Student Research Poster Symposium

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Continuous Dependence Results for Ill-Posed Evolution Problems

Matthew Fury and Rhonda Hughes
Bryn Mawr College

We prove Hölder-continuous dependence results for the difference between certain ill-posed and approximate well-posed evolution problems. Specifically, given a positive self-adjoint operator $D$ in a Hilbert space, we consider the ill-posed evolution problem $du(t)/dt = A(t,D)u(t), u(0) = \chi, 0 \leq t < T$. We determine functions $f$ for which solutions of the well-posed problem $dv(t)/dt = f(t,D)v(t), v(0) = \chi, 0 \leq t < T$ approximate known solutions of the original ill-posed problem, thereby establishing continuous dependence on modeling for the problems under consideration.

Welcome from the Poster Symposium Organizers

Welcome to the 2009 Villanova University Sigma Xi’s Student Research Poster Symposium! Sigma Xi is the international honor society for research scientists and engineers. The Villanova chapter of Sigma Xi is proud to sponsor this poster symposium event to recognize and celebrate the research work accomplished by our students, and to give students an opportunity to further develop their skills in communicating those accomplishments.

This book contains abstracts of 44 contributed posters. Many thanks to all students who contributed to this symposium. We gratefully acknowledge the dedicated poster judges who committed to evaluating the research posters and providing written feedback at the end of the symposium. Special thanks for their time and commitment to promoting research at Villanova University.

Outstanding posters will be recognized in the form of poster awards. In keeping with recent tradition, the induction ceremony for new Sigma Xi members will follow the student award presentations.

Congratulations to all!

Phil Maurone Sigma Xi Chapter President
Robert Styer Sigma Xi Chapter Past-President
Mirela Damian Sigma Xi Chapter President-Elect
Sridhar Santhanam Sigma Xi Chapter Secretary-Treasurer
Robust Classifier of Radar Backscatter Imagery Using Linear Prediction Model

Dr. Bijan Mobasseri, Imad Estephan
Center for Advanced Communications, Electrical Engineering

The main task of this project is the design and implementation of a robust classifier for through-the-wall radar images. Radar images are produced by probing the scene with an array of sensors, followed by conventional delay and sum beamforming of the collected data. However, the radar images obtained from the raw backscatter data are not easily interpreted because of the presence of reflections unrelated to real objects. The challenge in image classification occurs when trying to classify an object located at a position different from the training position initially used to create the database. Our technique uses principal component analysis (PCA) as a dimensionality reduction tool, the Mahalanobis distance as our classifier, and linear prediction for aligning unknown targets appearing at arbitrary locations in the scene prior to classification. This approach builds a classifier that is robust to target displacement in the scene.
Modeling Reverberation on Watermark-Carrying Sonar
Preethi Krishnamurthy and Dr. Bijan Mobasseri
Electrical and Computer Engineering, Villanova University

Underwater communications finds applications in ocean sensing, shipping and anti-submarine warfare. Sound navigation and ranging (Sonar) signals are typically used for this purpose. The propagation of sound underwater is mainly determined by reverberation, temperature, pressure, depth, noise, transmission loss and spatio-temporal variability of the channel. The main contribution of this research is in modeling the effects of reverberation on the sonar echoes. This knowledge is required to understand the effect of acoustic channel on identifying sonars based on embedded watermarks. Time-varying multipath influences signal design and processing, imposing limitations on the performance of the watermarks. Although watermarking itself has appeared in a host of applications previously, they have not been used in sonar. The challenge is in designing watermarks that survive the acoustic channel.

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Yao Spanners for Wireless Networks
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Department of Computer Science, Villanova University

Wireless nodes are often powered by batteries and have limited memory resources. These characteristics make it critical to compute and maintain, at each node, only a subset of neighbors that the node communicates with. The collection of nodes and their neighbors define a graph called topology graph. An important topology graphs is the Yao graph, which can be constructed and updated efficiently in a dynamic environment. Let P be a set of points in the plane representing wireless devices. The Yao graph Yk(P), for k > 2, is defined as follows. At each point u ∈ P, any k equal-separated rays originated at u define k cones; the Yao graph Yk contains edges connecting u to a nearest neighbor in each nonempty cone, for a total of at most k edges incident to u.

It is a standing open problem to determine whether the Yao graph Yk is a t-spanner, for some constant t > 0 and k < 6: for any pair of vertices u, v ∈ P, the shortest path in Yk from u to v is no longer than t times the Euclidean distance between u and v. We make progress towards resolving this problem by showing that Y4 is a (12 + √2)-spanner for sets of points in convex position. For a fixed vertex pair u, v ∈ P, our method constructs a path of Yao edges confined to the smallest square square passing through u and v, and defines a relationship between the length of this path and the boundary of the square. We also show that a related Yao-based graph, called Yao-Yao, is a spanner for point sets of bounded aspect ratio.
Let $S$ be a set of $n$ points in general position in the plane (i.e., no three points of $S$ are on a line and no four points of $S$ are on a circle). Connect each pair of points $u, v \in S$ for which there is a circle passing through $u$ and $v$ that contains no points of $S$ in its interior. The resulting structure is a graph $\text{Del}(S)$ with vertex set $S$, called the Delaunay triangulation of $S$. It has been shown that $\text{Del}(S)$ is a spanner with stretch factor $t = 4\pi\sqrt{3}/9$, meaning that for each pair of vertices $u, v \in S$, the shortest path in $\text{Del}(S)$ from $u$ to $v$ is no longer than $t$ times the Euclidean distance between $u$ and $v$. One attractive property of $\text{Del}(S)$ is planarity: no two edges cross each other in $\text{Del}(S)$. Planar topologies enable the use of good routing strategies for wireless ad-hoc networks, where battery and memory resources are scarce and must be used efficiently. In the case of Delaunay topologies, the efficiency of routing depends on the stretch factor of $\text{Del}(S)$.

It is widely believed that $\text{Del}(S)$ has stretch factor $\pi/2$. We investigate this conjecture experimentally for complete Euclidean graphs and for unit disk graphs, which are better wireless network models. For each class of graphs, we determine the maximum stretch factor and the average stretch factor, computed over 20 random graphs. In the case of Euclidean graphs, we obtained values of $0.35\pi$ and $0.2\pi$ respectively; in the case of unit disk graphs, these values are $0.4\pi$ and $0.25\pi$ respectively – slightly larger, supporting the intuition that unit disks graphs have fewer edges (and consequently longer paths) compared to complete Euclidean graphs. Our results support the conjecture that $\text{Del}(S)$ has stretch factor $\pi/2$.

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1 This work was supported by NSF grant CCF-0728909.
In the context of Service Oriented Architecture (SOA), the non-functional aspects such as service granularity, composition, and orchestration become an overarching concern due to their impact on service usability and return of investment. Assessment of these attributes and emergent behaviors should be carried out at the architecture design stage. Colored Petri Nets (CPNs) being a graphical modeling language suitable for modeling concurrent and distributed systems with synchronous and asynchronous communications, offer a natural choice for this endeavor. This work describes steps and approach to create an executable Colored Petri Net model by means of an example service orchestration. Design alternatives are evaluated by means of collecting and analyzing simulation data.
Distributed Expertise involves the integration of computing with other disciplines like engineering, sciences, business, and arts and explores the challenge by bringing together instructors and researchers across the disciplinary boundaries. This project is collaborated by Villanova University, Virginia Tech, and The College of New Jersey (TCNJ). The first activity of the project was a new Game Development course introduced at Villanova University through collaboration with TCNJ and is offered to students of any major and attracted students from majors of Computing Sciences, Computer Engineering, English, Psychology and Business.

All students in the class are designated as Liaisons for the games like Rice, Role Playing Game (RPG), and Super Character's Name Land (SCNL) and game developing tools that are developed at TCNJ. Games developed in this course include **Snake Game** and **Total World Domination** games developed using Processing, **Treasure Huntia**, developed on Torque software, **Mancala**, developed on Flash software using Action Script& **Jewel Nabber**, **Zombie Nation** and **Zombie Township** games developed using the Game Maker software.

The poster will describe the accomplishments of this course, including lessons learned with regard to cross-institutional collaboration. This project is funded by National Science Foundation (NSF).

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BK Lyn: A Unique Nova-Like Variable Below The Period Gap with a Hot White Dwarf

R.-L. Ballouz¹, E.M. Sion¹, B. Gänsicke², K. Long³, P. Szkody⁴
¹Villanova University, ²University of Warwick, ³Space Telescope Science Institute, ⁴University of Washington

BK Lyn is a nova-like variable observed with HST as part of a multi-HST cycle CV snapshot survey (B. Gaensicke, PI) which was only partially completed due to the failure of STIS. With an orbital period of 108 minutes, BK Lyn is the only bona fide nova-like variable lying below the CV period gap. Using the method of Knigge (2006, MNRAS, 373, 484), its distance lies within the range 116 to 281 pc. Optically thick accretion disk models yield distances in excess of 1.5 kpc. We have found good synthetic spectral fits with white dwarf model photospheres having Teff between 38,000 K and 34,000 K, log g between 7 and 8.6 and model-derived distances of 137 and 303 pc, respectively. Both distances are in reasonable agreement with the Knigge distance range. The white dwarf may be the hottest CV primary below the period gap. The evolutionary significance and implications of BK Lyn are discussed.

Applications of Computing Ontology

Dr. Lillian (Boots) Cassel, Siva Kumar Inguva²
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An Ontology is a semantic form of knowledge representation that deals with a set of concepts within a domain and the relationship between those concepts. The Computing Ontology describes various disciplines, topics, and subtopics that belong to the domain of Computing Sciences. It also describes the ways in which these topics and subtopics are related to each other and to various sub disciplines. Creating and maintaining a computing ontology can come in handy for various real time applications such as Curriculum Developments, Indexing of Digital Libraries, and supporting searching.

This poster describes two major applications of ontology, one project in which a computing ontology is created and given a visual and user friendly interface using action scripting and flash. The application of this visualization project is to know the inter-relations and the bridges among various disciplines of the computing sciences. The other project is using the ontology as an index into a Dspace [software developed by MIT Libraries and HP Labs provides a useful and relatively easy-to-maintain digital library system] digital library of computing materials.
Ensemble: Enriching Communities and Collections to Support Education in Computing

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Department of Computing Sciences, Villanova University

Ensemble is a new NSF NSDL Pathways project working to establish a distributed digital library for computing education. This project is funded by the National Science Foundation. The project includes the CSTA portal for teaching materials for teachers in schools. Ensemble adds a computing pathway to the existing set of NSF STEM Digital Libraries (NSDL). The addition ensures that the NSDL pathways provide a more complete coverage of STEM areas. The computing pathway supports the full range of computing education communities, provides a base for the development of programs blending computing with other STEM areas, and produces digital library innovations that are propagated to other NSDL pathways.

The main goals of this project are to (a) Building a distributed portal providing access to a broad range of existing educational resources for computing while preserving the collections and their associated curation processes. (b) Encouraging contribution, use, reuse, review and evaluation of educational materials at multiple levels of granularity. (c) Creating and disseminating materials to support the implementation of the curriculum. Facilitate sharing of projects/ideas among members.

Ensemble is funded by the National Science Foundation, NSDL program, DUE 0840713. This is a collaborative project of the authors plus Lois Delcambre, Edward A. Fox, Richard Furuta and others.

Eclipsing Binaries that Don't Eclipse Anymore: The Cessation of Eclipses of the former Eclipsing Binary QX Cas

Bonaro, Michael; Guinan, E. F.; Prsa, A. and Zola, S.
Department of Astronomy and Astrophysics

We report on the cessation of eclipses of the former 6-day eclipsing binary QX Cas. In 1954 QX Cas (B1 IV-V + B3 V) was discovered by Erleksova (1954; Astr. Circ. 155) to be a 10th-mag eclipsing binary (P = 6.005 days) in the field of the young open cluster NGC 7790. To secure modern light curves, we have carried out UBVRI photometry using the 0.8m Four College Automatic Photoelectric Telescope (FCAPT). Photometry was conducted on >110 nights and the observations now cover all the phase-space of the binary. However, this photometry show no evidence of eclipses. Thus QX Cas is no longer an eclipsing binary! We present the analysis of previous light curves and the analysis of recent spectroscopy and HST observations of QX Cas to determine its orbital and physical properties. We discuss the reasons that could cause QX Cas to cease eclipsing. These include binary system disruption or an impulsive orbital change from a close encounter with another cluster star or (more likely) orbital perturbations from a putative bound tertiary companion.

This research is supported by NSF/RUI Grants AST05-07542 & AST05-07536 as well as NASA Grant HST-GO 10116 which we gratefully acknowledge.
Far Ultraviolet Spectroscopic Explorer Satellite
Observations of α Centauri B

K.M. Datin¹, L.E. DeWarf, E.F. Guinan, and J.M. Carton¹
Astronomy & Astrophysics

Over the last several decades we have been carrying out a study of stellar magnetic activity, dynamos, atmospheric physics, and spectral irradiances from a sample of solar-like G0-5 V stars with different ages. One of the major goals of this program is to study the evolution of our Sun's X-ray through UV spectral irradiances with age. Of particular interest is the determination of the young Sun's high levels of high energy fluxes because of the critical roles that X-ray and FUV coronal through chromospheric emissions play on the photochemical and photoionization evolution (and possible erosion) of early young planetary atmospheres and ionospheres.

Motivated by the upcoming exoplanetary search missions (Kepler, Eddington, SIM, Darwin/TPF) that will search for earth-size planets in the habitable zones of nearby G-M stars, we are extending this program to cooler, less luminous (but much more numerous) early K-type stars, such as α Centauri B (HD128621; \( V = 1.33; \ (B-V) = 0.88; \tau = 5.5 \) Gyr). This program parallels our “Sun in Time” program, but extends the study to stars with deeper convective zone depths.

We gratefully acknowledge support by NASA Grants NNX06AC45G, NNX08AG95G, and the Villanova University Research for Undergraduates Award Program.

Experimental Evaluation of GFRP Bars as Reinforcement for Cast-in-Place Bridge Decks: Low Cycle Fatigue Study

Joseph Yost and Angela Russo²
Civil and Environmental Engineering

Corrosion of steel reinforcement in cast-in-place concrete bridge decks is a costly burden on the nation's and world's transportation infrastructure. Long term durability of bridge decks can be significantly improved by replacing the corrosion prone steel reinforcement with high strength, noncorrosive glass fiber reinforced polymer (GFRP) reinforcement bars. Experimental evaluation of GFRP bars as structural reinforcement for highway bridge decks must recognize the load and support conditions specific to this application. Laboratory testing should consider load magnitudes associated with AASHTO service, strength and fatigue limit states, indeterminacy of the deck in the transverse direction, two-way distribution of wheel loads, and load application and deck support conditions as affected by truck tire contact area and girder flange stiffness, respectively. In this research study 2-span continuous concrete beams doubly reinforced with GFRP bars are tested under load and support conditions designed to simulate performance of the GFRP reinforcement in a highway bridge deck environment. Test results related to deflection, concrete and GFRP strains, and crack widths are presented.
Prior to the 1994 Northridge earthquake in California, steel moment frame buildings were thought to perform well under seismic loading conditions. Though none fully collapsed, over 200 buildings with steel moment frames as their primary lateral force resisting system experienced brittle fractures within column to beam connection elements. These fractures were typically initiated in the column-beam flange welds and many propagated into column faces creating an extremely hazardous, weakened condition. Much research has been conducted in order to better understand the behavior steel moment frames, as well as to develop new connection types that demonstrate adequate structural performance under seismic loading conditions. Prior research suggests that castellated and cellular beams may perform well under such conditions due to inelastic deformation developed in the beam web away from the column face, however no explicit tests have been conducted. The primary goal of this study is to gain an understanding of the behavior of castellated and cellular beams in steel moment frames. Both analytical modeling methods and full scale testing of beam to connection assemblages are to be employed in order to demonstrate that such beams exhibit sufficient strength, ductility, and stable failure mechanisms under seismic loading. Ultimately, an AISC prequalified connection is desired to enable widespread use of castellated and cellular beams in steel moment frame construction.

The Trojan asteroids provide key clues about the evolution of our, and feasibly other, planetary systems. Despite their importance, a scarcity of data is available, leading to rough estimates of radii, rotational period, and albedo. Previously obtained spectra using the Infrared Telescope Facility at Mauna Kea Observatory have all proven to be featureless in the shorter wavelength visible and near infrared (0.4 – 2.5 microns) region, thus limiting our ability to make composition conclusions. For this reason we have studied 17 asteroids residing in the fourth and fifth Lagrangian points of the Jupiter-Sun system using the Infrared Array Camera on the Spitzer Space Telescope at four wavelength bands: 3.6, 4.5, 5.8, 8.0 microns. New radii, visible geometric - and channel specific-albedos were calculated and combined with short wavelength visible and NIR spectra for compositional analysis. Specifically, we are searching for absorptions at wavelengths greater than 2.5 microns attributable to water ice, hydrated silicates, and/or macromolecular organic material. For additional perspective, new light curves have been obtained for several objects from the 1 and 3 meter telescopes at Lick Observatory since 2004, improving period estimates and enabling us to compare data within rotation context/ phase for each asteroid.
We present an analysis and preliminary fundamental properties of the eccentric eclipsing and spectroscopic binary system, MACHO*053648.7-691700, in the Large Magellanic Cloud (LMC). This is a detached system consisting of two similar late-O or early-B components with a 3.85 day period. Previously published CCD u, V, and Ic photometry (Bayne et al. 2004) and HST/STIS spectroscopy obtained by us were used to analyze the system. The modeling of the light curve reveals the temperature ratio and relative radii of the component stars, as well as the orbital inclination, longitude of periastron, and eccentricity. The radial velocity study, when combined with the photometry, reveals the temperatures, radii, reddening, and masses of the stars. Of particular importance is the distance to this system, obtained from a knowledge of the radii, temperatures, and reddening, since the location of the system is within ~7 arc-min of SN 1987A, whose distance is thought to be known accurately.

The Girder-Slab System is a new and innovative technology developed in the field of civil engineering design and construction. The Girder-Slab system is comprised of a modified concrete slab and asymmetric steel girder system. The steel girders are castellated and have a depth of 8 inches. The concrete slab is made by assembling numerous 4’ x 28’ x 8” hollow core concrete planks. Both the steel girder and concrete plank are grouted together with reinforcing steel to achieve composite action. Full Scale and component testing will be performed under various loading patterns and magnitudes.

The goal of my research is to establish a better understanding of how the Girder-Slab System behaves. Methods to calculate the effective width of the structure (how much of the concrete plank contributes to the strength of the steel beam) are also a main focus. Three methods to find the effective width that will be used include: concrete slab surface strain, steel girder profile strain, and deflection analysis of the steel girder. In the future this information will give structural engineers flexibility in their design.
Concrete Sustainability with Alkali Activated Cements

Jamie Mucha
Civil and Environmental Engineering

Most of the concrete produced today contains ordinary portland cement (OPC) as the main cementitious material. The production of OPC emits large amounts of carbon dioxide into the Earth’s atmosphere. Carbon dioxide, which is approximately 85% of all greenhouse gases, contributes significantly to the global warming problem. Portland cement production itself accounts for roughly 5% of the total carbon dioxide emissions worldwide. As such, the need exists to create more sustainable concrete with lower environmental impact. One method to enhance the sustainability of concrete is to replace OPC with a ‘green cement.’ The ‘green cement,’ designed by Drexel University, eliminates portland cement from the concrete and replaces it with a combination of slag, sodium carbonate, and lime. Sodium carbonate activates the slag and lime to create the binding phase of the green cement. The purpose of this research is to determine the mechanical properties of the cement, such as strength, shrinkage, creep, and time of set, to evaluate performance of ‘green cement’ in comparison with traditional OPC.

The Accretion Rates and White Dwarf Components of Nova-Like Cataclysmic Variables

T. Mizusawa, J. Merritt, M. Bonaro, S. Foran, C. Plumberg, H. Stewart, T. Wiley, R.-L. Ballouz, E. Sion
Astronomy & Astrophysics

We present the results of a multi-component synthetic spectral analysis of the archival far ultraviolet spectra of several key nova-like variables including members of the SW Sex, RW Tri, UX UMa and VY Scl subclasses: KR Aur, V795 Her, BP Lyn, V825 Her, HL Aqr, RW Tri and V425 Cas. Accretion rates as well as the flux contribution of the accreting white dwarf are included in our analysis. Except for RW Tri, which has a reliable trigonometric parallax, we computed the distances to the nova-like systems using the method of Knigge. For KR Aur, we find that the white dwarf has $T_{\text{eff}}=29000\pm2000$K, $\log g = 8.4$ and contributes 18% of the flux while an accretion disk with accretion rate $M(\dot{m})=3\times10^{-10}$M$_{\odot}$/yr at an inclination of 41 degrees, contributes the remainder. Our analysis of seven archival IUE spectra of RW Tri at its parallax distance consistently yields a low mass (0.4 M$_{\odot}$) white dwarf and an average accretion rate, $M(\dot{m})=6.3\times10^{-9}$ M$_{\odot}$/yr. We discuss the implications of our results for the evolutionary status of nova-like variables.
Neuronal Differentiation in the Rapidly Growing Chick Embryo Brain

Charity Calloway and Dr. Mary Desmond, PhD
Villanova Summer Research Grant

The chick embryo is used as a model for vertebrate brain growth because of the ease in accessing the brain. Moreover, chick brains are similar to mammalian brains. The early vertebrate brain is composed of a large cavity surrounded by the neuroepithelium. A critical time in brain development is when the neuroepithelium becomes greater than the cavity. During this time, cell proliferation and neuronal differentiation are directed by the pressure created by and trophic factors contained in the cerebrospinal fluid (CSF). Based on previous work demonstrating that DNA synthesis abruptly declines throughout early brain growth, this project aims to demonstrate that during the downregulation of DNA synthesis the neuroepithelium is primarily undergoing neuronal differentiation. As the brain tissue continues to expand neurons in the brain pass through three phases of differentiation; early, middle and late. This study used HH chicken embryo stages 21, 23, 25, 28, 30, and 39 to detect neuronal differentiation throughout the expanding chick brain. I hypothesize that neurons in the early phase of differentiation will be expressed in early stages while intermediate and late neuron differentiation will be detected in middle and older stages, respectively. I further hypothesize that the distribution of the neurons across the width of the neuroepithelium will change over this time period and may differ for the forebrain and midbrain. To assess neuronal differentiation in the neuroepithelium, specific markers for each phase of differentiation were used. Results indicate nestin expression is not detected between stages 25 and 30, but is found to be present in stage 39. Beta-3-tubulin is detected in all stages, but only heavily expressed in all regions of the neuroepithelium during and after stage 25. NeuroD is not detected until stage 25, where it is most concentrated in the forebrain.

Flexural Behavior of Continuous GFRP Reinforced Concrete Beams

Matthew DeSimone, & Shawn Gross, Ph.D.
Civil Engineering Department

Twelve three-span continuous reinforced concrete beams were tested under service-level loads using various distributed loading schemes. The amount of reinforcement was the main parameter that was investigated. Three beam variations were designed and tested: Glass fiber-reinforced polymer (GFRP) reinforced concrete beams with a balanced reinforcement ratio, over-reinforced GFRP reinforced concrete beams, and control steel-reinforced beams were tested. The experimental results are used to analyze the flexural behavior of GFRP reinforced concrete beams under service loads. Comparisons are made to existing design methodologies and modifications to those methodologies are suggested as an outcome of this work.
Design and Behavior of Ductile Open Web Steel Joists: Phase II

Paul A. Cianci, Joseph R. Yost, Shane Moran
Civil Engineering: Structural Engineering Teaching & Research Laboratory (SETRL).

Open web steel joists are prefabricated steel trusses commonly used in roof and floor structural systems. When loaded to its maximum capacity, an open web steel joist can fail by either yielding of a critical tension member or buckling of the critical compression member. When the failure mode is yield, the force resisting capacity of the joist remains intact as inelastic deformation occurs. When the failure mode is buckling, the force resisting capacity of the joist instantly reduces to zero. Considering this behavior the ductile design is the desired mode of failure. Currently, there is no requirement that the mode of failure be governed by either tension yield or compression buckling. The purpose of this study is to develop a design methodology that ensures that the failure sequence is tensile yield first followed by inelastic deformation and ultimately terminating in secondary failure by compression buckling. To achieve this goal, a series of steel tests were conducted at Villanova University’s Structural Engineering Teaching and Research Laboratory (SETRL). Experimental results show that it is economically feasible to achieve the desired ductile mode of failure and that ductile behavior was achieved without any increase in cost or reduction in strength.

Field and laboratory growth estimates for the sea urchin Lytechinus variegatus in Bermuda

Victoria Garcia, Michael P. Russell, Thomas A. Ebert, Andrea Bodner
Biology Department

Lytechinus variegatus is an abundant sub-tropical and tropical sea urchin found as far north as North Carolina (USA) and extending as far south as Brazil. We conducted a tagging study for 1 year (2005 – 2006) in Bermuda to estimate growth and longevity. All individuals were collected from two field sites in 2005: Flatts Inlet (n=245) and Emily’s Bay (n=242). We recorded test diameters, injected them with the fluorochrome calcein, and released them back into the field. Concurrent with the field study we collected a sample to hold in the laboratory (n=117) – these sea urchins were also tagged with calcein. In the lab sea urchins were held in a concrete tank, lined with coral rocks, and stocked with seagrass on a periodic basis. After one year all samples were collected, test diameters recorded, and skeletal elements cleaned with Sodium Hypochlorite (household bleach). The demipyramids of Aristotle’s lanterns, which is the urchin’s feeding apparatus, were measured and examined under UV illumination for the calcein tag. Field results indicate a high degree of immigration and emigration. We recovered 498 sea urchins with 11 tagged and 22 with zero tagged from Flatts Inlet and Emily’s Bay respectively. There was a significant difference in the jaw-test allometric relationships between the lab and Flatts Inlet samples indicating the lab sample was food limited. Growth parameters for the Tanaka function will be reported for both the lab and Flatts Inlet samples.
The Phylogeography of the *Trachylepis* genus;  
Specifically a detailed look at the *T. striata* complex and  
the widespread distribution and naming of *T. varia*  
species.

Brandon Eck, Dr. Aaron Bauer, and Dr. Todd Jackman  
Villanova University Department of Biology

The genus *Trachylepis* is one of the most widespread and  
species rich genera of lizards in Africa, and among the most speciose of  
all scincid genera. Previous phylogenetic studies have examined only a  
few of the outstanding taxonomic issues of *Trachylepis* and have not  
included large, taxon complete data sets, or have used only  
morphological data to determine taxonomic relationships within this  
genus. Using a large set of sequenced data including approximately 250  
specimens from 48 taxa, support has been gathered to determine broader  
relationships within this genus, and particularly within the species *T. varia* and the *T. striata*. Extensively sequencing mitochondrial and  
nuclear genes has lead to the generation of phyletic trees that show  
support for taxonomic changes within this genus. Many *Trachylepis*  
species exhibit very similar morphology though they are reproductively  
isolated (cryptic speciation). The results of this study gather support to  
identify the type localities of the *T. varia* species and bring species  
names out of synonymy. In 2000 Donald Broadley proposed that the  
species included in the *T. striata* complex be raised to full species status  
based primarily on morphological data. The results show that the  
hypothesis proposed by Broadley is further supported by these results.

The Characterization of an Unusual β-Hydroxybutyrate  
Dehydrogenase from Trypanosomes

Meghan Hickey and Jennifer Palenchar  
Chemistry Department

There are many unusual features of energy metabolism in African  
trypanosomes, the unicellular eukaryotic parasites responsible for  
African Sleeping Sickness. For example, several of the glycolytic  
enzymes are compartmentalized and are regulated uniquely. We have  
identified an unusual trypanosomal β-hydroxybutyrate dehydrogenase  
(HBDH), an enzyme involved in the production of ketone bodies. This  
enzyme, which catalyzes the reversible NADH-dependent conversion of  
acetoacetate to hydroxybutyrate, closely resembles bacterial forms of the  
enzyme. Furthermore, unlike its homologs in higher eukaryotes, the  
trypanosome enzyme appears not to be a membrane protein. We have  
cloned this enzyme from *Trypanosoma brucei* genomic DNA,  
overexpressed soluble protein in *E. coli*, and have purified active enzyme  
to approximate homogeneity. The preliminary kinetic characterization of  
this enzyme is presented.
The Role of Ly-6 in serum IgA expression, with $\lambda$ light chain, in Gut Associated Lymphoid Tissue

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The first barrier of protection in many genes is mucosal tissue. Mucosal immunity is essential in fighting infection. B lymphocytes in the lamina propria produce and secrete immunoglobulin A (IgA), a critical mediator in fighting harmful pathogens that can penetrate the tissue. The Ly-6 gene is a family of proteins with expression patterns in developing immune cells whose functional role in the development and function of B lymphocytes is unknown. Studies showed that mice with Ly-6 knockout mutation had significantly elevated serum levels of IgA with $\lambda$ light chain compared to C57 Bl/6 wildtype control mice (Jones, M 2008). This suggests an enhanced presence of serum IgA in mucosal tissues; specifically the gut associated lymphoid tissues (GALT), including Peyer’s patches, lymphoid nodules in the ileum. In this study I report increased IgA and Ig $\lambda$ expression on the surface of B lymphocytes in the GALT and Peyer’s patches of Ly6 deficiency. This study will provide insight into the mechanism of IgA by B cells and the role of the Ly-6 protein, which will enhance understanding of immunoglobulin isotype, IgA, and more specifically, the $\lambda$ light chain. This can then impact development of vaccines against pathogens that attack mucosal tissues.

Estimating Echinoid Test Volume

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The purple sea urchin, *Strongylocentrotus purpuratus*, occurs along the west coast of the United States, and shows considerable phenotypic plasticity in response to varying environmental conditions throughout its range. Typically, diameter has been the metric used to quantify and compare populations both between and within habitats. However, diameter is not an accurate reflection of overall size because it does not account for variations in shape and height:diameter ratio. Volume is a superior indicator of urchin size and two formulas have been proposed to estimate urchin volume: The Vasseur formula (1952) and The Oblate Spheroid formula. The accuracy of these formulas has never been evaluated. To find a formula that will accurately predict volume when only height and diameter are known, the volume of 572 urchins was empirically determined in the lab. The urchins were collected from 16 sites along the geographic range and encompassed the size and shape spectrum. The Vasseur formula was found to underestimate volume whereas a modified elliptical spheroid provided a better estimate. This formula allows for estimates of urchin volume to be easily determined in the field. Using volume as the basis of urchin size instead of diameter will yield different results in allometric studies.
Endocrine disrupting compounds (EDCs) are environmental chemicals that mimic endogenous hormones in structure and function. Bisphenol A (BPA), an estrogen-mimicking EDC, is found in polycarbonate plastics and epoxy resins. BPA frequently leaches out and can bind the estrogen receptor, activating expression of estrogen-regulated genes and inducing various morphological changes. This research investigates whether and how BPA acts synergistically with the main form of estrogen, 17β-estradiol (E2), in the adult, ovariectomized mouse model to alter estrogen-regulated gene expression and morphological changes in uterus and mammary tissue. C57/Bl6 mice received orally administered BPA (50 mg/kg/day) and one of three doses (0.04, 0.4, or 4 μg/kg/day) of injected E2 over seven days. Analysis of extracted uteri and mammary glands indicated that BPA does not modulate the increase in uterine weight associated with higher levels of E2. BPA appears to act synergistically with high doses of E2 for expression of C3, an estrogen-regulated gene in the uterus, but antagonistically at low and medium E2 doses. In the mammary gland, the gene expression response is less dramatic, although synergism between BPA and E2 seems present at high E2 levels. Thus, BPA differentially modulates estrogen responses depending on the dose of E2.

Previous studies on human embryonic brain growth revealed that the ratio of cavity to tissue in the forebrain, midbrain, and hindbrain favors cavity in earlier stages of development, but also that this ratio switches to favor tissue between stages 21-24 of development. In addition, the growth patterns of the human and chick embryonic brains show similar characteristics, suggesting comparable mechanisms of growth. Initially, the chick and human embryo brain cavities are filled with cerebrospinal fluid that generates pressure. This pressure is essential for early brain growth in the chick embryo and is maintained because the neurocoel is occluded posterior to the brain. This project aims to determine the exact stage at which a change in the ratio of cavity to tissue in chick embryos occurs. The brains of White Leghorn chicks, at stages 21, 23, 25, 28, and 30 of development, were processed, sectioned, measured, and then analyzed. We predict that stages 21 - 23 will have an equal proportion of cavity to tissue. Likewise, we predict that around stage 23 – 25 of development, the ratio will switch to favor tissue. Our findings will add further support to our hypothesis that early brain growth in vertebrates is similar, particularly in the chick and human. Such corroboration allows us to do further experiments on the chick embryo to increase our understanding of the mechanisms underlying human congenital conditions, such as spina bifida and hydrocephaly.
Shivering thermogenesis (ST) in skeletal muscle has been considered the primary mode of thermogenesis in birds, but the discovery of avian uncoupling protein (avUCP) in muscle mitochondria raises the possibility that regulatory nonshivering thermogenesis (NST) may also be important. Precocial birds possess some thermogenic capabilities at hatching, but their small muscle size may prevent them from relying solely on ST. NST may be further induced through exposure to chronically cold ambient temperatures during development. To investigate this possibility, Japanese Quail were acclimated to cold (5°C) or warm temperatures (25°C) for three weeks starting at age 14d posthatching (CA and WA birds, resp.). Previous work revealed that pectoralis muscle of CA birds possessed more avUCP, but, contrary to predictions, mitochondrial area (as %total fiber area) was not elevated. However, muscle mitochondria of CA birds possessed more cristae, suggesting that muscles of CA birds may have higher catabolic capacities to support both elevated ST and NST. Activities of the regulatory enzymes pyruvate kinase, citrate synthase, and β-hydroxyacyl-CoA-dehydrogenase were assayed spectrophotometrically in pectoralis and gastrocnemius muscles of CA and WA birds, and used as indices of the capacities for glycolysis, aerobiosis, and lipid oxidation (resp.). Preliminary results indicate mass-specific activities of all three enzymes do not differ significantly between the two groups, suggesting that all birds possess the capability for high catabolic fluxes.

Mouse mammary tumor virus (MMTV) is a retrovirus that promotes tumorigenesis within murine mammary tissue by means of insertional mutagenesis. Integrating randomly into the host genome, the MMTV provirus, which contains enhancer elements within its sequence, upregulates transcription of adjacent genes. Thereby, tumorigenesis is induced if a proto-oncogene lies within this region. Previous experiments have shown that a potential transmembrane protein, Tmem170, is adjacent to the MMTV provirus in multiple tumor cell lines, suggesting it to be a proto-oncogene. Two splice variants for Tmem170 were cloned into a v5-his TOPO expression vector and transfected into NIH 3T3 fibroblast cells. Previous experiments indicate increased cell proliferation rates for these cells. The focus of my research project is to characterize the Tmem170 protein, study its protein expression, and determine any protein interactions; especially with regard to beta-Actin, as immunohistochemistry experiments indicate that Tmem170 and beta-Actin cofluoresce. Using the V5-tag, Tmem170 is to be detected from an immunoblot. In addition, any proteins interacting with Tmem170 are to be isolated under non-denaturing conditions by his-tag purification using Nickel charged iminodiacetic acid beads. Proteins will also be extracted from culture media in order to determine if Tmem170 is extracted from the cell.
Understanding the mechanisms driving biotic invasions is of great importance to contemporary ecology, especially considering the impacts of losses in native biodiversity. It was once thought that native diversity would protect against invasions (theory of biotic resistance); however, it has been shown that more diverse areas are sometimes more susceptible to non-natives. Recently, it has been suggested that plant invasions may be the result of anthropogenic disturbances such as nitrogen deposition. Studies have suggested that non-natives take up larger proportions of soil nitrogen which, coupled with increased deposition, could reduce native richness and diversity in favor of non-natives. We collected diversity, richness and productivity data for native and non-native plants within 25 sites throughout Ridley Creek State Park, Pennsylvania. Soil cores were taken from each site to measure available soil nitrogen. Native diversity was found to be significantly negatively correlated with non-native diversity (p=0.067) and richness (p=0.0372), supporting the theory of biotic resistance. Native richness was also negatively correlated with increases in NO₃, NH₄, and total N which suggests that increased nitrogen benefited non-natives at the expense of natives. This study will advance our knowledge of how nitrogen can impact plant invasion, a critical factor to understand for mitigating invasions.

Hair is a protein filament that grows from follicles in the dermis. Processing can alter the chemical and physical nature of hair, affecting its carbon, and sulfur elemental make-up. It is unknown if different hair quality, indicative of ethnic background, may be contributing factors to resistance to chemical and physical manipulation. In this qualitative and quantitative study, the appearance of human hair is correlated to ethnicity, hair maintenance routines, and elemental make-up in treated and untreated human hair. I hypothesis that the integrity of hair is affected by an individual’s lifestyle.

Samples (N=66) were collected at random from university students of African/Black, Asian, Caucasian/European, Hispanic, and Multi-ethnic descent. Gold plated samples, prepared using Polaron sputter coating, were processed for analysis of fine structure via Scanning Electron Microscopy (SEM) imaging. Taken at 800x, 1000x and 1200x magnifications, images of the root, mid-section, and tip of each sample are analyzed to determine how intact the hair shaft remains with, or in absence of chemical processing. Elemental analysis using carbon coating techniques allows the chemical composition of hair to be correlated to its appearance and texture. Trends observed within each ethnic group will address if healthy hair can be determined by appearance alone.
Restoring the Carbon Balance of a Boreal Peat Bog after Oil Drilling Disturbance in Peace River, Alberta, Canada

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Peatlands are wetlands in which net primary production exceeds organic matter decomposition, resulting in the accumulation of partially decomposed organic matter. These thick layers of peat sequester carbon (C), reducing atmospheric gaseous C, which is increasingly important in reducing global warming. With 80% of the world’s peatlands in the boreal and subarctic region, it is important to keep these ecosystems intact.

Alberta, Canada has large bitumen (oil sands) deposits, which are increasingly being utilized with rising oil prices. To drill for the bitumen beneath peatlands, oil companies must build pads and access roads, which disturbs the natural ecosystem. New legislation requires these pads and roads to be removed and the peatlands restored.

I am investigating the most efficient methods to restore peat bogs in Peace River, Alberta after oil drilling disturbance. My research develops combinations of treatments, amendments, and planting regimes to gauge the gaseous C balance of each subplot. I am measuring CO₂ and methane fluxes to calculate net ecosystem production (NEPᵰ). NEPᵰ is an indicator of whether the restored area is acting as a C source or sink to the atmosphere. NEPᵰ assists in answering the ultimate question of whether these peat bogs are being restored to functionality.

Identification of Regulators of the Phosphate Signal Transduction Pathway in Schizosaccharomyces pombe

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Inorganic phosphate (PO₄) is required for cellular activities such as synthesis of ATP, DNA and phospholipids. In low extracellular PO₄, cells activate a signal transduction pathway (the PHO pathway) in order to maintain growth and survive. This pathway is well characterized in brewer's yeast and under low PO₄ conditions an inducible phosphatase (PHO5) is transcriptionally upregulated. The analogous pathway in fission yeast is unknown; however, during PO₄ starvation a phosphatase (PHO1) is transcriptionally upregulated leading to increased acid phosphatase activity. Additionally, comparative genomic analyses indicate fission yeast does not contain homologous genes of the PHO pathway relative to budding yeast. To provide insight into the ways evolutionarily divergent organisms adapt to low PO₄ environments, we identified putative regulatory mutants of the PHO pathway in Sz. pombe (fission yeast). We isolated three mutants that abnormally regulate phosphatase expression in low PO₄ conditions and were unlinked to PHO1. We utilized genetic mapping to determine the linkage between the mutant gene(s) and known auxotrophic markers, increasing our ability to identify the specific gene each mutant is defective in. Additionally, rt-qPCR is currently underway to determine the induction of PHO1 in the mutants relative to the wild-type Sz. pombe strain.
Interactions between the hydrology and carbon cycle of a peatland in Alberta, Canada

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Biology

Peatlands are long term carbon (C) sinks that hold vast deposits of partially decomposed organic matter in water logged conditions. While peatlands cover only 3% of the world’s total land area, they sequester 30% of the world’s soil carbon. Northern peatlands are dominated by bryophytes that are sensitive to chemical and physical disturbances. Disturbances to the hydrology of these peatlands often result in changes to ecosystem processes such as net primary production (NPP), autotrophic and heterotrophic respiration and decomposition. These processes in turn are closely tied to the C cycle of a peatland and can have implications on the net C source or sink strength of a region. My research focuses on the effects of anthropogenic disturbances on the C cycle in peatlands of Alberta, Canada. Here, road development through peatlands disturbs the water table and the water chemistry of a peatland. These changes alter bryophyte growth, species distribution and decomposition, resulting in altered carbon fluxes. I characterize a continental poor fen for its C cycle, water chemistry and fluctuations in the water table and investigate trends between changes in water table and carbon flux.

Spatiotemporal analysis of apoptosis patterns in the developing brain of the Brd2-knockdown zebrafish embryo

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Brd2, Bromodomain-containing-2, is a transcriptional co-regulator implicated in the control of apoptosis and mitosis in mammals and in homeotic gene regulation in Drosophila. Disruption of Brd2 expression in humans may confer susceptibility to Juvenile Myoclonic Epilepsy presumably by contributing to abnormal brain morphogenesis. In zebrafish, Brd2 mRNAs are present in oocytes and embryos, suggesting a critical role early in development. Brd2 mRNA in situ analyses in embryos reveal enrichment in the developing central nervous system. 24-hour post-fertilization Brd2-knockdown embryos, created by injection of Brd2-specific morpholino antisense oligomers, exhibit brain abnormalities characterized by a reduced hindbrain and blurred midbrain-hindbrain barrier. As normal development depends largely on a balance of apoptosis and proliferation, and Brd2 is a suspected modulator of both processes, it is likely that misexpression of Brd2 alters apoptosis patterns, providing a mechanism underlying the decreased area and lack of structural clarity in the brain of the Brd2-knockdown embryo. TUNEL assay and confocal microscopy of whole-mount embryos revealed an increase in cell death in the 24hpf Brd2-knockdown as compared to both wild-type and control-MO embryos. We are quantifying cell death in the brain of control and knockdown embryos at stages preceding 24hpf to examine spatiotemporal apoptosis patterns in these embryos.