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INTRODUCTION

This volume presents the research abstracts of Simons Fellows working at Stony Brook University during the summer of 2010. These abstracts will also be posted on the Simons Program Website: <http://stonybrook.edu/simons/>

Established in 1984, the Simons Summer Research Program enables academically talented high school students who have completed their junior year to come to Stony Brook University for a summer to engage in scientific research and experience life at a research university. Simons Fellows are given the opportunity to work with distinguished faculty mentors, learn laboratory techniques and tools, and become part of active research teams. All Simons Fellows have been nominated by their high schools, and have undergone a competitive selection process.

Take a look at what the students have accomplished in only seven weeks. You'll be impressed by what they have done, and what they have learned by working within a community of faculty, post docs, graduate students and undergraduates. We wish all the Simons Fellows well, and anticipate that these students will have great success with their future careers and future research endeavors.

We are grateful to all the Stony Brook University faculty research mentors, as well as the graduate students and post docs and lab colleagues who served as co-mentors, for devoting their time, energy and resources to the Simons Fellows. And we especially thank Dr. James Simons, Marilyn Simons and the Simons Foundation for their generous and ongoing support of this program.

The Simons Program is supported by the Simons Foundation and individual faculty grants, and is administered by Programs for Research & Creative Activity, UAA.

-Karen Kernan
Director, Programs for Research & Creative Activity
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An autonomous robotic assistant for the visually impaired: a novel system employing digital image tracking and sonar range detection

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In contemporary society, giving visually impaired humans the ability to exhibit a great degree of freedom in their daily lives has been a challenging task to achieve. As an attempt to present one possible alternative to the need for constant human or animal accompaniment, an autonomous robotic assistant for the visually impaired has been proposed. The primary focus of the study involves physically constructing, programming and improving the accuracy of a mobile robot which can guide a vision-deprived human and provide instructions for re-routing if any obstacles are detected along the human's chosen path. The robotic system consists of a mobile robotic platform, the iRobot Create, with an Atmel168 microcontroller, a camera mounted on an extendable arm, a sonar rangefinder mounted on a digital servo, a PC, and a platform to hold all of the other components. Because the robot must serve as a guide, the camera is mounted on an adjustable arm pointed at the human's back, which allows the robot to proceed alongside the human. The Sonar sensor is mounted on the front edge of the platform with room for 180 degree motion. The software for the robot consists of two major components: human tracking via digital color image processing, and obstacle detection and mapping via sonar sensing. So far, various algorithms for tracking a human based on a colored ID marker have been tested and implemented, including the RGB intensity filter, Gaussian Blur, and Blob tracking modules. The threshold values for the filters were determined by a pixel histogram analysis. Based on the position of a Center of Gravity (COG) box, which serves as a method for assuring the identification of the marker, the robot can move based on the position of the colored marker. In this way the robot will be able to successfully recognize and guide its respective human. The next step of the project is to calibrate and program a Deventech sonar sensor which will be used to identify the distance between the robot and a perceived obstacle, determine the width of the obstacle by servo motion, and then determine the optimal path to avoid the obstacle. Extensive live testing with humans will be conducted to determine the efficiency and sophistication of the robotic system. The expected outcome is a fully functional, efficient, and low cost autonomous aid which has immediate applications in the aid for the visually-impaired.

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Thermal aggregation of red blood cells

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While necrosis occurs instantaneously at the site of a skin burn, sludge forms in the blood vessels of adjacent epidermal tissue (zone of ischemia) which can result in further damage from restricted flow of nutrients and elimination of waste. This sludge is composed of RBC (red blood cell) aggregations, clumps held together presumably by weak electrostatic attractions. Our purpose was to investigate whether thermal energy is the underlying mechanism responsible for their development. Washed hamster RBCs were diluted with saline to achieve the appropriate hematocrit percentage (the ratio of RBC volume to total volume). Hematocrit percentages of 10-50% were used in a flowing system (300 micron Teflon tube) to mimic blood flow in the skin. The tube and RBC solution was heated to 37 °C to 61 °C; room temperature was used as a control. Four treatments were: static control (no treatment); static heat (stationary in the water bath); heated with flow at 1000 microns/s velocity; heated with flow + sonication (30 seconds to attempt to disassociate the clumps of RBC). A blood smear on a microscope slide was viewed (Nikon microscope, 20x objective) and digital images were taken (Retiga; Q capture software). From the image, total cells, blebs (vesicles arising from the damaged RBC), and crenations (damaged RBCs) were counted in one of four randomly chosen regions of interest (ROI). The number of clumps were counted on the whole image and recorded as: 3 RBC, of 4 RBC, or 5 or greater RBC clumped. The preliminary results have shown that there is an optimal range for clumping in approximately the 40 to 50°C range and generally there is more clumping at the lower hematocrit percentages. More trials will be run to verify the preliminary findings. Porcine blood will also be used and compared to the skin burn animal model.

This work was supported by the Simons Foundation and by AFIRM, the Armed Forces Institute of Regenerative Medicine.

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Ultrasound characterization of bone demineralization using scanning confocal acoustic diagnosis, micro-CT, and mechanical testing

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Osteoporosis, characterized by low bone density and deterioration of trabecular structure, is a major health threat to fifty-five percent of people 50 years old and older, or approximately 44 million Americans. Researchers continue to seek more efficient methods to diagnose osteoporosis, since early treatment can lead to the implementation of effective treatments. The current diagnostic method used is dual energy x-ray absorptiometry (DXA); although precise, this method is not cost effective, is harmful to patients since it generates harmful ionizing radiation, and is limited to determine only the bone mineral density (BMD) of bone.

A promising alternative to the method of diagnosing osteoporosis is the use of quantitative ultrasound (QUS). QUS measures how ultrasound beam changes as it passes through the bone and loses energy, known as attenuation. The slope of this attenuation versus frequency is given by the linear regression, or BUA, and is an important QUS parameter to be evaluated. A newly developed scanning confocal acoustic diagnostic component can, in addition, image the area scanned. However, the application of QUS is limited due to its poorer precision compared to DXA, as the interactions between the mechanical properties and ultrasound parameters are not well understood.

The purpose of this study is to analyze the effects of controlled bone mineral content on the correlation between mechanical properties of trabecular bone and ultrasound parameters. The ultrasound parameters to be observed are BUA and ultrasound velocity (UV), while the mechanical properties of bone to be focused on are elastic modulus, as well as bone quality determinants, such as trabecular thickness, bone volume and total volume. In order to decalcify the trabecular bone samples, various concentrations of formic acids were used to create a demineralization curve that was used. Ideally, the cubes will demineralized to five precise stages—0% (baseline), 10%, 20%, 30%, and 40% of the original quantity of bone mineral. The samples will be analyzed with the micro-CT to determine bone properties, such as bone mineral density and trabecular thickness, after each demineralization stage. The samples will then be analyzed with the scanning confocal acoustic diagnosis, which will determine the ultrasound parameters with the bone samples. The samples will be compressed as well to determine the elastic modulus of the bone samples and the relationship between BUA, UV and strain will be determined. MatLab will be used for further analysis of data. By understanding how QUS parameters (BUA and UV) interact with the mechanical properties of trabecular bone under various degrees of demineralization, researchers will have a better understanding of how to interpret QUS results for better diagnosis of osteoporosis.

This work was supported by the NSBRI, NIH, and the Simons Foundation.

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Properties of Quark Gluon Plasma: Estimating the shear viscosity of QGP and identifying the threshold transverse momentum that signals a breakdown of hydrodynamics and a transition to jet suppression

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The Relativistic Heavy Ion Collider (RHIC), located at Brookhaven National Laboratory is able to create a plasma quarks and gluons by colliding gold ions (Au) at ultra relativistic speeds. The Pioneering High-Energy Nuclear Interactions eXperiment (PHENIX) aims to study the properties of this new state of matter among which are specific shear viscosity η/s and freeze-out temperature T_f . Recent PHENIX measurements have revealed anisotropy in the azimuthal distribution of hadrons emitted relative to the reaction plane Ψ_R . In this study, the magnitude of this anisotropy was quantified by the second Fourier coefficient v_2 and studied as a function of collision centrality and the transverse momentum p_T of the emitted hadrons. v_2 was then scaled with the initial eccentricity ε to investigate scaling violations predicted by hydrodynamic calculations. The observed scaling violations allow the estimate $4\pi\eta/s = 2.1 \pm 0.2$ and $T_f = 173 \pm 11$ and signal a transition from elliptic flow to jet suppression at $p_T \approx 3$ GeV/c.

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Creating a demonstration liquid mirror telescope

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It is a familiar fact that the surface of a rotating liquid assumes a concave shape. Three hundred years ago Sir Isaac Newton proved that this shape is in fact a paraboloid of revolution described by the equation $y = (\omega^2 / 2g) x^2$, where ω is the angular velocity in radians per second and g is the acceleration of gravity. Ernesto Capocci first proposed using such a parabolic surface as the primary mirror of a telescope around 1850, but it was only about two decades ago that the numerous technical challenges were overcome and a successful full-scale telescope created. Liquid mirror telescopes are much cheaper than comparable glass mirror telescopes. They can only observe objects directly overhead, but in practice this isn't an important limitation.

The goal of our project is to build and test a basic liquid mirror telescope. Our telescope is simply a shallow container of water about 30 cm in diameter placed on a record player. The rotational speed of the record player can be varied between 30 – 36 rpm or 40 – 46 rpm. An effective container must first and foremost be watertight. It also has to be rigid, so as to not bend under stress from the water, and balanced to continue spinning well. Finally, there must be a way to keep the container centered on the spinning platform. Our current container is made from two plastic gardening pots, which are about 15 cm and 33 cm in diameter, respectively. A hole that provides a snug fit around the spindle of the record player was drilled in the exact center of the smaller pot. An indent on the bottom of the larger pot keeps it centered on the smaller one, and hence concentric with the axis of the turntable.

Currently two related types of measurements are being carried out with our prototype device and a precision 0.5 meter height gauge. The first procedure creates a map of the parabolic surface by probing its depth at several locations. The second determines the focal length of the mirror by projecting an image of a small incandescent lamp filament on the ceiling. Both results can be compared to predictions derived from the formula above. Once these measurements are completed we will place a CCD camera near the focal point and use the resulting telescope to create an image of a simulated star.

We would like to thank the Simons Foundation for funding this research, Jeff Slechta for his expert assistance, and Prof. Harold Metcalf for establishing and supporting the Laser Teaching Center.

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Crystallization of POL λ bound to DNA with an 8-oxoguanine lesion

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Maintenance of the structural integrity of DNA is vital for human survival; however, lesions caused by oxidation and cell stress happen frequently due to exposure to various environmental factors or endogenous cellular by-products such as reactive oxygen species. One common oxidation lesion is 8-oxoguanine (8oxoG). If not repaired by the cell, during replication, this mutated base can be incorrectly paired with adenine and not cytosine. This incorrect insertion can lead to a C/G \rightarrow A/T transversion mutation. Different DNA polymerases and other proteins recognize and repair these lesions through the base-excision repair (BER) pathway. Although many polymerases pair the 8oxoG lesion with adenine, DNA polymerase Lambda (POL λ) has been shown to be involved in the preferential insertion of cytosine instead of adenine across the 8oxoG lesion. In order to understand how POL λ recognizes the lesion and inserts the correct base, we attempted crystallization of POL λ when bound to DNA with an 8oxoG lesion in order to generate a structural model of the complex.

We purified polymerase λ by using Q Sepharose, Heparin, and Mono S columns. We then mixed the polymerase with the double stranded DNA fragment containing the 8oxoG lesion. Using the hanging drop technique, we screened for and selected crystals from different cryo-conditions that were suitable for crystallization; using a condition with 400 PEG, we expanded the screening set to further acquire suitable crystals of our protein complex. We obtained a diffracting crystal at a 2.2 Å resolution by using synchrotron radiation. We solved the structure using Molecular Replacement and refined it using Phenix and Coot for model building.

This work was supported by the Simons Foundation and the NIH.

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The environmental impact of Andean coca cultivation: past, present, and future

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Coca has been harvested abundantly in the Andean region for two thousand years, though only recently has mass production started. Plots are frequently grown in forests, and it was hypothesized that deforestation occurs not just from plots but from other, coca-driven forces. To prove this, a statistical model was used to predict future deforestation, with and without coca, so as to compare the differences in southern Colombia. Models were created with real data regarding new coca plots each year and then the value for coca (the plot size) was reduced to its minimum from the set and the value for distance to other plots was maxed so as to have the smallest possible coca yield. Models were typically about 93% effective. The results suggest that about 90% of deforestation in southern Colombia is somehow due to cocaine. This could be in the form of plots, lodgings for the farmers, transport routes, etc., yet the root cause of them all seems to be cocaine.

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Clouds: influences on brown dwarfs' bolometric luminosities

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Brown dwarfs are substellar objects that have masses too small to maintain nuclear fusion of hydrogen into helium and too large to be planets, forming the intermediates between small mass stars and high mass planets. Theoretical models have shown that clouds appear to have a considerable influence on brown dwarfs' total luminosities, from which we can determine their chemical composition, age, and mass. We examined the brown dwarfs' brightness through the astronomical J band (1.25 micron), H band (1.60 micron), and K band (2.16 micron.) Brown dwarfs with unusually cloudy or cloudless atmosphere were selected based on displaying J-K_s colors at least 1.5 sigma from the mean J-K_s color. In an effort to find a relation between cloudiness and total luminosity, we calculated and compared the bolometric magnitudes for outliers and normal dwarfs using the 10 percent of the sample that we had parallax measurements of. We expected the total luminosity of a dwarf to increase as its cloud density decreases. However, only tentative evidence of such a relationship was found. Parallax measurements of the other 90 percent of the sample would allow a more decisive relationship and hence a more accurate determination of brown dwarfs' composition, age, and mass.

This work was supported by the Simons Foundation and by the Department of Physics and Astronomy at Stony Brook University.

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A novel framework for quasi-dynamic scheduling on parallel computers

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We present a unique solution to the scheduling problem on massively parallel computers. The problem, NP-Complete in general, involves dispatching subtasks of a parallel job onto processors such that the total execution time is minimized while meeting all data dependencies. Most existing work relies on oversimplification of the problem, such as the assumption of a completely-connected network. Our framework is designed to build upon these heuristics while relaxing such constraints. We adopt a recent graph theoretical model, i.e., the “quasi-dynamic” model, in which both the parallel job and the network architecture are represented by arbitrary graphs. The crux of our framework is based on the classic idea of divide-and-conquer: the parallel job is divided into dense regions called *colonies* and the network is divided into dense regions called *zones*. *Colonies* are then assigned to *zones*, and schedules are created for each *colony* using existing heuristic methods. This framework proposes several advantages: the heuristic methods are only applied to small pieces of the parallel job, reducing execution time and enhancing scalability. Furthermore, solutions gain accuracy because of the quasi-dynamic model, and efficiency because of the emphasis on local communication. In this work, we give a detailed description of the framework, and apply it to 3 popular heuristics. Each heuristic is simulated, both within and without our framework, on 500 random task graphs and on five networks of different topologies. The results indicate that the framework produces an average of 30% better solution quality. We provide an in depth analysis of the results, and illuminate trends based on graph size, graph density, and other properties. This work is supported by the Simons Foundation.

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The *in silico* analysis of mutagenic effects on structural dynamics of the SMN tudor domain

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The neuromuscular disease Spinal Muscular Atrophy (SMA) is the most common genetic cause of infant mortality, resulting from mutations in the Survival of Motor Neuron 1 (SMN1) gene. The SMN1 gene encodes for SMN protein, a crucial component in uridine-rich small nuclear ribonucleoprotein (U snRNP) assembly that functions in spliceosomal removal of introns from pre-mRNA. The Tudor domain, a highly conserved motif of approximately fifty residues, binds Sm proteins to form the U snRNP core. Certain missense mutations are known to severely reduce this binding interaction, thereby causing SMA, but exact mechanistic details are still unclear. Molecular dynamics were performed through the AMBER 11 suite to provide atomistic insight into the structural behavior of the functional Tudor domain, and a thorough equilibration was completed to assimilate the structure to the simulation environment. Although the energies stabilized and root mean square deviation (RMSD) to the NMR reference remained relatively low, several peaks in the RMSD graphs warranted further analysis. It was determined that two flexible loop regions of the domain structure became distorted at moments of high RMSD. After determining the cause of this distortion and subsequently extending the simulation to collect production data, the missense mutations will be induced to the Tudor structure in an effort to explore conformational and energetic changes to the resulting domain. These findings will possibly introduce a dynamic mechanism concerning the Tudor deficiency that causes SMA.

This work was supported by grants from the Simons Foundation and the Research and Engineering Apprenticeship Program (REAP).

Aileen Jiang
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The effect of frequency ranges and demineralization levels on broadband ultrasound attenuation results

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Osteoporosis occurs when bone mineral density decreases progressively, resulting in decreased mechanical strength of bone and increased risk of fractures. However, if properly diagnosed before a fracture occurs, treatments can be carried out to delay the progression of the condition. Quantitative ultrasound (QUS) is a type of diagnostic tool that is gradually being used as an alternative to the more popular Dual Energy X-Ray Absorptiometry as a means of measuring bone quality and other bone properties without emitting ionizing radiation

In QUS, the attenuation of ultrasound through bone is dependent on frequency and thus, the two variables can be plotted to form an attenuation curve. As previous studies have shown, the slope of the linear region of the curve, known as broadband ultrasound attenuation (BUA), correlates to many structural properties of bone, making it an important parameter in trabecular bone quality assessment. While the linear range of the attenuation curve is usually between 300 kHz and 700 kHz, BUA is susceptible to many data variations, so this study measures ultrasound attenuation in four consecutive frequency ranges (300-700 kHz, 700-1100 kHz, 1100-1500 kHz, 1500-1900 kHz) using one frequency sweep signal for each of the four frequency ranges. The goal of the study is to determine at which frequency range attenuation is best correlated with bone parameters, such as bone mineral content and bone volume fraction.

The setup of the study consisted of bone samples placed in degassed water between two aligned transducers, while the control consisted of the same setup with no bone sample. Five 1 cm by 1 cm left bovine femur bone cubes without bone marrow were tested with each of the four different sweep signals and in three orientations (proximal-distal, medial-lateral, posterior-anterior.) The bone samples were also tested at 10%, 20%, 30%, and 40% bone mineral loss levels attained by demineralizing the bone with 1.9% formic acid solution. Testing samples with different bone mineral densities created a variation of data that allowed for stronger correlations during data analysis.

Ultrasound attenuation, calculated at different frequency ranges and demineralization levels using MATLAB, was correlated with bone parameters determined by micro-CT. It is expected that the attenuation of one of the sweep signals will highly correlate with properties such as bone mineral content and bone quality, thus determining the optimal frequency range in which ultrasound testing may act as a diagnostic tool for osteoporosis.

This work was supported by the Simons Foundation, NSBRI, and NIH.

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Identification of structures required for O-fucosylation of TSRs

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Glycobiology, the study of carbohydrate structure and function, is a rapidly growing field of science. Sugars are essential in numerous cellular signal transduction pathways and control many cellular events, including lysosomal degradation or pathogen susceptibility. Glycans, sugars used to modify other molecules, can range from the simple glucose to the complex glucosaminoglycans. Fucose, a simple deoxyhexose glycan, has been shown to play critical roles in cell to cell recognition and signaling. O-Fucosylation, an unusual type of glycosylation in which a fucose modifies a serine or threonine, occurs on two specific cysteine rich protein motifs: Epidermal Growth Factor (EGF) repeats and Thrombospondin Type 1 Repeats (TSRs). Both motifs have six cysteines, which form three disulfide bonds. On TSRs, the O-fucose can be extended by the addition of β 1,3-glucose. This study focuses on TSRs because of their presence on some of the body's most influential proteins, such as properdin, an immune system protein, and thrombospondin, an anti-angiogenic protein. Improper glycosylation of these repeats can render these essential proteins inactive, resulting in disorders from Peters' Plus Syndrome to cancer to thrombotic thrombocytopenia purpura. Understanding more about O-fucosylation of TSRs is essential to understand the cause of these diseases so that therapies can be developed. Prior studies suggest that the TSR must be properly folded to be O-fucosylated. We hypothesize that all six cysteines must be in their proper disulfide bonding pattern (C1-C5, C2-C6, C3-C4) for O-fucosylation to occur. We are testing this by generating mutations in of the six cysteines in TSR3 of human thrombospondin 1 to prevent disulfide bond formation. In order to measure any effect on O-fucosylation, Chinese Hamster Ovary (CHO) cells were transfected with these mutants and supplemented with 6-alkynyl fucose (a fucose analogue), which was utilized during "click chemistry" reactions. Visualization of the relative degree of O-fucosylation was done through western blotting procedures with both myc antibodies, for measurement of total protein, and streptavidin, for amount of O-fucosylation. Mutants for cysteines 1-4 were achieved and preliminary transfections indicate that these mutants are produced. To determine whether they are O-fucosylated, click chemistry will be performed on the cell lysate and run on a streptavidin blot.

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Violations of associativity on homotopy algebras

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In this study, we approximate the algebra of functions and forms in one and two dimensions by an algebra $A = A_0 \oplus A_1$, on points and edges, and $A = A_0 \oplus A_1 \oplus A_2$ on points, edges and faces, respectively. We define a differential d on this algebra that maps the subalgebra on points into the subalgebra on edges $d: A_0 \rightarrow A_1$, etc. This differential is nilpotent: $d^2 = 0$. We also defined a commutative multiplication m_2 that maps $A \otimes A \rightarrow A$ which turns out to violate associativity. This allows us to define a three product $m_3: A \otimes A \otimes A \rightarrow A$. Using Leibniz Rule for m_3 , we show that the violation of associativity can be written in terms of d and m_2 as $d m_2 - m_2 d$. Using the nilpotency of d and Leibniz Rule on m_3 , we find that the violation of associativity obeys a few term identity called the pentagon identity. In the one dimensional case, m_2 itself obeys the pentagon identity, but in the two dimensional case, m_2 does not obey the pentagon identity which implies there must be a four product m_4 , which we are currently computing. This structure is an explicit non-trivial example of an algebra with a product that is associative modulo a nilpotent differential; this is an example of a homotopy algebra.

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Creating dark lines in space with linear zone plates

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This project was inspired by a general fascination with zone plates and the interesting work on zone plates containing a π phase jump done by Vinas et al. [1]. Such specialized optical devices create a series of dark focal points in space which can be used for precision alignment. Zone plates are optical elements which focus light by *diffraction* instead of refraction as in conventional lenses. A Fresnel-type zone plate has many concentric circular regions which are alternately opaque and transparent. The widths and radii of the zones are such that light diffracted from the center of every transparent region reaches a focal point on the axis of the plate in phase. The result is constructive interference, and the creation of a bright spot. Such Fresnel zone plates also have minor bright spots along the beam axis, which occur when the phase shift from adjacent transparent regions is an integer multiple of 2π .

Linear zone plates, which are the subject of this project, have one-dimensional patterns and act like cylinder lenses to create line foci. Introducing a π phase jump across the center of such a zone plate effectively inverts the focus, creating a "dark line in space" between two bright lines. A π phase jump occurs when one half of the zone plate has transparent regions where the other half has opaque regions. The π phase jump causes half of the light passing through the zone plate to be completely out of phase with the other half of the light, thus causing fully destructive interference along the dark line.

The goal of our project is to create and investigate a linear *sinusoidal* zone plate with a π phase jump. Sinusoidal zone plates have smooth transitions from completely transparent regions to completely opaque regions, unlike binary zone plates, which are strictly opaque or transparent. The smooth transitions lead to sharper focal lines, and eliminate the minor focal lines that are present with the use of binary zone plates. Zone plate patterns were generated by using Mathematica to map the varying transparency across the zone plate with the function,

$$T(x) = \frac{1 + \cos\left(\frac{\pi x}{f\lambda}\right)}{2}$$

where f is the focal length, x is the lateral distance from the center line of the zone plate, and λ is the wavelength of the light illuminating the zone plate. Several 8 mm square patterns generated in this way have been imaged onto 35 mm black and white film by photographer Gene Lewis (Darkroom Specialties LLC, Eugene, OR). We are currently observing and recording the diffraction patterns at various distances that result when the zone plate is illuminated with the expanded beam from a HeNe laser.

We would like to thank the Simons Foundation for funding this research, Michael Raymer for recommending a printing service, and Prof. Harold Metcalf for establishing and supporting the Laser Teaching Center.

References

- [1] S.B. Vinas *et al.*, "Zone plates with black focal spots," *Applied Optics* **31**, 192 – 198 (1992).
- [2] J. Ojeda-Castaneda, and G. Ramirez, "Zone plates for zero axial irradiance," *Optics Letters* **18**, 87 – 89 (1993).
- [3] T.D. Beynon, I. Kirk, and T.R. Mathews, "Gabor zone plates with binary transmittance values." *Optics Letters* **17**, 544 – 546.
- [4] J. W. Goodman, *Introduction to Fourier optics*. Robert and Company, 2005.
- [5] Nityan Nair, "Diffraction with a twist: creating optical vortices with a spiral Fresnel zone plate." Siemens competition report, October 2008. <http://laser.physics.sunysb.edu/~nityan/Siemens.pdf>

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Laminin expression during developmental myelination

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Myelination is the insulation of neuronal axons, and it plays an important role in proper nervous system function. In diseases where myelin is destroyed such as Multiple Sclerosis, nervous system function is perturbed. Currently there is no cure for this pervasive disease. Oligodendrocytes are the myelinating cells of the central nervous system, and to this day, their development remains incompletely characterized. These cells are known to respond to signals in their local environment. One of these signals is a group of proteins known as the laminins, which are found in the extracellular matrix, a protein mesh found outside of cells. Mutations affecting the laminin genes have been found to be associated with abnormal myelination, suggesting that laminins regulate the myelination process itself. The aim of our project is to determine the temporal and spatial distribution of laminin mRNA during developmental myelination. To accomplish this, we isolated gene products from the cortex and the cerebellum at different time points in of development and determined the expression of laminins using Reverse Transcriptase-Polymerase Chain Reaction, a method to detect gene products. We found that various laminin chains are expressed in these brain tissues and that the mRNA levels change dramatically throughout the myelination process. This information will be useful in building our understanding of the proteins that affect developmental myelination.

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Incipient speciation of the mustached bat *Pteronotus parnellii* in the Caribbean Islands

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In the Caribbean, bats are the most abundant of all mammals and 50% of all species are endemic to the region because although they are capable of flight, isolation of populations can still occur in island environments. Caribbean island populations of *Pteronotus parnellii*, a geographically variable bat species, were studied to determine whether the populations on Hispaniola and Puerto Rico are genetically isolated and should be recognized as two separate species. Preliminary echolocation studies suggest a divergence between the two populations. For further support of this hypothesis, molecular as well as morphological data of individuals from Hispaniola, Puerto Rico, and the geographic intermediate Isla Mona were analyzed.

Gene amplifications were conducted for mitochondrial cytochrome *b* (*cytb*) and nuclear introns ATP7A, STAT5A, and PLCB4. Thus far, only *cytb* sequences exhibit sufficient variation for significant analysis. Both maximum likelihood as well as Bayesian trees constructed from *cytb* data indicates the grouping of the Hispaniola and Puerto Rican individuals into largely exclusive clades. Interestingly, Isla Mona individuals are genetically similar to the Puerto Rican specimens indicating gene flow between these two islands. Fixed pairwise differences (F_{ST}) calculated for the three islands indicate very high separation values of 0.79633 between Hispaniola and Puerto Rico and 0.77734 between Hispaniola and Isla Mona, both with $P < 1 \times 10^{-5}$. There is no significant difference between Puerto Rico and Isla Mona.

Morphological analysis of body, tail, ear, foot, and forearm length and weight supported mitochondrial molecular results. Unpaired t-test statistics show significant ($P < 0.05$) differences between the Hispaniola and the Puerto Rico/Isla Mona populations for all six studied characteristics. Hispaniola individuals tend to be smaller and lighter, with smaller forearms and feet but longer ears and tails.

The obtained results suggest *P. parnellii* populations on Hispaniola and Puerto Rico are separate species. Additional useful nuclear sequence data will be collected and investigation into the use of the FoxP2 echolocation gene is currently underway. Further statistical analysis of echolocation call recordings will also be made.

This research was supported by the Simons Foundation and a National Science Foundation grant to the lab.

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The use of molecular dynamics to understand slow-onset inhibition of *Mycobacterium tuberculosis* KasA by potent lead compound thiolactomycin

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The ability of *Mycobacterium tuberculosis*, the causative agent of tuberculosis (TB), to survive within its host is dependent upon the presence of mycolic acids in the pathogen's cell wall. Mycobacterial β -ketoacyl-acyl carrier protein synthase I (KasA), an essential enzyme in the type II fatty acid synthase (FAS-II) system, is needed for the elongation of mycolic acid precursors. KasA is reversibly inhibited in both its apo and acylated states by the natural product thiolactomycin (TLM). A slow-onset inhibitor of the acyl-enzyme intermediate, TLM has a greater binding affinity for acylated KasA, which can be structurally represented by substituting a glutamine for the catalytic cysteine. In this study, we employed molecular dynamics using the Amber biomolecular simulation program to examine for the first time the behavioral differences between wild type and C171Q KasA in the context of their contributions to slow-onset inhibition. Tests for internal and local motion, like root mean square deviation (RMSD), atomic fluctuation and distance calculations, revealed that the dimer interface is the most flexible region of the enzyme and that overall enzyme behavior changes in the slow-onset binding model. Specific relationships, like the distance between Tyr126 and Tyr541 in the dimer interface, also differ between wild type and C171Q KasA. These results were combined with quasi-harmonic analyses to characterize the most dominant and biologically relevant motions of KasA. It was determined that the $\alpha 5$ and $\alpha 5'$ helices, from monomer one and two respectively, not only govern access to the enzyme's acyl-binding channels but also have differential dynamics in the normal and slow-onset systems. In addition, the reversible nature of TLM as an inhibitor was confirmed.

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Investigating optical vortices created with a single cylinder lens

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This work extends the work of Hamsa Sridhar, a former Simons Fellow, who discovered a way of converting Hermite-Gaussian (HG) laser modes to Laguerre-Gaussian (LG) modes with a single cylinder lens [1]. Her "single lens mode converter" is simpler than the previous design, which used two cylinder lenses, but the generated optical vortex is only approximate. In this work we are investigating several aspects of the optical vortices created by the single lens mode converter, through measurements and simulations.

An optical vortex is a phase singularity - a point in a light beam where the phase of the light wave takes on every value and hence is undefined. This ambiguity necessarily results in a point of zero intensity, or dark core. Certain LG modes contain an optical vortex since these specialized laser modes contain azimuthally-varying phases. One possible way of generating such a laser beam is by converting a HG mode into the LG mode by using astigmatic elements (cylinder lenses), which affect the two orthogonal transverse components (x and y for a beam moving along the z -direction) in different ways. A regular astigmatic mode converter uses the first cylinder lens to introduce astigmatism, and the second cylinder lens to restore the beam to isotropy. However, in the single lens mode converter, the astigmatic beam is not converted back to its isotropic state due to the lack of the second cylinder lens. But the divergence rates of the two beam components are the same, so the beam gradually becomes circular in the far-field where the width difference in the two axes is insignificant.

The original concept of this project was to study the quality of the optical vortex mode created by a single lens converter. Prior to any experimentation, we expected that the vortex would pass through a sequence of elliptical shapes when it was focused with a spherical lens, as a result of its residual astigmatism. Very recently, as we tried to observe these shape changes, we discovered that at the midpoint of the focal region where the two beam components share the same width, the vortex disappears and a Hermite-Gaussian mode reappears. We now understand that this happens because the Gouy phase shift gained at the cylinder lens is totally undone at this midpoint, so the beam is restored to a Hermite Gaussian form there. Future work will seek to model our observations by creating a computer spreadsheet model based on the q -parameter formalism.

We would like to thank the Simons Foundation for funding this research, Hamsa Sridhar for helpful discussions, and Prof. Harold Metcalf for establishing and supporting the Laser Teaching Center.

Reference

- [1] Hamsa Sridhar, Martin G. Cohen and John W. Noé. "Creating optical vortex modes with a single cylinder lens." Proc. SPIE 7613, Complex Light and Optical Forces IV, Photonics West, January 2010.

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The effects of dispersants and their surfactants on *Cyprinodon variegatus* embryos

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On April 20, 2010 BP's Deepwater Horizon oilrig sank and ultimately spewed almost 205 million gallons of oil into the Gulf of Mexico, creating one of the world's worst oil spills. Given the magnitude of the spill, dispersants were used in ways and in quantities never seen before. Much debate continues about the potential toxic effects of dispersant use in the Gulf. Most available literature indicates that dispersed oil is more toxic than the actual oil spill itself. Because dispersants make oil more soluble, particularly when used at unusually deep depths as was done for the first time at the Deepwater Horizon site, their use spreads oil in the water column where it can affect deeper dwelling organisms. Yet, dispersants are used to reduce oil slicks and minimize the amount of crude oil reaching the shore and damaging delicate marshlands and soiling pristine beaches. While dispersants also help break up and dissolve oil, potentially making it easier for marine microbes to break it down, the amount of petroleum hydrocarbons in the water column actually increases, thus exposing marine organisms to potentially toxic concentrations of oil and dispersants for a longer period of time. Corexit 9527 was originally used in the spill. However, over the course of the spill, that dispersant was replaced by Corexit 9500 due to concerns about 9527's toxicity. The two Corexit formulations contain complex and overlapping mixtures of component chemicals. It is important to understand the toxic properties of the component surfactants and their longevity in the marine environment to understand the toxic potential of dispersants. My study focuses on determining the toxicity of the Corexit dispersants and their surfactants to early life stages of the Sheepshead Minnow, *Cyprinodon variegatus*, a species indigenous to the Gulf. Based on preliminary studies of acute mortality of Sheepshead Minnow embryos exposed to dispersants and their surfactants: Corexit 9527 and 9500 have similar toxicities; Tween 80 is more toxic than Tween 85, and somewhat less toxic than the Corexits; AOT and Span are less toxic, but seemed to have appreciable toxicity at the lowest concentration tested. Although not quantitatively evaluated, embryos exposed to dispersants and surfactants all seemed to have fuzzy coats indicative of bacterial infestation. In contrast, control embryos were visually free of infection. A follow-up experiment is currently underway to determine the LC50 for Corexit and quantitatively compare all the dispersants and surfactants tested.

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Factors involved in prediction of intergenerational preferences

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Individuals must frequently decide whether or not to make costly sacrifices for the sole benefit of future generations. Such decisions are referred to as intergenerational dilemmas. For example, when nations enact policies to curb greenhouse gases, they incur large, immediate costs. However, such choices suggest that policy makers believe the short-term costs are worth the long-term benefits. Previous psychological research on intergenerational dilemmas has shown that factors such as insensitivity to future outcomes, generosity, and fairness are related to individual's intergenerational preferences. However, it remains unclear whether and how these factors interact to produce intergenerational preferences. In the current study, participants completed multiple decision-related individual difference measures so as to provide an individualized subject-record. These measures were then entered into a multiple regression model to predict participants' responses to a set of intergenerational scenarios. The regression results suggest that social discounting (willingness to forgo money in favor of giving to others) and intertemporal discounting (willingness to forgo immediate rewards in favor of delayed rewards) accounted for a significant portion of the observed variance in intergenerational preferences. A measure of fairness (inequity aversion) did not account for significant variance in intergenerational preferences. Intertemporal discounting rates were also correlated with intergenerational preferences, as were social discounting rates. However, there was no relationship between intertemporal discounting and social discounting. These results suggest that insensitivity to future outcomes and generosity play an important role in predicting one's intergenerational preferences, but one's sense of fairness may play little to no role. These results seem to suggest that intergenerational preferences are a unique blend of intertemporal and social preferences. This suggests a future work may fruitfully bring previous research conducted on intertemporal choice and social discounting to bear on the problem of intergenerational preferences.

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The effect of dialect representation on the perception of phonemic variation

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Dialects are more than just spoken word variants; they are fundamentally categorized by both their production and perception. Therefore, people who do not speak with a certain dialect or accent can still have the dialect due to family history, with the dialect supporting their ability to easily comprehend the phonemic variations of the dialect. The Long Island accent contains several idiosyncratic divergences from “general” American, including the pronunciation of the open mid-back rounded vowel (e.g., “*caʷfee*” instead of coffee). Within the Long Island region, native speakers who do not produce such variations are considered to be covert, while their counterparts who do produce the characteristic phonemes are considered overt speakers. This study examines the differences between the types of speakers in selective adaptation and perceptual learning experiments.

In both paradigms, participants will be exposed to the Long Island vowel and will then be asked to categorize a randomized continuum of phonemes as either /ah/ or /aw/. This should result in shifts in the perceptual system for both covert and overt Long Island as well as general American speakers. Perceptual learning should cause them to expand their Long Island vowel category to create a new perceptual model for the dialect, causing them to either expand or contract their boundaries to create a new perceptual model for the dialect. Selective adaptation should cause them to contract the category. This study seeks to analyze the magnitude and direction of speakers of these dialects. The results of these experiments could provide insights into the nature of the perceptual system and how speakers deal with different dialects.

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Functionalized single walled carbon nanotubes for multimodal tumor-targeted therapy and biological imaging

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Cancer is the second deadliest disease in the United States, taking more than 1500 lives per day and is responsible for over \$250 billion of medically-related costs every year. Current treatment options include radiation therapy, surgery, and chemotherapy. However, chemotherapy, a regimen of cytotoxic chemicals frequently administered to a majority of cancer patients, is not specific to cancer cells and leads to systemic toxicity and severe side effects such as hair loss, kidney, liver, and bone marrow damage. Therefore, it will be advantageous if novel anticancer treatments are developed that can combine different forms of therapy and possess tumor-targeting characteristics to increase therapeutic efficacy. Single-Walled Carbon Nanotubes (SWNTs) have been previously studied as platforms for drug delivery and biological imaging because their sidewalls allow for the covalent and noncovalent introduction of contrasting agents, drugs, and genes. Moreover, carbon nanotubes exploit the enhanced permeability and retention (EPR) effect of tumors caused by their porous vasculature and poor lymphatic drainage system, resulting in accumulation of the SWNTs in the tumor tissue.

SWNTs have been shown to absorb NIR frequency and convert it to heat, making them excellent candidates for inducing thermal ablation. Therefore, conjugates bearing biotin as a tumor-targeting moiety (TTM) and fluorescein isothiocyanate (FITC) were previously synthesized for thermal ablation testing on cancer cell lines. Confocal microscopy showed successful internalization into the cells and subsequent radiation-induced thermal ablation was observed. The purpose of this study was to synthesize a SWNT-based conjugate with attached cytotoxic drugs and tumor-targeting moieties to be coupled with thermal ablation for multimodal tumor-targeting therapy and preliminary biological testing.

The first conjugate for synthesis was a SWNT conjugated to a highly potent, second generation taxoid known as SB-T-1214, a cleavable disulfide linker, biotin TTM, and FITC for *in vitro* imaging. The cleavable linker is advantageous because it only cleaves inside of the tumor where the glutathione concentration is 1000 times more than in the blood plasma, thereby ensuring that the drug will only be released inside of the tumor. Cytotoxicity assays will be carried out to determine the efficacy of the targeted delivery of SB-T-1214. Furthermore, internalization of this conjugate will be measured with CFM and flow cytometry. The second conjugate will be the same as the first one except in place of FITC, a chelator will be introduced with an attached radiotracer (technetium) for *in vivo* imaging. *In vivo* imaging will allow us to determine biodistribution of the SWNTs.

Advances towards the synthesis of a novel targeted anticancer therapy were made. Ultimately, this conjugate will allow for the targeted delivery of cytotoxic agents and *in vitro* and *in vivo* imaging. This more potent form of tumor-targeted drug delivery coupled with thermal ablation can serve as a whole new form of therapy that can kill a greater percentage of cancer cells and also enhance molecular imaging capabilities. Future studies may include co-administering other highly potent drugs with SB-T-1214 that reverse resistance to taxoid-based apoptosis by inhibition of specific molecular pathways.

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The importance of measuring exoplanet density in Kepler's search for Earth-like planets

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Exoplanets are planets that lie beyond our Solar System and are the focus of NASA's *Kepler* Mission in the search for other habitable, Earth-like worlds. This study provided a basis that calculating density is necessary for suggesting the habitability, or sustainability of life, of exoplanets through the *Kepler* Mission. *Kepler* devises the transit method to detect such planets, in which planets pass in front of their parent stars and the change in brightness is measured. By generating a light curve to graph this change in brightness, the depth of the "dip" can be calculated as the ratio of the areas of the parent star to the transiting planet, simplified to $(R^*/R_p)^2$. The length of the transit is found through the formula at first approximation, $(2R^*a^{1/2})/(GM^*)^{1/2}$, where the stellar radius, R^* , and mass, M^* , are known, G is the gravitational constant, and a is the semi-major axis of orbit. Yet with this transiting method come several limitations, such as eccentricity, orbital inclination, limb darkening, and likely false positives of binary stars. Furthermore, the probability of *Kepler* finding one transit, regardless of habitability, is .005%. Once a transit is identified, the planet must be identified by its composition. This is where calculating density is vital, given the equation $\rho = M_p / (4/3)\pi R_p^3$ to determine the structure and nature of the exoplanet. A planet must have high density to suggest or further prove habitability. In conclusion, the transiting method may aid the *Kepler* mission in identifying exoplanets, although the chances of this may be slim, but it is the calculation of density that will further confirm an Earth-like planet before habitability can even be considered.

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Using *in vivo* photocrosslinking to map protein interactions during pilus biogenesis

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The purpose of this study was to map the protein interactions involved in uropathogenic *Escherichia coli* P pilus secretion. P pili are external structures that facilitate adhesion to kidney epithelial cells, playing a major role in bacterial pathogenesis. They are composed of monomeric proteins that are assembled and secreted at the cell surface through the chaperone/usher pathway, in which periplasmic chaperones transport pilus subunits to the outer membrane to be secreted through outer membrane usher proteins. The N terminal domain of the usher has been shown to be involved in both targeting chaperone-subunit complexes and at a currently unidentified later stage of pilus biogenesis. It contains a disulfide loop region that is required for pilus assembly, but not to bind chaperone-subunit complexes, performing instead an unknown function. By capturing the *in vivo* protein interactions, *in vivo* site-directed photocrosslinking was used to map interactions made by the disulfide loop region. Amber stop codons were introduced using site-directed mutagenesis at positions evenly distributed throughout the loop region. Mutant amber suppressor tRNA was used to incorporate a synthetic photocrosslinkable amino acid, *p*-benzoylphenylalanine (*p*BpF), at chosen sites. When the usher expressing *p*BpF was irradiated with UV light, the incorporated *p*BpF reacted with nearby carbon-hydrogen bonds. Preliminary results indicate that the amber stop codon effectively prevents wild-type protein expression in the absence of suppressor tRNA and allows incorporation of *p*BpF at specified sites in the presence of suppressor tRNA. Understanding the mechanisms of the chaperone/usher pathway can lead not only to a further understanding of bacterial pathogenesis, but also to the development of novel methods for fighting bacterial infection.

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Brian Ralph
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The size trends of basal Saurischia

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Although much work has been done to analyze the evolutionary and morphologic trends within Dinosauria, little analysis has been done on earlier parts of the phylogeny. In the past few decades there have been many new discoveries of species that fall into basal Dinosauria and though many of these species have been thoroughly examined, the general trends within the clade have not been addressed.

In this study, Saurischia, a branch of Dinosauria, was studied to determine evolutionary changes with respect to body mass within the basal clades of the group. Saurischia consists of the branches Theropoda and Sauropodomorpha. In order to obtain the body mass of basal species of Theropoda and Sauropodomorpha, femur lengths of the charted specimen were required. Femur length has a strong correlation to body mass in many extant groups, such as mammals, and is believed to have a similar significant correlation in Dinosauria. Body masses were calculated and log transformed for thirty-eight species of basal Theropoda and seventeen species of basal Sauropodomorpha. The approximate ages of the specimen were used to obtain values for the branch lengths used in the production of two phylogenetic trees. The phylogenies were constructed in the program Mesquite OSX and were based on Theropoda and Sauropodomorpha. The computer coding from Mesquite was then altered and imported into TNT (ver. 1) where a linear comparison was performed to estimate the ancestral body mass at each branching point in the phylogenies. Next, the coding was utilized in a final program called BayesTraits. For each phylogeny four tests were run. Each test resulted in a Maximum Likelihood Score (ML). The first test, which simulated random changes throughout the phylogenetic paths, was the random walk model and served as the null model. Then, tests for punctuated evolution (equilibrium), directional evolution, and modifications of model parameters (λ , κ , δ) were performed. Likelihood Ratio Tests were used to check for statistically significant differences between these models.

In the end, both failed the test for directional evolution, but passed the punctuated evolution and the modified parameters tests. With regard to the modified parameters test, basal Theropoda displayed $\lambda=1$ signifying a strong trait to tree correlation; it displayed $\kappa=.4596$, which just passed the test, and indicates punctuated evolution. Sauropodomorpha displayed $\lambda=.780997$, which is close enough to 1 to signify a strong trait to tree correlation; it displayed $\kappa=0$, which indicates punctuated evolution. By identifying trends, researchers are able to then study the causes behind those trends. Knowing how body size has changed over time can give rise to the understanding of other integral trends since body mass correlates with significant biological functions such as metabolic and reproductive rates.

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Anomalous diffusion of light in InP semiconductor scintillator

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Gamma ray detection is an important aspect of national security as it is a primary method for detection of radioactive materials. In this work, we discuss the use of an InP semiconductor scintillator to detect gamma rays. When a gamma ray interacts with the scintillator, it creates a cloud of electron-hole pairs that diffuse throughout the semiconductor. These electron-hole pairs recombine, producing secondary photons (infrared light) that propagate in the semiconductor in random directions. This process, which is similar to a random walk, repeats until the infrared light is registered by epitaxial photodetectors at the scintillator surface. The photodetectors measure the total energy of the infrared light. This energy is proportional to the energy of the gamma photon, and is used for its estimation. Some of the infrared photons can be lost in their walk to detector, so it is vital that this diffusion of secondary photons is well understood. Accurate modeling of this process will lead to higher resolution gamma ray detectors. However, unlike normal diffusive processes, the recycled photons' mean square displacement for each step is infinite. This research seeks to model this anomalous diffusion using Monte Carlo simulations and to compare the results of modeling with pertinent analytical and experimental results.

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Mutational analysis of the *Escherichia coli* MoeB Protein provides insight into the mechanism of E1-like enzyme activation

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Elucidation of the ubiquitin-dependent protein degradation pathway served as the first example of a protein tag being used to modify another protein. These post-translational modifications are implicated in the regulation of many essential cellular pathways including differentiation, apoptosis, cell cycle progression and responses to stress. Surprisingly, the MoeB protein from *Escherichia coli* shares significant sequence homology to the E1 superfamily of ubiquitin and ubiquitin-like (Ubl) activating enzymes. MoeB is involved in the biosynthesis of the molybdenum cofactor. In an effort to probe the reaction mechanism of Ubl activation, nine highly or strictly conserved amino acids at the active site of MoeB were mutated and their activity was measured using a modified nitrate reductase overlay assay. Results suggest a vital role for amino acids Asp62, Phe63, and Asn70 in the activation of MoeB. Knowledge of the mechanism of ATP-dependent Ubl activation may provide a starting point for the rational design of pharmaceuticals that inhibit the E1 family of activating enzymes, potentially providing therapies for various forms of cancer and retroviruses including HIV. Currently, we are attempting to crystallize a MoeB homodimer along with a MoeB-MoaD complex. Following the purification and crystallization of the MoeB protein and a MoeB-MoaD complex, the compound PYR-41, a synthetic E1 inhibitor, will be introduced to evaluate if the compound is capable of binding the active site of MoeB. Isothermal titration calorimetry will also be utilized to determine the thermodynamic parameters of the compound's interaction with MoeB and to estimate its binding affinity. The mutational, structural, and kinetic data produced from this research will be crucial for rational drug design.

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Effect of trabecular bone orientation on quantitative ultrasound

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Quantitative ultrasound (QUS) is currently being studied as an alternative to dual x-ray absorptiometry (DXA) for diagnosis of osteoporosis that reflects the anisotropic nature of trabecular bone. However, prior studies have shown that the orientation of trabecular bone plays a factor in QUS results, and ultrasound velocity (UV) varies significantly with the direction of measurement [1]. This experiment vies to determine the effect of the orientation of trabecular bone on QUS parameters.

Three cylindrical cores in the proximal-distal (PD) direction and three cylindrical cores in the medial-lateral (ML) direction were taken from two bovine distal femurs. A pair of focused broadband transducers (V318, Panametrics Inc., Waltham, MA) was placed on either side of the bone (control=water), and the samples were rotated in 5° intervals. Micro-computed tomography (micro-CT) was performed on all six samples using viva-CT 75 (ScancoMedical, Zurich, Switzerland).

Depending on the angle of rotation of a sample, UV had a range of 462.4 m/s, ATT had a range of 15.2 dB, and BUA had a range of 148.3 dB/MHz. The average UV for the PD cylinders was 1848.6, 1853.8, and 1852.3 m/s, and the average ATT was 31.4, 32.7, and 31.8 dB. Pearson 2-tailed correlation tests were performed on all six samples for UV and ATT, and the r-values in the ML direction were 0.973 and 0.917 ($p < 0.0001$).

The angle of rotation had a significant effect on all three QUS parameters studied; nevertheless, the average UV and ATT values for the PD cylinders are fairly constant. It may be possible to use rotating transducers to obtain data for multiple angles of rotation, and the average of these values may help account for trabecular orientation in the assessment of bone quality. Taking the angle of rotation into account, UV and ATT were significantly correlated in the ML direction, and further experimentation may determine if trabecular orientation improves the correlation between QUS parameters.

In conclusion, trabecular orientation has significant influence on ultrasound attenuation and velocity and may be a valuable indicator in predicting bone's structural properties. Modified ultrasound assessment based on orientation may also improve the correlations between QUS parameters, and average QUS values taken at multiple angles of rotation may be more accurate and useful in the assessment of trabecular bone strength.

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[1] Hans, D. *et al.*, (1999), *Calcif Tissue Int*

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Exploring the dose-dependent activity of the *Drosophila* Fushi-tarazu (Ftz) homeodomain protein

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The proper regulation of gene expression is essential for development; defects in gene regulation are frequently associated with human disease. The establishment of the segmented body pattern of *Drosophila melanogaster* provides a remarkable example of the critical role of transcription regulation and cell fate specification. The body pattern is established by specific DNA-binding transcription factors encoded by the pair-rule and segment polarity genes. *Ftz* (*Fushi tarazu*) is a pair-rule gene that plays a crucial role in the regulation of the expression of the segment polarity genes. *Ftz* is best characterized for its role in coordination with Runt in activating *engrailed* (*en*) expression, but these same two factors also repress *sloppy-paired-1* (*slp1*) in the anterior half of each even parasegment. Here, I use an ectopic expression system to further investigate *Ftz*'s role in regulating segment polarity gene expression. It is hypothesized that the lethality associated with *ftz* mutant embryos is caused by the repression of *slp1*, therefore making *slp1* the most sensitive target of *Ftz*. However, the analyses of the responses of *wingless* (*wg*), *paired* (*prd*), and other segment polarity targets to quantitative manipulations in *ftz* activity had previously not yet been completed. To complete these analyses, flies went through a series of crosses to produce progeny carrying *UAS-ftz* transgenes inserted at different insertion sites with different expression levels. Male flies of each line were crossed to females that exhibited the maternally expressed yeast transcription factor, *GAL4*, to examine dose dependent activity by further varying the expression levels of the *ftz* transgene. In situ hybridizations with digoxigenin-labeled antisense RNA probes were performed using seven different probes and the endogenous genes' sensitivities to *Ftz* were scored to determine if *slp1* was in fact the most affected target. Surprisingly, many other endogenous genes responded strongly to high *Ftz* levels.

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Synthesis, biological evaluation, and potential synergism of tumor-targeting drug conjugates bearing dual-warheads

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A drug delivery system consisting of a tumor-targeting module (TTM) and two warheads with different mechanisms of action has been synthesized. The TTMs utilized in this project are biotin and folic acid, two vitamins essential to cellular growth that have been shown to be overexpressed on tumor cell surfaces. The two warheads used are SB-T-1214, a second-generation taxoid that inhibits microtubule polymerization in the G₂/M phase, and topotecan, a camptothecin analog that inhibits topoisomerase I during the S phase. It has been reported that a synergistic interaction exists between paclitaxel and camptothecin. Treatment with paclitaxel first increases the activity of a camptothecin, yet reversing order or simultaneous treatment only yields additive effects. Based on these findings, the DDS has been designed to consist of two different disulfide linkers so that SB-T-1214 can be released before topotecan. Both SB-T-1214 and topotecan are more active derivatives of their parent compounds, thus we believe that the DDS will be more efficacious than the parent drugs. In addition with the co-delivery of the warheads, we believe the DDS will be more efficacious than the single drugs.

The biological activity was evaluated *in vitro* using a series of cancer cell lines. The IC₅₀ values for SB-T-1214, topotecan, camptothecin, a 1:1 combination of SB-T-1214:topotecan and a 1:1 combination of SB-T-1214:camptothecin were determined. SB-T-1214 showed excellent activity in all of the cancer cell lines (subnanomolar activity), whereas camptothecin and topotecan showed nominal activity (submicromolar level). However, the combination of SB-T-1214 and topotecan proved to be extremely effective against MCF-7, a breast cancer cell line. The IC₅₀ value dropped significantly subnanomolar, reflecting a possible synergism of these two drugs in this specific cancer cell line.

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On the exploration of large oligosaccharides through the use of the Monte Carlo method

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Glycoproteins play a major role in cell to cell recognition. For example, the HIV viral envelope glycoprotein, gp120, plays a key role in the initial infection of cells by HIV, due to interactions with cell-surface receptors including CD4. The glycosylation of gp120 is essential for viral infectivity, but also plays an important role in viral avoidance of the immune system. Because these oligosaccharides play a large role the first step of the HIV life cycle, modeling these large polysaccharides is important to both the rational design of lectins that bind to oligosaccharides in addition to the understanding how oligosaccharides function in cell recognition. Current computational techniques are very effective in the simulation of large biomolecular system, as has been well-demonstrated with proteins; however, there are important differences between oligosaccharides and proteins that must be considered. In particular, because sugar polysaccharides can be highly branched, their energy landscapes typically consist of multiple minima separated by high energy barriers; these multiple conformations all coexist at equilibrium. Monte Carlo is such a method that is well suited for such exploration of the diverse energy landscape due to its ability to freely traverse through energy barriers and wells. This project focuses on the use of Monte Carlo simulations to explore the energy landscape of the oligosaccharides in implicit water. A Metropolis-Hastings Algorithm that randomly samples from the Boltzmann distribution, the CHARMM Monte Carlo Module makes random torsions from a predefined move set and accepts or rejects the move based on the probabilities as dictated by the Boltzmann distribution. Starting from two N-acetyl glucosamine molecules and building one sugar molecule onto each branch at a time, the oligosaccharide underwent several Monte Carlo simulations. Every rotatable bond was rotated with equal weights and with 180 degrees of freedom. Then, at each step of simulation for 10^7 steps, the dihedral angles of each of those bonds were measured and binned into histograms. Initial analyses of the histogram reveal not only adequate sampling but also optimum dihedrals from each bond. Then by combining these optimum angles, we can reconstruct the optimum conformations that the polysaccharides adopt.

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