

Bringing Culture and Technology Together

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The elders from Mescalero Apache tribe, located in Mescalero New Mexico. They wanted to created a way where students will merge the language (Apache) and technology together. They fear that will today's culture the young students are losing part of the Apache culture (language). This is a huge problem with within the tribe. The lost of culture in particularly the languages.

Our solution to merging the culture with today's technology, Coding in Apache. Our program will teach our elementary students how to code using the Apache language. We want to start with 3rd-5th grade students afterschool robot training program. They will meet with the instructors (High School students) twice a week afterschool to learn how to code Botball Robots. The program will not only teach them how to code, but also continue to instruct them in the apache language and culture.

Future application we want to start this program in our lower grades as well. It can become part of our Apache language program as well. Our students can compete in robotic competition using their own language as part of the competition. We also want to develop this coding in our high school robotic program as well. Working on this project, it give us a chance to combine two culture and form one working solution that benefit us and our young students. We can keep the language alive with technology.

Keywords: Culture, Coding, Technolgy

The Pythagorean Forest

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We show how a network of ideas—a forest of trees—that constitute a 3-D tree graph of a proof in geometry both interact and accumulate in number and kind. Our bar graph, adjacency matrix, and a new 3-D acrylic and wood sculpture represent ways to visualize a geometry proof (in our case, the Pythagorean Theorem) and its interacting premises.

Keywords: Math, Art, Pythagorean Theorem, Euclid's, Proofs

Low-head Hydropower

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Low-head hydropower has the potential to bring reliable baseload electricity to rural towns and villages around the world. New Mexico's acequias system delivers water to much of rural central New Mexico. Recent improvements in technology have reduced the cost of building micro hydropower systems. A new Belgian technology of a prefabricated whirlpool hydropower system can power 60 homes for less than \$100,000. The outflow of Cochiti Dam is more than 400 cubic meters per second. 3 of these systems could provide 24/7 power to Cochiti Pueblo with plenty of water left over to power other rural communities.

Keywords: Hydropower, Acequia, Baseload Electricity

Testing of Multiple 3D Printed Cylinders Against Surface Flash Over

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Insulators in a high voltage environment are a consistently challenging problem because of the threat of electrical breakdown and permanent damage resulting equipment failure. While engineered polymers such as acrylic and polycarbonate have substantial voltage holdoff capability, shaping is achieved by machining, requiring substantial effort. In many engineering areas, 3D printing has shown to be a novel and cost-effective manufacturing technique. The use of 3D printed insulators are used primarily because they can be designed to the exact specifications as required, with a variety of materials.

However, many 3D printing fabrication methods result in embedded air pockets which is detrimental to high voltage performance. In experimenting with one method, stereolithography (SLA), we have shown that it has excellent high voltage properties. This provides a unique and interesting way to investigate a variety of parameters in relation to electrical breakdown phenomena.

The manipulation of the length and material is the primary focus of this project. When dealing with insulators and high discharge, surface flashover is the result of electrons accelerating across the surface of an insulator where it eventually creates an arc between conductors of difference potentials, resulting in the limitation of voltage it can support. For this project, several 3d printed materials as well as Lexan will be tested in 1 in. diameter cylinders, with varying heights using a 25 stage Marx pulse generator in order to determine how each behaves and responds to surface flashover.

Keywords: Electrical Engineering, Surface Flashover, Insulators

Social Preference of *Cyprinodon variegatus* from Crescent Lake

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New species emerge as a result of evolutionary processes that prevent reproduction between populations. Here we use a model system of pupfishes to examine how social behavior influences barriers to reproduction between populations. Three species of minnow-like pupfish inhabit interior lakes on San Salvador Island, The Bahamas. They have overlapping habitats but are reproductively isolated. *Cyprinodon variegatus* are generalist feeders and are the ancestral type that the other two species derived from. *C. desquamator* exhibit a rare diet of scale-eating, and *C. brontotheroides* who specialize in eating hard-shelled organisms. These fish can be identified through their mouth morphology, with *C. variegatus* having a small mouth, *C. desquamator* having an under-bite that aides in scale-eating, and *C. brontotheroides* having a big mouth to help with shell crushing. In the case of the Bahamian Pupfish, sexual preference for conspecifics and hybrid mortality is what maintains these species in the wild. Here we examine the role of social preferences in these fish. We hypothesize that prey-species should prefer to socialize with conspecifics, as socializing with predatory heterospecifics can be costly. We also hypothesize that fish from the same lake should prefer to socialize with fish of the same lake over fish from a different lake, as costs can be associated with socializing with novel conspecifics

Keywords: Speciation, Reproductive Barriers, Cyprinodon variegatus

Water Source Determination Using Sap Flux and Budyko Analysis

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As climate changes, “hot droughts” or “global change-type droughts” should dramatically alter semi-arid ecosystems in the Southwestern United States. Because these areas are already water limited, understanding how hot droughts impact the hydrology of these ecosystems is crucial. Little is known, however, about vegetation groundwater (GW) usage in semi-arid ecosystems. Species able to access GW may have a competitive advantage over species that do not access GW in future climate conditions. While isotopic analysis is often used to determine water resources used by plants. However, this method is laborious, costly and does not indicate if water sources change over time. In this study, we looked for evidence of GW usage at both the organismal and ecosystem scales in a stand of *Pinus ponderosa* (ponderosa pine) using measured sap velocity (Js), soil water content (SWC), evapotranspiration (ET), micrometeorological data, and calculated potential evapotranspiration (PET). Overall, we hypothesized that this stand uses GW to maintain physiological function during dry periods of the year. At the ecosystem level, annual ET was greater than precipitation (P) for 4 out of 8 years (ratio of ET/P was 1.08, 1.127, 1.061, and 1.038 for the years 2012, 2014, 2016, and 2017 respectively), suggesting a potential role for GW as at least an inconsistent source of water for this ponderosa pine stand. We used a Budyko analysis to identify energy-restricted or water restricted years. This analysis demonstrated that the ratio between PET and P at our site was greater than one during the same 4 years when ET was greater than P, indicating extreme water limitation. At the organismal level, we observed a significant correlation between Js and SWC, particularly when SWC was low (>18%), which is not consistent with GW use. If the stand is able to access GW, sap flow (Js) of individual trees should not be directly related to the dry upper soil layers. Our organism-level results do not support the ecosystem scale results of GW acting as a consistent source of water for this stand in dry years. One possible explanation is the inconsistent ability of all trees to access GW. An alternative explanation is that the level of groundwater in this system fluctuates

with incoming precipitation, which regulates the ability of the trees in this stand to access it during drought. Therefore, contrary to our hypothesis, this stand is only able to access GW during wetter periods. This suggests that in dry years, ecosystem annual $ET/P > 1$ values reflect the ability of trees to more efficiently access deeper soil layers and/or groundwater following incoming precipitation, compared to wet years.

Keywords: Drought Resiliency, Groundwater, Hydraulic Redistribution, Ponderosa Pine, Semi-arid Woodlands

Synthesis and Characterization of Ladder-Type Penta(p-phenylene) for Organic Solar Cells

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With rising demands for energy production, non-renewable resources are being used rapidly, resulting in an increase of associated pollutants. In efforts to preserve the environment many researchers are searching for ways to transition to effective renewable resources. Solar energy is one of the most abundant and clean energy resources that can be utilized to try and reduce our carbon footprint. We are synthesizing conjugated molecules that are solution-processable and expected to absorb and convert light energy into electricity effectively. Particularly, we are synthesizing ladder-type oligo(p-phenylene)s with the incorporation of a nitrile group, serving as an infrared reporter group. The nitrile group will help us probe electron delocalization, a key technological bottleneck for enhancing the conversion efficiency of organic solar cells. The multistep synthesis for ladder-type penta(p-phenylene) involves Suzuki cross coupling, cyclization, alkylation, bromination and cyanation. Five out of nine steps have been completed. Reaction progress and purity were monitored using thin layer chromatography. Column chromatography is used to purify the intermediate compounds. We have successfully synthesized uncyclized ladder-type penta-phenylene, a key intermediate for the target compound. Structure and purity of the synthesized compound were confirmed using ^1H NMR and ^{13}C NMR. Redox potentials will be determined using cyclic voltammetry in electrolyte free environment.

Keywords: Organic Synthesis, Renewable Energy, Organic Solar Cells

Who Will be Dead After We Save the Bats?

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White-nose syndrome (WNS) is a devastating disease to the bat population in North America. The fungus, *Pseudogymnoascus destructans*, causes bats to come out of torpor early in the winter, expending crucial energy stores and resulting in the death of up to 99% of some bat species. A new method of UV-C treatment has been shown to be effective in killing *Pseudogymnoascus destructans*. However, caves are home to a wide range of microbial communities that may be harmed by UV-C. The aim of this experiment is to investigate if this treatment will have potential collateral damage to native cave bacterial species. Samples were taken from caves across three national parks, sub-cultured in the lab and resulting isolates will be exposed to UV-C treatment. Initial cultures from Lava Beds National Monument, Oregon Caves National Monument, and Mammoth Caves National Park, have resulted in 2,721 subcultures currently under investigation. Sequencing of the 16S rDNA gene is being used to identify a maximum of 100 unique bacterial cultures per national park for UV-C testing in the lab. Understanding the potential negative implications of UV-C on native microbial cave ecosystems is crucial before this treatment can be considered for wider implementation.

Keywords: Whitenose Syndrome, Bats, Microbiology, UV Light

A Planar Blumlein Circuit for Agricultural Enhancements with Plasma

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Plasma agriculture is a nascent but emerging field which has shown great promise in organically and sustainably enhancing agricultural yields. Demonstrated enhancements include seed germination, plant health and growth, enhanced crop yields, and post-harvest storage terms. Transitions from the laboratory to the field is inhibited by a lack of understanding of the physical mechanisms which produce the observed enhancements. The first step in elucidating the physical effects is to measure the plasma parameters produced in a nonthermal discharge produced with nanosecond pulsed power generator. We are currently designing a suitable generator known as a Blumlein. A Blumlien is a fast-transient circuit topology, named after its inventor A.D. Blumlien, that has the useful and unique property of delivering the full charge voltage to the load. The theory of operation, preliminary results and an overview of applications to agriculture will be given.

Keywords: Agriculture, Engineering, Plasma

Climate and Tree Source Effects on *Pinus edulis* Mortality, Bud Performance, and Growth in Southwest United States

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Climate change is causing *Pinus edulis*, pinyon pine, mortality and growth declines throughout its range. We sought to understand which tree seed sources and sites will have the highest survival and productivity. Local adaptation suggests that seeds from differing climates will vary in optimal growing conditions and phenology. Furthermore, planting sites with different climates will also influence survival, growth, and phenological variation. Pinyon pine seedling survival, growth, and phenology was surveyed at two common gardens to help understand variation in pinyon pine seed sources and their acclimation to different environments. Pinyon pine seed from the Navajo Nation and from Sunset Crater Volcanic Field, AZ were grown in two common gardens, one in Crownpoint, NM and the other at Sunset Crater Volcanic Field, AZ. For the first year in the common gardens, we assayed survival and overall plant size. To understand the progression of pinyon pine growth through the second year in the gardens we measured bud stage, bud type, bud size, and needle elongation, as an additional representation of pinyon pine performance. The Sunset Crater garden generally had lower survival and plant size. Plant size in the first year did not show local adaptation. Instead, one of the Navajo Nation seed sources consistently had the largest plants at both gardens. For phenology measures in the second year, Crownpoint garden and Sunset Crater garden data showed that seedlings performed better in a climate more similar to their source climate, showing evidence of local adaptation.

Keywords: Phenology, Climate Change, Mortality

Implementation of the Central Limit Theorem to Sensor Fusion in Drone Applications

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A quadcopter's performance can be characterized by its ability to both accurately and precisely locate and land on points of interest. As applications of quadcopters are extensive and often of high importance, the performance of these drones is expected to be near perfect. However, sensor errors can prevent a high degree of both accuracy and precision in this process. To resolve this issue, a sensor fusion technique that is to combine data from multiple sensors will be employed. Sensor data is often unreliable due to its intrinsic Gaussian or Non-Gaussian distribution, with deviations occurring above and below a mean value. This data can lead to skewed quadcopter performance, especially with respect to autonomous landing features, which rely on accurate position values with high precision. The concept of sensor fusion can be realized in multiple ways, the most common of which is the Central Limit Theorem (CLT). The CLT uses the mean and standard deviation values of more than one data set (provided that the data set has characteristics of Gaussian distribution) to produce a combined data set with a Gaussian distribution that has a smaller standard deviation. This means that the outputted data is more reliable and can be used more confidently by the system. The two data sets being combined are position information from an infrared camera and position information derived from an inertial measurement unit (IMU), both of which are mounted onto the quadcopter. The combined sensor data is expected to be more precise than either of the individual data sets. This reflects the viability of the CLT as a method of sensor fusion, supporting its applications with respect to drone development. Future challenges involve combining more than just two data sets. This can be done by the expansion of the CLT.

Keywords: Quadcopter, Precision Landing, Sensor Fusion, Central Limit Theorem

TRANSMISSION LINE PULSER TOPOLOGY: THE PROS & CONS

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The generation of fast, high voltage pulses is essential for studying phenomena involving ionized fluids and their applications. Two line-pulsers are being developed. The first is a coaxial transmission line pulse and the other is a modification known as a self-matching pulser. The coaxial transmission line pulser, is simple yet robust, but is subject to the form of its output waveform being dependent on the relative mismatch between the transmission line and load impedances. While a well-known device, our implementation is devised to be self-contained and portable for maximum utility. The self-matching pulser arranges the component transmission lines so that the generator is always impedance matched and is load independent. The self-matching circuit has only rarely been implemented and is sparsely known. Moreover, the dependence of critical parameters has not been fully explored and researchers need to know more about them before investing their resources. This presentation will describe and explain the basic physics of both circuits. In addition, the data will show the outputs with different resistive loads, power outputs, reflections, and different applications.

Keywords: Pulse Power, High Voltage, Electromagnetics

Seeking Meaning in the Data: A Confirmatory Factor Analysis of the SONG Measure

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An existential perspective on psychological processes posits that seeking meaning in life is related to the development of psychopathology in clinical samples. The Seeking of Noetic Goals (SONG) assessment was developed to evaluate the degree to which an individual seeks meaning. However, only two prior studies have evaluated the psychometric properties of SONG. The original publication did not employ analytic procedures to support construct validity (e.g., confirmatory factor analysis [CFA]; Crumbaugh, 1977) and Schulenberg, Baczowski, and Buchanan (2014) validated a two-factor structure of SONG, but in a non-clinical sample. The purpose of this study is to replicate the factor structure of the SONG proposed by Schulenberg et al (2014) using CFA in individuals seeking treatment for Alcohol Use Disorder (AUD).

The data was collected from Project MATCH (N=1,714), a multisite randomized clinical trial for individuals with AUD. A CFA of SONG was performed to determine if a two-factor structure fit the data. The data was split into an aftercare and outpatient sample. Model building was conducted on the outpatient sample and hypothesis testing on the aftercare sample to determine model fit of the data. In addition, participants completed measures of purpose in life (PIL) and depression to assess convergent and discriminant validity.

The proposed two-factor model was replicated, and convergent and divergent validity were supported. CFA analyses provided adequate model fit for a two-factor structure measuring 'will to meaning' and 'existential vacuum'. Regression analyses indicated that both SONG factors predicted more severe depressive symptoms and the existential vacuum factor negatively predicted PIL. Interestingly, the will to meaning factor was unrelated to PIL.

Future investigations should evaluate how seeking meaning in life predicts outcomes in a clinical AUD sample. It may also be beneficial to validate SONG with other psychopathology measures (e.g., anxiety). Limitations and future directions will be further discussed.

Keywords: Seeking of Noetic Goals, Project MATCH, Alcohol Use Disorder, Confirmatory Factor Analysis, Replication

Impact of Hyperglycemia on Germline Stem Cells

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Diabetes significantly increases the lifetime risk of cancer. Chronic exposure to high glycemic levels (hyperglycemia) can affect gene expression through genetic/epigenetic mechanisms and lead to alterations in cellular homeostasis. All body cells are affected by hyperglycemic exposure; however, it is only the stem cells that are destined to prevail in the system for a long time and more importantly the germline stem cells which directly contributes to transgenerational inheritance. We hypothesize that hyperglycemic exposure affects the germline phenotype by altering the proliferative ability of the distal mitotic stem cells. We have looked into the germline changes as a result of hyperglycemia using epifluorescence imaging. Materials and Methods: We used OD 95 strains of *C. elegans* maintained at 20C in Nematode Growth Media (NGM). Control and experimental groups consisted of worms grown in NGM only and NGM supplemented with different concentrations of glucose (100mM and 400mM) respectively. Worms at larval stage 1 were cultured in NGM supplemented with high glucose levels until they reached adulthood. Adult worms (~35) from control and experimental were collected and fixed before DAPI staining to visualize the germline using a fluorescence microscope.

Our observations indicate that the germline stem cells in the distal mitotic zone are affected by glucose enrichment. Worms fed with high level of glucose demonstrated signs of germline atrophy and disintegration.

Future Directions: We plan to study the hyperglycemia led alteration of proliferative ability of the germline cells by employing specific proliferation assays.

Keywords: Biology, Diabetes, Stem Cells

Anthropogenically Caused Damage to Turtles in an Urban Creek in New Mexico

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Recreational activities (i.e., fishing, motorboats, etc.) have been underestimated threats to freshwater turtles. Berrendo Creek is a small tributary of Rio Hondo located in Roswell, New Mexico. It is surrounded by privately owned farmland with a portion open to the public for recreational fishing through the New Mexico Department of Game and Fish (NMDGF) Open Gate Program. Along with fish, at least 4 species of freshwater turtles are inhabitants of the recreational area. In July 2019, we surveyed turtles along a 500m stretch of Berrendo Creek using hoopnet traps. For each turtle, we took standard measurements and marked them by notching marginal scutes. We then assessed their physical features to determine damage. We discovered that three species including the common snapping turtle (*Chelydra serpentina*), red-eared slider (*Trachemys scripta*), and spiny softshell turtle (*Apalone spinifera*) displayed evidence of anthropogenic damage. The most common sources of damage were found to be gunshot wounds and fishhook ingestion. Of 69 red-eared sliders, 1 had gunshot wounds (1%) and 1 had ingested fishhook (1%). Of 7 snapping turtles, 5 had gunshot wounds (71%) while 1 of 16 softshells showed evidence of fishhook damage (6%). Using size and species as covariates, we ran a logistic regression in R. There was no significant correlation between turtle size and damage. Snapping turtles were more likely to be wounded than red-eared sliders, but there was no difference in the likelihood of damage between spiny softshells and red-eared sliders. The fishhook ingestion is likely the result of accidental by-catch from recreational fishing. However, NMDGF prohibits shooting of freshwater turtles and recreational shooting is prohibited through the Open Gate Program, leading to speculation of illegal activities. Future studies should include assessments of recreational activities as a part of the evaluation of conservation status and health of freshwater turtles in New Mexico.

Keywords: Anthropogenic Threats, Turtles, Fishing, Shooting

The Analysis of the Water Quality for Different Samples in Hobbs, New Mexico

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Chloride ion as a significant electrolyte has an impact on hypertension. Concern for excess calcium intake is directed primarily to those who are prone to milk alkali syndrome and hypercalcaemia. The objective of the study is to determine the concentrations of chloride and calcium ion in daily drinking water from various source in Hobbs New Mexico. The samples from a domestic drinking well, city water delivery system, home water filtering device and bottled water merchandise were collected in September 2019. Mohr's method was used to determine the chloride ion concentration by titration. Water hardness was measured by EDTA titration. The datum were calculated using one-way analysis of variance and t test. The results showed that chloride ion concentrations and water hardness were significantly different among these samples because the probabilities of F values were much smaller than 0.05. Both orders of the chloride ion concentration and water hardness from high to low were the same, i.e. city water > boiled city water > well water > home filtered water > bottled water. For chloride ion concentration, there was no significant difference between well and boiled city water. All other samples were significantly different. For water hardness, it was not significantly different between bottled and home filtered water. All other samples were significantly different. The results indicated that home filtered and bottled water contained much less chloride and calcium ion concentrations than the ones in other samples.

Keywords: Water Quality, Chloride ion, Water hardness, Titration

Using Alternate Energy to Power the Mescalero Tribal Fish Hatchery

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Fish from the Tribal Mescalero Fish Hatchery have been stocked as far away as Yuma, AZ (Quechan), Ignacio, CO (Southern Ute), and on the San Carlos Apache Reservation. In addition to providing rainbow trout for recreational fishing, several efforts have been made to propagate and reintroduce the native Rio Grande Cutthroat Trout.

The Mescalero Fish Hatchery is concerned that with their new pumps in place, their electrical bill has tripled. In talking to them these new pumps were needed to continue providing quality trout, but with the price of upgrading to new equipment, the cost of electricity has increased from \$125.00 per month to over \$2500.00 per month.

Our solution to their problem is a wind generator that is connected to their pumps. By using this wind generator, it will cut their electricity bill in half or less depending on the size of the wind generator. Future application install a larger wind generator to power the entire fish hatchery, thus using renewable energy sources.

Keywords: Renewable, Energy, Environment

Synthesis and Reaction Kinetics of Reversible Epoxies by Diels-Alder Reaction

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Epoxies are an important class of thermosetting polymers for many long-term applications such as adhesives, structural materials, paints, and coatings. While they provide durable and robust mechanical properties, epoxies are extremely difficult to remove, recycle, and rework due to the thermosetting nature. To address the limitation of conventional epoxies, epoxies capable of reversible polymerization are of interest. In this research, reversible epoxies were synthesized by introducing the Diels-Alder reaction groups to epoxy monomers. 1,1'-(Methylenedi-4,1-phenylene) bismaleimide and furfuryl glycidyl ether were reacted to form a Diels-Alder cycloadduct. Formation of the Diels-Alder cycloadduct was confirmed using Fourier Transform-Infrared (FTIR) Spectrometry. Next, the forward and reverse Diels-Alder reaction – corresponding to re-polymerization and depolymerization, respectively – was monitored by FTIR measurements at 90 °C and 110 °C as a function of exposure time. IR absorption peaks relevant to the reverse Diels-Alder reaction were gradually stronger as longer exposure time at 90 °C and 110 °C. The equilibrium shift was observed toward the reverse reaction dominant side at higher temperature by comparison of FTIR spectra at 90 °C and 110 °C. The reversible epoxy resins will be cured with various curing agents and their reaction kinetics will be studied.

Keywords: Epoxies, Diels-Alder, Polymers, Reversible

Is It Gravity? A Comparative Analysis on The Behavior of Baryonic Acoustic Oscillations and Gravitational Waves

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In the beginning there were Baryonic Acoustic Oscillations. Sound waves from the beginning of time that determined the distribution of Large-Scale structures such as Galaxies and Dark Matter. Until the time of recombination these sound waves traveled throughout the expanding universe. Approx. 379,000 years. If these soundwaves are responsible for the distribution of density throughout the universe then couldn't we say that they are the initial cause of gravity? These shrieking soundwaves that manipulated matter into the first generation of stars. This is the purpose of this project. Relating sound to density and how its combination can result in the weak fundamental force known as gravity.

Keywords: Gravity, Acoustics, Cosmology

Glowing Garnets: Polycrystalline Scintillators Produced via Co-Precipitation

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Scintillators are materials that luminesce upon absorption of ionizing radiation. Because of this unique capability, scintillators are employed in fields utilizing radiation detection, such as medical imaging and cargo scanning. Inorganic single crystal scintillators are commonly used because of their excellent optical properties; however, fabricating single crystals is time, labor, and resource-intensive. Polycrystalline scintillators offer improved uniformity in composition and lower fabrication time and cost. Dopants often control the scintillator performance, so quantifying and optimizing the dopant concentration in the scintillator is critical to efficient development.

To produce powder for garnet polycrystalline scintillators of the composition $\text{Y}_2\text{LuAl}_5\text{O}_{12}:\text{Ce}$, a reverse-strike co-precipitation method was used. This method involves addition of a stoichiometric metal-nitrate salt solution into ammonium bicarbonate to precipitate a precursor, which is then calcined to produce the final scintillator material. A set of samples with varying cerium dopant concentrations were produced. Additionally, samples were taken at each step of the co-precipitation process and analyzed via ICP-MS, quantifying composition and revealing parameters that can be refined. Powder x-ray diffraction confirmed the phase purity of the final powder, validating the co-precipitation method. Identifying and improving alternative synthesis routes and formats for scintillators alleviates restrictions and difficulties in production, opening the door to new applications.

Keywords: Scintillator, Radiation Detection, Co-precipitation, Material Synthesis

Kilonova Emissions - Particle-In-Cell Simulations of Mildly Relativistic Outflows

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Collisionless shocks are ubiquitous in astrophysical plasmas, and are observed to be the sites of very high energy particles (which then radiate photons over a wide range of energies). A long-standing, unsolved problems in high energy astrophysics how magnetic fields are generated in these shocks, and how these fields relate to the process of particle acceleration. Particle-in-cell codes are ideally suited to address this question and previous work has looked at cases of magnetic field generation and particle acceleration in both highly relativistic and non-relativistic shocks. The aim of this project is to examine shock development, magnetic field generation and particle acceleration in the case of mildly relativistic shocks, which are expected when the tidal ejecta of neutron star mergers shocks with the external medium. Using LANL's VPIC (vector particle-in-cell), we have run simulations of such mildly-relativistic, collisionless, (initially unmagnetized) plasmas and compute the resultant magnetic fields and particle energy spectra. We show the effects of varying plasma conditions, as well as explore the validity of using different and often unrealistic proton to electron mass ratios in VPIC. Our results have implications for observing late-time electromagnetic counterparts to gravitational wave detections of neutron star mergers.

Keywords: Astrophysics, Plasma processes, Outflows

Role of the bHLH Transcription Factor ASCL1 in Glial Development

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Glial cells are most abundant type of cell in the central nervous system and include oligodendrocytes and astrocytes. Glial cells are also very diverse in form and function, however the mechanisms that control their development in different brain regions remain unclear. Interest in glial cells and their abnormal development has increased due to their potential roles in neurological disorders (such as schizophrenia, autism, multiple sclerosis and even amyotrophic lateral sclerosis (ALS)) and cancer. During development, the basic-helix-loop-helix (bHLH) transcription factor achaete-scute complex homolog-like 1 (ASCL1) is expressed in glial progenitors in the brain and is differentially maintained in astrocyte and oligodendrocyte lineages. However, how ASCL1 contributes to the development of both of these glial lineages is unclear. Research on ASCL1 is important as it will help in understanding its role in neuronal differentiation. I will be analyzing the role of ASCL1 in glial cell development using transgenic mice. The goals of this project include tracing the lineage of ASCL1+ glial progenitors in the cell and analyzing the effects of ASCL overexpression in the brain. The first goal consists of understanding what kind of neural progenitors ASCL1 expresses in the brain and where. The second goal is to see whether the expression of ASCL1 leads to the formation of astrocytes and oligodendrocytes in the brain. The final goal will be looking at whether the expression of ASCL1 in glial progenitors affect the specification, distribution and development of astrocytes and oligodendrocytes in the gray and white matter of the brain.

Keywords: Neuroscience, Cell Biology, Molecular Biology

Using Machine Learning to Counteract Gerrymandering

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Gerrymandering is an issue in this country that lets political parties group voters in a way such that they can maintain political power. The congressional districts of Texas are an example of this, where Republicans are significantly over-represented in the House of Representatives. Using the k-means clustering algorithm is a possibility of drawing maps for congressional districts that are fair and lawful. By modifying the k-means clustering algorithm by adding weights to the centroids, generated congressional districts can have roughly equal populations (satisfying a federal law for the drawing of congressional districts). After simulating elections with historical voting data, the generated congressional districts will closely represent the political preferences of the population.

Keywords: Machine Learning, Gerrymandering, K-means clustering

A New Morphotype of *Machaeroprosoopus* from Canjilon Quarry, New Mexico

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Ghost Ranch's Canjilon quarry is a significant source of phytosaur material from the upper Triassic; two identified phytosaur species (*Machaeroprosoopus buceros* and *Machaeroprosoopus pristinus*) have thus far been represented at Canjilon and are believed to be a contemporaneous population. Canjilon's phytosaur population is notable because of prior work by Dr. Kate Zeigler which suggests that *M. buceros* and *M. pristinus* are in fact sexual dimorphs of a single species (*M. buceros*), with the "male" possessing a robust rostrum and nasal crest, and the "female" being far more gracile and lacking a crest. (Zeigler et al, 2003) However, skull material from Canjilon quarry that was not thoroughly considered in Zeigler's work suggests the existence of a third phytosaur morph present in the population.

All available diagnostic phytosaur skull material from Canjilon was reevaluated and compared, using high quality images and physical specimens when available. UCMP 27228 is a phytosaur skull currently in the collection at Ghost Ranch and represents a phytosaur skull that has not been thoroughly considered for the purposes of studying morphology at Canjilon. This is significant because UCMP 27228 differs drastically in the squamosal region when compared to the two traditional morphs from Canjilon. Observational evidence concludes that UCMP 27228 possesses enough apomorphy to be considered separate from both *M. buceros* and *M. pristinus*. The presence of a third distinct morphotype with a robust rostrum and crest and no counterpart gracile morph precludes Zeigler's conclusion that Canjilon's entire phytosaur population can be represented by binary sexual morphology.

Keywords: Paleontology, Phytosaur, Machaeroprosoopus, Canjilon Quarry

The study on Genetic Patterns of Eye Color and Wing Presence in *Drosophila melanogaster*

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The traditional genetic patterns of eye color and wing presence in *Drosophila melanogaster* were studied using the commercial strains and χ^2 statistical test. In monohybrids of these two traits, the segregation of male flies followed 3:1 ratio, but that of female flies didn't. In the dihybrids of them, the segregations of male, female and overall results didn't fit 9:3:3:1 ratio. The same situations occurred in another dihybrid of four different eye colors. Meiotic drive elements and environmental factors may play the role in the variations

Keywords: Drosophila melanogaster, χ^2 test, Dihybrid

The Houston Traffic Problem

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This project dealt with the freeway traffic system in Houston, Texas. Given the flow, meaning vehicles per hour, a model was made to determine where traffic jams occur. Then the model was compared to the real world to see how precisely the traffic jams were located based on the model. Then potential solutions to the traffic jams were discussed.

Keywords: Traffic Theory, Computer Science, Houston

Investigating the Biochemical Effects of Salt Stress and Taurine Supplementation on the Green Alga *C. reinhardtii*

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Taurine, an amino acid-derivative, is present in many eukaryotes. There are some eukaryotic organisms that lack taurine production, and therefore metabolic activity of taurine is nonexistent. The biochemical effects of adding taurine to the growth media of a photosynthetic eukaryotic organism that does not normally synthesize or use taurine, has not been extensively studied. In this project, we grew the green alga *C. reinhardtii* under normal media and salt stress conditions, both in the absence and presence of elevated and supra-elevated taurine. We then isolated metabolites from cells grown in all five-growth environments to identify metabolites using mass spectrometry analysis. We analyzed cell size and change in cell density over time. *C. reinhardtii* cells in the presence of supra-elevated taurine had a higher cell density and cell size than cells grown in normal media alone. Growth curve analysis indicates an increase in cell density in supra-elevated taurine levels, with salt and without, occurring across all replicates. The comparative metabolomics results is expected to information about biochemical changes in *C. reinhardtii* cells, after in vitro exposure to taurine. From this study, we will determine if a photosynthetic eukaryotic organism, *C. reinhardtii*, can use exogenous taurine in its metabolic processes to confer resistance to high salt concentrations.

Keywords: Algae, Nutrient, Growth, Stress