



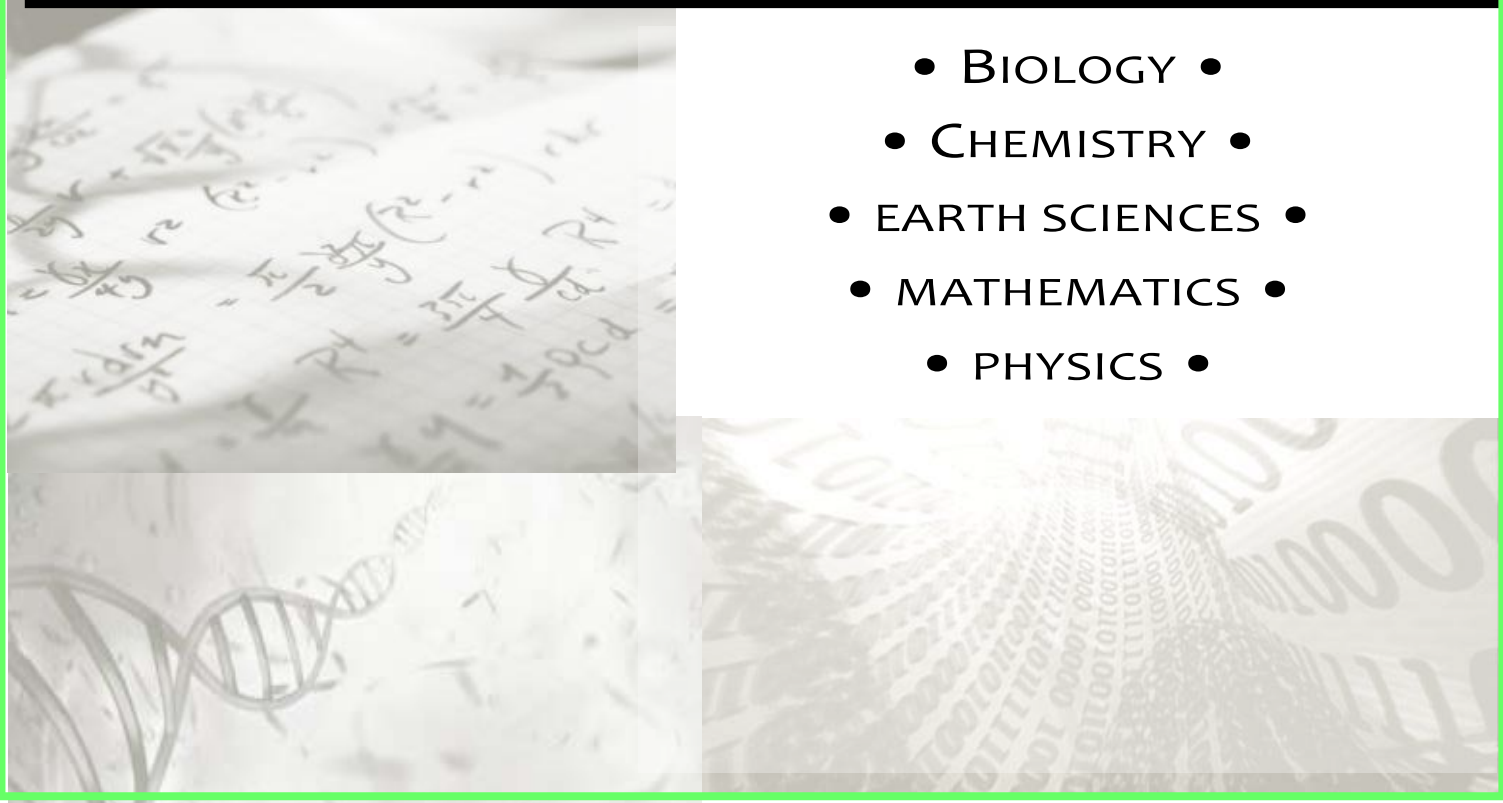
SCHOOL OF SCIENCE AND MATHEMATICS

# Student Research

## Poster Display

Caputo Hall Lobby

October 27—29, 2011

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- BIOLOGY •
  - CHEMISTRY •
  - EARTH SCIENCES •
  - MATHEMATICS •
  - PHYSICS •

# TABLE OF CONTENTS

	<b>Abstract Number</b>
Biology.....	1-7
Chemistry.....	8
Earth Sciences.....	9-13
Mathematics.....	14-16
Physics.....	17-18
Index of Authors.....	i-ii

Note: The names of Millersville University faculty advisors are designated by an asterisk (\*) in the abstracts.

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# BIOLOGY

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## **1. Analysis of Fish Catch Data for Marine Ichthyology (Biol 396) at The Marine Science Consortium from Summers 2006 – 2011**

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The collection of organisms at the Marine Science Consortium (MSC) has been a component of a wide variety of courses and classroom activities at the MSC over the past 46 years; however, long-term data sets on these collection activities have not been analyzed. In order to determine potential impacts to the abundance and diversity of fishes due to classroom activities, data from Marine Ichthyology (Biol 396) over the past 6 years (2006 – 2011) was analyzed. Fishes were collected using trawls and seine within a 3-week period from July 2 – Aug 2 each year. In order to assess whether abiotic factors played a role in fish abundance, temperature data from the past 6 years were also analyzed. Our hypothesis is that fish abundance and diversity varies by year and temperature plays a role in the diversity and abundance of fishes collected. Fish abundance and diversity does vary by year; however, specific data on how classroom activities impacted fish abundance was not able to be determined with this data set. The analysis of long-term datasets from classroom activities should prove beneficial in the future in assessing impacts.

## **2. Providing an Explanation for an Evolutionary Novelty: The Development of the Turtle Plastron**

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The turtle shell is an evolutionary novelty, and understanding how it is formed will help to explain a major puzzle in macroevolution. The goal of this research was to examine the cells that produce the plastron, or ventral shell, of the turtle, and to study their developmental origin and the mechanism by which they differentiate into bone. Previous studies have shown that the bones of the plastron form in a similar manner to facial and skull bones. The flat bones of the skull form through a unique process, in which loosely packed cells convert directly into osteoblasts (bone-forming cells), without first producing cartilage. In addition, the skull bones are produced by a unique population of migrating cells known as cranial neural crest cells. Our lab has previously demonstrated that a unique second wave of trunk neural crest cells occurs later in development in the turtle. These cells migrate mostly dorsolaterally to form the plastron. However, once in the plastron, the cells start to express markers of cranial neural crest. To further study this phenomenon, we examined the expression of two genes expressed in cranial neural crest cells. We found that these neural crest markers were expressed in the plastron providing further support for the neural crest origin of the cells that form the bones of the plastron. Our hypothesis is that not only is the early plastron constructed from neural crest cells, similar to those that produce the bones of the face and skull, but it will also express genes involved in bone, but not cartilage, differentiation. To investigate this hypothesis, we are examining the pattern of gene expression in the plastron just as the bones are beginning to form by isolating RNA and performing PCR assays.

### **3. Winter Colonization of *Hydra* in a South-Eastern Pennsylvania Pond**

Mlynek, Kevin; Sparr, Dustin; Hicks, Robbie; Neilson, Katherine; Miller, Ian (MU 2010); Reinking, Larry\*

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*Hydra* are well-known freshwater cnidarians but surprisingly, little is known about the parameters that govern population size and habitat specificity. In a previous study (Miller, I.P. et al CPUB 2010) we showed that *Hydra viridissima* displayed a strong preference for shallow (~ 1 m) pond water habitats characterized by dense infralittoral vegetation. This study also found increased population densities in early spring sampling as opposed to summer and fall sampling.

In the current study, *Hydra* colonization rates were monitored from mid October 2010 to late March 2011. Permanent monitoring stations were positioned in a 0.2 hectare pond located in Millersville, PA (Roddy research pond). Six sampling stations were distributed in the pond, with four stations located in the shallow (~1 m) apex and two in the deeper (~2.5 m) dock region. Each station had floating towers with vertical tiers consisting of three settling plates per depth (100mm X 15mm sanded Polystyrene Petri lids) located at 25 cm and 50 cm with respect to the water surface. Sampling stations located in the deeper dock region had an additional tier of settling plates located at a depth of 125 cm. These stations were assayed every three weeks for colonization of *H. viridissima*, *H. oligactis*, and *H. americana*. In conjunction with these three week sampling cycles, zooplankton counts and abiotic factors such as temperature, pond level, dissolved oxygen, and pH were monitored.

We found a low level (<20 total *Hydra*) of colonization from November to February, whereas in early March colonization had begun to increase (> 100). Low colonization rates during winter sampling seem to be related to the degree of ice cover.

### **4. The Effect of Varying Concentrations of Hyaluronan on Fibroblast Migration and Morphology During Wound Healing**

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During wound healing, the migration of fibroblasts through a fibrin clot is a key step to the formation of granulation tissue and the progression of wound repair. Research involving the optimization of this process is of significant interest because its potential clinical application. Hyaluronan (HA), a glycosaminoglycan that is distributed widely throughout the extracellular matrix of connective tissue, has been found to influence cell migration during wound healing. In this study, the morphological characteristics of chick embryonic fibroblasts were monitored during migration through a fibrin matrix under the influence of varying concentrations of exogenous HA (40, 120, and 400 µg/ml). The results suggest that HA promotes increased fibroblast migration through the inhibition of gap junction communication. The results also demonstrate that fibroblasts lengthen perhaps in part through increased actin microfilament distribution and organization. The effect that HA has on fibroblast migration rates and morphology is of clinical relevance because the faster that fibroblasts migrate into the wounded tissue, the more rapid collagen synthesis and contraction can take place, producing a shorter recovery time for patients. The quantification

of fibroblast migration distances under varying concentrations of HA provides a basis for further research into the mechanisms of its effects and possible clinical importance for the optimization of wound healing.

## **5. Using Predator/Prey Population Dynamics to Assess Disease Risk Along an Urbanization Gradient in Baltimore County, MD.**

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West Nile Virus was first introduced to the United States in 1999 in New York City. Since then, viral and vector distributions have been on the rise with thousands of reported human cases each year, especially in urban environments. This high risk of disease could be explained by many of the changes to landscape which occur with urbanization.

One such potential explanation presented by this research investigates the idea that urban environments facilitate the introduction of invasive species. Our primary interest in this study was to determine the influence of an urbanization gradient on WNV risk by comparing the population dynamics of both WNV larval vector mosquitoes and their aquatic insect predators as a function of this gradient. This study was conducted April – June 2009-2010.

Study sites were located along a 17-mile urban gradient extending from inner city Baltimore to state park land in Baltimore County, Maryland. Sampling was conducted weekly for mosquito populations along with monthly samplings of macroinvertebrate populations in order to compare both mosquito and predator diversity along this land use gradient.

Mosquitoes were sampled using a 250 mL mosquito dipper (n = 10 dips weekly and n = 25 dips monthly), whereas, macroinvertebrates were sampled using a D-frame net sweep (n = 5 replicates for each site). Species diversity for both macroinvertebrate and mosquito samples was analyzed using the Simpson-Yule Diversity Index. We found that urban environments appeared to have lower macroinvertebrate and predator diversity (1-D = 0.6571) than rural areas (1-D = 0.7608). Mosquito diversity also decreased along the rural to urban gradient.

Rural mosquito diversity was 1-D = 0.7305, suburban diversity was 1-D = 0.6080, and urban diversity was 1-D = 0.5486. When mosquito abundance was compared to predator abundance, we found a strong inverse relationship ( $R^2 = 0.987$ ) with the rural site, but not in the urban sites ( $R^2 = 0.026$ ). From a temporal perspective, mosquito species composition changed over time, with those species which feed on birds-only and those species which feed on both humans and birds typically existing separate of each other throughout the season.

Our results suggest that land-use change does affect mosquito predator abundance, and also demonstrates a key relationship between mosquito larvae and their aquatic predators.

## **6. Habitat Preferences of *Ixodes scapularis* Nymphs: Edge vs. Woodland**

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*Ixodes scapularis*, commonly known as the blacklegged tick or deer tick, is the vector for Lyme disease. *Ixodes scapularis* nymphs are responsible for transmitting the majority of Lyme disease cases to humans because of their small size and peak activity during late spring

and early summer. It is important to study the habitat distribution of these nymphs to determine the areas where humans are most at risk of contracting Lyme disease. The densities of nymphs were compared between four transects: the edge of a woodland, 10 meters, 25 meters, and 50 meters into the woodland over a six week period. Nymph survival was compared to location by placing ticks in survival cages, and checking the cages every 2 weeks for survivors. Since relative humidity and temperature are known to be important abiotic factors contributing to tick survival, these factors were monitored by location and compared to nymph density and survival. Nymph migration was also monitored using mark-release-recapture methods on a grid located near the edge. Location was found to affect nymph density, specifically at the 50-meter transect where densities were significantly higher. Survival rates were not significantly different between edge and woodland habitats, and relative humidity and temperature did not correlate directly with either nymph survival or density. However, it is likely that relative humidity is partially responsible for nymph habitat preferences. Nymphs demonstrated migration away from the edge, into a woodland habitat. From this study it can be concluded that *Ixodes scapularis* nymphs prefer woodland to edge habitat. Supported by NSF grant NSF # 1063076 to Fordham University.

### **7. The Effect of Food Availability on Crystalline Inclusions in *Paramecium***

Bennett, Joshua W. (MU 2011); Reinking, Larry\*

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We examined variation in the size and number of crystals formed by *Paramecium caudatum* in response to changes in the population of their food. We accomplished this by starting two 200 mL sub-cultures of a modified Sonneberg's media inoculated with *Klebsiella pneumonia* as a primary food source and *P. caudatum*. Each subculture was allowed to develop without further input until the *P. caudatum* declined in population. During that time each subculture was sampled three times a week. Each sampling took 2.5 mL of the subculture to create an index of the *P. caudatum*'s population, 0.5 mL of the subculture to create slides to analyze the attributes of the crystalline inclusions, and 0.1 mL of the subculture to create slides to index the bacterial population. The paramecium counting was performed using a Sedwick rafter counting cell, VersaCount counting software and a compound light microscope. The crystal analysis was performed by air drying the paramecium on a slide in a desiccating chamber then taking digital images of fifteen individuals per sample. Each individual was photographed twice; once using bright field imaging to find the area of paramecium and once using polarization to capture the crystals for counting and finding their area. The bacteria were air dried on a slide in four wells made by applying ring stickers to the slide, desiccated, and then stained with acradine orange. Three spots on each well were randomly selected and imaged with a fluorescing microscope to visualize the bacteria. The analysis of the crystals and bacteria was done with the Image J software from the NIH.

# CHEMISTRY

## **8. Efficient Synthesis of 1,1,3-Trimethyl-3-phenylindan-4',5-dicarboxylic acid (PIDA): A green process.**

Focht, Ryan (MU 2011); Bonser, Steven M.\*

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1,1,3-Trimethyl-3-Phenylindan-4',5-Dicarboxylic Acid, commonly referred to as PIDA, is a polycondensation monomer used in industrial polyester polymerization processes. Although a number of syntheses of PIDA have been reported, a more environmentally friendly and cost effective process is desirable. The development of an optimized synthesis for PIDA is the subject of this study. The updated synthesis represents an efficient four stage approach from readily available starting materials. The key step in the new reaction scheme is the use of "Green" chemistry principles to oxidize the aryl methyl groups of 1,1,3,5-tetramethyl-3-(*p*-methylphenyl)indane to the corresponding dicarboxylic acid moieties of PIDA in the last step. This can be accomplished through the use of certain transition metal chemistry.

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# EARTH SCIENCES

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## **9. Seasonal Circulation Off Delmarva**

Stelma, Sigourney; Kumar, Ajoy\*

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The Mid-Atlantic Bight (MAB) shelf waters are one of the most productive in the world (Yoder et. al., 2002). However, the mid-shelf region of the MAB has some of the most stratified continental shelf waters and encompasses the location of the 1976 Anoxic Episode, where intense stratification was one important element of the synergism resulting in anoxia and extensive fish/shellfish mortalities (Campbell & O'Reily, 1988). In this work we analyzed CTD and nutrient data sampled bi-monthly by NASA Wallop scientists during 2005-2007 which cut across the mid-shelf region of the MAB. Seasonal variations in the temperature and salinity fields will be discussed and related to stratification conditions of the mid-shelf region. How the stratification affects the nutrient, oxygen and chlorophyll fields will be evaluated. The goal of this work will be to identify areas of stratification and relate to possible low oxygen conditions in the region. Another goal of this undergraduate research is to develop skills in oceanographic data analysis, interpretation and presentation.

## **10. Inter-annual variations in Temperature, Salinity, and Oxygen Off Wallops Island, VA**

Burcicki Jr., David M.; Kumar, Ajoy\*

Department of Earth Sciences, Millersville University, Millersville, PA 17551

Human induced global warming has already started causing physical and biological impacts on both global and regional scales (IPCC, 2007). What is more troubling is that such impacts are occurring earlier and faster than scientists have predicted. Although there have been a lot of studies on the consequences of the climate perturbation due to anthropogenic carbon emissions affecting oceanic carbon cycling, not much attention has been given to the response of oceanic oxygen especially in coastal waters. The Mid-Atlantic Bight (MAB) shelf waters are one of the most productive in the world (Yoder et. al., 2002). However, the mid-shelf region of the MAB has some of the most stratified continental shelf waters and encompasses the location of the 1976 Anoxic Episode, where intense stratification was one important element of the synergism resulting in anoxia and extensive fish/shellfish mortalities (Campbell & O'Reily, 1988). In this work we will analyze CTD data sampled off Wallops Island, VA from 2001 through 2011 and archived at the Marine Science Consortium, Wallops Island, Va. We will look at inter-annual trends in the temperature and salinity anomaly field and relate them to oxygen data collected in the same region.

## **11. Satellite Image Classification of Wetlands**

Cool, Russell Jr.; Kumar, Ajoy\*

Department of Earth Sciences, Millersville University of Pennsylvania, Millersville, PA 17551

In this study we will use Landsat satellite imagery of Wallops Island, Virginia and image processing tools available via ENVI Image Analysis Software to classify vegetation types, water, land, beach and man-made materials.. Our goal is to take these classified images and



look for changes in the landscape over time. We will use 2 methods (i) Simple Ratio (SR) and (2) Normalized Difference Vegetation Index (NDVI) to classify the images. The simple ratio is  $SR = (\rho_1/\rho_2)$  where  $\rho_1$  is red reflected radiant flux associated with the red band, and  $\rho_2$  is the near-IR radiant flux associated with the near-IR band. The simple ratio gives the Leaf Area Index (LAI) which will give different values of biomasses, and will help in determining different types of vegetation. The normalized difference vegetation index is  $NDVI = (\rho_2 - \rho_1) / (\rho_2 + \rho_1)$ . This method allows one to see the seasonal changes over time as well as reducing noise from the image. The classified images will be used to study seasonal variations in vegetation, beach changes, water, low marsh, high marsh, and agricultural land. Once the image is classified, we will use GIS to overlay the image on the Digital Terrain Model (DTM) produced from the NASA project this summer. The end result will be a 3D wetland classified image overlaid on LIDAR derived elevation.

## **12. Optical Properties of Coastal Waters: Assessing The Role of Riverine Input on the Transport of Dissolved and Particulate Carbon to the Coastal Ocean off The Delmarva Peninsula**

Kordell, Tia; Vaillancourt, Robert D.\*

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Since an important source of colored dissolved organic material (CDOM) is riverine input to the coastal ocean, the concentration of CDOM typically displays an inverse relationship to salinity. Particulate matter can be transported from rivers too, or also formed *in-situ* in ocean water by biological processes. CDOM and particles effectively attenuate a beam of light, making optical measurements a useful means of determining the presence of these materials. We present observations of in-water optics using a WET Labs' long-tube absorption meter (AC-9), along a cross-shelf transect from the Delmarva Peninsula seaward to the 30-meter isobath. Our objective was to relate the presence of dissolved and particulate light attenuation to the hydrographic and bio-optical properties of the water column, in order to infer their sources and origins. This project is significant in analyzing the transport of organic carbon from the land to the ocean, and to provide a deeper understanding of the ocean's carbon cycle.

## **13. Airborne Lidar Data Assessment of Wallops Island, VA**

Murry, Nathan; Mizioro, Matthias; Kumar, Ajoy\*

Department of Earth Sciences, Millersville University, Millersville, PA 17551

The Virginia eastern shore & Delmarva Peninsula are ideal test locations for developing adaptive conservation approaches & strategies for analyzing the effect of sea level rise on coastal ecology & municipal establishment. This work will use remote sensing LiDAR data collected by the NASA Wallops Flight Facility to develop various digital models of the elevation & terrain (surface & bare-earth) of Wallops and the surrounding areas. The digital model developed are used to map current distributions of important coastal habitats, create beach profiles, & detail areas likely to experience the greatest impact from sea level rise. The goal of this study is to understand the effects of sea level rise particularly for migratory birds & their habitats.

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# MATHEMATICS

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## **14. The Dependency of Students and Teachers on Calculators in the Classroom**

Coleman, Stephanie; Miller, Travis K.; White, Janet A.\*

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The world has embraced a new age of technology, which has made its way to the mathematics classroom through calculators. Yet, even years after the original calculator was invented, teachers are divided concerning the calculator's role in the classroom. Calculators do allow for real world applications, the exploration of concepts, and connections between mathematical concepts. Still, are students relying on them too much by using them to perform basic operations that they should be doing either in their heads or by using paper and pencil? The purpose of this study is to examine the role of the calculator in the mathematics classroom and how teachers feel about this device. In this study, the researcher developed a survey about calculators that was then completed by one hundred and thirty-six teachers. These results were analyzed in the hope of discovering what role calculators should have in the mathematics classroom.

Among other findings, results indicated that the most experienced teachers felt more comfortable with calculators and didn't agree with the statement that calculators hurt basic math skills. Instead, significantly more of the most experienced teachers agreed that the time saved by using calculators outweighs the loss of basic computational skills.

In general, the results indicated that teachers are divided when it comes to the role of the calculator in the classroom. A majority agreed that calculators are beneficial because they allow for exploration of concepts, yet they also agreed that the appropriate use of calculators needs to be taught.

## **15. Math Teaching Strategies for Algebra**

Coleman, Katelyn; Miller, Travis K.; White, Janet A.\*

Department of Mathematics, Millersville University, Millersville, PA 17551

Students in the United States are constantly struggling with mathematics. In particular, students in the United States are struggling with algebra due to its abstract nature. There is a lot of literature on different techniques that may help students transition smoother from arithmetic to algebra. However, there is not a lot of literature on whether or not these suggested techniques actually help students understand algebra concepts. Therefore this study was created to examine some of these techniques and determine which techniques teachers believe are beneficial to use when teaching algebra. One of the main questions that the researcher examined was what strategy or strategies are the most effective in an algebra classroom? A survey was created that included questions pertaining to what methods teachers believe are the most effective for teaching their students algebra. The survey was sent out to a wide range of teachers and then the results were examined by the researcher. Based on the results from a wide variety of experience level of teachers, the researcher concluded that the combination of individual practice, group projects, and lecture is the most effective method for teaching algebra, while individual practice is the teaching method that helps students develop a greater understanding of algebra.

## **16. Assessment of Simple and Alternative Bayesian Ranking Methods Utilizing Parallel Computing**

Allen, Samantha<sup>1</sup>; Kirlew, Dorothy<sup>2</sup>; Obetz, Neil<sup>3</sup>; Wade, Derek<sup>4</sup>; Albertine, April<sup>5</sup>; Neerchal, Nagaraj K.<sup>5</sup>; Klein, Martin<sup>6</sup>; Umble, R.\*

<sup>1</sup>Department of Mathematics and Computer Science, High Point University, High Point, NC

<sup>2</sup>Departments of Mathematics and Computer Science, Hood College, Frederick, MD

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The U.S. Census Bureau (USCB) assists the federal government in distributing over \$400 billion of aid by ranking the states according to certain criteria, such as average poverty level. The current ranking algorithm is based on sample estimates which are associated with a certain amount of error. Klein and Wright of the USCB have compared the performance of non-informative Bayesian techniques to the USCB's current method. We expand on this work to add informed Bayesian and regression models to the comparison. By employing moderation techniques, we obtain excellent probabilities of correct rankings.

### Acknowledgements:

This research was conducted during Summer 2011 in the REU Site: Interdisciplinary Program in High Performance Computing ([www.umbc.edu/hpcreu](http://www.umbc.edu/hpcreu)) in the Department of Mathematics and Statistics, funded by the National Science Foundation (grant no. DMS-0851749). This program is also supported by UMBC, the Department of Mathematics and Statistics, the Center for Interdisciplinary Research and Consulting (CIRC), and the UMBC High Performance Computing Facility (HPCF). The computational hardware in HPCF is partially funded by the National Science Foundation through the MRI program (grant no. CNS-0821258) and the SCREMS program (grant no. DMS-0821311), with additional substantial support from UMBC.

# PHYSICS

## **17. Atomic Layer Deposition (ALD) Films as Oxidant Barriers for Silver Artifacts – Effect of Surface Preparation and Evidence for Ag<sub>2</sub>S Self-Passivation**

Lewis, M.<sup>1,2</sup>; Marquardt, A.<sup>3</sup>; Phaneuf, R.J.<sup>3</sup>; Dushkina, N.\*

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We propose using atomic layer deposition (ALD) to create diffusion barrier coatings in order to reduce the tarnishing rate of silver artifacts — an immense problem for museums with large silver collections for which the current preservation technique requires frequent labor-intensive applications of polymeric nitrocellulose. Various methods for surface preparation were tested, including mechanical and chemical cleaning techniques. TiO<sub>2</sub> films with thicknesses between 5-100nm were grown on silver substrates using ALD. Reflectance spectroscopy was used to approximate the silver sulfide thickness at the oxide-metal interface as the samples were tarnished by accelerated heating tests. The effectiveness of each sample preparation method was evaluated using atomic force microscopy (AFM) and x-ray photoelectric spectroscopy (XPS). Preparing the substrate with a 2μm polishing cloth and a 5% ethylenediaminetetraacetic acid (EDTA) solution was the most successful in reducing surface sulfur concentration and creating a smooth substrate. This method yielded RMS roughness values of 5.35 nm±2.35 nm for sterling silver, and 7.76 nm±1.83 nm for fine silver; with a sulfur content of 0.0058 At%±0.0007 At% for sterling silver and an undetectable amount of sulfur on fine silver substrates. Partial self-passivation of the silver sulfide layer is suggested from the decrease in its growth rate and saturation of the tarnish layer thickness. As the thickness of the TiO<sub>2</sub> films increased, the silver sulfide growth rate decreased, effectively slowing the diffusion rate. However, thicker TiO<sub>2</sub> films increasingly altered the appearance of the silver substrate.

## **18. X-ray Analysis of Magellanic Cloud Supernova Remnants**

Timlin, John; Jacobs, Adam; Keshel, David; Hendrick, Sean\*

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We present our examination of supernova remnants (SNRs) in the Magellanic Clouds. There are two different types of supernova explosions; the thermonuclear detonation of White Dwarf stars which have exceeded the Chandrasekhar mass limit (Type Ia) and the gravitational core collapse of massive stars (Types II, Ib/c). Each explosion yields the same energy, but has different chemical composition in the newly synthesized matter created and ejected by the explosion. Over time, supernova remnants undergo different stages of expansion; the ejecta dominated phase, the Sedov phase, and the radiative phase. We will examine archival data from the Chandra X-ray Observatory obtained from NASA's High Energy Astrophysics Science Archive Research Center (HEASARC). The data is processed with the CIAO software package to extract images and spectra. We can then analyze the SNRs using the XSPEC software package to determine the elemental abundances present in the ejecta. Our targets are N103B and DEM L71 in the LMC, and SNR 0103-72.6 in the

SMC. N103B is a young remnant in the ejecta dominated phase. DEM L71 and SNR 0103-72.6 are remnants transitioning to the Sedov phase, but still contain ejecta. In XSPEC, we will use the Non-equilibrium Ionization (NEI) and Plane-Parallel Shock Plasma (PSHOCK) models to analyze the ejecta regions, and the Sedov model to analyze the limb regions. Physical properties in the SNRs can be approximated from the best, most physically sound, fits including age, mass, initial explosion energy, and chemical composition.

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# INDEX

---

<b><u>Name</u></b>	<b><u>Abstract Number</u></b>
Bennett, Joshua W. ....	7
Bonser, Steven M.* .....	8
Burcicki Jr., David M. ....	10
Cebra-Thomas, Judith A.* .....	2
Coleman, Katelyn .....	15
Coleman, Stephanie .....	14
Cool Jr., Russell .....	11
Dagit, Dominique D.* .....	1,6
Dungan, Susan .....	1
Dushkina, N.* .....	17
Focht, Ryan .....	8
Hendrick, Sean* .....	18
Hicks, Robbie .....	3
Hoover, John.* .....	4
Jacobs, Adam .....	18
Keshel, David .....	18
Kordell, Tia .....	12
Kumar, Ajoy* .....	1,9,10,11,13
Lewis, M. ....	17
Mangat, Gulnar .....	2
McCarthy, James .....	2
Miller, Ian .....	3
Miller, Travis K. ....	14,15
Miziorko, Matthias .....	13
Mlynek, Kevin .....	3
Murry, Nathan .....	13
Neilson, Katherine .....	3
Obetz, Neil .....	16
Reinking, Larry* .....	3,7
Shah, Sonal .....	2

Sheaffer, Brain	.....	<b>4</b>
Sloyer, Kristin E.	.....	<b>5</b>
Sparr, Dustin	.....	<b>3</b>
Stelma, Sigourney	.....	<b>9</b>
Timlin, John	.....	<b>18</b>
Umble, R.*	.....	<b>16</b>
Vaillancourt, Robert D.*	.....	<b>12</b>
Wallace, John R.*	.....	<b>5</b>
Weicheld, Julie	.....	<b>6</b>
White, Janet A.*	.....	<b>14,15</b>