School of Science and Mathematics

Student Research

Poster Display

Caputo Hall Lobby

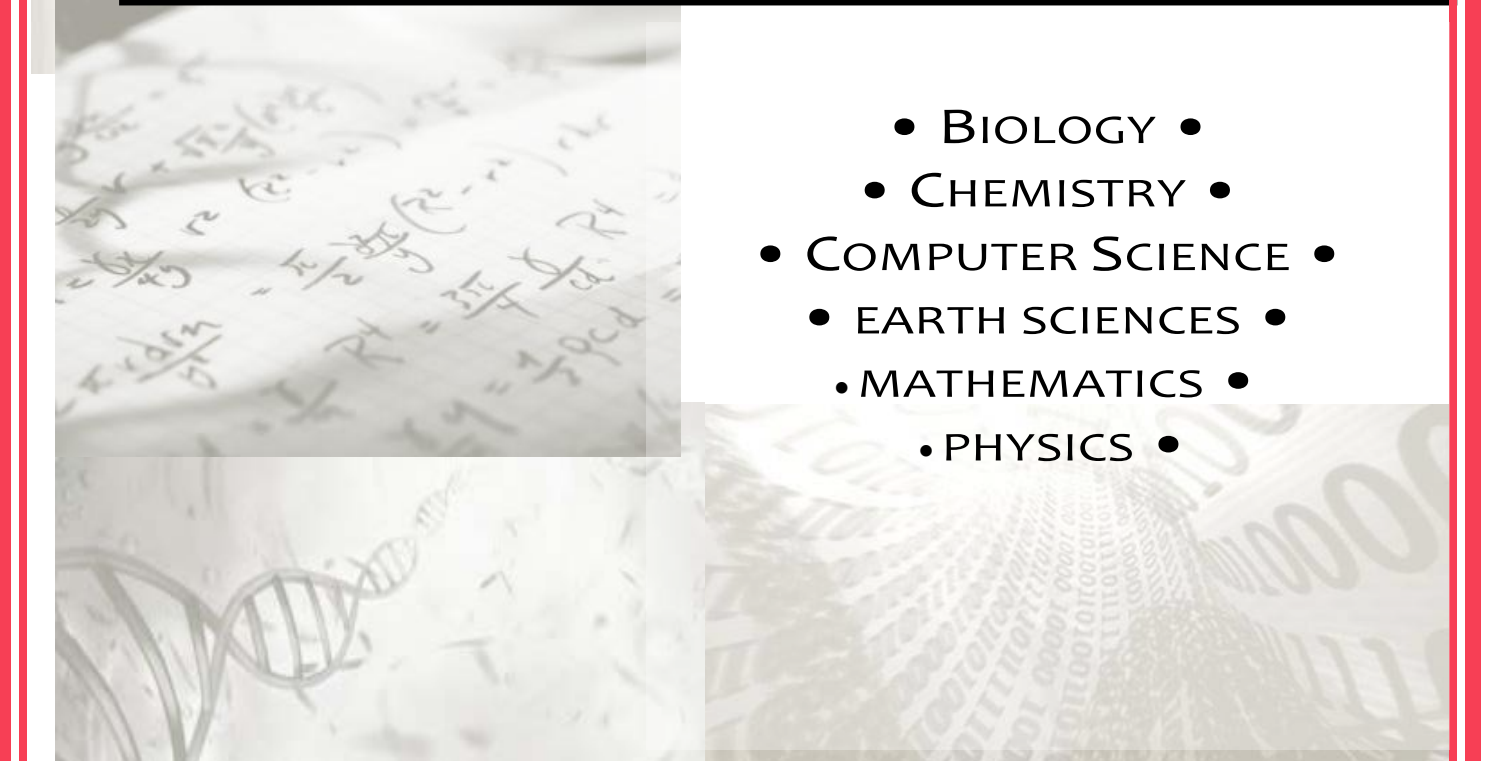## April 24 — May 1, 2012

- • Biology •
- • Chemistry •
- • Computer Science •
- • earth sciences •
- • mathematics •
- • physics •

TABLE OF CONTENTS

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

BIOLOGY

1. **Optimization and Development of PCR-based Genetic Tests to Detect Androgen Receptor Mutations Associated with Complete Androgen Insensitivity Syndrome (CAIS) and the G1754A site**

Dombach, Janae; Charles, Benjamin (2011); Hepfer, Carol E.*
Department of Biology, Millersville University, Millersville, PA 17551

Individuals affected by Complete Androgen Insensitivity Syndrome (CAIS) have both X and Y chromosomes typical of males, but they develop externally as females, and they are sterile. A mutation in the androgen receptor (*AR*) gene, located on the X chromosome, is responsible for this condition. With no functional receptor, the cells in the developing embryo are unable to detect testosterone and maleness cannot develop. Currently, to detect if a person has a mutation in the *AR* gene, DNA sequencing is used. Different methods are necessary to detect these mutations quickly and with less expense. My goal was to develop and optimize a simpler and more cost-effective method that uses PCR (Polymerase Chain Reaction) analysis to evaluate the *AR* gene. To detect mutations, PCR primers are designed to bind to known sequences within the gene of interest; one primer set matches the normal gene sequence and a second primer set matches the mutant sequence. If the 3' end of a primer does not match the DNA template sequence exactly, no product will be produced. By evaluating DNA with both primer sets, the genotype of the individual can be evaluated. Once optimized and working consistently, this test will be an effective and inexpensive way to determine the status of many potential CAIS carriers in this family. Another mutation on the AR gene was also evaluated using restriction enzymes.

2. **Antibacterial Activity of Secondary Metabolite Products of *Ailanthus altissima***

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The antibacterial properties of secondary metabolites from *Ailanthus altissima* were investigated in this study. Antibacterial activity was determined by well agar diffusions to examine for susceptibility of a broad range of bacterial organisms, *Escherichia coli*, *Flavobacterium capsulatum*, *Micrococcus luteus*, *Micrococcus roseus*, *Pseudomonas putida*, and *Staphylococcus epidermidis*, against various *A. altissima* extracts. Extracts were made using four different solvents, methanol, water, petroleum ether, and chloroform, also utilizing different tissues including leaves, outer bark, and inner bark from *A. altissima*. Leaf methanol extract was shown to have the highest effectiveness against the bacterial organisms. *F. capsulatum* and *M. roseus* showed the greatest susceptibility to the various *A. altissima* extracts; *P. putida* showed the greatest resistance to the extracts from *A. altissima*. A dose response assay utilizing the leaf methanol extracts have demonstrated a significant increase in the inhibition of *M. roseus*. Future testing is planned to explore further concentration methods of the extract and establishing isolation methods designed to determine the specific secondary metabolic products responsible for the antibacterial properties present in the extracts.

3. Identification of Sex-Specific Genetic Sequences in the Squid *Doryteuthis pealeii*

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Genetic differences are responsible for the existence of distinct sexes in most species. In mammals, females have two X chromosomes while males have one X and one Y with unique male-specific genes that trigger maleness. While an XY chromosome system determines sex in many mollusks studied to date, XO and ZW mechanisms have also been reported for this phylum. Sex determination has not been elucidated in cephalopods such as the octopus and squid. To investigate the potential existence of sex-specific genetic sequences in squid, we used amplified fragment length polymorphism (AFLP) analysis. Pools of male and female genomic DNA were separately cleaved with restriction enzymes and DNA adaptors attached to the ends of all resulting fragments to enable amplification with PCR primers. Selective amplification of specific fragment subsets was accomplished using the same primers with additional 3' nucleotides that specifically bind genomic sequences adjacent to the adaptors. Electrophoretic analysis of these AFLP products on 2% agarose gels revealed many differences in product sizes when male and female patterns were compared. Several prospective male- and female-specific bands were isolated for cloning into *E. coli* and subsequent DNA sequencing. Preliminary results with a 1.1 kb male-specific AFLP band indicate no significant homology with any previously characterized genes. DNA sequences of sex-specific bands will be used to develop sequence-specific primers that can be used to evaluate several individuals of both sexes. If a PCR product were observed consistently in all individuals of one sex only, this would verify that the sequence contained within the corresponding AFLP band is truly sex-specific. A primer set that amplifies a sex-specific marker would be useful in discerning the sex of immature individuals. Further analysis of sex-specific sequences should also provide insight into the mechanism for sex determination in this species.

4. Insight into the Evolutionary Relationship Between Short-chain Isoprenyl Diphosphate Synthases, Terpene Synthases and Triterpene synthases.

Kettering, Jonny[1]; Parker, Michael[1]; Wang, Shiliang[2]; Zhong, Yuan[1]*
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[2]Department of Bioinformatics, J. Craig Venter Institute, 9704 Medical Center Dr., Rockville, MD 20850

Short-chain isoprenyl diphosphate synthases (IDS), members of prenyltransferases, catalyze the synthesis of the key intermediates for the biosynthesis of various terpenes. Terpene synthases (TPS) catalyze the synthesis of monoterpenes, sesquiterpenes and diterpenes, while triterpene synthases (TTPS) synthesize triterpenes. So far the evolutionary/phylogenetic relationship between these three mechanistically related families remain unclear. Also unclear is the evolutionary relationship of plant and microbial IDS, TPS and TTPS. A genome-wide identification of IDS, TPS and TTPS genes, their detailed structural analysis and chromosomal localization/gene clustering as well as phylogenetic analysis of these three gene families were conducted in both *Arabidopsis* and cyanobacteria. An evolutionary model has been developed as a result of these analyses. Our results suggest that the three gene families appear to have evolved in parallel from a common ancestor in both *Arabidopsis* and

cyanobacteria, via tandem duplication and divergence, domain deletion, and domain fusion. Each family appears to have a common proximate ancestor in *Arabidopsis,* as well as in the IDS and TPS (but not TTPS) of cyanobacteria. Cyanobacteria TTPS have likely evolved from two different but related proximate ancestors. *Arabidopsis* and cyanobacteria GGPPS exhibit higher homology to each other than to the other IDS in the same species as the most conserved group among the three families. Most other subfamilies exhibit species-specific homology to each other in this study. Our results provide novle insight into the evolution, relatedness and function of short-chain IDS, TPS and TTPS.

5.   Seasonal Colonization of *Hydra* in a South-Eastern Pennsylvania Pond

Mlynek, Kevin D.; Sparr, Dustin M.; Neilson, Katherine L.; Borowski, Jenna L.; Miller, Ian P. (MU 2010); Ambler, Julie W.*; Reinking, Larry N.*
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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 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 December 2011. Six monitoring stations with multiple tiers of settling plates were positioned in a 0.2 hectare pond located in Millersville, PA (Roddy research pond). These stations were assayed every three weeks for colonization of *H. viridissima* and *H. oligactis.* In conjunction with these three week sampling cycles, zooplankton counts and several abiotic factors were measured weekly.
We found a low level (<20 total *Hydra*) of colonization from November to February, whereas in early March colonization had begun to increase (>100) with peak colonization in June (>1000). *Hydra* colonization was significantly correlated ($p<0.05$) with cladoceran, nauplii, and copepod populations. *H. viridissima* colonization was additionally correlated ($p<0.05$) with solar radiance while *H. oligactis* was not. A negative correlation ($p<0.05$) was observed between *Hydra* colonization and protozoan populations.

6.   Genomic Analysis of Terpene Synthase Gene Family in Medicago and Arabidopsis

Parker, Michael[1]; Zhong,Yuan[1]*; Dai, Xinbin[2]; Wang, Shiliang[3]; Zhao, Patrick[2]
[1]Department of Biology, Millersville University, Millersville, PA 17551
[2] Plant Bioinformatics and Genomics Laboratory, The Samuel Roberts Noble Foundation, Ardmore, Oklahoma 73401. 2010
[3]Department of Bioinformatics, J. Craig Venter Institute, 9704 Medical Center Dr., Rockville, MD 20850

Terpene synthases (TPS) synthesize the largest class of plant metabolites, terpenes, which are important for plant growth and environmental interaction, and are used extensively in manufacturing medicines and nutritional supplements, pesticides, perfumes, and essential oils. A timely genome-wide analysis and comparison of the TPS gene family was conducted in glandular trichome (GT)-bearing *Medicago truncatula* and non-glandular trichome (NGT)-bearing *Arabidopsis thaliana*. This comprehensive in silico analysis identified 33 (3

new candidates) and 24 (18 new candidates) full length TPS genes in *Medicago* and *Arabidopsis*, respectively. This study has confirmed the overall well-conserved nature of TPS functional motifs, but also revealed exceptional variation in Subfamilies A and G. The structural similarity of MtTPS and AtTPS suggesting their shared ancestry. Expression pattern analysis suggests that the more important type of expression is multi-tissue expression in *Arabidopsis* but tissue specific in *Medicago*. NGT had the highest number of expressed genes in NGT-bearing *Arabidopsis*, but not in GT-bearing Medicago, which suggests the use of NGT as the plant biochemical factory in NGT-bearing plants like *Arabidopsis,* so NGT might not merely function in physical defense as commonly believed. These findings provide novel insight into the function and relatedness of the TPS gene family members in *Arabidopsis thaliana* and *Medicago truncatula*, and pave the way for further studies and applications of this important family to enhance biomedical and agricultural production. The discovery of the genes with trichome-specific gene expression in both species provides exciting opportunity for trichome-specific genetic engineering, which could lead to enhanced environmental protection and improved safety of transgenic crops.

7.   Climatological and Ecological Factors Affecting Expression of Polyphenol Oxidase in *Ailanthus altissima.*

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A seasonal analysis of polyphenol oxidase (PPO) activity was investigated in *Ailanthus altissima*. Leaflets were collected from the Millersville University campus from May 3, 2010 to October 5, 2010 and assayed for PPO activity. Crude proteins were extracted and analyzed for activity by detecting the formation of a colored product. A negative correlation was found between PPO activity and humidity, and elevated levels of PPO were found at dormancy break and leaf senescence. There was no significant variation found within the population, suggesting that of the trees sampled, they responded in a similar manner to environmental and/or developmental cues.   Many researchers have proposed a linkage between photosynthetic activity and PPO, and thus a connection to stomatal opening and photosynthesis. In addition, many other plants exhibit increased activity of PPO during different periods of development, especially senescence. Oxidative stress may be an issue when stomata are closed, during dormancy break, and senescence, producing an environment that would favor the activation of the enzyme.

8.   Development of Larva of the Sea Urchin *Lytechinus Variegatus*

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Sea urchins are considered great animals to study development with. The development of sea urchins is rapid and easy to monitor, which makes them ideal to study because a lot can be concluded in a short amount of time. However, once the embryos reach the larval stage, they require food to continue to develop. The goal of the experiment was to keep the larvae alive through the larval stages, to investigate the development of the skeleton. Commercially available phytoplankton invertebrate diets and living *Donaliella* phytoplankton cultures were used to feed the larva. Although the commercial preparations were able to maintain the

viability of the larva, only the living phytoplankton cultures were able to support further differentiation. *L.variegatus* larva were maintained for five weeks, and a portion of them developed to the to the eight arm stage, which involves the production of an elaborate endoskeleton built of calcium carbonate spicules. The ability to maintain the lavra will allow investigation of the effects of acidic pH or UV light exposure, both of which have been reported to affect skeletal development in urchins.

9.   Competition and Social Tolerance in the Naked Goby, *Gobiosoma bosc*

Wilt, Tyler J.; Boal, Jean G.*
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Territorial behavior is a common trait of gobies. The blackeye goby, Coryphopterus nicholsi, defends territories and shelters when shelters are abundant, while exhibiting tolerant behavior and a dominance hierarchy if few shelters are available. The current project was designed to determine if the naked goby, *G. bosc*, a common and well-studied species, shows similar density-dependent territorial behavior. In Exp. 1, five tanks with six gobies each were provided with 1, 3, 6, 9, or 12 shells and social interactions were recorded. As predicted, as shelter density increased, overall aggressive behavior increased, as did patrolling and chasing. To investigate dominance interactions, in Exp. 2, five tanks with six gobies each were provided with dark or light substrate, with or without dividers to separate the gobies into solitary conditions, and body coloration was recorded. Results showed that body coloration varied between individuals, substrate brightness and social context (solitary or grouped). Taken together, these experiments show that the behavior of these perciform fish responds to both physical factors (shelter density, substrate) and social context (fish density, dominance).

10. **Progress Towards the Synthesis of Novel 1-aryl-1-trimethylsilyl-1*H*-diazirino[1,2-*b*]-phthalazine-3,8-diones**

Fraccica, Daniel; Bonser, Steven M.*
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A long term goal in our laboratory is to develop some novel diaziridine compounds that may be useful intermediates to make a certain class of pharmaceutical; namely, the 2,4-benzodiazepines. We plan to utilize a new approach to synthesizing specific diaziridines that may provide a more robust entry into the 2,4-benzodiazepine ring system. This new approach will exploit the reaction between certain silylated-diaziridines with certain 1,2-diaroyl dichloride and 1,2-dibenzene -sulfonyl dichloride compounds to generate the specific "designer" diaziridines needed for this study.

11. **Synthesis and Chemistry of Some 2-sulfobenzoyl-, and benzene-1,2-disulfonyldiaziridines,II**

McWilliams, Hannah; Bonser, Steven M.*
Department of Chemistry, Millersville University, Millersville, PA 17551

Diaziridines are three-membered ring heterocycles that contain one carbon and two nitrogen atoms. They are useful intermediates in the synthesis of more complex heterocyclic compounds, some of which have found applications in the pharmaceutical industry. Although several studies on the synthesis and chemistry of 1,2-diaroyldiaziridines have appeared in the chemical literature, there are no reports on their dibenzenesulfonyl, or their 2-sulfobenzoyl analogues. We are attempting, therefore, to synthesize a variety of these diaziridine derivatives in order to study their chemical reactivity. It is expected that this project will shed some light on how different electron withdrawing groups influences the reactivity of the three-membered diaziridine ring. Furthermore, it is anticipated that these molecules may lead to some interesting new antidepressant, antipsychotic, and anxiolytic pharmaceuticals. The results of the progress are the subject of this poster.

12. **Targeted Drug Delivery with Aptamers**

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Broadly defined, targeted drug delivery is a means to provide therapeutic concentrations of anticancer agents to specific tissues, cells, or specific disease locations without adversely affecting normal tissues. One way to accomplish this is to link a therapeutic drug to an "escort" molecule that specifically binds to the target, such as an antibody. Because there are a variety of disadvantages using antibodies in this fashion, aptamers provide a new technology as possible escort molecules. Aptamers are relatively short (12-40 base) DNA, or RNA oligonucleotides (or peptides) that have the ability to bind to target molecules with extremely high affinity and specificity. Because of their greater stability, ease of synthesis, and lower production costs, aptamers appear to be an attractive alternative to antibodies. The overall goal of this new research is to develop aptamer-based systems to deliver anti-tumor drugs to specific targeted tissues. The initial anti-tumor drug to be used is methotrexate, because it is an inhibitor of tetrahydrofolate dehydrogenase, and prevents the

formation of tetrahydrofolate, necessary for the synthesis of an essential component of DNA in rapidly growing tumors. It is our initial intention to develop a robust chemical process to synthesize new methotrexate conjugated aptamers by applying traditional organic chemical techniques that covalently link methotrexate to the appropriate aptamer-escort molecules.

13. Characterization of Wild and Commercial Yeast Strains

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This project is focused on exploring diversity among wild and commercial yeast strains. We have begun a collection of both commercial strains for baking or brewing and wild strains captured from a range of local sources. Yeast can be isolated from a variety of fresh fruits or using a flour and water mixture. We plan to geographically expand source locations as opportunity or collaboration allows. Initially, we are looking at variations in general growth properties such as doubling times, sensitivity to elevated or reduced temperatures, nutritional dependence, and the ability to use different sugars for growth. Additional testing might focus on factors more directly relevant for yeast used in baking or brewing, like proofing times and alcohol tolerance. Collectively the findings will be used to inform further study of how genetic characteristics might correlate with observed phenotypical variations.

14. Promising Ir(I) and Rh(I) NHC-Based Catalysts for Green Chemistry

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[1]Crystallographer, University of Arizona, Tucson, AZ

A new series of the little studied triazole-based N-heterocyclic carbenes (NHCs) was developed as a ligand set for iridium and rhodium complexes of the general form $[(cod)M(NHC)L]BF_4$ (cod = cyclooctadiene, L = PPh_3, NHC). Compounds were characterized by multinuclear NMR, elemental analysis, and X-ray diffraction. Ligand electronics were investigated by synthesizing the corresponding carbonyl compounds, *cis*-$(CO)_2M(NHC)Cl$, and monitoring $\nu(CO)$. Initial catalytic studies show these complexes have moderate to excellent catalytic properties for transfer hydrogenation with isopropanol as the hydrogen source.

COMPUTER SCIENCE

15.   ExSciTecH: *Ex*ploring *Sci*ence, *Tec*hnology, and *H*ealth

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The ExSciTecH (*Ex*plore *Sci*ence, *Tec*hnology, and *H*ealth) project is a collaborative effort between Millersville University and the University of Delaware. The goal of the project is to develop an application in which chemistry-based games attract and educate users, motivating them to participate in volunteer computing where they use their newly acquired skills and unused computer cycles to help discover drug side effects and efficacy.
ExSciTech is based on the existing Docking@Home volunteer computing project, in which the idle computer cycles of over a million volunteers are used to perform the complex calculations needed to determine if a particular ligand will dock with a protein. Such knowledge could lead to significant breakthroughs in the treatment of diseases like breast cancer and HIV. Our goal is to more actively involve volunteers in this process by allowing them to choose which protein-ligand pairs, from the thousands available, the system should check. To prepare volunteers for this task, we intend to develop several "Learning Games" which entertain and engage volunteers while teaching them the skills they need to effectively contribute to the project. So far we have developed a sophisticated OpenGL graphics framework that uses advanced techniques such as geometry instancing to render accurate molecular representations at low computational cost, making the application accessible to more individuals. Currently we have used this framework to create two Learning Games, "Molecule Flashcards", in which players attempt to identify and classify various molecules as they fly ever faster past the screen, and "Drag n' Dock", where players can tow a ligand into a suitable docking location on a protein. We have also developed a game creation infrastructure that allows for easy integration of new games, many more of which will follow.

16. Measuring Potential Calcium Sources from Stream Sediment Minerals in the Loch Vale Watershed, Colorado

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Sources of calcium to the Loch Vale stream are currently under debate, specifically the minerals actinolite, apatite, and zoisite for this study. There is very little soil in the watershed, so stream samples provide the best study material, especially since actinolite and zoisite compose only less than 0.26% of the bedrock. If each mineral shows solubility, then an order of relative mineral contributions of calcium to stream water can be made.

In the lab, the stream samples began as bags of dry sediment. Each sample went through heavy mineral separation, where the hard sediment was crushed to a fine powder before being wet sieved. Once clean, each sample was dried and later placed in vials to prepare for thin sectioning. Seven heavy mineral thin sections each received 400-point counts to study their composition. Zoisite percentages were highest at the outlet (LVSS7) with 39.3%. The outlet also showed the highest actinolite percentage, at 20.8%. The lowest percentages for zoisite and actinolite were at LVSS2. When plotted in a zoisite/actinolite ratio versus the distance from the outlet, a positive relationship of R^2=0.5033 is evident. There is a clear 8-fold decrease of zoisite toward the stream outlet.

Apatite is probably contributing the most to calcium levels in Loch Vale streams, as it wasn't found during point-counting, yet it is abundant in the stream bedrock. Zoisite was the second-most soluble, as the plotted ratio shows zoisite must decrease in number for the R^2 value of 0.5033 to be created. Based on these results, relative mineral solubility can be listed apatite >> zoisite > actinolite.

MATHEMATICS

17.   Periodic Orbits on a 120⁰-isosceles Triangular Billiards Table

Baer, Ben; Brown, David; Gilani, Faheem; Pavoncello, Joshua; Han, Zhigang*; Umble, Ronald*
Department of Mathematics, Millersville University, Millersville, PA 17551

Consider a billiard table in the shape of a polygon. A periodic orbit on such a table is a trajectory of a billiard ball that begins and ends at some point on a bumper with equal initial and terminal angles. The period of an orbit is the number of times the ball strikes a bumper as it traverses the orbit.   In their paper "Periodic Orbits for Billiards on an Equilateral Triangle" [Am. Math. Monthly, June-July 2008], Baxter and Umble completely classified and counted the periodic orbits on an equilateral triangle using techniques from transformational geometry and combinatorics. In this project we employ similar techniques to study the periodic orbits on a 120^0-isosceles triangle. On an equilateral triangle, all periodic orbits with the same initial angle have the same period. On the 120^0-isosceles triangle however, some orbits with the same initial angle have different periods. Specifically, if two periodic orbits with the same initial angle have periods m and n with m<n, then n=2m+2 or n=2m-2. Given an initial angle, we derive a general formula that produces the period(s) of all orbits with the given initial angle.

18.   Multidimensional Scaling: Mathematics Course Comparison and Zooplankton Abundance

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The goal of this research project is to establish a firm understanding of what multidimensional scaling is and how it can be applied. Once a thorough description of the statistical method is discussed, two applications will be explained. The first application is an example created in order to describe the multidimensional scaling process and the second application is used in order to analyze data collected from the field of biology. For the first example, a survey was taken that asked mathematics students and professors to rate all 66 pairs of 12 undergraduate mathematics courses on how similar they are. These similarity ratings were averaged and the multidimensional scaling procedure was used to compare the various mathematics courses and how they could be classified in relation to each other. The MDS configurations of the students' and professors' similarity ratings are compared and contrasted. The second application uses multidimensional scaling to analyze biological data measuring zooplankton abundance in the Southern Mid-Atlantic Bight, which includes the Delaware Bay, Chesapeake Bay, and Chincoteague Bay. Zooplankton abundance of 25 species was measured in number per cubic meter and then transformed using a log transformation. Data from 16 stations located in the area was collected in addition to other water characteristic variables. Using the Bray-Curtis similarity index, measures of similarity between each pair of stations was calculated and analyzed using multidimensional scaling. In addition, the water characteristic variables were used in a multiple regression technique designed to interpret the dimensions and underlying interpretation of the MDS configuration. The results were analyzed in order to understand how the various stations differ according to both zooplankton abundance and water characteristics of the station.

PHYSICS

19. X-ray Analysis of Magellanic Cloud Supernova Remnants

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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 Chadrasekhar 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 in the LMC, and SNR 0103-72.6 in the SMC. N103B is a young remnant in the ejecta dominated phase. SNR 0103-72.6 is a remnant 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.

20. Investigation of the Rail Gun

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The rail gun system is simple in design and clearly demonstrates the existence of the Lorentz force through the acceleration of a small object. This investigation will take a look at this rail gun system, specifically some of the interesting physics behind the limitations of the system as well as their effects on the efficiency of its operation. These limiting factors include friction, air resistance, heating within the rails, and melting as a result of a plasma arc traversing the length of the rails. This investigation will also review some design considerations for the rail gun as well as our design that will be used to compare any measured results with our theoretical predictions.

21. Electromagnetically Induced Transparency in a Four-Level W Scheme: Effect of Beam Intensity and Phase on Propagation

Lewis, Matthew; Nelson, Christopher*
Department of Physics, Millersville University of Pennsylvania, Millersville, PA 17551

Electromagnetically induced transparency is a quantum interference technique which eliminates the effect of the medium on an incident beam of electromagnetic radiation. The basic principles of electromagnetically induced transparency and its affect on the complex optical susceptibilities are investigated. Variation in the optical susceptibilities leads to a change in group velocities of incident pulses which can be manipulated through the variation

of beam intensities and phases. This is then applied to a four level atomic system in which the first excited state of a magnesium atom is split into three Zeeman states; allowing for the simultaneous co-propagation of two incident beams. To account for the ultracold, low density medium through which the beams propagate the group velocities of the probe beams are obtained using the solution of the density matrix master equation. Parameters are optimized such that both beams propagate with similar group velocities for the purpose of enabling the transfer of information.

22. X-Ray Analysis of SNR DEM L71 in the LMC

Timlin, John; Hendrick, Sean P.*
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We present our examination of the supernova remnant (SNR) DEM L71 in the Large Magellanic Cloud (LMC). DEM L71 is located 50 kiloparsecs (kpc) from Earth and is approximately 81 kpc in diameter. There are two different physical causes supernova explosions; a thermonuclear detonation of a White Dwarf star (optical Type Ia), and a gravitational core collapse of a large star (optical Type Ib/c and II). Supernova remnants undergo three different stages of expansion; the ejecta dominated phase, the Sedov phase, and the radiative phase in which the energy or momentum of the ejecta is conserved. DEM L71 is a supernova remnant in transition into the Sedov phase, however there is still an ample amount of ejecta to observe. Data is taken using the *Chandra* X-ray satellite and is downloaded from NASA's High Energy Astrophysics Science Archive Research Center (HEASARC) website. It is then processed with the program Chandra Interactive Analysis of Observations (CIAO) to create images of the remnant and spectral files. These files are used in an X-ray fitting package (XSPEC) to determine elemental abundances and to fit models to these files. To analyze the ejecta filled center region, we will use the parallel-plane shock (*pshock*) and non-equilibrium ionization (*nei*) models. The limb regions will be analyzed by the *Sedov* model. Using the best fit *Sedov* model, we can find the age, initial explosion energy, mass, and chemical composition of DEM L71.

INDEX

Millersville University