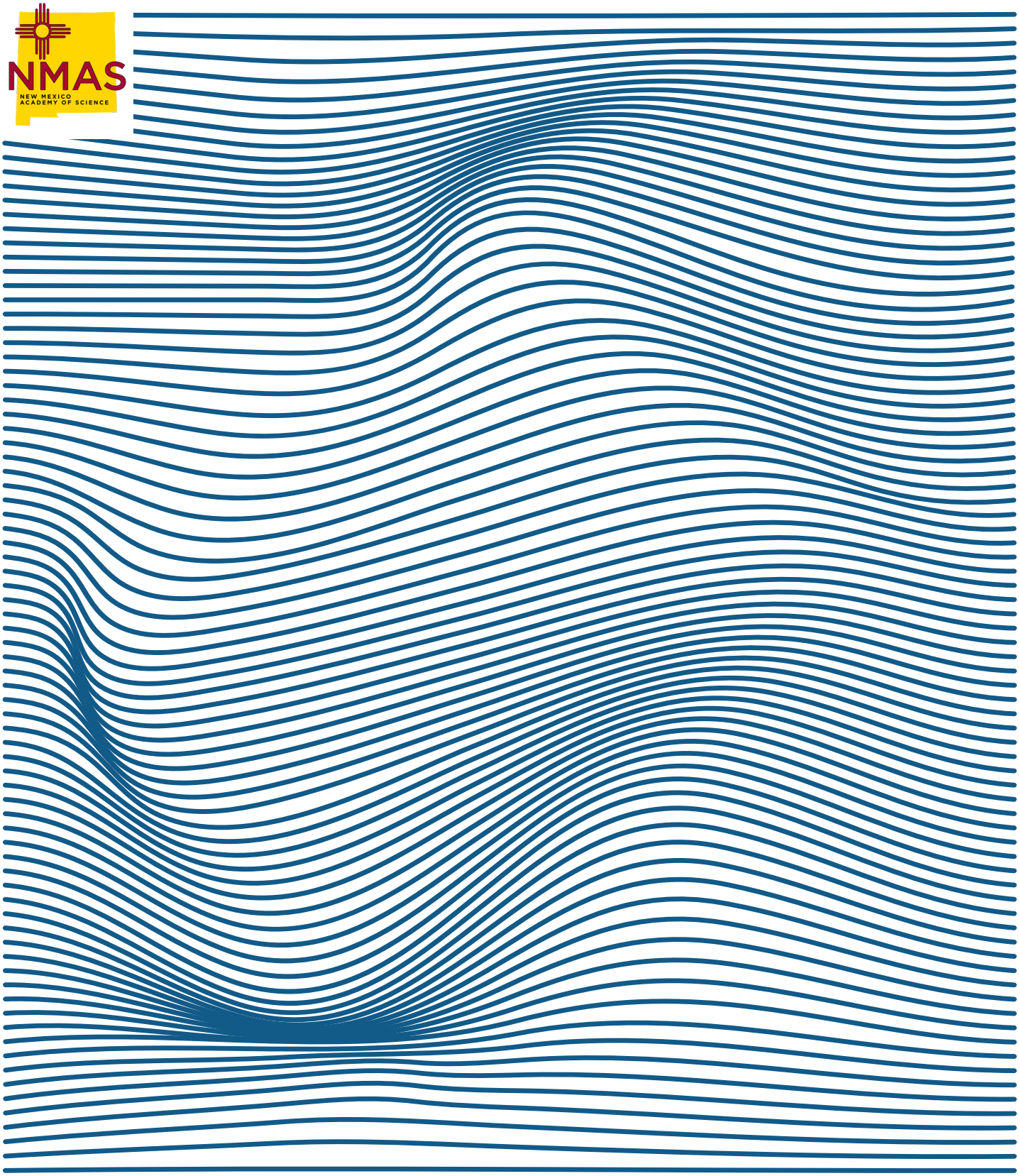

THE NEW MEXICO **JOURNAL OF SCIENCE**

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Natalie A. Rogers, Editor

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The New Mexico Journal of Science

Editor's Note

The *New Mexico Journal of Science* is a publication of the New Mexico Academy of Science. Each issue of the Journal, which has been published since 1906, contains research papers and articles deemed of interest to the scientists, educators, and citizens of New Mexico. Some volumes address scientific topics of social or economic interest to the state, while others emphasize scientific research in areas where New Mexico is particularly active.

This year, the *Journal* features a paper on water quality in Hobbs by biology professor Dr. Yusheng Wu and his students at the University of the Southwest. The Academy also partnered with The University of New Mexico (UNM) chapter of Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) to feature abstracts from their national conference.

The New Mexico Academy of Science Research Symposium was held in Albuquerque, New Mexico on November 2, 2019. Oral and poster presentations at the Symposium described scientific research conducted by undergraduate students, graduate students, and faculty at New Mexico's colleges and universities, and the abstracts of those presentations are once again included in this year's Journal. The New Mexico Academy of Science also presented its annual Outstanding Science Teacher Awards at the meeting. We wish to acknowledge the organizations which co-sponsored the 2019 Research Symposium: the New Mexico Experimental Program to Stimulate Competitive Research (NM EPSCoR), the Central New Mexico Local Section of the American Chemical Society (ACS), the New Mexico Alliance for Minority Participation (NM AMP) and the UNM Center for Water and the Environment.

The New Mexico Journal of Science is published in an electronic-only format; it can be freely downloaded from the Academy's website at www.nmas.org. This enables the Academy to reach a much wider readership without incurring the considerable monetary and environmental costs associated with the printing and distribution of paper copies. Thank you for your support!

Natalie A. Rogers, Editor
New Mexico Journal of Science

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FEATURED PAPER

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

Meghan Morey, University of the Southwest
Heidi Stringfellow, University of the Southwest
Chantley Wilson, Utilities Department City of Hobbs New Mexico
Yusheng Wu, University of the Southwest

ABSTRACT

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 hypercalcemia. The objective of the study was 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 and EDTA methods were used to determine chloride ion concentration and water hardness, respectively. The datum were calculated using one-way analysis of variance and pairwise t test. The results showed that for the chloride ion concentration, the order from high to low was city water > well water > boiled water > home filtered water > bottled water. Based on the results of the t test, the probabilities of all samples were much lower than 0.05 indicating that it is significantly different. However, the probability between boiled and well water was 0.4140 larger than 0.05 showing no difference between these two samples. With respect to water hardness, the order from high to low was city water > boiled water > well water > bottle water > home filtered water. In accordance with the results of the t test, the probabilities of all samples were much lower than 0.05 demonstrating that it is significantly different. However, the probability between home filter and bottle water was 0.1254 larger than 0.05 meaning no difference between these two samples. The results indicated that boiling water could reduce the concentration of chloride ion apparently. Home filter system removed chloride ion in water noticeably, but not as equivalently as the commercial water filter system. Boiling water and aquifer well water could diminish the water hardness efficiently. Home filter system lessened it in a noticeable way followed by the commercial filter system.

INTRODUCTION

Water plays an important role in of sustaining life on the Earth. Human beings are dependent on water to survive and reproduce. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and created health problems (Raja et al. 2002). Although the United States has one of the safest drinking water supplies in the world, sources of drinking water can still become contaminated through naturally occurring chemicals and minerals (arsenic, radon), local land use practices (pesticides, chemicals, animal feeding operations), malfunctioning wastewater treatment systems (for example, sewer overflows), and other sources (CDC 2016).

Chlorides are widely distributed in nature as salts of sodium (NaCl), potassium (KCl), and calcium (CaCl2). The taste threshold of the chloride anion in water depends on the associated cation. Taste thresholds for sodium chloride and calcium chloride in water are in the range 200–300 mg/litre (Weast 1986). There is the evidence that supports an independent role for chloride on hypertension and cardiovascular health (McCallum et al. 2015). Several studies have suggested that the chloride ion may play a more active and independent role in renal function (Jaina et al. 1980, Toto et al. 1984) neurophysiology (Sackmann et al. 1984) and nutrition (Honeyfield et al. 1985).

Water hardness is defined as the total concentration of calcium and magnesium in a water source. Ecologically, water hardness impacts fish cultures as well as many other species that rely on a steady calcium carbonate

concentration (Wurts 2006). Hard water in the municipal water supply also raises economic issues as a considerable amount of money is spent yearly to ensure that water is softened (minerals are removed) to avoid its negative impacts such as degrading soaps and precipitate deposition on faucets.(Campbell et al. 2010). Health questions regarding drinking hard water have also begun to emerge. The World Health Organization states that hard water may lead to cardiovascular disease (WHO 1996).

The objective of the study was to determine the concentrations of chloride and calcium ion in daily drinking water from various source in Hobbs New Mexico and to evaluate the corresponding health concerns.

MATERIALS & METHODS

The samples from a domestic drinking well, city water delivery system, home water filtering device and bottled water merchandise were collected in Hobbs New Mexico in September 2019.

Mohr's method was used to determine the chloride ion concentration by titration with silver nitrate. As the silver nitrate solution is slowly added, a precipitate of silver chloride forms.

Eq. 1: $Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl (s)$

The end point of the titration occurs when all the chloride ions are precipitated. Then additional silver ions react with the chromate ions of the indicator, potassium chromate, to form a red-brown precipitate of silver chromate.

$$2\ Ag^+ (aq) + CrO_4^{2-} (aq) \rightarrow Ag_2CrO_4 (s)$$

Equipment

- Burette and stand
- 10 and 20 mL pipettes
- 100 mL volumetric flask
- 250 mL conical flasks
- 10 mL and 100 mL measuring cylinders

Reagents

- Standard $AgNO_3$ titrant (0.01 M)
- Chromate indicator
- Distilled water

Sample Collection/Preservative /Storage

1. Sample collection: Water samples may be collected in clean plastic or glass screw top container (250 to 1000 mL). Alternately, the sample may be collected directly into a graduated cylinder if sample is analyzed immediately.
2. Maximum sample holding time: 28 days. The Laboratory Certification Section recommends analyzing samples immediately after collection.

Analysis Procedure

1. Fill the burette with 0.010 M $AgNO_3$ titrant, if self-leveling burette is used.
2. Rinse out the titrating vessel with sample and discard.
3. Pipette 10 mL of sample to a flask and add 1 mL of chromate indicator.
4. Titrate the sample with $AgNO_3$ solution.
5. Slowly add titrant to the sample, mixing with a magnetic stir bar.
6. Stop adding titrant when a stable red-brown color is reached; color persists for 1 minute.
7. Record the volume of titrant used for total hardness determination.

Color Display

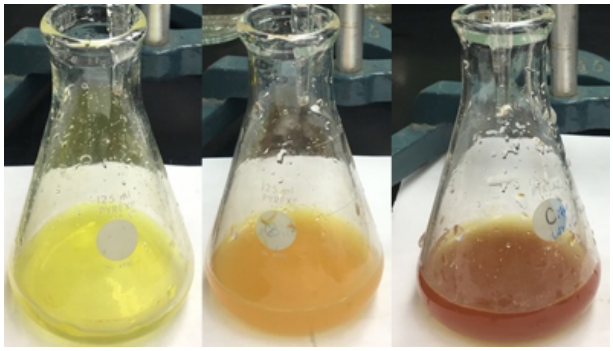

Figure 1: A display of color changes during the titration. Left flask: before the titration endpoint, the chromate indicator forms a lemon-yellow color. Centre flask: at the endpoint, the indicator gives rise to a slight red-brown coloration. Right flask: past the endpoint, the indicator bring about a strong red-brown color result.

Calculation of unknown sample concentration

To calculate the concentration of the unknown sample we must begin with a balanced equation above-shown (Eq 1). Stoichiometrically we see that one mole of Ag^+ reacts with one mole of Cl^-. Because of this one-to-one relationship we can use the following formula to calculate the unknown sample concentration:

$$M_{Ag+} \times V_{Ag+} = M_{Cl-} \times V_{Cl-}$$

Rearrange the equation to solve for the unknown concentration of the base:

$$M_{Cl-} = M_{Ag+} \times V_{Ag+} / V_{Cl-}$$

Water hardness was measured by EDTA titration. The ions involved in water hardness, i.e. Ca2+(aq) and Mg2+(aq), can be determined by titration with a chelating agent, ethylenediamine tetraacetic acid (EDTA), usually in the form of disodium salt (H_2Y^{2-}).

The titration reaction is:

Eq. 2: Ca^{2+} (aq) + H_2Y^{2-} (aq) → CaY^{2-} (aq) + 2 H^+ (aq)

Eriochrome black T is commonly used as indicator for the above titration. At pH 10, Ca^{2+}(aq) ion first complexes with the indicator as $CaIn^+$(aq) which is wine red. As the stronger ligand EDTA is added, the $CaIn^+$(aq) complex is replaced by the CaY^{2-}(aq) complex which is blue. The end point of titration is indicated by a sharp color change from wine red to blue.

Equipment

- 25 to 50 mL digital or self-leveling automatic burette. *Note: Burette must be of sufficient capacity so that all tests and standardizations can be performed without refilling the burette.*
- 10.0 mL Class A volumetric pipet(s)
- Titration vessels of appropriate volume
- Graduated cylinders (50 to 100 mL)
- Magnetic stirring device & stirring bars
- Balance

Reagents

- Standard EDTA titrant (0.01 M)
- Make 0.1 M EDTA (stock)
- Take about 10 ml of water in a cleaned and dried 100 ml volumetric flask.
- Add about 3.72 mg of EDTA with continues stirring.
- Add more about 70 ml of water mix.
- Make up the volume 1000 ml with water.
- Buffer solution (pH=10)
- Mixed eriochrome black T indicator
- Weigh out approximately 0.5 g of solid Eriochrome Black T, (EBT) on a balance and transfer it to a small beaker or flask. Add about 50 mL of 95 percent ethyl alcohol and swirl the mixture until the EBT has fully dissolved.
- Weigh out 4.5 g of hydroxylamine hydrochloride on a balance and transfer it to the beaker or flask containing the EBT. Swirl until the hydroxylamine hydrochloride has fully dissolved.
- Transfer the solution containing the EBT and hydroxylamine hydrochloride to a 100-mL graduated cylinder. Add enough 95 percent ethyl alcohol to bring the total volume to exactly 100 mL.
- Transfer the EBT solution from the 100-mL graduated cylinder to a dropper bottle and label the bottle "0.5% Eriochrome Black T in Ethanol."
- Calcium carbonate standard (0.010 M)
- Distilled water

Sample Collection/Preservative /Storage

1. Sample collection: Hardness samples may be collected in clean plastic or glass screw top container (250 to 1000 mL). Alternately, the sample may be collected directly into a graduated cylinder if sample is analyzed immediately.
2. Preservation: Adjust to pH less than 2.0 with HNO_3, 4°C. Preservation is not required if sample is analyzed immediately.
3. Maximum sample holding time: 28 days. The Laboratory Certification Section recommends analyzing samples immediately after collection.

Analysis Procedure

1. Fill the burette with 0.010 M EDTA titrant, if self-leveling burette is used.
2. Rinse out the titrating vessel with sample and discard.
3. Measure 10 mL of sample with an appropriately sized graduated cylinder.
4. Add 0.5 to 1.0 mL of hardness buffer if not contained in color indicator.
5. Add color indicator.
6. Slowly add titrant to the sample, mixing with a magnetic stir bar.
7. Stop adding titrant when a stable blue color is reached; color persists for 1 minute.
8. Record the volume of titrant used for total hardness determination.

Calculation of unknown sample concentration

To calculate the concentration of the unknown sample we must begin with a balanced equation above-shown (Eq 2). Stoichiometrically we see that one mole of EDTA

reacts with one mole of Ca2+. Because of this one-to-one relationship we can use the following formula to calculate the unknown sample concentration:

$$M_{EDTA} \times V_{EDTA} = M_{Ca2}+ \times V_{Ca2+}$$

Rearrange the equation to solve for the unknown concentration of the base:

$$M_{Ca2}+ = M_{EDTA} \times V_{EDTA} / V_{Ca2+}$$

The datum were calculated through one-way analysis of variance (ANOVA) and t test using MegaStat in Excel.

Color Display

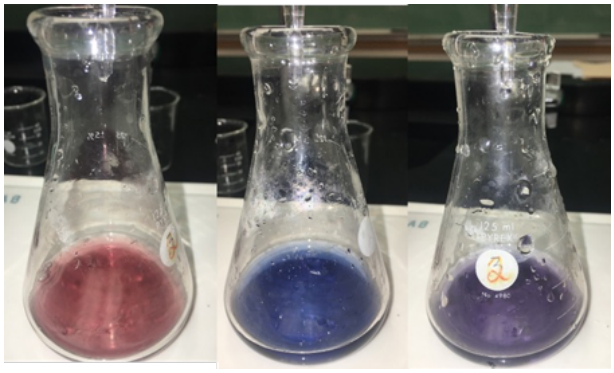

Figure 2: A display of color changes during the titration. Left flask: before the titration endpoint, eriochrome black T indicator gives a red color. Centre flask: at the endpoint, the indicator generates a light blue color. Right flask: past the endpoint, the indicator produces a purple color.

RESULTS

Chloride ion concentration

The means and standard deviations for chloride ion concentration were listed in Table 1. The sample of city water was the one with highest chloride ion concentration. The samples of boiled and well water were in the second group after the city water sample. Then the samples of home filter and bottle water were in third group. The standard deviation values were very small indicating that the repeated measurements were pretty close.

In ANOVA (Table 2), the probability of F value in F test was much less than 0.05 meaning that there were the significant differences among the means of samples in chloride ion concentration and the pairwise t test was necessary to determine which ones were significantly different.

Based on the results of the t test in Table 3, the probabilities of all samples were much lower than 0.05 except that the one between boiled and well water was 0.4140 larger than 0.05. It demonstrated that the chloride ion concentration in city water was significantly higher than that in other samples. The chloride ion concentration in bottle water was the significantly lowest one followed by that in home filter water.

Treatment	Mean (mM)	n	Std. Dev (mM)
City H_2O	3.377	3	0.0301
Boiled H_2O	1.417	3	0.0208
Well H_2O	1.432	3	0.0275
Home Filter H_2O	0.867	3	0.0144
Bottle H_2O	0.623	3	0.0038
Total		**15**	

Table 1. The basic statistics of one-way ANOVA in chloride ion concentration

Source	SS	df	MS	F	p-value
Treatment	14.0817	4	3.52043	7577.60	2.34×10^{-17}
Error	0.0046	10	0.00046		
Total	14.0864	**14**			

Table 2. F test of one-way ANOVA in chloride ion concentration

Treatment	Treatment Concentration (mM)	Bottle H_2O 0.623	Home Filter H_2O 0.867	Boiled H_2O 1.417	Well H_2O 1.432
Home Filter H_2O	0.867	7.63×10^{-8}			
Boiled H_2O	1.417	6.94×10^{-13}	2.64×10^{-11}		
Well H_2O	1.432	5.76×10^{-13}	2.02×10^{-11}	0.4140	
City H_2O	3.377	2.80×10^{-18}	7.05×10^{-18}	8.35×10^{-17}	9.02×10^{-17}

Table 3. The p-values for pairwise t-tests based on one way ANOVA in chloride concentration

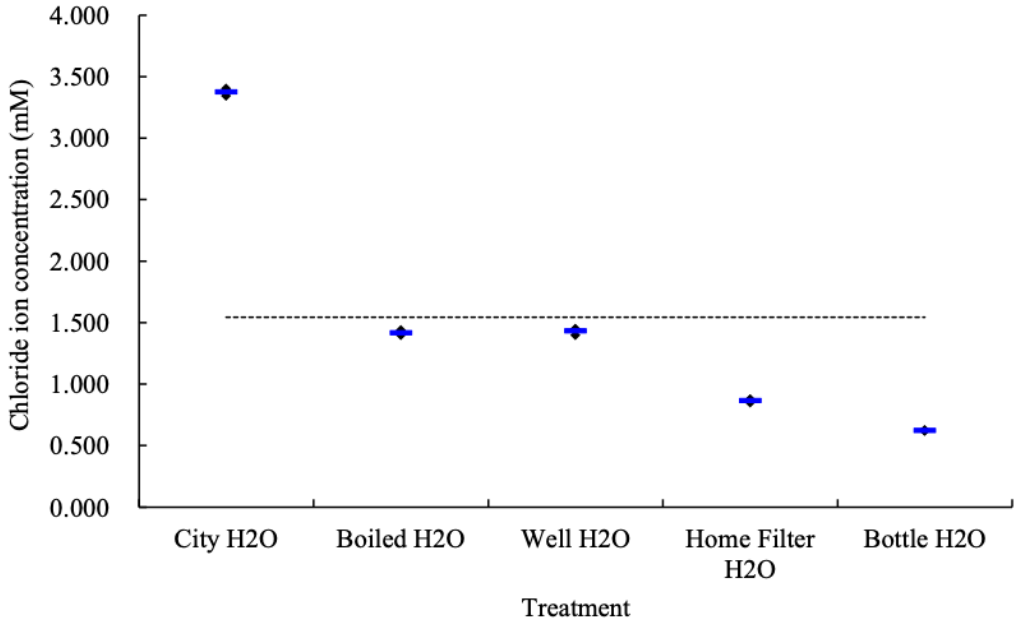

Figure 3. The comparison of the treatments in chloride ion concentration

Treatment	Mean (mM)	n	Std. Dev (mM)
City H2O	5.763	3	0.0551
Boiled H2O	4.987	3	0.0058
Well H2O	3.280	3	0.0200
Home Filter H2O	0.313	3	0.0246
Bottle H2O	0.353	3	0.0147
Total		**15**	

Table 4. The basic statistics of one-way ANOVA in water hardness

Source	SS	df	MS	F	p-value
Treatment	77.6081	4	19.40201	22609.55	9.91×10^{-20}
Error	0.0086	10	0.00086		
Total	77.6166	**14**			

Table 5. F test of one-way ANOVA in chloride ion concentration

From Figure 3, the same trend of the chloride ion concentration in all the samples was shown vividly. It was clear that the concentration in city water was at the highest place followed by boiled and well water in second group, and finally these in home filter and bottle water were lowest in the third group.

In Table 4, listed were the means and standard deviations for water hardness. The sample of city water was in the highest place followed by the one of boiled and well water. Then the samples of home filter and bottle water were in last group. The standard deviation values were very small illustrating that the repeated measurements were quite close.

In accordance with the ANOVA in Table 5, the probability of F value in F test was much less than 0.05 meaning that there were the significant differences among the means of samples in water hardness and the pairwise t test was necessary to determine which ones were significantly different.

With regard to the results of the t test in Table 6, the probabilities of all samples were much lower than 0.05 except that the one between home filter and bottle water was 0.1254 larger than 0.05. It indicated that the water hardness in city water was significantly higher than that in other samples. The water hardness in the sample of home filter water was the significantly lowest one followed by the sample of bottle water. The water hardness in boiled and well water fell between the highest and lowest.

In Figure 4, the same tendency of the water hardness in all the samples was shown distinctly. It was apparent that the water hardness in city water was at the highest place followed by boiled and well water, and finally these in home filter and bottle water were lowest in the last group.

Treatment	Treatment Concentration (mM)	Bottle H_2O 0.313	Home Filter H_2O 0.353	Boiled H_2O 3.280	Well H_2O 4.987
Home Filter H_2O	0.353	0.1254			
Boiled H_2O	3.280	2.84×10^{-17}	3.26×10^{-17}		
Well H_2O	4.987	3.03×10^{-19}	3.30×10^{-19}	7.13×10^{-15}	
City H_2O	5.763	6.51×10^{-20}	7.01×10^{-20}	1.68×10^{-16}	1.81×10^{-11}

Table 3. The p-values for pairwise t-tests based on one way ANOVA in water hardness

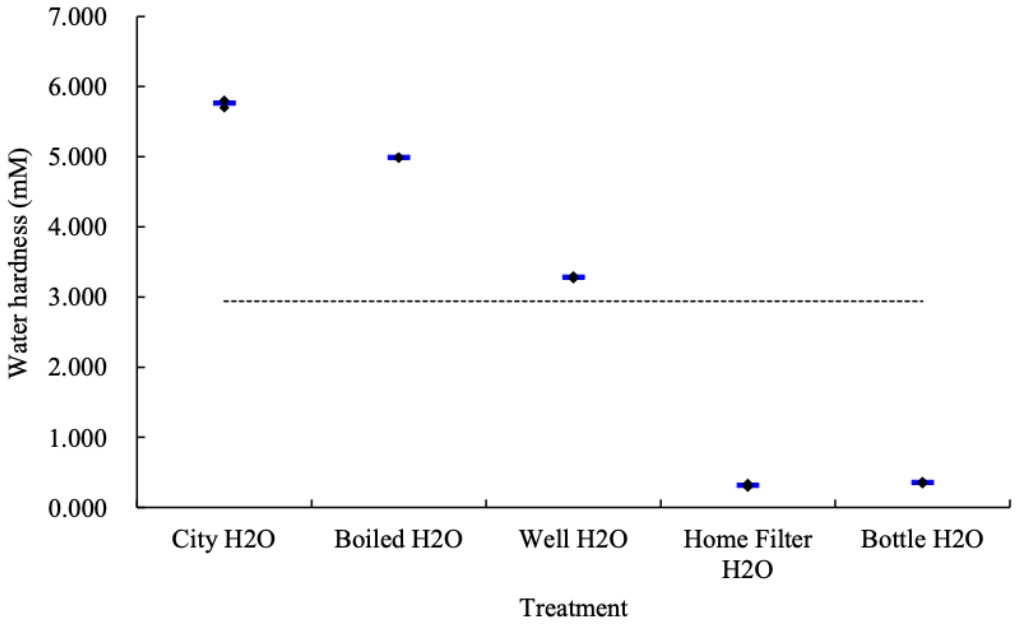

Figure 3. The comparison of the treatments in water hardness

DISCUSSION

Chloride concentrations in excess of about 250 mg/L (7.143 mM) can give rise to detectable taste in water. A normal adult human body contains approximately 81.7 g chloride. On the basis of a total obligatory loss of chloride of approximately 530 mg/day, a dietary intake for adults of 9 mg of chloride per kg of body weight has been recommended (equivalent to slightly more than 1 g of table salt per person per day) (WHO 1996). The chloride concentrations in all measured samples were lower than 7.143 mM. There was no health concern for the types of water in the regard.

Calcium concentrations up to and exceeding 100 mg/L (2.500 mM) are common in natural sources of water, particularly groundwater. Magnesium is present in natural groundwater usually at lower concentrations (from negligible to about 50 mg/L and rarely above 100 mg/L), so calcium-based hardness usually predominates. Inadequate intakes of calcium have been associated with increased risks of osteoporosis, nephrolithiasis (kidney stones), colorectal cancer, hypertension and stroke, coronary artery disease, insulin resistance and obesity. Concern for excess calcium intake is directed primarily to those who are prone to milk alkali syndrome (the simultaneous presence of hypercalcaemia, metabolic alkalosis and renal insufficiency) and hypercalcaemia (WHO 1996). The calcium concentrations in three samples, city, boiled and well water exceeded 2.500 mM. The concentrations in other two samples were below the standard value. To some extent, the health concern for these three types of water rises in the regard.

CONCLUSIONS

For the chloride ion concentration, the order from high to low was city water > well water > boiled water > home filtered water > bottled water. Based on the results of the pairwise t test, the probabilities of all samples were much lower than 0.05 indicating that it is significantly different. However, the probability between boiled and well water was 0.4140 larger than 0.05 showing no difference between these two samples. Boiling water could reduce the concentration of chloride ion apparently. Home filter system removed chloride ion in water noticeably, but not as equivalently as the commercial water falter system.

With respect to water hardness, the order from high to low was city water > boiled water > well water > bottle water > home filtered water. In accordance with the results of the pairwise t test, the probabilities of all samples were much lower than 0.05 demonstrating that it is significantly different. However, the probability between home filter and bottle water was 0.1254 larger than 0.05 meaning no difference between these two samples. Boiling water and aquifer well water could diminish the water hardness efficiently. Home filter system lessened it in a noticeable way followed by the commercial filter system.

ACKNOWLEDGMENTS

We thank College of Arts and Sciences and Department of Biology at University of the Southwest for the guidance and support in the project.

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UNM Chapter of the Society for Advancement of Chicanos and Native Americans in Science

Expanding natural product diversity through the study of *Lysobacter* species

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Mark Walker, University of New Mexico

Nearly 75% of approved antibiotics in the last 30 years stem from natural products (NPs). However, the present rise in antibiotic resistant bacterial infections threatens to usher in a post-antibiotic era. To address this challenge, it is essential that new compounds with new modes of action be identified. Fortunately, genome sequencing efforts over the past two decades have revealed that the known set of NPs are produced by only about ten percent of the NP biosynthetic pathways that exist. The remaining ninety percent of biosynthetic pathways represent an enormous untapped pool of compounds. This project aims to identify new antibiotic compounds produced by *Lysobacter* species, some of which have been isolated from disease protective soils, and the genomes of which encode between 10 and 15 uncharacterized NP biosynthetic pathways. Characterization of these compounds and their biosynthetic pathways can lead to novel NPs or NP-like molecules for the treatment of disease.

Keywords: antibiotics, product diversity, Lysobacter

Development of a platform for the biosynthesis of unnatural natural products

Cielo Gonzales Kirkpatrick, University of New Mexico Jillian Stafford, University of New Mexico
Mark Walker, University of New Mexico

The goal of this project is to develop a process of producing and screening modified peptides to identify new compounds with desired biological activities. To accomplish this, we use enzymes that structurally modify peptides resulting in ribosomally synthesized post-translationally modified peptides (RiPPs), which are a growing class of natural products. If we can use these enzymes to biosynthesize uncharacterized compounds, we can screen these compounds for biological activities to identify new antibiotics, therapeutic drugs, or other useful products. We are currently developing a method of expressing and isolating soluble and active enzymes that can perform modifications to variant core peptide chains. This process will increase the rate of discovery of natural products. Using methods of directed evolution, we may be able to engineer these molecules to preform specific biological functions.

Keywords: peptides, biochemistry, directed evolution

KSRP-encoded miR-3940 inhibits Rictor expression and NDRG1 phosphorylation in glioblastoma cells

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Glioblastoma multiforme (GBM) is the most common central nervous system malignancy. This aggressive cancer is incurable, and treatment regimens, which include surgical resection, radiation therapy, and oral temozolomide (TMZ), result in a median survival of just 15 months. KSRP is a multi-functional RNA-binding protein whose expression in glioblastoma tissues is significantly associated with overall and disease-free patient survival. miR-3940 is a recently discovered microRNA that is processed from an intron of KSRP. miR-3940 expression is tightly correlated with KSRP in glioblastoma tissues, and like KSRP, miR-3940 may have an important role in glioblastoma. Using bioinformatic analyses, we identified Rictor, a component of the mTORC2 signaling complex, as a putative target of miR-3940. We hypothesized that miR-3940 regulates Rictor expression and its downstream targets in glioblastoma. Using quantitative RT-PCR, we found that Rictor mRNA levels are altered in glioblastoma cells transfected with miR-3940 mimics or inhibitors. We then performed western blotting to confirm that miR-3940 alters protein levels of Rictor and also to analyze downstream signaling targets of Rictor. We found that Rictor protein was decreased by miR-3940, and similarly, that Rictor protein was increased after

miR-3940 inhibition. We further found that phosphorylation of the Rictor target NDRG1 were decreased following miR-3940 overexpression and increased following its inhibition. Rictor was previously shown to regulate the migration of glioblastoma cells, and its suppression increased sensitivity to TMZ and reduced tumor growth. NDRG1 was shown to confer resistance to TMZ. Thus, promoting miR-3940 expression and thereby inhibiting its targets, could improve response to therapy and enhance glioblastoma patient survival.

Keywords: cancer, RNA, proteins, Glioblastoma

Characterization of mitochondrial genomes for improving snail phylogeny

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V. Sanchez, University of New Mexico
Coen Adema, University of New Mexico
Hsiu-Ping Liu, Metropolitan State University of Denver

Toward improving the phylogeny of snails (Mollusca, Gastropoda), the mitogenome of *Pyrgulopsis owensensis* (springsnail) was sequenced. The modest size (~16,000 bp) makes mitogenome sequencing feasible, conserved mitochondrial sequences and gene order facilitate phylogenetic reconstruction. *Pyrgulopsis owensensis* (Caenogastropoda, family Hydrobiidae) represents a group of understudied freshwater snails that are highly prevalent and abundant in lotic habitats in northwest America. Application of primer design, Long Range PCR, cloning, Sanger sequencing, and computational bioinformatics yielded the 15,334 bp mitogenome of *P. owensensis*, containing 13 protein-coding genes, 2 rRNAs, and 22 tRNAs (typical for Metazoa). Initial comparisons (Mega 7) showed similarities among gene order and sequence orthologs that enable ongoing phylogenetic evaluation of hydrobiid snails. This previous experience is currently applied to graduate research of phylogeny of the clade Stylommatophora (terrestrial snails), currently challenged by lacking reagents to reliably obtain valid sequences. NGS genomic data (Illumina) were collected to reconstruct and annotate mitogenomes of 10 representative species of stylommatophoran phylogeny. Alignments revealed conserved gene regions for design of primers that are being tested for consistent PCR amplification of phylogenetically informative sequences for all stylommatophoran snail species. Improved resolution of snail phylogeny will afford strategic selection of representative taxa to study biological properties (including immune function) of larger groups of snails.

Keywords: snails, mitochondria, genetics, biology

Mechanical and thermodynamic stability of virulence effectors proteins and the role in secretion by the type 3 secretion system

Diego Trujillo, University of New Mexico
Morgan Fink, University of Colorado Boulder
Katherine DaPron, University of Colorado Boulder
Marcelo Sousa, University of Colorado Boulder

The Type 3 Secretion System (T3SS) is a protein complex in Gram-negative bacteria that spans their inner and outer membrane and forms a pore in the membrane of a host cell. The T3SS serves as a conduit that allows bacteria to inject proteins into a host cell's cytosol to facilitate infection. For T3SSs to function efficiently, the system relies on an ATPase complex to unfold polypeptides, so they can be secreted through the narrow needle-like structure of the T3SS. Whereas effector proteins can be unfolded, and secreted, other proteins cannot be unfolded and become stuck in the TTSS. This led to the current model that effector proteins are thermodynamically labile. We hypothesize that unfolding by the T3SS is a mechanic process powered by a relatively weak ATPase, and therefore secreted effector proteins have evolved to be mechanically labile, so they can be unfolded, but thermodynamically stable, so they can refold stably in the host to exert their function. Here, we test this hypothesis by analyzing the thermodynamic and mechanical properties of effector proteins. We use single molecule atomic force microscopy to measure the mechanical properties of proteins and circular dichroism to evaluate their folding stability. Preliminary results show that effector proteins have thermodynamic stabilities that are typical of globular proteins. Comparing properties of effector proteins vs. other effectors, as well as against their non-secreted homologs, can elucidate what makes a protein secretable. This will provide understanding of host-microbe interactions and how bacteria are able to infect their hosts.

Keywords: proteins, bacteria, cell biology

New Mexico Academy of Science 2019 Awards for Outstanding Science Teaching

ABOUT THE AWARDS

The Outstanding Science Teacher Award given by the New Mexico Academy of Science honor New Mexico science and math educators. These awards have been given since 1968. The Academy recognizes teachers who provide opportunities for students to succeed in science. Nominations are open to all preK-12 teachers and informal science educators throughout New Mexico. NMAS presents an award plaque and a monetary award to each teacher. The American Chemical Society joins with the Academy in this award and also presents a monetary award to the winning teachers.

2019 RECIPIENTS

*The 2019 New Mexico Outstanding Science Teacher Award Winners are **Amanda Pacheco-Suazo** and **Mark Walker**, both from Albuquerque Public Schools.*

Amanda Pacheco-Suazo is a kindergarten teacher at Mission Academy Elementary School, a STEAM magnet school in the Albuquerque Public School System. She has been teaching preK-2 for 9 years. The Academy has never honored a kindergarten teacher before but Mrs. Amanda (as her students call her) is a unique kindergarten teacher. She teaches kindergarten in a high poverty area in Albuquerque. 100% of students qualify for free breakfast and free lunch. Mission Elementary is a title one school with many diverse learners, many English language learners and students from diverse economic and cultural background. The first year that Mission Elementary became a magnet school, she began a program she called “Master Scientist.” She fund-raised for materials on an education donation website and used those funds to purchase lab coats and fairy tale STEM problem solving kits for her students.

Mrs. Pacheco-Suazo created an environment that encouraged unique learning,and a classroom that promoted creativity, independence and cooperative exploration of problems. She cleverly used the lab coats to make her students feel like real scientists as they worked through problems in fairy tales—such as designing a house for the 3 Little Pigs or figuring out how to support a tall beanstalk. She utilized the school’s iPads, digital lab, and STEM lab to teach computer science. She introduced the concept of testing hypotheses. She piqued student interest in engineering with a marble chase and a LEGO project. She has taken her students on field trips to science-oriented destinations to learn about habitats. In late October of this year, she hosted visitors to her class from the “Magnet Schools of America” national meeting. The bottom line is: Her students enjoy science. They have learned how to ask questions, imagine and plan, create and improve and share ideas. These students are starting out with a successful experience in "doing science." This is the type of early childhood education that will result in building a scientifically literate society. All of Mrs. Pacheco-Suazo’s students will not become scientists, but all of her students will remember their first experience with science as a joyful one.

Mark Walker is from the Early College Academy and Career Enrichment Center. He has been teaching for 18 years and currently teaches Biology and Forensic Science to grades 9-12. For many years, Mr. Walker has been a mentor to students participating in the Junior Academy of Science, many of whom have won awards.

Mr. Walker’s nomination actually came from 4 of his students. One of them wrote the following: “Mr. Walker is an excellent mentor for his students; his ability to keep labs, lectures, quizzes, and even tests entertaining keeps the students engaged and helps them to process the information faster and easier. His love for science and teaching are shown in his passion to help students grow an understanding and love for science themselves. He is a compassionate and charismatic teacher who cares about the well being of his students. Mr. Walker has been the best teacher that I have ever had.” Ms. Rebecca Florienz, Vice Principal of the Early College Academy accepted the award at the ceremony for Mr. Walker who unfortunately could not attend.

2019 NMAS Research Symposium

ABOUT THE RESEARCH SYMPOSIUM

The 2019 New Mexico Academy of Science Research Symposium was held in Albuquerque on 02 November 2019. The Symposium was sponsored by the New Mexico Academy of Science (NMAS), the New Mexico Experimental Program to Stimulate Competitive Research (NM EPSCoR), the University of New Mexico Center for Water and the Environment, the American Chemical Society (ACS), and the New Mexico Alliance for Minority Participation (NM AMP). The Symposium schedule included 24 oral presentations and 50 poster offerings from the students and faculty of 19 of New Mexico's educational institutions. The luncheon included the New Mexico Academy of Science's two annual awards for Outstanding Science Teaching, and Dr. Gwen Perea Warniment from the New Mexico Department of Education provided the luncheon keynote address. Abstracts of these presentations are included in this annual volume of the NMAS *New Mexico Journal of Science*. The Symposium closed with the poster competition for the best graduate and undergraduate posters. The full agenda is online at www.nmepscor.org.

SYMPOSIUM WELCOME FROM 2019 NMAS PRESIDENT

On behalf of the New Mexico Academy of Science, I would like to welcome each of you to the 2019 Research Symposium! NMAS is pleased to once again partner with New Mexico EPSCoR, the UNM Center for Water and the Environment, the American Chemical Society, and New Mexico AMP for this annual conference to promote science and science education in our community. Our keynote speaker is Dr. Gwen Perea Warniment. Her lunchtime presentation is called, " An Overview of the Goals and Strategic Plan of the NM Public Education Department" and will cover the current and future status of public education in New Mexico. Join us for her illuminating talk, as well as for the awards for Outstanding Teacher in our state, plus a day of interesting and engaging presentations by students and professors, and the student poster session in the afternoon.

Stephen Jett, NMAS President

KEYNOTE SPEAKER: GWEN PEREA WARNIMENT, PHD

Gwen serves as the Deputy Secretary for Teaching and Learning for the New Mexico Public Education Department (NM PED). In this role, she oversees three divisions: Educator Quality, Curriculum and Instruction, and Assessment. With a little over two decades of experience supporting public education, Dr. Warniment has taught across the elementary to post-secondary landscape, chiefly focused on bilingual, STEM education.

Before joining NM PED, Gwen was the Program Director for the Los Alamos National Laboratory Foundation with a portfolio that included direct programming, advocacy and grant making in support of public education. In this role, she directed various initiatives to support teacher retention in rural districts, socio-emotional support systems and professional learning for educators, as well as a consortium designed to build educator capacity in inquiry science and the Next Generation Science Standards.

Gwen is passionate about student voice, culturally and linguistically sustaining instruction, and supporting educators in their reflective practice. She holds a doctorate in Curriculum and Instruction from New Mexico State University.

ABOUT THE SPONSORS

New Mexico Academy of Science

Founded in 1902, the New Mexico Academy of Science has been in continuous existence since 1915. The Academy is a member of the National Association of Academies of Science (NAAS) and an affiliate of the American Association for the Advancement of Science (AAAS). The New Mexico Academy of Science works with teachers, state agencies, and the legislature to establish appropriate standards for the teaching of the sciences. The Academy goals are to foster scientific research and scientific cooperation, increase public awareness of the role of science in human progress and human welfare, and promote science education in New Mexico. Visit www.nmas.org to learn more.

New Mexico EPSCoR

The New Mexico Established Program to Stimulate Competitive Research (NM EPSCoR) is funded by the National Science Foundation (NSF) to build the state's capacity to conduct scientific research. The infrastructure and activities of Energize New Mexico are designed to support shared–use equipment, engage new research and community college faculty, and support the STEM pipeline by training teachers, undergraduate and graduate students, and post–doctoral fellows. Research findings are communicated broadly through various outlets, including local museums. Visit www.nmepscor.org to learn more about NM EPSCoR, and visit www.nsf.gov/epscor to learn more about the NSF EPSCoR initiative and other jurisdictions.

American Chemical Society

The American Chemical Society (ACS) is the world's largest scientific society and one of the world's leading sources of authoritative scientific information. A nonprofit organization, chartered by Congress, ACS is at the forefront of the evolving worldwide chemical enterprise and the premier professional home for chemists, chemical engineers and related professions around the globe. The Central New Mexico Local Section of the American Chemical Society was founded in 1946 and generally serves the northern 2/3rds of the state of New Mexico. The Local Section specifically includes the following New Mexico counties: Bernalillo, Los Alamos, Rio Arriba, San Miguel, Sandoval, Santa Fe, Socorro, Taos, Torrance, and Valencia.

UNM Center for Water & the Environment

The mission of the Center for Water and the Environment at the University of New Mexico (UNM) is to increase the participation of underrepresented minorities (URM) in science, technology, engineering and math (STEM) professions while conducting cutting-edge research into technological and engineering-based solutions to problems with water and the environment, in a framework that considers the social, economic, policy, regulatory, and legal implications. Practical solutions to problems related to water availability in arid environments and in times of drought, and problems associated with energy generation and consumption are particularly relevant, in light of the criticality of these issues to the state of New Mexico, the southwestern United States, and their global importance. Learn more at cwe.unm.edu.

New Mexico Alliance for minority Participation

Established in 1993 with major funding from the NSF, the New Mexico AMP program is a partnership of the state's two- and four-year colleges and universities, with a primary goal of increasing the number of B.S. degrees awarded to under-represented students in New Mexico. NM AMP supports students with scholarships; research assistantships; professional development; and enhanced teaching, learning, and mentoring experiences. Program activities are designed to attend to individual student retention, development, and progression; support student progression to the STEM workforce and graduate school; and promote the replication of best practices, both within New Mexico and nationally. To learn more, visit www.nmsu.edu/~nmamp/.

CONCURRENT SESSION PRESENTATION ABSTRACTS

SESSION A: CHEMICAL, PHYSICAL AND ENERGY SYSTEMS I

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

Mohira Rassel, Los Alamos National Laboratory

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

Biosensing with Spatial Resolution Using Arrays of Graphene Nanodisks

Lauren Zundel, The University of New Mexico

The ability to detect the presence of molecules in low concentrations poses a unique but pressing technological challenge due to the weak interactions of these structures with light. In this context, metallic nanostructures capable of supporting surface plasmons, the collective oscillations of conduction electrons, have emerged as a promising platform to achieve this goal. This is because plasmons couple strongly to light, producing large confinement and enhancement of incident electromagnetic fields, which serve amplify the interaction with the vibrational modes of molecules placed in their vicinity. One material that is especially promising to this end is graphene, a two-dimensional honeycomb lattice of carbon atoms. This is because it can be doped to support surface plasmons in the mid-infrared part of the spectrum, which is where most molecules have their vibrational modes. In addition, the plasmons supported by graphene can be actively tuned by changing the doping level, which enables the detection of a wide range of chemical species using the same device. Here, we exploit these extraordinary properties to design and model an ultrasensitive optical sensor made of arrays of graphene nanodisks. Our proposed device, which consists of a set of subarrays, or pixels, each of which can be individually doped, can enable the detection of low concentrations of molecules with the added advantage of having sub-wavelength spatial resolution. This is achieved by sequentially bringing each pixel into resonance with a desired chemical species. The results of our work serve to inspire the development of new lab-on-a-chip technologies that can be used to study, in real time, complex biological structures and processes.

Keywords: plasmons, graphene, biosensing, periodic arrays

Transmission Line Pulser Topology: The Pros & Cons

Ken Le, The University of New Mexico

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: transmission lines, high voltage, circuitry

Testing of Multiple 3D Printed Cylinders Against Surface Flash Over

Nikita Dougan, The University of New Mexico

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

SESSION B: HEALTH AND BIOLOGY

Blood Based Lipoarabinomannan Detection in Tuberculosis Patients: Results from a Double-blinded Clinical Cohort in Uganda

Shailja Jakhar, Los Alamos National Laboratory and The University of New Mexico

Almost one-third of the world's population is infected with tuberculosis (TB), the leading cause of death worldwide from single infectious agent ranking above HIV/AIDS. About 10% of those infected have a potential risk to develop active TB at some point in their life. Alarmingly, 40% of TB cases are either not diagnosed, or not notified to TB control programs, highlighting the limitations of current diagnostic platforms, which are either inaccurate or inaccessible. A simple blood-based diagnostic would alleviate this problem, developing which is the goal of our work. Our team has determined that Lipoarabinomannan (LAM), an amphiphilic tuberculosis biomarker, is carried by lipoprotein molecules such as HDL in blood. To detect presence of LAM in blood, we have developed a modified sandwich assay termed lipoprotein capture assay, which utilizes the association of LAM with HDL to achieve rapid biodetection. We have evaluated performance of the Lipoprotein capture assay in a blinded cohort of TB patients from Uganda (n=48), and demonstrate performance inpatients presenting with pulmonary and extrapulmonary variants of the disease. The measurements were made using an ultrasensitive biosensor platform developed at the Los Alamos National Laboratory. The results indicate the feasibility of developing a simple, blood-based diagnostic for active tuberculosis. In addition, they also indicate the dependence of assay performance on co-morbidities such as HIV which impact outcomes, thereby providing some valuable information on disease manifestation that can guide the development of intervention strategies.

Keywords: tuberculosis, LAM, diagnostic testing

Fire and Submerged Aquatic Plants: Are Changes to Key Nutrients Lurking Below the Surface?

Virginia Thompson, The University of New Mexico

It is often assumed that fire does not affect aquatic organisms given that they are not directly burned in fires that pass through the area. However, this assumption may be incorrect. Fire in the southwestern US and beyond is a rapidly growing problem in the face of climate change, and while wildfire impacts can be immediate, including loss of life, structures, and vegetation, other impacts can be delayed but still create significant disturbance to the ecosystem. Although fire impacts on terrestrial vegetation that can be burned are well studied, little is known about fire impacts on submerged aquatic macrophytes (SAMs), which are plants that conduct their whole life cycle underwater. Previously, we found that fire-related nutrient inputs to a nutrient-limited stream created a significant increase in SAM biomass accumulation compared to pre-fire levels of biomass. To investigate the mechanisms behind this increase in biomass post-fire, we asked whether the concentrations of three key nutrients in the SAM tissues changed after the fire. We analyzed pre- and post-fire SAM tissue samples for carbon (C), nitrogen (N) and phosphorous (P) content and used multivariate statistics to test for statistically significant differences among pre- and post-fire tissues. Compared to pre-fire tissue nutrient content, we found a significant reduction in these key nutrients in SAM tissues when biomasses peaked after the fire-related nutrient inputs. This was a surprise, as we expected concentrations of these nutrients would be higher in postfire tissues. These results highlight the notable impacts that fire can have on SAMs despite a lack of visible initial impact directly from the fire. Reductions in SAM nutrient content and consequently, quality as a food source could have detrimental effects on other organisms dependent on them, magnifying impacts on local biota and food webs.

Keywords: fire, aquatic ecosystems, nutrient content, aquatic plants

Exploring Biochemical Reactions Involved in Taurine Biosynthesis

Steven Karpowicz, Eastern New Mexico University

Taurine (2-aminoethanesulfonic acid) is a highly abundant, amino-acid derived molecule in humans and various animals. Deficiency for taurine is associated with numerous physiological and health problems. The identities and characteristics of reactions involved in taurine biosynthesis are not fully understood, including those that involve reactive oxygen species. Recent analytical and biochemical experiments will be presented that provide details as to the mechanisms and kinetics by which taurine is synthesized.

Keywords: biochemistry, kinetics, taurine

SESSION C: NM SMART GRID CENTER

Property-Relation Binding: Integrating an Optimized Naming Scheme in ICN-IoT

Casey Tran, New Mexico State University

The main problems dealing with scalability and interoperability of constraint (IoT) devices stem from the inherent inception of TCP/IP. However, networking under an ICN architecture requires that these devices utilize minimal resources. To realize this, the names that are used to route data is taken into consideration in the paper to scale for IoT devices. In this research I list the current state of the art naming schemes such as (NDN's) Hierarchical. Then I present Property-Relation Binding as a naming scheme for IoT devices that may take on globally unique and fully hierarchical names yet using fewer resources than hierarchical while remaining effectively interoperable. To make the case, I conduct an experiment with different variations. The results prove that PRB names can perform better than pure hierarchical. By FNV1a hashing the variable number prefixes, followed by performing a shortened number prefix by prefix matching on the full name, the computation time is actually reduced. The mean match time for a Content Store of NDN names to NDN nodes is 8.6 microseconds. Against the same names, the PRB node performs better at matching its CS with an average of 3.5 microseconds. Additionally, for PRB names to PRB nodes, the computation time average is even lower at 2.1 microseconds. The longer variable prefix shows NDN names to PRB nodes at an average of 8.0 microseconds and

PRB names to PRB nodes at 6.0 microseconds. For the 20,000 generated hierarchical names, there were no collisions when they were converted to PRB names. For 5kB, 10kB, and 50kB content stores, PRB was able to hold 67, 82 & 82% more names from the 20,000 generated hierarchical names respectively.

Keywords: ICN, NDN, future internet architecture, naming, IoT

SMART Idea? Willingness to Accept Utility Controlled Thermostats During Peak Demand (Preliminary Results)

Jesse Kaczmarski, The University of New Mexico

Advancements in SMART (specific, measurable, achievable, realistic, and timely) technologies often lacks research into consumer demand and acceptance for these technologies. In this study, we estimate consumer acceptance for a utility-controlled thermostat with a national survey of electric bill payers. We find that 49% of respondents would be willing to allow the electric utility to control their thermostat, and preliminary results show that the average amount of monthly compensation needed for the participation is relatively low, approximately $2.00. We find that demographics such as region, income, and education do not affect participation. However, we find that attitudes and preferences surrounding energy conservation, the electricity provider, and technological solutions to climate change are significant in predicting participation in the program. This suggests that efficient and effective adoption of SMART technologies will depend on consumer targeting by attitudes and preferences as opposed to demographics. This study contributes to the paucity of research on consumer response to SMART technologies by being one of leading studies into consumer preferences and attitudes surrounding utility control for public benefit.

Keywords: willingness to accept, consumer demand, contingent valuation, consumer energy, demand response

Detecting Cyber-Attacks in Smart Grids Using Semi-Supervised Outlier Detection and Deep Feature Extraction

Ruobin Qi, New Mexico Tech

Smart grids are facing many challenges including cyber-attacks which can cause devastating damages to the grids. Machine learning based approaches has shown to be a promising solution for detecting cyber-attacks in smart grids. However, majority of existing work focused on using supervised learning, which needs representative instances from various attack types to obtain good detection models. In this project, we investigated semi-supervised outlier detection algorithms for this problem which only use instances of normal event for model training. Seven popular semi-supervised outlier detection algorithms were considered in our study including one-class support vector machine (OCSVM), histogram-based outlier score (HBOS), local outlier factor (LOF), cluster based local outlier factor (CBLOF), semi supervised k-nearest-neighbors (k-NN), feature bagging, and isolation forest (iForest). The detection models were trained using the data collected from phasor measurement units (PMUs). Our results show that OCSVM, CBLOF and iForest are the three best algorithms, which also perform better than two popular supervised learning algorithms, SVM and k-NN. We further investigated how feature dimension reduction through feature extraction can improve the detection performance of semi-supervised outlier detection algorithms. We found that nonlinear methods like deep feature extraction with autoencoder can significantly improve the performance while linear methods like principal component analysis (PCA) don't work well.

Keywords: SMART grid, PCA, outlier detection

Iterative Threshold Decoding of Braided Convolutional Codes

Andrew Cummins, New Mexico State University

Modern high-speed digital communications rely on a careful orchestration of information encoding and decoding to ensure low-latency, error-free information transfer. Braided convolutional codes (BCCs), a type of parallel-concatenated turbo code, have been shown to have excellent error-correcting capabilities when decoded using optimal, high-complexity iterative methods. However, such decoding strategies could result in unacceptable power and latency

costs. In this work, we employ parallel low-complexity component threshold decoders that greatly reduce decoding complexity and are thus faster, more energy efficient, and easier to implement. Our preliminary results suggest that competitive performance could be achieved with careful choice of the component code and tuning of decoder parameters, providing a path toward future highly efficient codec designs.

Keywords: FEC, telecommunications, coding theory

Iterative Threshold Decoding of Braided Convolutional Codes

Binod Poudel, The University of New Mexico

Due to the deployment of communication and control technologies, DC microgrid resembles a cyber-physical system that is highly exposed to cyber-threats. The bulk of the research in cybersecurity of power systems focuses on the detection of attacks. This research addresses the cyber-threat detection and mitigation in a DC microgrid distributed control system. The scheme relies on a Kullback-Liebler divergence-based criterion. This criterion detects the misbehavior of a compromised Distributed Energy Resource (DER) control unit and, consequently, calculates an interior-belief factor and communicates it with its neighboring DERs to inform them of the reliability of its outgoing information. Moreover, DERs calculate an exterior-belief value related to the trustworthiness of the received information from neighbors. The cyber-threat mitigation scheme at each DER utilizes the neighbors' interior-belief and its own calculated exterior-belief value for neighboring DERs to slow down and eventually mitigate attacks. The proposed approach requires a communication network with mild graph connectivity. A typical medium-voltage DC microgrid system is simulated to verify the validity of proposed distributed cyber-secure control scheme. It is shown that using the proposed cybersecure approach, the voltage of a critical bus of microgrid is well regulated and DERs can successfully distinguish cyber-attacks from legitimate events. This will help to make a robust smart distributed microgrid control system.

Keywords: cyber-threats, microgrid, Distributed Energy Resource, Kullback-Liebler divergence

SESSION D: CHEMICAL, PHYSICAL AND ENERGY SYSTEMS II

Understanding Metal-Ligand Covalency in DMSO Reductase Family Enzymes by X-ray Absorption Near Edge Structure (XANES)

Khadanand KC, The University of New Mexico

Dimethyl sulfoxide reductase (DMSOr) family enzymes play critical roles in C, S, and N biogeochemical cycles. These enzymes are coordinated by the ene-1,2-dithiolate side chains of two pyranopterin cofactors, typically an amino acid donor (e.g. SCys, SeSec, or OSer) and for oxidized enzyme forms a terminal oxo or sulfido ligand. The structures of fully oxidized and fully reduced enzyme forms have been probed by Xray crystallography, EXAFS, and resonance Raman spectroscopy. Unfortunately gaining insight into their electronic structures via optical spectroscopy has proven to be quite difficult due to the presence of other chromophores strongly absorbing chromophores such as Fe-S clusters and hemes. Similarly, obtaining Mo-S covalency information using S K-edge XAS is effectively impossible due to the presence of other, non-coordinating Cys and Met amino acids in the protein. Paramagnetic Mo(V) enzyme intermediates have been extensively studied by electron paramagnetic resonance (EPR) spectroscopy, but these enzyme forms are typically not amenable to crystallographic studies. To address this problem, we have elected to synthesize new models for paramagnetic DMSOr enzyme intermediates. This allows us to correlate enzyme EPR spin-Hamiltonian and EXAFS structural parameters with model systems of known structure. Specifically, we will detail the results of S K-edge XAS, EXAFS, electronic absorption and EPR spectroscopies on [Mo(dithiolene)2(E-E)]1- complexes in order to understand the relationships between the geometric and electronic structure of Mo(V) enzyme species and understand how covalency effects control electron transfer reactivity in the enzymes.

Keywords: XANES, enzymes, DMSO

New Oligo-Phenylene-Based Materials in Probing Electron Delocalization for Organic Photovoltaics

Juchao Yan, Eastern New Mexico University

Phenylene-based conjugated oligomers and polymers (e.g., fluorenes) are promising candidates for organic electronics and solar cells. To control the energetics and dynamics of electrons, we have selected time-resolved infrared spectroscopy coupled with pulse radiolysis for a series of newly designed laddertype oligo(p-phenylene)s. Such oligo(p-phenylene)s are rigidified, and bear a nitrile group as an infrared reporter group and hexyl side chains for increasing their solubility. Compared to the oligofluorene counterparts, they have conformational rigidity and planarity and are expected to exhibit sharper infrared peaks and faster electron transfer rates. In this talk, I will illustrate our organic syntheses and characterizations of several title oligo(p-phenylene)s, and will discuss our time-resolved infrared spectroscopic results from the laser-electron accelerator facility at Brookhaven National Laboratory. The focus will be on their optical signatures of the charged and triplet states.

Keywords: oligo-(p-phenylene)s, electron delocalization, organic photovoltaics, pulse radiolysis

Radical Appended Donor-Acceptor Pt complexes: An Ideal Platform for Electron Transfer, Electron Transport, and Excited State Processes

Ranjana Dangi, The University of New Mexico

Square planer Pt donor-acceptor complexes have garnered considerable interest due to their rich photochemical properties and their photoluminescence behavior. These complexes possess a low energy Donor → Acceptor ligand-to-ligand charge transfer (LL'CT) transition that effectively creates charge separated singlet biradicals (semiquinone and bpy•-) in the LL'CT excited state. Herein, we describe a new molecular biradical framework to develop greater insight into excited state magnetic coupling and spin polarizations. Importantly, these new complexes will allow for detailed spectroscopic interrogation by magnetic circular dichroism (MCD) spectroscopy to understand their electronic structure, and by time-resolved spectroscopies to understand their excited state lifetimes and dynamics. Understanding these complex excited state interactions is crucial for the further development of quantum information science, molecular electronics, and molecular spintronics applications. We will discuss here our latest results in the context of how to create novel excited states where three spin ½ centers are localized on three different sites in the same molecule.

Keywords: donor, acceptor, radical, biradical, spin

Predicting the Effects of Density Gradients on the Hydrodynamic Behavior of PBX9502 in Shaped Charges

Irene Fang, Los Alamos National Laboratory

High explosive materials may be exposed to a variety of thermal stimuli during their service lifetime. For TATB-based explosives, which are often anisotropic, the explosive component may undergo irreversible volume expansion or density reduction. For example, if asymmetric heating is applied, the initially uniform part will develop a density gradient. In a real-world scenario, this can be caused by something as simple as exposing part of an explosive to the sun. Here, we seek to investigate the hydrodynamic effects of these density gradients in the explosive PBX 9502 on the performance of a common military shaped charge by varying density regions around the shaped charge liner. Previous work with flyer impact simulations shows that density gradients affect wave shape. Wave shape affects performance in shaped charges, and therefore we expect to observe significant changes in the resulting jet due to the presence of low-density regions.

Keywords: TATB, hydrodynamic, PBX 9502

Adjusted Design Effect Model and Longitudinal Generalized Variance Functions for Survey Data

Mohammed Quazi, The University of New Mexico

Many large-scale surveys such as the Current Population Survey (CPS) collect data over multiple years. Each year, thousands of estimates and standard error for each published estimator need to be reported, which involves a large amount of work. The longitudinal generalized variance functions (LGVF) proposed by Zhang, Cheng, and Lu (2019) provides convenient variance estimates by using longitudinal data. This research extends the LGVF by incorporating the design effects into modeling for use in a longitudinal survey data. The March CPS data from 2003 to 2017 is used in simulation studies and the March 2018 data is used for the purpose of model validation. Simulation results show that the proposed methods are effective and promising when compared with other methods in literature.

Keywords: LGVF, CPS, adjusted design effect, cluster, variance

Identification of Technical Analysis Patterns with Smoothing Splines for Bitcoin Prices

Nikolay Miller, The University of New Mexico

This research studies automatic price pattern search procedure for Bitcoin cryptocurrency based on one-minute price data. To achieve this, search algorithm is proposed based on nonparametric regression method of smoothing splines. We investigate some well-known technical analysis patterns and construct algorithmic trading strategy to evaluate the effectiveness of the patterns. We found that the use of method of smoothing splines for identifying the technical analysis patterns and strategies based on certain technical analysis patterns yield returns that significantly exceed results of unconditional trading strategies. By using one month of BTCUSD data from Coinbase Pro, we have identified several potentially very profitable technical analysis patterns, among them Head-And-Shoulders, Inverted Head-And-Shoulders and Triangle Bottoms. We have also proposed a method to evaluate the effectiveness of the technical analysis patterns by market returns. Our results are promising and could be used as a reference to develop a successful algorithmic trading strategy.

Keywords: algorithmic trading, technical analysis, pattern recognition, statistics, trading, finance, cryptocurrency

Does the Solemn Oath Lower WTP Responses in a Discrete Choice Experiment Application to Solar Energy?

Jamal Mamkhezri, New Mexico State University

One way to eliminate or mitigate hypothetical bias associated with stated preference surveys is the solemn oath script. While the efficacy of solemn oath script is still debatable, the key objective of this paper is to provide an initial field setting test of the solemn oath script to a particular discrete choice experiment survey application to solar energy. We conducted a discrete choice experiment survey with two treatment groups: with and without having respondents sign the solemn oath prior to taking the survey. Utilizing random parameter logit models in both preference-space and WTP-space, our results provide no evidence that the solemn oath script lowers respondents' willingness-to-pay for the good in question. Either there is no hypothetical bias in the current study, which we are unable to test as there is no real expenditure at issue, or the solemn oath script may have limited application outside of the experimental lab and is not effective under every condition. Lastly, this calls for more research on the efficacy of solemn oath script.

Keywords: solemn oath script; hypothetical bias; choice experiment survey; solar energy; marginal willingness-to-pay

100% Renewable-Electricity Demand: A Dream or Dreaming a Dream

Jamal Mamkhezri, New Mexico State University

State-mandated renewable portfolio standards (RPS) contribute to a substantial fraction of total electricity supply in the U.S. (Barbose, 2018). RPS is an environmentally motivated policy, yet it has the potential to greatly impact economy. There is not a concise agreement in the literature surrounding the impact of RPS policies on regional economies, especially on job creation. Integrating various methodologies such as econometrics, geographic information system, and input-output into a unique system dynamics model, this paper estimates the impact of RPS on an economy and the environment under four scenarios: 10%, 20%, 50%, and 100% RPS by 2050. We carry out our analysis in New Mexico, a southwestern state in the U.S. with an RPS of 20% by 2020 (reference case scenario) and abundant potential for fossil fuel and renewable energy sources. Under the latter two scenarios, our findings suggest supporting jobs in rural counties that are most suitable for future renewable energy installation, the former two scenarios support jobs primarily in the fossil fuel sector in urban counties. Further, our results indicate that the fossil fuel intensive scenarios will be the most beneficial scenarios, with the highest employment and economic output impacts, without considering their consequential environmental impacts. However, considering environmental impacts such as water usage, greenhouse-gases, air pollution, and human and avian mortalities and morbidities will reverse the results: the higher the RPS level, the higher the overall benefits to the state. Although the employment values appear to have minimal impacts, the disparity in job and economic output distribution across counties and energy sources suggest that counties with different energy potential and population density will experience a variation in impacts. Given the rural nature of New Mexico and variable economic outlook across its counties, higher renewable energy diffusion may become an economic tool to stimulate growth in economically depressed areas.

Keywords: renewable portfolio standard, employment, economic output, water use, greenhouse-gas

SESSION F: STEM EDUCATION

Heroes and Heroines of Chemistry

Lawrence Berliner, University of Denver and Ohio State University

The talk highlights some very famous people who influenced chemistry and the sciences in a profound way that still impacts us today. We cover Alfred Nobel and the Nobel Prizes, Amedeo Avogadro, John Dalton, Dmitri Mendeleev and the periodic table, Marie Curie, Fritz Haber and Linus Pauling. It is aimed for a broad audience with just a minor knowledge of science and emphasizes some unforgettable amazing features on personal life and creativity. The talk was previously presented to the Colorado outstanding high school chemistry students, teachers and parents in celebration of the International Year of the Periodic Table.

Keywords: chemistry, history, Year of the Periodic Table

CISTAR Program at Purdue University: Why Teacher's Need to Engage as Active Researchers

Jerry Cronin, Hopi Junior/Senior High School

As students, staff, teachers or administrators at Hopi Jr./Sr. High School; all of us need new challenges and new educational experiences in our lives. Many of our students tune out the material they are supposed to learn because they think: 'when will I ever use this again?' This past summer I was invited to participate in the CISTAR program for teachers at Purdue University in West Lafayette, Indiana. This program accepted only 7 teachers into the Chemical Engineering Department at one of our nation's most competitive Engineering universities. I was 1 of only 2 educators from the western United States. The intent of the CISTAR program is to provide research experiences and a teaching unit for STEM teachers at the secondary level that teachers will apply in their teaching situation. My project studied how to remove noxious gasses from diesel engines to clean up the air and make the big trucks on the interstates run more efficiently. We simulated a diesel engine in the Chemical Engineering labs at Purdue using gasses in the same ratio as a diesel engine would use them. We tested our own Copper Hydroxide catalyst that was similar in every way

to a commercially available Copper hydroxide catalyst that was supposed to make noxious chemicals stick to it and hence not get released into the air. Another part of our study was to improve efficiency of the diesel motor at under 200 degrees Celsius. This is essential because big rig diesel engines take about 20 minutes to warm up and that is when they are belching out the greatest amount black smoke. After the engine warms up, there is a lot less pollution sent into the environment. This is the holy grail of Chemical Engineering and the person who figures this problem out will become a very wealthy person. If this sounds interesting to you or somebody you know; please contact the Principal Investigator at fabio@purdue.edu.

Keywords: chemical engineering, CISTAR, STEM teachers

Tackling Attrition in a Rural 2-year HSI Adaptive Case Study

Karen Henry, New Mexico State University—Grants

NMSU Grants conducted a research study to identify obstacles to freshman student success and persistence using student demographics, course analysis, and student and faculty surveys. The results of the study disproved many of the long-held campus beliefs and may challenge what you think you know about your students and campus.

Keywords: case study, student success, higher education retention

UNDERGRADUATE STUDENT POSTER ABSTRACTS

Poster session participants are listed alphabetically by last name of registered presenter. ***** *indicates the poster received an outstanding Undergraduate poster award at the NMAS 2018 Research Symposium.*

Bringing Culture and Technology Together

Lani Cojo, Mescalero Apache School

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 after-school robot training program. They will meet with the instructors (High School students) twice a week after-school 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, technology

The Pythagorean Forest

Melany Cordova, Northern New Mexico College Josef Weese, Northern New Mexico College

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

David Corriz, Santa Fe Community College

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: math, art, Pythagorean theorem, Euclid's proofs

Testing of Multiple 3D Printed Cylinders Against Surface Flashover

Nikita Dougan, The University of New Mexico Cameron Harjes, The University of New Mexico
Jane Lehr, The University of New Mexico

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

Jonathan Enriquez Madrid, Northern New Mexico College Rhiannon West, Northern New Mexico College

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

Devon Fisher-Chavez, The University of New Mexico

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*

Haily Galindo, Eastern New Mexico University Juchao Yan , Eastern New Mexico University
John Miller, Brookhaven National Laboratory

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 13C 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?

Christopher Gallegos, The University of New Mexico Anastasia Pittis, The University of New Mexico
Diana Northup, The University of New Mexico

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: white-nose syndrome, bats, microbiology, UV light

A Planar Blumlein Circuit for Agricultural Enhancements with Plasma

Isaac Garcia, The University of New Mexico
Jane Lehr, The University of New Mexico
David Hanson, The University of New Mexico
Andrew Fierro, The University of New Mexico

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 it to measure the plasma parameters produced in a nonthermal discharge produced with nano-second 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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R. Data, Navajo Technical University
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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

Jacob Langford, New Mexico Tech
Kooktae Lee, New Mexico Tech
Stephanie Weber, University of Florida

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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Cameron Harjes, The University of New Mexico
Andrew Fierro, The University of New Mexico
Jane Lehr, The University of New Mexico

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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Kathryn McCollum, The University of New Mexico

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, Baczwaski, 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 after-care 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*

Shae Madrid, Northern New Mexico College

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. In the future 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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Ivana Mali, Eastern New Mexico University
Vinicius-Ortega Berno, Eastern New Mexico University

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

Meghan Morey, University of the Southwest
Yusheng Wu, University of the Southwest
Heidi Stringfellow, University of the Southwest
Chantley Wilson, City of Hobbs Utilities Department

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

William Old Chief, Mescalero Apache School

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 additions 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 concern that with their new pumps in place, their electrical bill has triple. In talking to them these new pumps were needed to continue providing quality trout's, but will the price of upgrading to new equipment, the cost of electricity has increase from $125 per month to over $2500 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 will 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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Youngmin Lee, New Mexico Tech

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

Glowing Garnets: Polycrystalline Scintillators Produced via Co-Precipitation

Kimberly Pestovich, Los Alamos National Laboratory Kenneth McClellan, Los Alamos National Laboratory
Caleb Chandler, Los Alamos National Laboratory

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 Y2LuAl5O12: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

Mohira Rassel, Los Alamos National Laboratory

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*

Antonella Riega, The University of New Mexico

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 uncleared. 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

Alan Shen, The University of New Mexico

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 Machaeroprosopus from Canjilon Quarry, New Mexico

Matthew Stivland, Cornell College and Ghost Ranch

Ghost Ranch's Canjilon quarry is a significant source of phytosaur material from the upper Triassic; two identified phytosaur species (Machaeroprosopus buceros and Machaeroprosopus 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, machaeroprosopus, Canjilon quarry

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

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Yusheng Wu, University of the Southwest
Heidi Stringfellow, University of the Southwest

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

Clayne Williams, Eastern New Mexico University

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*

Anna Winslow, Eastern New Mexico University Steven Karpowicz, Eastern New Mexico University

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

NMSU OASIS: Optimized Architecture for Sustainable Innovative Spaces

Orland Whitney, New Mexico State University Satish Ranade, New Mexico State University
Olga Lavrova, New Mexico State University

The Solar District Cup Is a new competition challenging student teams to design and model solar + storage systems for a campus or urban district, organized by the US Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL). Student teams are challenged to design a solar + storage system for a campus or district that maximizes energy offset and financial savings over 20 years. We assume the role of a solar + storage developer to produce a proposal and analyze electric distribution grid interactions for a district use case. One of our objectives is to learn about the development of distributed energy + storage systems and present solutions to judges and industry. New Mexico State University's team is developing an OASIS concept, which stands for: Optimized Architecture for Sustainable Innovative Spaces. This poster presents current work of NMSU's SDCC project.

Keywords: DOE, NREL, solar storage

GRADUATE STUDENT POSTER ABSTRACTS

Poster session participants are listed alphabetically by last name of registered presenter. * indicates the poster received an outstanding Graduate poster award at the NMAS 2018 Research Symposium.

Wolves, Coyotes, Dogs, and Dingoes: The Evolution and Subspeciation of *Canis lupus*

Samuel Graham Burke, Ghost Ranch

This research discusses the evolution of the grey wolf (*Canis lupus*) and its various subspecies. The study seeks to find the time and place at which various subspecies diverged from the main branch of *Canis lupus*. The genetic and archeological history of the golden jackal (*Canis aureus*), coyote (*Canis latrans*), dingo (*Canis lupus dingo*), and domestic dog (*Canis lupus familiaris*) are all examined. There has been fairly extensive research on genetic relations between the different subspecies. Findings of this research show that coyotes (*Canis latrans*) did not diverge from wolves at all, but rather from a common ancestor, *Canis leophagans*, in North America. Golden jackals (*Canis aureus*) also diverged from a common ancestor, albeit a much more distant one. Domestic dogs (*Canis lupus familiaris*) diverged from grey wolves roughly 15,000 years ago in the area of Central-Eastern Europe, while dingoes (*Canis lupus dingo*) diverged from domestic dogs roughly 8,000 years ago. This means that dingoes diverged from domestic dogs before their arrival in Australia, and that the divergence must have taken place while dingoes were still in Southeast Asia.

Keywords: canidae, evolution, speciation

Charge-Separated Excited State Lifetime Modulation by Hole Migration

Ju Chen, The University of New Mexico

Controlling lifetimes of excited states are of key importance in designing photo- voltaic and related devices. A primary mechanism for controlling T1→S0 decay is spin-orbit induced intersystem crossing coupled with long-distance charge separation. This process allows for an adequate reaction time for solar energy conversion or to introduce long-lived emission for various photonic applications. Here we have devised systems which possess two, close-lying excited states, the mixing of which can affect the lifetime. Without changing the spin multiplicity, lifetime modulation is achieved by hole migration between different excited states.

Keywords: donor-acceptor, excited state lifetime modulation, hole migration

Iterative Threshold Decoding of Braided Convolutional Codes

Andrew Cummins, New Mexico State University
David Mitchell, New Mexico State University
Daniel Constello Jr., University of Norte Dame

Modern high-speed digital communications rely on a careful orchestration of information encoding and decoding to ensure low-latency, error-free information transfer. Braided convolutional codes (BCCs), a type of parallel-concatenated turbo code, have been shown to have excellent error-correcting capabilities when decoded using optimal, high-complexity iterative methods. However, such decoding strategies could result in unacceptable power and latency costs. In this work, we employ parallel low-complexity component threshold decoders that greatly reduce decoding complexity and are thus faster, more energy efficient, and easier to implement. Our preliminary results suggest that competitive performance could be achieved with careful choice of the component code and tuning of decoder parameters, providing a path toward future highly efficient codec designs.

Keywords: FEC, telecommunications, coding theory

Caffeic Acid Derivatives as a Treatment in Medicinal Anticancer Applications

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As oxidative stress and inflammation are increasingly being contributed to the development of cancerous cells, the study of compounds such as the already employed caffeic acid (CA) become logical next steps. Many modern chemical

treatments to the development of cancer cells exhibit highly destructive mechanisms to local healthy cellular growth, as well as to the diseased cells, while new methods are being developed from phytochemicals. At the current state, these phytochemicals are being targeted as potential treatments, as the already published results on CAs has shown a significant promise. Several researchers are currently employing the use of CA with other compounds to emphasize the increase of apoptosis states of effected regions, while minimizing the disruption of native biochemical processes. From the success of the CA mixed reaction, working with derivatives of CA may lead to more effective results in inducing apoptosis without unneeded toxicity. We will be running a variety of caffeic acid derivatives simulations specifically targeting the binding affinity of Cyclooxygenase type-1 (COX-1) and type-2 (COX-2) proteins, as both proteins show contributions to inflammation and carcinogenesis in breast tissue. After this initial phase, the testing will then move onto a treatment of cancer cell cultures. Using isothermal titration calorimetry (ITC) and gel electrophoresis (GE) to test and provide the basis for observing affinities for the derivatives of interest. Through the current hypothesis using these derivatives, we expect to find potential anti-inflammation and anticancer agents.

Keywords: medicinal chemistry, anti-cancer agents, anti-inflammation agents

Concatenated Spatially Coupled LDPC Codes for Joint Source-Channel Coding

Ahmad Golmohammadi, New Mexico State University David Mitchell, New Mexico State University

We investigated a method for joint source-channel coding (JSCC) based on concatenated spatially coupled low-density parity-check (SC-LDPC) codes. A construction consisting of two SC-LDPC codes is proposed: one for source coding and the other for channel coding, with a joint belief propagation-based decoder. Also, a novel windowed decoding (WD) scheme is presented with significantly reduced latency and complexity requirements. Simulation results show a notable performance improvement compared to existing state-of-the-art JSCC schemes based on LDPC codes. Moreover, the asymptotic behavior is analyzed using a protograph-based Extrinsic Information Transfer (EXIT) chart for LDPC block codes with block decoding and also for SC-LDPC codes with the WD scheme.

Keywords: spatially, LDPC, joint source-channel

Blood Based Lipoarabinomannan Detection in Tuberculosis Patients: Results from a Double-Blinded Clinical Cohort in Uganda

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Dung Vu, Los Alamos National Laboratory
Basil Swanson, Los Alamos National Laboratory
Heather Mendez, The University of New Mexico
Susan Dorman, Medical University of South Carolina
Ramamurthy Sakamuri, New York University
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Emmanuel Moreau, Foundation for Innovative New Diagnostics

Almost one-third of the world's population is infected with tuberculosis (TB), the leading cause of death worldwide from single infectious agent ranking above HIV/AIDS. About 10% of those infected have a potential risk to develop active TB at some point in their life. Alarmingly, 40% of TB cases are either not diagnosed, or not notified to TB control programs, highlighting the limitations of current diagnostic platforms, which are either inaccurate or inaccessible. A simple blood-based diagnostic would alleviate this problem, developing which is the goal of our work. Our team has determined that Lipoarabinomannan (LAM), an amphiphilic tuberculosis biomarker, is carried by lipoprotein molecules such as HDL in blood. To detect presence of LAM in blood, we have developed a modified sandwich assay termed lipoprotein capture assay, which utilizes the association of LAM with HDL to achieve rapid biodetection. We have evaluated performance of the Lipoprotein capture assay in a blinded cohort of TB patients from Uganda (n=48), and demonstrate performance in patients presenting with pulmonary and extra- pulmonary variants of the disease. The measurements were made using an ultra-sensitive biosensor platform developed at the Los Alamos National Laboratory. The results indicate the feasibility of developing a simple, blood-based diagnostic for active tuberculosis. In addition, they also indicate the dependence of assay performance on co-morbidities such as HIV which impact outcomes, thereby providing some valuable information on disease manifestation that can guide the development of intervention strategies.

Keywords: tuberculosis, lipoarabinomannan, diagnostics

SMART Idea? Willingness To Accept Utility Controlled Thermostats During Peak Demand (Preliminary Results)

Jesse Kaczmarski, The University of New Mexico Joseph Ulibarri, The University of New Mexico

Advancements in SMART (specific, measurable, achievable, realistic, and timely) technologies often lacks research into consumer demand and acceptance for these technologies. In this study, we estimate consumer acceptance for a utility-controlled thermostat with a national survey of electric bill payers. We find that 49% of respondents would be willing to allow the electric utility to control their thermostat, and preliminary results show that the average amount of monthly compensation needed for the participation is relatively low, approximately $2.00. We find that demographics such as region, income, and education do not affect participation. However, we find that attitudes and preferences surrounding energy conservation, the electricity provider, and technological solutions to climate change are significant in predicting participation in the program. This suggests that efficient and effective adoption of SMART technologies will depend on consumer targeting by attitudes and preferences as opposed to demographics. This study contributes to the paucity of research on consumer response to SMART technologies by being one of leading studies into consumer preferences and attitudes surrounding utility control for public benefit.

Keywords: willingness to accept, consumer demand, contingent valuation, consumer energy, demand response

On Generalized LDPC Codes for 5G Ultra Reliable Communication

Yanfang Liu, New Mexico State University

Generalized LDPC (GLDPC) codes were first proposed by Tanner, and have many potential advantages. We propose a practical construction of quasi-cyclic (QC) GLDPC codes, where the proportion of generalized constraints is determined by an asymptotic analysis.We analyze quantized finite-precision decoding. The block error rate (BLER) performance of the GLDPC codes, combined with a complementary outer code, is shown to outperform a variety of state-of-the-art code and decoder designs with suitable lengths and rates for the 5G Ultra Reliable Communication (URC) regime.

Keywords: GLDPC, 5G, URC

Powering the Red Planet in Pursuit of Becoming Interplanetary Species

Vedant Mehta, Los Alamos National Laboratory

Microreactors are state-of-the-art reactor concept with power level rated in- between 1 kWe to 10 MWe. Yttrium-Hydride is being considered as primary moderator for microreactor due to its superior hydrogen containment capability compared to other hydrides. However, as all hydrides, yttrium hydride experiences hydrogen dissociation (and thus losses) at elevated temperatures. This loss affects the neutronics of the system due to the availability of less hydrogen, and hence less moderation. Several material property data is missing for yttrium hydride. In the first part of the study, we investigate material data generation from the first principle quantum mechanical simulations. These properties include thermal scattering laws, diffusion coefficients, heat capacities etc. In parallel, advanced multiphysics simulation techniques are developed to further understand the dependence of neutronics and thermomechanics on hydrogen dissociation. The newly created data from quantum mechanics is then implemented in the advanced multiphysics toolset to properly understand how the microreactor evolves over time. Finally, system optimization is applied to generate the ideal reactor candidate for space applications including nuclear electric propulsion and surface power production. This presentation covers material data generation, benchmark, multiphysics toolset creation, and system optimization.

Keywords: nuclear engineering, material science, Mars, space nuclear reactors, microreactors

Thermodynamics of Taurine Metal-Binding

Garrett Meyer, Eastern New Mexico University Steven Karpowicz, Eastern New Mexico University

Taurine (2-aminoethanesulfonic acid) is an abundant, biologically-relevant amino acid-derivative found in many Eukaryotes. Its potential function as a chelator has not been fully investigated. Chelation is the ability of a molecule to

bind metals. Taurine's sulfonic acid chemical group is a possible chelate complex. Using isothermal titration calorimetry, metal-binding of taurine is measured. Determining the chelating abilities of taurine provides information about the potential biochemical roles of taurine, such as preventing metal-catalyzed cell damage or removal of toxic heavy metals.

Keywords: calorimetry, chelation, biochemistry

Studying the Environmental Strategies for Reduction of Occupational Stress of the Employees in the Working Places

Hirbod Norouzianpour, The University of New Mexico

In our modern world, people are constantly facing chronic stress from different sources which some are related to environmental design and urban policy. The author discusses the sources of stress in the contemporary built environment from urban to workstation scale and introduces the intervention strategies for mitigating occupational stress. Due to the importance of this issue, the main question of this research is; what are the main environmental factors in offices that can help the employees experience lower stress lever or help them to reduce the stress after facing it? In other words, occupational stress is the agent and built environment is vector and risk factor of causing disease for employees. Stress affects the efficiency of the work and the health of the employees directly. Moreover, the adverse effects of stress are not only limited to mental health but also those cause diabetes, high pressure, overweight and many other health problems. In this presentation, I am going to discuss how built environment affects a workplace and what kind of intervention in design reduce the stress level in working places on employees. To limit this research, we limited the target population to high stressed employees, since they face chronic stress more than other target population. The result of this research is a better understanding of what are the characteristic responsible working places and milieu that can affect the stress of employees during the day. According to the research, set of effective interventions that might cause lower stress levels in working places will be categorized. This research is based on the cross-disciplinary systematic literature review of architecture, planning, public health, medical, management and psychological sciences, in the form of Meta-analyze.

Keywords: environmental design, urban policy, built environment

A Comparison of Stable Isotope and Fecal Sample Analyses to Study Diet of a Freshwater Turtle*

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Ivana Mali, Florida Fish & Wildlife Conservation Commission

Freshwater turtles' dietary habits have been studied using a variety of techniques. Stomach flushing, stomach dissection and fecal collection have been used to gather information about recently consumed prey while the long-term assessment techniques such as stable isotope analysis have been employed to assess diets on a broader spectrum. In this study, we integrated fecal sample analyses with claw carbon and nitrogen stable isotope analyses to assess diets of Rio Grande Cooters (Pseudemys gorzugi) and make a side by side comparison of the two methods. In the fecal samples, we found mainly plants (i.e. Cottonwood, Salt Cedar, Netleaf Hackberry, Willow) and filamentous algae with relatively low percent volume of animal matter (i.e., beetles and insect larvae). Interestingly, stable isotope analyses revealed higher animal intake (i.e., high 13N) in certain classes (i.e., males and females) than previously assumed. Furthermore, based on both nitrogen values and fecal samples, we observed differences in trophic levels in turtles caught at different localities. Therefore, we speculate that different dietary habits may be related to the habitat characteristics. Overall, we conclude that the simultaneous use of stable isotopes and fecal content analyses can provide more detailed information about dietary items as well as aid knowledge regarding species habitat and nutritional requirements.

Keywords: dietary habits, freshwater turtle, Pseudemys gorzugi, stable isotopes, fecal contents

Detecting Cyber-Attacks in Smart Grids Using Semi- Supervised Outlier Detection and Deep Feature Extraction

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Smart grids are facing many challenges including cyber-attacks which can cause devastating damages to the grids. Machine learning based approaches has shown to be a promising solution for detecting cyber-attacks in smart grids. However, majority of existing work focused on using supervised learning, which needs representative instances from various attack types to obtain good detection models. In this project, we investigated semi-supervised outlier detection algorithms for this problem which only use instances of normal event for model training. Seven popular semi-supervised outlier detection algorithms were considered in our study including one-class support vector machine (OCSVM), histogram-based outlier score (HBOS), local outlier factor (LOF), cluster based local outlier factor (CBLOF), semi-supervised k-nearest-neighbors (k-NN), feature bagging, and isolation forest (iForest). The detection models were trained using the data collected from phasor measurement units (PMUs). Our results show that OCSVM, CBLOF and iForest are the three best algorithms, which also perform better than two popular supervised learning algorithms, SVM and k-NN. We further investigated how feature dimension reduction through feature extraction can improve the detection performance of semi-supervised outlier detection algorithms. We found that nonlinear methods like deep feature extraction with autoencoder can significantly improve the performance while linear methods like principal component analysis (PCA) don't work well.

Keywords: smart grid, cyber-attacks, semi-supervised outlier detection, deep feature extraction, autoencoder

Water-Fertilizer Coupling Effects on Vegetative Growth of Young Jujube Trees in Semiarid Regions of New Mexico

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Sanjib Sapkota, Eastern New Mexico University
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Jujube fruits are nutritious, widely consumed in all Asian countries, but relatively unknown to America due to the very limited study of the plant species. Effects of water and fertilizer application on vegetative growth of the jujube trees in semiarid regions have not been investigated. Thus, a field study was conducted in an orchard near the city of Portales, New Mexico, USA. Two-year-old young jujube trees were subjected to one of the combinations of three levels of water: 2 L/plant (W1), 8 L/plant (W2) ,16 L/plant (W3), and three levels of fertilizer: 35 g/plant (F1), 70 g/plant (F2), and 140 g/plant (F3). The increment in stem height (SH), stem diameter (SD), number of leaves (NL), Leaf size (LS), number of shoots (NS), and chlorophyll content (CC) were measured. The data analysis suggested a significant effect of W x F treatment on SH, SD, and NL. Results showed that the combination of high water and mild fertilizer level (W3F2) had the highest increment in SH, SD, and NL. W3F2 treatment increased SH and SD by 60.1 cm and 0.5 cm, respectively. The average number of leaves produced was 674.4 (W3F2). Furthermore, an identical pattern was observed with the interactions of W x F positively effecting leaf CC. Based on this study the recommended combination of water and fertilizer application for jujube growers in the semi-arid region was 16 L and 70 g per plant in order to achieve the optimal growth of young jujube trees. The information provides guidance for scientific management of water and fertilizer in jujube orchards.

Keywords: jujube, water-fertilizer coupling, growth

Experimental Investigation of the Wind Energy Harvesting Potential of a Stand-Alone Piezoelectric Blade

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In recent decades, there has been a growing interest in the harvesting of renewable energy sources on both an industrial scale and on a personal scale. While photovoltaic cells are essentially the agreed-upon means of collecting solar energy for an individual dwelling, no such standard yet exists for the personal collection of wind power. While wind

turbines work well for harvesting wind power on large utility-wide scales, there are difficulties involved in deploying the same technology on a consumer scale in urban or suburban environments. These include the lack of steady high-speed winds such as those that exist 80-100 m above the ground in rural areas. One possible solution is to utilize electro-active materials such as a flexible piezoelectric polymer in which aeroelastic flutter is excited by erratic lower velocity winds. The objective of this study is to investigate this possibility in detail. To date, continuing experiments have been conducted on individual samples of polyvinylidene fluoride (PVDF) mounted in an ELD 401 subsonic wind tunnel with a 152.4 mm rectangular test section provided by the Mechanical Engineering Department at The University of New Mexico. Parameters such as length, thickness, width, and shape were varied between samples. Some of the best permutations of these parameters tested so far have produced voltages in hundreds of millivolts.

Keywords: wind, energy harvesting, piezoelectric, renewable energy

Developmental Changes in Resting State and the Association with Neuropsychological Measures

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Vince Calhoun, Mind Research Network
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Resting state activity (assessed by neurophysiological or hemodynamic measures) has the potential to reveal bio-markers for developmental neuropsychiatric disorders. Previous studies have revealed an association between resting state activity and cognition in adults. A common network found during resting state is the frontoparietal network (FPN) which has been associated with cognition. Developmental resting state activity is less well understood, although neural oscillations are known to change with age. The present study aimed to examine resting state activity in the FPN, in children and adolescents, across theta (5-8 Hz) and alpha (9-13 Hz) frequency bands. We hypothesized that older children and those with high attentional skills would have higher parietal alpha activity and frontal theta while at rest. Magnetoencephalography data were collected in 65 children (29 females) ages 9-14 (M=11.73, SD=1.8) years as a part of the Developmental Chronnecto-Genomics (DevCog) study. Resting state data were collected during eyes open (EO) and eyes closed (EC) for five minutes. Participants completed the NIH Toolbox Flanker Inhibitory Control and Attention Test and Dimensional Change Card Sort Test to assess selective attention. Power spectral density was used to characterize spectral power in the FPN. We found during EO and EC, all participants had higher theta ($F = 27.62$, $p < .001$) and alpha ($F = 27.11$, $p < .001$) power in parietal regions relative to frontal regions. During EC, the high attentional group had higher alpha power ($F = 4.89$, $p = .031$) across the FPN compared to the low attentional group. However, we did not find any associations with age. Thus, the present results demonstrate that developmental changes are gradual in the FPN across the theta and alpha frequency bands. The current findings also suggest that high alpha power at rest may be associated with higher attentional skills in children and adolescents.

Keywords: magnetoencephalography, frontoparietal network, neurodevelopment, resting state

Property-Relation Binding: Integrating an Optimized Naming Scheme in ICN-IoT

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The main problems dealing with scalability and interoperability of constraint (IoT) devices stem from the inherent inception of TCP/IP. However, networking under an ICN architecture requires that these devices utilize minimal resources. To realize this, the names that are used to route data is taken into consideration in the paper to scale for IoT devices. In this research I list the current state of the art naming schemes such as (NDN's) Hierarchical. Then I present Property-Relation Binding as a naming scheme for IoT devices that may take on globally unique and fully hierarchical names yet using fewer resources than hierarchical while remaining effectively interoperable. To make the case, I conduct an experiment with different variations. The results prove that PRB names can perform better than pure hierarchical. By FNV1a hashing the variable number prefixes, followed by performing a shortened number prefix by prefix matching

on the full name, the computation time is actually reduced. The mean match time for a Content Store of NDN names to NDN nodes is 8.6 microseconds. Against the same names, the PRB node performs better at matching its CS with an average of 3.5 microseconds. Additionally, for PRB names to PRB nodes, the computation time average is even lower at 2.1 microseconds. The longer variable prefix shows NDN names to PRB nodes at an average of 8.0 microseconds and PRB names to PRB nodes at 6.0 microseconds. For the 20,000 generated hierarchical names, there were no collisions when they were converted to PRB names. For 5kB, 10kB, and 50kB content stores, PRB was able to hold 67, 82 & 82% more names from the 20,000 generated hierarchical names respectively.

Keywords: ICN, NDN, future Internet architecture, naming, IoT

Efficient Device Authentication and Communication Scheme for Smart Grid-Enabled Home Area Networks

Anhao Xiang , New Mexico Tech Jun Zheng, New Mexico Tech

The smart grid-enabled home area network (HAN) connects many devices of a smart home such as smart appliances, renewable energy sources and storage, electric cars etc. to the smart grid to save energy and reduce cost. Since not directly controlled by the Utility, the HAN is the most vulnerable part of the smart grid while device authentication is one of the major challenges for the security of the HAN. In this work, we developed an efficient device authentication and communication scheme for smart grid-enabled HAN utilizing the situation awareness feature of smart home system. The smart home system can detect the current security risk level of the HAN based on information collected from activity recognition and cyber threats. The device authentication and communication protocols are designed based on the security risk levels. A more light-weight protocol is used when the security risk level is low. We developed an example design that considered two levels of security risk. The security of the proposed protocols against various attacks was analyzed. The performance analysis results show that the proposed design can significantly reduce computational and communication cost.

Keywords: smart grid, home area network, device authentication, situation awareness

Electrochemical Characterization of Oligo(p-phenylene)s for Organic Solar Cells*

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Due to the growing demand for “green” and sustainable energy, and the obligation to control greenhouse gas emissions, people have to look for a renewable energy source to reduce emissions of greenhouse gas, such as carbon dioxide. Based on its benefits of no pollution and renewable nature, solar cells have become a highly researched subject in recent years. The conversion efficiency of inorganic solar cells have a limitation around 20%, and silicon solar panels are vulnerable to temperature fluctuations. In addition, because solar cells have a high cost of raw materials, and these materials are difficult to construct into large flexible panels, more attention has been paid to the development of organic solar materials. Organic materials are abundant and easy to process. Thus, organic solar cells are a low-cost technology to harness solar energy. Phenylene-based conjugated oligomers and polymers are promising candidates for organic electronics and solar cells. Several terphenylenes and tetraphenylenes have been synthesized and purified, and 1H-NMR, 13C-NMR, and X-Ray diffraction have already been used to characterize these compounds. To further investigate the properties of these phenylenes, I propose to use cyclic voltammetry to study their electrochemical behaviors, including the number of electrons transferred, and the redox potential. Because cyclic voltammetry is a popular and powerful electrochemical tool to probe reaction involving electron transfer. Particular attention will be paid on the effects of different number of benzene rings and different substituenting groups on the redox behaviors. The completion of this experiment is intended to provide some useful information to further understand of conversion efficiency of organic solar cells, which use the oligo(p-phenylene)s as their materials.

Keywords: electrochemistry, organic solar cells, cyclic voltammetry, phenylene-based conjugated oligomers

Surface Plasmon Polaritons with Flat Top Profiles*

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Surface plasmon polaritons (SPPs), the collective oscillations of conduction electrons in a metal, coupled to electromagnetic fields, have emerged as a promising platform to manipulate light at the nanoscale. These excitations can propagate for hundreds of wavelengths along the interface between a metal and a dielectric, making them ideal for application in photonic interconnnects, ultrasensitive biosensing, and superresolution near-field imaging, to name a few. SPP beams with uniform intensity profiles can serve to advance these applications by enabling new uniform coupling and excitation scenarios not possible with conventional Gaussian profiles. Here, using Hermite-Gaussian modes, which form a complete orthonormal basis for the solutions of Maxwell's Equations for a metal- dielectric interface in the paraxial approximation, we describe and analyze the evolution of the transversal profile shape of SPP beams having flat top intensity profiles over hundreds of wavelengths of propagation. The results of our work serve to advance the fundamental understanding of the propagation of SPP beams with nontrivial profiles and therefore enable new ways of manipulating light below the diffraction limit.

Keywords: surface plasmon polaritons, flat top beams, metal-dielectric interface

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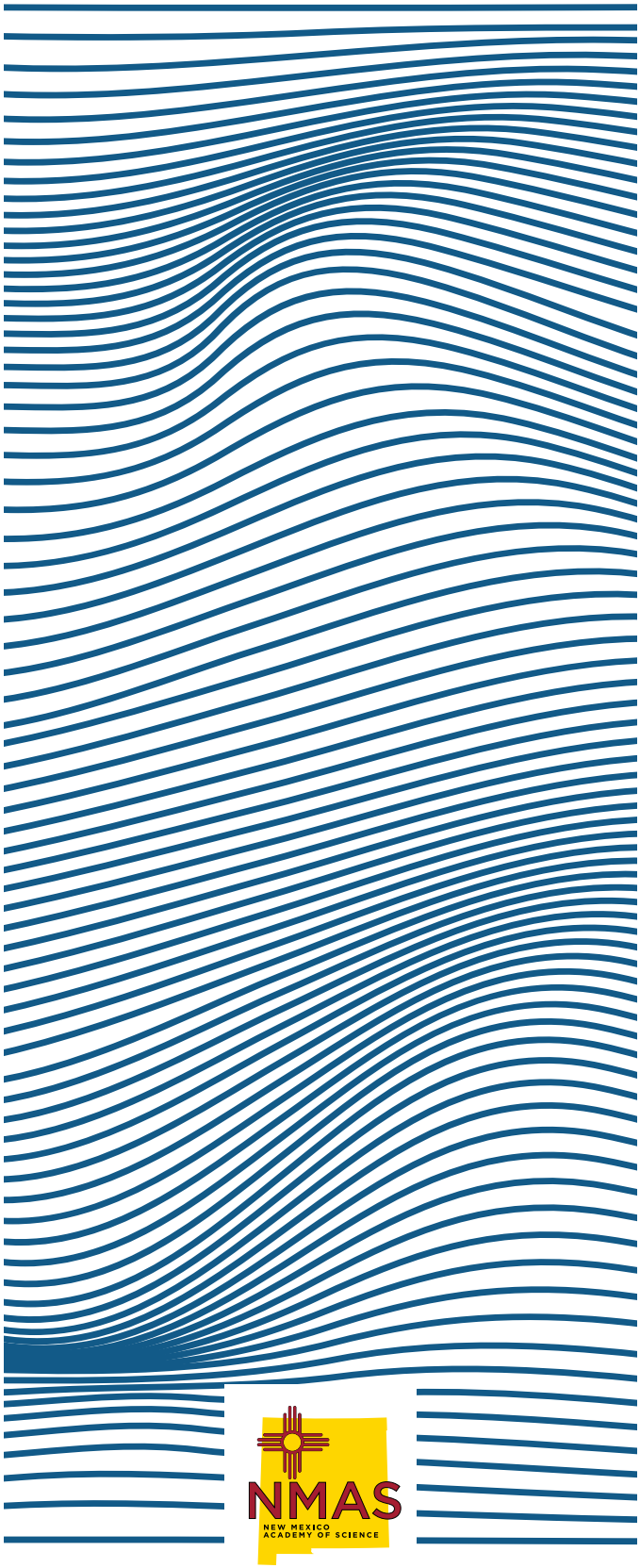
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