a thick collimator capable of producing a hard X-ray beam on the order of a .001". Combinations of lead and tantalum are being investigated to do this. The collimator is currently being tested using a HeNe laser and the preliminary results show that the surface of the lead might be too inconsistent to create a narrow beam. The secondary task was the minimization of noise in the read-out electronics to improve energy resolutions. Careful shielding methods and ground schemes were employed to achieve a 3.5% FWHM at 122 keV. Thirdly, a detector probe station was designed and constructed with micrometer precision to take full advantage of the narrow beam of x-rays created.

Poster 2

Land-Use History Reconstruction: Brazil

H. Bain and G. Hurtt

Earth Ocean and Space Department, University of New Hampshire

The prediction of ecosystems and their corresponding carbon consequences have interested ecologists for years. Ecologists generally turn to ecosystem modeling to provide these predictions. Modeling, however, relies heavily on detailed information on the current state of the ecosystem. The traditional method of field analysis and compilation of data is unreasonable over a large, remote area like the Amazon rainforest in Brazil. Our solution was to reconstruct the last 300 years of land use in Brazil. In this reconstruction, we attain detailed information on the present state of the Amazon forest because we have information on how the land use changes every year at a one degree resolution level.

In order to do this reconstruction, we need to solve for a transformation matrix. This problem, in its entirety, contains ~1.6 million variables. We are able to solve for these parameters by making our data consistent with 6 sources of data, and by making some strong assumptions.

In the future, we will use this detailed information to run an ecosystem model various times. Then we will be able to test the sensitivity of different parameters within the modeling process and also the sensitivity of some of our assumptions. We can then make conclusions about the future of the Amazon rainforest in Brazil and the carbon fluxes associated with that ecosystem.

We jointly thank the Research and Discover program and NASA for financial support.

Poster 3

Boosting Sleep in Public School 7th Graders: A Pilot Evaluation

Kimberly LeChasseur & Professor Amy Wolfson
Department of Psychology, College of the Holy Cross

Students start learning about health early in their education; however, the subject of sleep is generally not taught. With 25%-50% of adolescents feeling sleep deprived on any given day (Meijer, Habekoth, & Van Dan Wittenboer, 2000; Mindell, Owens, & Carskadon, 2000), sleep is an important topic that deserves more attention in health classes. The purpose of this pilot is to evaluate the effectiveness of a school-based preventive intervention program designed to teach middle school students healthy sleep hygiene. Based on the social learning model, the Sleep Smart Program (Wolfson, 2002) specifically aims to increase total sleep time and increase the consistency of preadolescents' sleep, as well as to teach healthy sleep habits, such as proper caffeine intake.

There were 26 participants recruited from two 7th grade health classes at a local public middle school. The ages of the participants ranged from 12 to 14 ($M=12.5$, $SD=.61$), with 5 males and 16 females. Twelve of these students were in the prevention group and the other students served as a comparison group.

Sleep habits were measured using self-report questionnaires as well as actigraphy. Comparisons between the groups were done both before and after the Sleep Smart Program. The prevention group participants reported increased weekend total sleep time and more consistent sleep schedules following the Sleep Smart Program, as compared to the other 7th graders. Participants in the prevention group also reported a greater sense of self-efficacy in regards to managing their sleep habits after taking part in the program.

Acknowledgements: The Fisher Fellowship Program at the College of the Holy Cross and the College of the Holy Cross O'Leary Faculty Award.

Poster 4

Analytical Investigation on the Discoloration of an Injectable Pharmaceutical Product

*Timothy M. Blicharz (1), K. J. Dennis, Ph.D. (2), A. Drew (2), D. Song,
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Pfizer Global Manufacturing, GQAR/STAD, Groton, CT*

A manufacturing plant produced 6 lots of an injectable pharmaceutical product. The first 5 lots had a normal medium yellow color, while the 6th lot was rejected due to having a dark, amber color. The same raw materials were used to produce all 6 lots and were approved for use without any restrictions. The rejected lot in question was the first of its kind at the plant.

Preliminary research on the injectable solution reported that the color darkening could be due to an autoxidation of the active ingredient, which is promoted by exposure to oxygen, light, trace peroxides, trace metals, as well as high pH and temperature. Knowledge of the manufacturing environment as well as when the color darkening occurred during production prompted an iron content analysis of the accepted and rejected lots. Analysis by AA reported that the rejected lot contained more than 8 times the amount of iron that the accepted lots. Aliquots of an approved lot were also spiked with a solution containing iron, and a trend between iron content and the darkening color of solution was observed.

The study obtained strong evidence that trace iron was a likely cause of the darkening of the rejected lot, and would allow the plant to investigate the actual origin of the iron. A proactive measure to prevent the problem from occurring in the future involves increasing the scrutiny of the plant's controls over raw materials and equipment. The study also illustrated the importance of researching the material under investigation prior to testing, which could narrow down the amount of factors to be examined without having to exclude them through experimentation.

Poster 5

Wash Your Apples! An Investigative Study of Organophosphorus Pesticides

*Mike Corey and Prof. Jane Van Doren
Department of Chemistry, College of the Holy Cross*

Pesticides have revolutionized the farm industry. For years, farmers have used these carcinogenic chemicals as a means to eliminate pesky insects from their crops. These substances have allowed farmers to dramatically increase their crop yields each season. But after the harvest, to what extent do these pesticides still exist on our fruits and vegetables? Is there an effective way to remove these toxic chemicals from our food? This summer, I have investigated this dilemma and procured reproducible results to draw important conclusions.

I have analyzed carbaryl, simazine, and ametryne solutions using GC-FID and GC-MS and found that with each pesticide the lowest concentration that still produced a signal was about 5 ppm. Since 5 ppm was the lowest concentration that I could detect, I was unable to collect environmental samples of soil or fruit and analyze them for their pesticide content since environmental samples would contain concentrations in the parts per billion range. Secondly, I have found that Organiclean Fruit and Vegetable Wash is the most effective method of removing pesticide (Carbaryl) from apples. Soap and water was not as effective but proved to be efficient enough in pesticide elimination.

I would like to thank the Chemistry Department at the College of the Holy Cross and Fisher Scientific for financial support.

Poster 6

Investigation of Arsenic Concentrations in the Worcester and Acton Communities

*Christine Lillie and Professor Jane Van Doren
Department of Chemistry, College of the Holy Cross*

Long-term exposure to arsenic is known to cause cancer of the liver, prostate, lungs, kidneys, and bladder. Arsenic in the environment can result from naturally occurring deposits, residual farming fertilizers, certain pesticides and leaching from wood pressure-treated with the preservative named chromated copper arsenate. Because central Massachusetts is both highly agricultural and known to have natural arsenic deposits, the Worcester and Acton residents are especially vulnerable to arsenic exposure

The objective of this research project was to develop a method to determine if local soil samples contained a threatening level of the toxin using the Zeeman Polarized Atomic Absorption Spectrometer available in the Holy Cross Chemistry Department. After establishing an appropriate procedure for studying soil samples, I studied soil near public areas such as picnic tables, play structures and yards where playing children may accidentally ingest the toxin from the play structures or soil.

Recent standards set by the EPA suggest that one gram of soil should contain no more than 4 μg of arsenic. My research indicates areas near Worcester were found to contain levels up to almost four times higher (15.82 μg) than the level deemed safe. Future research will be aimed at determining ways to lower the arsenic concentrations in soil.

Special thanks to the Simeon J. Fortin Charitable Trust for financial support.

Poster 7

Hellenistic and Roman Pottery from Hacimusalar Hoyuk

Patrick Battersby

Classics Department, College of the Holy Cross

Hacimusalar Hoyuk is an archaeological site in Elmali, which is located in southwestern Turkey. It is a manmade mound which is believed to be the ancient town of Choma, mentioned in Roman inscriptions. This site has evidence of habitation from the Bronze Age all the way up to the Byzantine Period. Its major finds include the remains of a Christian church, a building, bones, coins, inscriptions, and pottery.

My main focus was dealing with the Hellenistic and Roman pottery. All of the sherds that I studied were from a trench, labeled D4d8, which is in the central part of the mound. It is believed to be the only trench in southwestern Turkey which has a sequence of Lycian pottery uninterrupted by walls. This allows for archaeologists to create a sequence of the evolution for this type of pottery.

The sherds in each locus in the strata were divided into categories based upon their texture, color of slip, and the fabric of the clay which was fired. An actual date is able to be assigned to some of the pottery in each loci by coins and other items, which are able to be given exact dates.

Other diagnostic information obtained by the study of this pottery was that the town of Choma might have been a major producer of pottery in the region. A local fabric noticed in the majority of the pottery indicated this. Also the appearance of pottery sherds, called wasters, which are over fired deformed pieces indicated that D4d8 could have been an industrial area with many kilns for the mass manufacturing of pottery.

Special thanks goes to the Office of the Dean of the College for financial support.

Poster 8

Mechanism of the post-translational modification of murine Sonic Hedgehog with cholesterol

Lisa A. Wuerdeman and Prof. Kenneth V. Mills
Department of Chemistry, College of the Holy Cross

Hedgehog proteins (*Hh*) are signaling molecules first discovered in *Drosophila*. These proteins play a pivotal role in the development of vertebrate embryos. Experiments also implicate hedgehog signaling pathways in the development of various cancers, particularly basal cell carcinomas and medulloblastomas. These previous studies investigated the mechanism of signal transduction of *Hh* proteins to receptor cells through the receptor *Ptc1*. The goal of my research is to study the post-translational modification of the murine Sonic Hedgehog protein (*Shh*) with cholesterol. Cholesterol is added to the C-terminal end of the N-terminal domain, which serves as the signaling domain. Cholesterol anchors the hedgehog protein to the cell membrane, influencing the pattern of proximal cellular responses. We plan to study the influence of the local conformation of the protein near the scissile bond by observing the effect of mutations of nearby residues on the position of the equilibrium between the amide and thioester and on the efficiency of the conjugation reaction.

The *Shh* gene was amplified by PCR from mouse cDNA and subcloned into an *Escherichia coli* vector. Two out of the four stages of subcloning are completed and we hope to begin experiments with recombinant proteins during the academic year.

We gratefully acknowledge the Simeon J. Fortin Charitable Trust, the Chemistry Department of the College of the Holy Cross, and the Donors of the Petroleum Research Fund, administered by the American Chemical Society, for support of the research.

Poster 9

Cluster Analysis of Water Molecules in Ethanol/Water Solutions

Owen Speer and Ramona Taylor

Department of Chemistry, College of the Holy Cross

A recent article published in *Nature* disclosed the results of a study that used x-ray diffraction to profile the “molecular-scale structure” of water in a concentrated methanol/water solution.¹ This research provided the spark that interested us in understanding the origin of this “molecular level structure”. Liquid ethanol/water solutions varying in concentration from 0.2 to 0.7 mole fraction are “built” and are analyzed over a 200 ps time interval. The radial distribution functions as well as several cluster analysis histograms will provide the insight needed to understand the structure of these liquid solutions. Through our simulations, we hope to answer the following questions: Do the water molecules in these ethanol solutions come together and form pockets of bulk water, or do they separate evenly to form a well mixed liquid?

All of this research is being done on SGI Octane2 workstations using AMBER 4, AMBER 6, and SPARTAN software as well as programs written in Fortran. Funding for this work has been provided by the Research Corporation (#CC5158), the National Science Foundation (CHE-0116435) and the Fisher Foundation.

¹ Dixit, S.; Crain, J.; Poon, W.C.K.; Finney, J.L.; Soper, A.K. *Nature*. **2002**, 416, 829-832.

Poster 10

The Correlation of Olfactory Tasks in Mice

Cheryl Armstrong and Elizabeth Constabile

Department of Psychology, College of the Holy Cross

Previous research in our lab using mice indicated that subjects evidenced significant positive correlation on tasks that incorporated olfactory learning. This high correlation encouraged our lab to develop a more extensive battery of olfactory tasks in order to investigate this tendency. This summer, we piloted two olfactory tasks that will now be added to our battery. The first was an odor discrimination task, in which the animal must discriminate between two odors. The second was a novelty odor task, in which the animal must use working memory to identify a novel scent. The data was then analyzed from these pilot studies to determine whether they were successful enough to be used in an attempt to show a correlation among subjects' performances on olfactory tasks. The results indicated that the tasks were successful, and we hope to run large groups of subjects through these tasks in the near future to collect a substantial amount of data that will verify whether or not a correlation does exist among olfactory tasks.

Poster 11

Left Ventricular Assist Devices as a Bridge to Transplant and as Destination Therapy

Michelle Mercado

College of the Holy Cross

Dr. Mehmet C. Oz

*Columbia Presbyterian Medical Center, College of Physicians and
Surgeons*

Mechanical devices such as the left ventricular assist device (LVAD) represent the most significant recent addition to the range of options available to surgeons in managing end stage heart failure. Traditionally, LVAD's have served as a bridge to transplant, but current research suggests that native cardiac function can improve in patients supported by the device. This reverse remodeling is seen in the reversal of chamber enlargement, decreased ventricular mass, and increased contractility. The main question raised by reverse remodeling is whether the device allows recovery to the point where neither further LVAD support, nor transplantation is needed.

Patients who are not transplant candidates due to contraindications such as age, or other high risk factors may eventually derive benefit from life-long LVAD support. Advances in LVAD technology will ultimately see the devices serving as destination therapy for these patients, and outpatient LVAD support has become a recent possibility due to the increased portability of the device.

Studies done at Columbia Presbyterian Medical Center have aimed to reinforce these hypotheses by enrolling LVAD patients in studies that follow changes in their native heart function while supported by the device. Regular electrocardiograms and echocardiograms are performed, as well as exercise stress tests at various points during a patient's therapy. Columbia has recently initiated a multi-center database to track these LVAD patients in an attempt to help perfect the design of the LVAD as a destination therapy. Advances made in device technology have already significantly broadened the range of heart failure patients who can benefit from LVAD support, and further research will serve to increase the ease with which surgeons implant the device.

Poster 12

Modeling the Muon Monitors in MiniBooNE

A. T. Finn and P. Nienaber

Department of Physics, College of the Holy Cross

B. Roe

Department of Physics, University of Michigan

BooNE (Booster Neutrino Experiment; see www-boone.fnal.gov), a collaboration based at the Fermi National Accelerator Laboratory in Batavia, IL, is designed to search for the oscillation of muon neutrinos into electron neutrinos. The first phase of this experiment, MiniBooNE, began its two-year data collection run in August 2002, and has observed its first neutrino events. Since the oscillation phenomenon is relatively rare, understanding the muon neutrino beam and associated background processes is crucial to the experiment's success.

MiniBooNE's muon monitors are ionization counters located behind approximately 3 meters of steel and concrete shielding at the end of the 50 m long meson decay pipe. Since the muons and muon neutrinos come directly from meson decay, modeling the monitor performance and comparing this to data provides a useful check on beam dynamics. This summer we carried out a first order computer simulation of the muon flux at the monitor position in the MiniBooNE beam line. The results show a deficit close to the center of the monitors, and further structure at increasing radius. Ongoing Monte Carlo (MARS/GEANT) studies will further investigate this radial profile as a function of horn current and meson momentum.

Financial support for A. T. Finn and B. Roe was provided by the National Science Foundation Research Experience for Undergraduates grant number PHY-0139464.

Poster 13

A Study of the Autoprocessing Mechanism of Warthog and Groundhog Proteins in *Caenorhabditis elegans*

Timothy D. Quinn and Kenneth V. Mills

Department of Chemistry, College of the Holy Cross

The Hedgehog (Hh) family of proteins are integral in embryonic spinal cord development in vertebrates. The hedgehog protein undergoes an N-S acyl rearrangement of the conserved glycine-cysteine scissile bond. This rearrangement is energetically unfavorable, but is driven by the protein to form a thioester vulnerable to nucleophilic attack by the β -hydroxyl of cholesterol. The hydrophobic "tail" anchors the signaling domain to the membrane. Aberrations of the signaling pathway have been linked to various cancers including basal cell carcinoma.

We plan to study the autoprocessing mechanism of the warthog and groundhog proteins in *Caenorhabditis elegans*. The cDNA coding for the genes was obtained as a λ -phage insert, which we amplified by infection of *Escherichia coli*. We amplified the target gene by polymerase chain reaction (PCR) and purified these DNA fragments by agarose gel electrophoresis. We attempted to ligate each gene separately into an *E. coli* expression vector. After this step is completed we will examine whether or not the warthog and groundhog proteins undergo the same N-S acyl rearrangement. Finally, we will investigate what moiety is responsible for the nucleophilic attack on the thioester in the nematode, whether it is cholesterol, a different sterol or another molecule altogether.

We gratefully acknowledge Pfizer, the Holy Cross Chemistry Department, and the Donors of the Petroleum Research Fund, administered by the American Chemical Society, for financial support of this project.

Poster 14

Protein Splicing in *Deinococcus radiodurans*

Jennifer S. Manning and Kenneth V. Mills
Department of Chemistry, College of the Holy Cross

Protein splicing consists of the excision of an intervening polypeptide sequence, known as an intein, concomitant with the ligation of the two flanking polypeptides, or exteins. Currently, we are examining the effect of amino acid substitutions immediately upstream of the scissile bond on splicing efficiency. We are especially curious to determine if splicing can occur with proline in this position, as no such intein has ever been demonstrated to splice. Thus far, we have been able to amplify the DNA fragment containing the gene for the intein by the polymerase chain reaction (PCR) and isolate it by agarose gel electrophoresis. We have also cut the *E. coli* cloning vector pMal-c2x with restriction enzymes and purified it via gel electrophoresis. This semester we hope to be able to purify the remaining DNA fragments required for subcloning, overexpress the intein in *E. coli* and investigate protein splicing of the intein. We gratefully acknowledge the Simeon J. Fortin Charitable Trust, the Chemistry Department and the donors of the Petroleum Research Fund, administered by the American Chemical Society, for their support of this research.

Poster 15

A screening system for intein *trans*-splicing using *Synechocystis* sp. PCC6803

*Alicia M. Garcia*¹ and *Kenneth V. Mills*²

*Departments of Biology*¹ and *Chemistry*², *College of the Holy Cross*

Inteins are protein segments that interrupt the sequence of amino acids in a protein and may prevent the interrupted protein from folding and functioning properly unless the intein is excised. The cyanobacterium *Synechocystis* sp. PCC6803 contains a *trans*-splicing intein in its DnaE gene product (the replicative DNA polymerase). We intend to use the *trans*-splicing capabilities of the *Synechocystis* intein to create a selection system for *trans*-splicing. We will insert the two fragments of the *Synechocystis* intein (the N- and C- terminal domains) into a gene that confers resistance to the antibiotic kanamycin. The interrupted gene product will likely be nonfunctional and the organism will be sensitive to kanamycin if splicing does not occur. We will use kanamycin resistance as a criteria to select for suppressor mutations that activate a non-splicing intein. Using transformations, DNA purification, ligation, gel electrophoresis, and polymerase chain reaction (PCR) technology we were able to amplify and isolate four of the DNA fragments we will need to create the vector for the *trans*-splicing screen system.

We would like to extend our gratitude to the Simeon J. Fortin Charitable Trust, the Chemistry Department of the College of the Holy Cross, and the Donors of the Petroleum Research Fund, administered by the American Chemical Society, for their support of this research.

Poster 16

Using Microarray Technology to Explore the Metabolism of *S. cerevisiae* Under Varying Physiological Conditions

C.A. Farrell, Y.P. Hung, E.A. Simmons, and Prof. M.L.S. Ledbetter

Department of Biology, College of the Holy Cross

The goal of our project was to use microarray technology to determine the quantitative differences in gene expression profiles between yeast (*Saccharomyces cerevisiae*) growing under varying conditions. We grew yeast under strictly aerobic or anaerobic conditions, and provided either glucose or ethanol in the growth medium as a carbon source. We used assays to monitor the concentration of glucose and ethanol in the medium while simultaneously recording cell concentrations. We found that cultures growing on glucose grew the fastest, while those growing aerobically grew to higher final cell concentrations. We then set up the three preparations we wanted to compare (aerobic glucose, anaerobic glucose, and aerobic ethanol), and isolated the total RNA. We used spectrophotometry and gel electrophoresis to assess the yield, purity, and integrity of our product. We then prepared cDNA from the mRNA templates in our total RNA. We labeled each pair with one of two fluorescent probes and hybridized this preparation to a microarray chip (a microscope slide with all the open-reading frames of the expressed yeast genome spotted onto it). A chip reader generated an image for each probe, and those images were combined to produce a fused image of red, yellow, or green spots, their intensities varying based on the relative degrees of expression for each gene. Further computer analysis can be performed to cluster genes according to similar expression profiles; the function of unknown genes can often be thus inferred. Although the quality of our chips did not allow for further analysis, the foundation has been laid for future work in this area, and a significant body of data was generated concerning the growth of yeast under various conditions.

We would like to thank the Fortin Summer Research Fellowship for financial support.

Poster 17

Where Numerical Methods Fail, A Dynamical Systems Approach

Gabe Weaver and Prof. Gareth E. Roberts
Department of Mathematics and Computer Science
College of the Holy Cross

Sometimes computers can't solve the equations we ask them to. This is often caused by the computer's inability to find the roots of a given function. What causes this failure to occur? Using ideas from the theory of dynamical systems, we investigate this question by applying two numerical methods to find the roots of certain polynomials. More specifically, we study the iterative root-finding methods of Newton and König applied to special families of complex polynomials.

First, we investigate Newton's Method applied to the family of polynomials $(z^n - 1)(z - \alpha)$; $z, \alpha \in \mathbb{C}, n \in \mathbb{N}$. This polynomial has n roots equally spaced on the unit circle and a free root which can vary. This particular family is studied because the roots are symmetric and we expect to find interesting symmetrical figures giving insight into where the numerical method fails. We find Mandelbrot-like (M-like) sets in the parameter plane. These M-like sets correspond to where the numerical method fails on an open set of initial guesses.

Additionally, we learn that these M-like sets limit on a point lying on the axis of symmetry between the roots. As the number of roots on the unit circle increases, or as $n \rightarrow \infty$, the $\text{mod}(\alpha) \rightarrow 1$. This means that as $n \rightarrow \infty$ the basin of attraction of α converges to the unit circle.

Second, we investigate König's Method applied to the polynomial $(z-1)(z+1)(z-\alpha)$. Roberts and Horgan-Kobelski previously studied Newton's and Halley's Methods applied to this polynomial. Through a conjugacy via an affine mapping, one can study these methods on all cubic polynomials. As with the work of Roberts and Horgan-Kobelski, M-like sets are discovered in the parameter plane under König's Method.

This research was made possible through a *Fisher Summer Research Fellowship*.

Poster 18

Calibration of Mössbauer Spectrometer and Study of Nanocrystalline Ferrites

L. Lavoie and D. Yang

Department of Physics, College of the Holy Cross

Mössbauer spectroscopy is a useful tool in determining the magnetic properties of an unknown sample. The gamma-ray source is ^{57}Co in a Rh crystal and is designed to eliminate the recoil energy of a nucleus as it emits gamma-rays. An unknown sample is placed in front of these incident gamma-rays and the number transmitted is detected and recorded. A typical spectrum is a six-peak graph of the gamma-ray transmission versus the velocity of the ^{57}Co source. This data allows one to calculate the “mean field” (hyperfine magnetic field due to exchange interactions between individual magnetic moments) of the sample. The first part of my research involved producing a calibration procedure according to standard measurements.

Once the calibration was complete, the structural and magnetic properties of heat-treated $(\text{Ni}_{0.5}\text{Zn}_{0.5})\text{Fe}_2\text{O}_4$ nanoparticles were studied. Analysis of the spectra show that these particles maintain their crystalline structure, despite initial observations that may indicate amorphous structure. This is explained by concentrating on the spinel structure of the crystallized Ni-Zn ferrite, whose lattice is composed of oxygen ions; metallic ions occupy 8 tetrahedral (A) sites and 16 occupy octohedral (B) sites. Due to the properties of Zn and Ni, there is one relatively constant hyperfine field value at the A sites because its neighbors in the lattice are all magnetic. There are reduced values at the B sites, however, because its neighbors could include the non-magnetic Zn^{2+} . Analyzing the Mössbauer spectra shows that as the calcining temperature of the sample increases, the magnetic component increases as the paramagnetic one decreases. The threshold temperature for pure magnetic phase for our sample is 650° . Thanks to the Fisher Summer Grant Foundation for their financial support.

Poster 19

Particulate Size Dependence and Smoke Evolution in Environmental Tobacco Smoke

Mark Marzinke, Jaclyn Gareau and Professor Jane Van Doren

Department of Chemistry, College of the Holy Cross

Previous research has shown that environmental tobacco smoke (ETS) causes cancer, yet many questions still remain about the chemical mechanisms involved. The goal of our research was to investigate the chemical characteristics of ETS, specifically how tobacco smoke composition varies with (1) particulate size and (2) time after formation.

ETS smoke was collected on filters of differing pore size to determine whether the chemical composition of ETS particulate varies with smoke particle size. To determine time, ETS was collected in a bulb and allowed to sit for a designated period of time before collection on the filter. Gas chromatograph with flame ionization detection (GC-FID) and gas chromatograph with mass spectrometric detection (GC-MS) were used to analyze our results. Qualitative results indicate that there are some compositional differences between tobacco smoke particles of differing size. We also found that there are some chemical changes that occur in ETS over time. In particular, certain chemical peaks were present in smoke that was left for extended time intervals but were absent from smoke left for shorter periods.

We would like to thank both Fisher and Pfizer, Inc. for their financial support in this endeavor.

Poster 20

UV Protection : An Analytical Investigation

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Studying the properties of UV radiation (wavelength of 400nm to 220 nm) has garnered a lot of interest from many scientists in various scientific disciplines. Scientists are concerned with the impact that UV radiation has on life. Though these respective disciplines added their own perspective to UV radiation, it was my task to fuse them together and present a project that represented all the disciplines. This unison was then created into a paradigm, which dealt with the issue of “ Living with UV Radiation in our every day life”. An outcome was reached after testing the SPF value in sunscreens, the UV levels in protective lenses, and the UPF values in various fabrics. The key to this experiment was absorption. Absorption was the only method in which to show exactly how much UV radiation affected the other variables and in effect, how much UV radiation was used.

The absorption values were tested in each sunscreen ranging from SPF values 4-50. All of the sunscreens proved to be effective in terms of their respective SPF (in the UV range), although there was a significant difference in absorption within the UVB range (280nm to 320nm) where the higher the SPF value, the higher level of absorption. During the experiment with different UV lenses, an economically cheaper lens was compared with an economically more expensive lens and both were found to have the same amount of absorption in the UV range. However manipulating the amount of light intensity that passes through the lens can disprove this. The following factors affect the absorption level in fabric: the color of the material, whether the material is wet or dry, and how the material is woven. Results were found by using the UV-VIS Spectrophometer to pass a light beam through the various fabrics. The absorption of a wet material is greater than that of a dry material. Darker materials were also found to absorb more UV radiation than lighter colors. Materials with a tighter weave were found to absorb more than those with a looser knit.

I would like to thank the selection committee members of the Fischer Scholarship for giving me the opportunity to do this research.

The Making of a “New” Rubidium Beam

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Rubidium (Rb) beams were generally produced from a lump of pure Rubidium. Though this method was deemed a successful mean to produce an atomic beam it was by no means the most efficient. Working with this elemental source was proven to be quite a challenge as not only was it messy (melting at room temperature) but also being very reactive in its pure state. Due to the very reactive nature of Rb a lot of Rb atoms would be emitted into the chamber upon heating resulting in the chamber becoming saturated and unfavorable for the production of an atomic beam. This problem was solved by the implementation of two costly vacuum pumps.

With the making of the “new” atomic beam this past summer one of the first things we decided to change was the Rb source. This time around we used what is called rubidium chlorate (a getter source). This source employed the use of only one vacuum pump and was a lot easier to treat and manipulate than the elemental source. This getter source is simply an extremely thin strip of Rb embedded in a thicker piece of metal. This source emitted Rb atoms after running several amperes of current through it which made it easy to turn it on and off. Though this new source had some tremendous advantages it only managed to last for about two to three hours.

After we installed the getter source onto our Vacuum chamber apparatus we were then ready to incident laser light (of correct frequency) onto the Rb atoms being emitted through a relatively tiny aperture. By using an infrared sensitive camera we were able to monitor and detect the atomic beam inside the vacuum chamber as the emitted atoms would fluoresce upon contact with the laser light. We also measured how the fluorescence intensity depended upon the laser's frequency.

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Poster 22

The structure of individual differences in Heterogeneous Stock mice across problem types and motivational systems

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Sixty Heterogeneous Stock (HS) mice received a battery of six problem-solving tasks and three control procedures. The problem-solving tasks included Hebb-Williams, place learning, radial arm maze, a working memory test following the radial maze, a set of detour problems, and a visual non-matching to sample task. The control procedures consisted of land and water activity measures and a light-dark test. The correlation matrix derived from these tasks did not exhibit positive manifold, that is, positive correlations across all problem-solving tasks. Principal components analysis reduced the correlation matrix to four components with eigenvalues exceeding 1.0. Instead of the general factor solution common in the study of human problem-solving, this component structure appeared to be congenial to a more modular interpretation, with the four components each explaining approximately the same order of magnitude of matrix variance.

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Poster 23

OLFACTORY LEARNING AND AVERSION

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This summer we ran numerous pilot studies attempting to develop a fear conditioning task using olfactory stimuli. In our final procedure mice underwent a one second long shock 4 times in a span of 12 minutes. A banana scent was released into the chamber one minute prior to each shock. Several hours later, the mice were monitored to see if they would avoid the banana scent in a runway-choice procedure. Results indicated that the majority of mice did indeed learn this association. A subset of mice demonstrated a type of sensitization in which they showed little initial aversion to the scent but became more aversive to it as a function of extended choice testing.