

Nesting ecology of alligator snapping turtles (*Macrochelys temminckii*)

Courtney Nippert

Faculty Mentor: Stephen Dinkelacker

Are the adverse effects of neonatal pain retained into adulthood?

Shannon Palmer, Brian Bowden, Amanda Plummer, Sonja Isbell, Heather Delahunt, James Hyde, and Jason Talburt

Faculty Mentors: Barbara Clancy and K.S. Anand (ACHRI)

Identification of antimicrobial resistance genes on plasmids of multi-drug resistant strains of *Salmonella* Newport isolates from food animals

Bobbie S. Rhodes

Faculty Mentor: Steven Foley

Quantification of NHE and V-ATPase mRNA levels in MCF-7 tumor cells

Kyla R. Shelton, Andres Chang, and Candice Ray

Faculty Mentor: Steven Runge

Endothelin-1 constriction is unaffected by short-term exposure to estrogen in fresh and organ cultured coronary arteries from aged female pigs

Saigiridhar Tummala

Faculty Mentor: Brent Hill

Early life history and effect of flow on two cave-inhabiting salamanders, *Typhlotriton spelaeus* and *Eurycea lucifuga*, in Arkansas.

Kerry Wilkins

Faculty Mentor: Ginny Adams and Reid Adams

CHEMISTRY

SEIRA II: Studies of p-nitrobenzoic acid and o-, m-, and p-nitroaniline

Jacob Boucher, Bridget Bridges, Krystal Posey, Merritt Smith, Kaitlyn Stambaugh, Mark Viegas, and Chen Wang

Faculty Mentor: Don Perry

Phosphate collapse around cationic protein residues is correlated with DNA bending in DNA/protein complexes

Mason Breed

Faculty Mentor: Lori Isom

SEIRA I: UV/VIS and AFM characterization of silver films as substrates for Surface-Enhanced Infrared Absorption (SEIRA)

Bridget Bridges, Jacob Boucher, Krystal Posey, Merritt Smith, Kaitlyn Stambaugh, Mark Viegas, and Chen Wang

Faculty Mentor: Don Perry

Detecting cysteine and homocysteine with nickel

MATHEMATICS

Parametric symmetries of ordinary differential equations

Yousuf Abbasi

Faculty Mentor: Danny Arrigo

General compatibility of the 2+1 diffusion equation

Luke Brown

Faculty Mentor: Danny Arrigo

Symmetry analysis of the variable-coefficient beam equation

Joel Harris

Faculty Mentor: Danny Arrigo

Positive solutions of quadratic equations with a parameter

Ethan Hereth and Jason Norton

Faculty Mentors: Ramesh Garimella and Haiyan Wang

Non-classical symmetries of the one-dimensional diffusion equation

ABSTRACTS

BIOLOGY

Genotypic comparison of *Escherichia coli* isolated from food animals

Greg Asbury, Chris Winfrey, Kristin Mayhan, and Amber West

Faculty Mentor: Steven Foley

Escherichia coli can cause food-borne illnesses and serve as indicator organisms for fecal contamination in watersheds, therefore it is important to be able to determine the source of the organisms and understanding of how the organism disseminates in the food supply and in the environment. The objective of this study was to evaluate whether detection of specific virulence factors and/or plasmid DNA profiles from *E. coli* isolated from different animal species would provide a discriminatory method to distinguish the origin of *E. coli* isolated from different food animal sources. Two hundred *E. coli* isolates from cattle, swine, and chickens were screened using PCR for the presence of genes for K88 and K99 capsules, serum survival (*iss*), hemagglutinin (*tsh*), shiga-like toxin, (

cellular survival we hypothesize that under acidic stress, tumor cells will utilize an exocytic pathway to integrate pH regulatory proteins into the cellular membrane to help stabilize intracellular pH levels. Our hypothesis is based on previous identification of numerous proteins that are regulated via protein trafficking; including some involved in pH regulation.

Our present study evaluates how extracellular acidification affects the rate of exocytosis in human breast cancer cells using the fluorescent fluid phase marker fluorescein dextran (FD). Our hypothesis is that extracellular acidification will increase the exocytic rate in MCF-7 cells. If acidification stimulates vesicular trafficking, cells loaded with FD prior to the acid insult will release FD into the surrounding media. If the exocytic activity

Apoptotic-induction in MCF-7 cells by [dppeNi^{II}CYSEt⁺] Cl⁻

Laura Huffman and Kyle Basham

Faculty Mentors: Patrick Desrochers and Steven Runge

Recently there have been research efforts targeted at developing drugs that will treat platinum resistant tumors. One facet of these efforts has been aimed at the cytotoxic activity of dppe-phosphorous ligand compounds. The compound [dppeNi^{II}CYSEt⁺] Cl⁻, developed in Dr. Patrick Desrochers' laboratory, has cytotoxic activity in the human breast cancer cell line, MCF-7. Dose response experiments revealed the lowest effective concentration for inducing cell death to be 1.0 mM. Using Annexin-V-FITC staining kits, levels of apoptosis will be detected in the MCF-7 cells exposed to the nickel compound. During apoptosis, phosphatidylserine is translocated from the inner leaflet of the plasma membrane to the outer leaflet. Annexin-V-FITC has a strong Ca⁺-dependent affinity for phosphatidylserine and fluoresces green upon binding. Propidium iodide is used to detect necrosis. During necrosis, membrane integrity is lost, allowing this compound to enter the cell. Propidium iodide fluoresces red upon binding to the nuclear material of the cell. Apoptotic-induction in MCF-7 cells by [dppeNi^{II}CYSEt⁺] Cl⁻ could give possible insight into a new class of metal-containing chemotherapeutic drugs that would offer alternatives for treating tumors that are resistant to current therapeutic modalities.

Temporal patterns of development in field-sampled ammocoetes of the southern brook lamprey (*Ichthyomyzon gagei*) in Cadron Creek, Arkansas

Casey Kennedy

Faculty Mentor: Reid Adams

Lampreys are one of the few extant representatives of a primitive group of vertebrates, the jawless fishes. Marine and freshwater forms exist, and lamprey species are either parasitic or nonparasitic based on feeding strategies of adults. Both feeding forms have an extended larval period where they spend 3-7 years as ammocoetes burrowed into the sediments of streams and rivers. After development into an adult, adults of parasitic species may live for up to 2 years, attaching themselves to other fishes using their suctorial mouth to extract body fluids from their hosts. In contrast, adults of the nonparasitic species, known as the brook lampreys, do not feed as adults; following transformation, they live for 5-6 months, reproduce, then die. The southern brook lamprey, a nonparasitic species, is one of four lampreys occurring in Arkansas. Ammocoetes of this species reportedly begin metamorphosis into an adult during early fall in preparation for spawning during late spring/early summer. General changes in morphology that occur during development (e.g., increased eye size, reduction of digestive structures, and increase in gonadal mass) are known, but these morphological changes have rarely been quantified over time, particularly in southern populations. I collected southern brook lampreys in Cadron Creek every 4-5 weeks from September

2004 through March 2005 with a backpack electrofisher. Specimens were fixed in 10% formalin, dissected in the lab, and a number of morphological/anatomical parameters were measured. Weight of the digestive tract, gonad, visceral fat, and total wet body were measured with an Ohaus analytical balance. Total body length and eye diameter were measured with digital calipers. Both metamorphosing (ammocoetes that will reproduce during the subsequent spring season) and nonmetamorphosing (ammocoetes that will not reproduce this year) individuals were present in each sample. During the initial sampling interval in September, mass of visceral fat and of the gonad relative to total body weight were similar among all ammocoetes, but there was already a 4-fold difference in digestive tract mass between metamorphs and nonmetamorphs. However, beginning in November and continuing through February, visceral fat mass was lower and gonadal mass higher in metamorphs relative to nonmetamorphs. Eye diameter was greater in metamorphs throughout the study period; development of a larger eye is probably an adaptation to aid in predator avoidance and mate recognition when emerging from burrows. The digestive tract of metamorphs decreases to a nonfunctional remnant between September and November and remains a miniscule structure. During at least a 4-month time period with no exogenous source of energy, metamorphosing lampreys appear to rely heavily on stored fat (and probably the metabolism of some muscle tissue) to meet daily energetic requirements and to develop gametes. I plan to continue documenting morphological changes until spawning occurs in late spring/early summer and hopefully collect data on aspects of their reproductive biology.

Equating time across species

Brandon Kersh, Julie Staudinger, and Jessica Harrison

Faculty Mentor: Barbara Clancy

In this study, we use a bioinformatic approach to address a fundamental research question: How can developmental studies in experimental animals be equated to humans in an accessible and user-friendly format? Bioinformatics uses large databases to answer biological questions, uniting biology with disciplines such as computer science, mathematics, and statistics. We have created a Structured Query Language (SQL) database site that allows brain development to be converted across various mammalian species, including humans, using JavaScript to allow immediate feedback. The site is based on a statistical model initially formulated to describe brain evolution and adapted to translate time across species (Finlay & Darlington, 1995 *Sci.* 268:1578-1584; Clancy, et al., 2001 *Neurosci.* 105:7-17). This database-driven website also provides users with predicted dates of neural events when empirical data are unavailable. Our goal is for this site to be of value to researchers and clinicians across many disciplines. We will incorporate additional data from current and new species on a regular basis, ultimately allowing precise timing for medical procedures such as anesthesia intervals, diagnostic inquiries, and intervention strategies in humans. We have recently added data in which neural development in guinea pigs (a precocial mammalian species) and chickens (an altricial non-mammalian species) are compared. We find that guinea pigs fit the current model, although chickens do not.

**A single neuron causes foot contractions that lead to turning in the marine slug
Tritonia diomedea.**

Josh Morrison

Faculty Mentor: James Murray

Tritonia diomedea crawls forward propelled by cilia; turning is effected by contractions of the foot. During crawling the lateral edges of the foot (foot margin) contact the substrate, and motor neurons that lift the foot margin (up to 50% of the edge) dorsally effect turning toward the ipsilateral side. Although many pedal ganglion neurons control the foot muscles, one identified neuron, Pedal neuron 3 (Pd3) has a wide area of innervation and a strong effect on the lateral musculature in the middle of the anterior-posterior axis. Injection of current (0.1-6 nA) into this presumptive motor neuron elicited firing at 1-15 Hz and caused lifting of the foot margin away from the substrate (at 0.5-4 mm/s) in a way that resembles the lifting that was observed during normal turning. The movement starts 1 s after stimulation, and peaks in 2-3 s. Movement is reduced from 3 s until the end of the stimulus even though the firing does not accommodate, and relaxation takes over 60 s.

Other neurons that do not meet the description of Pe3 also produce contractions of the foot that may lead to turning, but we have not yet monitored their activity with fine wires during crawling. Some of these neurons produce shortening of the foot margin that does not involve lifting the foot. This alternative mechanism of turning is also observed in freely-crawling slugs. *Support Contributed By: State Undergraduate Research Fellowship , University of Central Arkansas, National Science Foundation*

Nesting ecology of alligator snapping turtles (*Macrochelys temminckii*)

Courtney Nippert

Faculty Mentor: Stephen Dinkelacker

Alligator snapping turtles (*Macrochelys temminckii*) were an economically important species during the late-1900s and as a result, their populations experienced over-harvesting by commercial trappers. In 1994, Arkansas passed legislation that prohibited the collection of alligator snapping turtles within the state. Currently, very little is known about the reproduction of this species in natural environments. Therefore, I intend to document the nesting ecology of alligator snapping turtles in central Arkansas. During May and June, previously captured females will be relocated via radio telemetry early in

early evening and build flask-shaped nests, into which they will deposit between 9-61 eggs. Data gained from this research will begin to elucidate vital life history characteristics of a species that is underrepresented in the literature.

Are the adverse effects of neonatal pain retained into adulthood?

*Shannon Palmer, Brian Bowden, Amanda Plummer, Sonja Isbell, Heather Delahunt,
James Hyde, and Jason Talburt*

Faculty Mentors: Barbara Clancy and K.S. Anand (ACHRI)

The repetitive pain related to preterm birth is associated with high occurrences of cognitive and behavioral defects at maturity in humans. This suggests that the cortex may be disrupted because it is the principal brain region involved in complex processing. Moreover, during the precise period when most preterm children are born, the cortex is involved in massive organizational strategies. We hypothesized that repetitive pain in a rat model would be evidenced through behavioral testing conducted at both early and late

of the 40 isolates contained the *tet* gene (codes for resistance to tetracycline), 11 of the 40 isolates contained the *bla_{AMP}* gene (codes for resistance to ampicillin), 20 of the 40 isolates had the *tem* gene (codes for resistance to broad-spectrum beta lactams such as ceftriaxone) and 2 of the 40 isolates exhibited the *aad* gene (codes for resistance to streptomycin). Fifty-eight percent (29) of the *S. Newport* isolates contained multiple antibiotic resistance genes located on their plasmids. Our study suggests that the identification and characterization of antimicrobial resistance genes located on plasmids provides needed information to understand the multi-drug resistant strains of *S. Newport* isolates from food animals.

Quantification of NHE and V-ATPase mRNA levels in MCF-7 tumor cells

Kyla R. Shelton, Andres Chang, and Candice Ray

Faculty Mentor: Steven Runge

Apoptosis is an orderly mechanism of cellular death used in multi-cellular organisms to remove cells that are exhausted, damaged, or abnormal. *In vivo* tumor cells thrive in hypoxic microenvironments with a more acidic extracellular pH (pH_e) than found in normal tissue. The low pH_e is due to the build up of metabolic waste as a result of poor vascularization; and the accumulation of H^+ within the cell can induce apoptosis. In order to survive such a microenvironment and avoid apoptosis, tumor cells may up-regulate pH regulatory proteins to extrude H^+ and maintain physiological pH_i (~7.3) that is necessary for normal cellular functions. Two of the pH regulatory proteins investigated here are the sodium/hydrogen exchangers (NHE) and the vacuolar proton adenosinetriphosphatases (V-ATPase). This project will investigate whether transcription levels of NHE and V-ATPase change in a human breast cancer cell line (MCF-7) incubated at different pH levels under normoxic and hypoxic conditions. The RNA Invader Assay (Third Wave Technologies) is a highly sensitive assay that allows direct, quantitative detection of RNA without target amplification or reverse transcription that is required for quantitative real time RT-PCR and is less expensive than RT-PCR methods.

Endothelin-1 constriction is unaffected by short-term exposure to estrogen in fresh and organ cultured coronary arteries from aged female pigs

Saigiridhar Tummala

Faculty Mentor: Brent Hill

The objective was to determine

control for estrogen, organ culture induced a 2-fold increase in tension to 3×10^{-7} M ET-1 compared to fresh arteries (113.68 ± 6.47 % and 52.11 ± 4.53 % of the paired 80 mM K⁺ contraction, respectively). The effective concentration to reach a 50% response (EC₅₀) was not different between fresh and organ cultured arteries ($1.86 \pm 0.77 \times 10^{-8}$ M and $1.75 \pm 0.82 \times 10^{-8}$ M, respectively). Rings incubated in each respective estrogen concentration did not show any change in the maximum contraction or EC₅₀ value to ET-1 in fresh or organ cultured arteries. Our results indicate that short-term exposure to estrogen did not attenuate the constrictive response to ET-1 in fresh and organ cultured coronary arteries from aged female pigs. Support: UCA Research Council.

**Early life history and effect of flow on two cave-inhabiting salamanders,
Typhlotriton spelaeus and *Eurycea lucifuga*, in Arkansas.**

Kerry Wilkins

Faculty Mentor: Ginny Adams and Reid Adams

Despite numerous studies on the biology of cave vertebrates, very little is known about the general life history parameters of cave-inhabiting salamanders in the United States. To address this knowledge gap, we examined the abundance and life history of grotto salamanders (*Typhlotriton spelaeus*) and cave salamanders (*Eurycea lucifuga*) in the cave environment and the effect of flow on larval salamanders. Three trips were made to caves along the Buffalo River between July and December 2004. A total of 35 larval and adult salamanders were observed along with nine eggs. In July, many of the grotto salamanders observed were in the process of metamorphosing from the aquatic larval to terrestrial adult stage. Subsequent trips in November and December revealed only adult terrestrial salamanders. Number of adult salamanders declined sharply from July to November, with continued low numbers in December. Salamander eggs were discovered in rimstone pools in the back of Fitton Spring Cave in November. It is likely these belong to cave salamanders given the similar size and placement to reports in the literature. If verified, this is the earliest reported date for cave salamander reproduction in Arkansas. Nine eggs were sighted in a total of four rimstone pools. Egg diameter ranged from 2.6-2.8 mm and all were laid singly. Pool dimensions were recorded and water quality was monitored in November and December. In December, only four of the nine eggs remained and these were in various stages of hatching. The five eggs from the largest pool were missing and raccoon tracks were observed in the silt-covered pool. In addition to field studies, we are currently preparing to compare the ability of larval grotto and cave salamanders to maintain station in low, medium and high flows in a laboratory flume. This will provide pertinent information on the ability of these species to resist downstream displacement during spring flooding events in the cave environment.

CHEMISTRY

SEIRA II: Studies of p-nitrobenzoic acid and o-, m-, and p-nitroaniline

*Jacob Boucher, Bridget Bridges, Krystal Posey, Merritt Smith, Kaitlyn Stambaugh,
Mark Viegas, and Chen Wang*
Faculty Mentor: Don Perry

P-nitrobenzoic acid (PNBA) was used as a standard for surface-enhanced infrared absorption (SEIRA) studies in order to compare the current work to experiments in the literature. Submonolayer coverages of PNBA were adsorbed on CaF₂ windows coated with silver films varying in thickness from one to twelve nm. The highest quality SEIRA spectra were obtained with seven nm thick silver films. NO₂ stretching modes of PNBA on seven nm thick silver films were symmetric and enhanced by approximately a factor of fifty when compared to thick PNBA layers adsorbed on clean CaF₂ windows. SEIRA studies were also performed with o-, m-, and p-nitroaniline. All m-nitroaniline infrared absorption bands were strongly enhanced when m-nitroaniline was adsorbed on seven nm thick silver films. O- and p-nitroaniline infrared peaks exhibited no SEIRA enhancement.

Phosphate collapse around cationic protein residues is correlated with DNA bending in DNA/protein complexes

Mason Breed
Faculty Mentor: Lori Isom

In this project, the theory that cation interactions with DNA phosphate groups result in partial charge neutralization, thereby inducing DNA bending and minor groove narrowing is tested.

Surface-Enhanced Infrared Absorption (SEIRA)

***Bridget Bridges, Jacob Boucher, Krystal Posey, Merritt Smith, Kaitlyn Stambaugh,
Mark Viegas, and Chen Wang***

Faculty Mentor: Don Perry

A vacuum apparatus has been constructed for the evaporation of silver films for use in surface-enhanced infrared absorption (SEIRA) studies. Silver atoms are evaporated from a silver wire wrapped around a double-stranded tungsten filament. Film thickness is monitored with a quartz-crystal microbalance (QCM) placed in a geometrically

The mechanism of DNA bending has long been debated and conflicting results from various solution and x-ray crystallographic methods exist. Solution methods have been used in the past to demonstrate the effect of MPD on DNA bending. These reports suggested that MPD, which is added to all crystals during growth, removes bends from DNA. This project focuses on explaining the mechanism by which MPD affects DNA bending and specifically investigates whether MPD chelates Mg^{2+} ions. If DNA bending is induced by cation binding then chelation of Mg^{2+} by MPD could sequester the ions away from the DNA thereby decreasing its curvature. To test this hypothesis, competition experiments between MPD and the indicator Eriochrome Black T (EBT) for Mg^{2+} ions have been used to test for the MPD Mg^{2+} chelation. Samples containing EBT/ Mg^{2+} with varying amounts of MPD were prepared and analyzed using UV spectroscopy. An absorbance wavelength maximum shift corresponding to the color transition from pink to blue indicates competitive removal by MPD of Mg^{2+} from EBT. This transition has been detected and quantitated by monitoring absorbance values at various MPD concentrations at two wavelengths: 550 nm (pink, EBT/ Mg^{2+}) and 650 nm (blue, MPD/ Mg^{2+}). A clear transition occurs at approximately 25% MPD concentration for mM solutions of $MgCl_2$. No such transition occurs for other alcohols that are incapable of chelation. Therefore, we can conclude that MPD chelates Mg^{2+} and currently, further experiments are being performed to quantify the strength of the interaction.

Peptide mimics as nanosensors

Garen Holman and Blake Robinson

Faculty Mentor: Richard Tarkka

Peptide mimicry is being used as a strategy for developing an opiate nanosensor. The amino acids implicated in the binding of opiates in the rat μ -opioid receptor are adjacent Asp(147)-Tyr(148) and Trp(318)-His(319) residues. Our strategy is to build a parallel combinatorial oligopeptide library, in which the 170 amino acid sequence that connects the four binding amino acids (in the native protein) is truncated to four residues. The library members will be screened for binding by exposure to a colored opiate derivative and looking for visible color changes in the library members. The status of this project will be reported.

Analysis of doubly-charged transition metal ions: Reactions of M^{2+} with chlorofluorocarbons

Cullen C. Matthews

Faculty Mentor: William Taylor

Examinations of the gas phase chemistry between metal ions and chlorofluorocarbons can provide fundamental information regarding mechanisms relating to catalytically-

in the environment. Our earlier work on the reactions of singly charged transition metal ions with chlorofluorocarbons has revealed that C-Cl bonds are readily activated by singly-charged gas phase metal ions, while activation of C-F bonds is not induced by M^+ . It has recently come to our attention that the energetics present in our instrument are sufficient to produce and observe the chemistry of doubly-charged transition metal ions, M^{2+} . While common in solution, the chemistry of doubly-charged gas phase metal ions has received much less attention due to energetic difficulties in their production. Here, we describe the reactions of M^{2+} with the family of chlorofluorocarbons used in our prior studies in which *direct* activation of C-F bonds is observed. C-F activation products observed here appear to be formed via mechanisms similar to those proposed for other, similar reacting systems involving M^{2+} . In addition, we have measured reduced zero-field mobilities for these ions which, to our knowledge have not been previously reported.

Detection and characterization of DNA distortion induced by cation-pi interactions

Mikaela Stewart

Faculty Mentor: Lori Isom

Cation-pi interactions are a type of cation-induced DNA distortion that pulls bases out of the helical stack and into the major groove where a bound Mg^{2+} ion or waters of its bound hydration shell interact with the exposed aromatic face of the unstacked base. Many high resolution DNA structures have been deposited in the PDB since the initial publication describing DNA cation-pi interactions in 2DNA and 2 RNA structures (Isom, et al., Biochemistry, 1998). A survey of the Nucleic Acid Database (NDB) produced 10 structures with resolution 1.6 Å or higher that contain groove-bound cations but no significant chemical modifications or bound ligands. Each structure's coordinates were analyzed using Visual Basic for Application programs written to calculate the distance (d) and angle (T) between the base centroids and the bound cation. Interactions having distances less than or equal to 5.0 Å and angles less than or equal to 50 degrees were considered cation-pi interactions. Using this procedure, cation-pi interactions were detected in 9 of the 10 high-resolution structures analyzed, including the surprising discovery of cation-pi interactions between DNA bases and monovalent thallium ions (PDB 1JGR). These interactions were found to induce DNA distortion including base unstacking in many of the structures. Based on these data, we conclude that cation-pi interactions are common between cations and DNA bases and that these interactions do, indeed, induce DNA distortion.

FTIR and GC/MS characterization of acidic sites on Al^V catalysts

*Chen Wang, Mark Viegas, Krystal Posey, Merritt Smith, Kaitlyn Stambaugh,
Bridget Bridges, and Jacob Boucher*

Faculty Mentor: Don Perry

David Lindquist, Rajesh Sharma, and Malay Mazumder

University of Arkansas, Little Rock (UALR)

Transitional phase aluminas are valued as adsorbents and catalysts due to a stable porous microstructure and their amphoteric properties. The lab of Dr. David Lindquist at UALR has created a patented method for the preparation of a very active Au catalyst for carbon monoxide oxidation using an Al_2O_3 having abundant surface defects. The activity, found to be substantially higher than that of a World Gold Council reference catalyst (Type A 1.5 wt% Au/ TiO_2

enhance the process of creation, editing, management, and publishing of original content within an organization,

As a case study, we have applied the above principles to design and implement an initial framework of the web-based content management system for the Department of Computer Science at UCA. The framework provides searchable, retrievable, and updatable access to and to manage digitized documents of the department. Software

Enhancing Boyer-Moore pattern matching algorithm with character pairs

Paul Opala

Faculty Mentor: Chenyi Hu

In distributed computing environment, processing flat text files is more cost efficient than that of other files. Therefore, text processing algorithms play very important roles in computational cost reduction nowadays. Among text processing problems, exact pattern matching finds the occurrence (s) of a given sequence of characters, called pattern, within a text. People believe the most effective algorithm currently available in practice for exact pattern matching is the Boyer-Moore algorithm developed in 1977.

In this research, by discovering the properties of character pairs in pattern, we have developed two modifications that further enhance the performance of Boyer-Moore algorithm noticeably. One of them is to skip an entire block of characters without character-wise comparison if the block does not satisfy the condition of a selected pair. And, the other is to check only a half of the text for locating a possible pair in a text. By embedding the two modifications into classical Boyer-Moore algorithm, we have achieved over 10% performance improvement in our experiments.

MATHEMATICS

Parametric symmetries of ordinary differential equations

Yousuf Abbasi

Faculty Mentor: Danny Arrigo

The method of symmetry analysis of ordinary differential equations (ODEs) was first introduced by Sophus Lie in 1881 as a method to unify the seemingly unrelated techniques in solving ODEs. It is well known that if a nonlinear second order ODE admits an 8-parameter Lie group of symmetries, it can be transformed into a linear second order ODE. If the ODE fails to admit an 8-parameter family of symmetries, it is still sometimes possible to linearize the equation. We will show that by the parameterization of both independent and dependent variables, it is possible through symmetry analysis to obtain an equation for the independent variable such that an 8-parameter family of symmetries is admitted, thereby indicating linearization.

General compatibility of the 2+1 diffusion equation

Luke Brown

Faculty Mentor: Danny Arrigo

We consider the compatibility between first order partial differential equations and nonlinear reaction-diffusion equations in 2+1 and 3+1 dimensions. In 2+1 dimensions, we give conditions on the reaction term such that the compatible equation is quasilinear. We further show that in 3+1 dimensions, compatible equations are quasilinear regardless of the nature of the reaction term.

Symmetry analysis of the variable-coefficient beam equation

Joel Harris

Faculty Mentor: Danny Arrigo

The one-dimensional beam equation models flexural waves in beams and thin rods. It is typically assumed that the beam is homogenous and has a constant cross-sectional area. These assumptions lead to a fourth order partial differential equation with constant coefficients that can be solved by standard methods. Without these assumptions, the coefficients become functions of the variable representing the axis of the beam. The goal of this research was to find forms of these functions that would allow the reduction of the original partial differential equation to an ordinary differential equation by means of a method called symmetry analysis, the ultimate goal of which was to find exact solutions of these more general forms of the beam equation.

Positive solutions of quadratic equations with a parameter.

Ethan Hereth and Jason Norton

Faculty Mentors: Ramesh Garimella and Haiyan Wang

A discussion of positive solutions to some quadratic equations which involve a threshold parameter that changes the structure of the equations. In particular we show the equation $x^2 = \lambda (x^2 + Ax + B)$, where $A, B, C > 0$ and λ is a parameter, will have two

positive solutions when $\lambda > \frac{A^2}{4B}$

equation with a nonlinear source term and a general class of nonlinear first order PDEs. Enforcing compatibility leads to a constraint in the form of another 2nd order nonlinear PDE. We will show that this constraint equation admits a first integral and further that it is reducible to solving an Abel equation of the second degree. Several examples are considered.

PHYSICS AND ASTRONOMY

Scanning electron microscope studies of bone sample: Influence of microgravity in adult male mice

Ashley Brown

Faculty Mentor: Rahul Mehta

Microgravity environment is known to induce changes in the ratio of elements present in

student research involvement. We have been obtaining 0.8 Angstrom/pixel resolution H-alpha line profiles for several bright Be stars since 2003 June. These spectra were acquired using the UCA Fiber Fed Spectrograph used at the UCA Observatory and the Nubbin Ridge Observatory in Royal, AR. H-alpha line profiles, velocities, and variability are shown for Delta Sco, Chi Oph, Eta PsA, 48 Lib, and Upsilon Sgr