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Part I - Oral Presentations

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Glossary:

GR means Graduate student.

UR means Undergraduate student.

UG-H means Undergraduate student in HASBSEB area.

UG-S means Undergraduate student in STEM area.

SURF means Summer Undergraduate Research Fellowship.

URG means Undergraduate Research Fellowship (at Lamar University)

H – Humanities, Arts, Social and Behavioral Sciences, Education, and Business

S – Science, Technology, Engineering, and Mathematics

McNair, SURF, Beck, Welch, and other sponsorship programs are indicated.

OFFICE OF UNDERGRADUATE RESEARCH
LAMAR UNIVERSITY

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UG-S / In-Progress
2025 SURF Project

Investigation of Thermally Energized Petroleum Mixtures Using Molecular Rotational Resonance (MRR).

This project builds upon preliminary results obtained during a Summer Undergraduate Research Fellowship (SURF), where initial Molecular Rotational Resonance (MRR) studies revealed temperature-dependent spectral changes and unidentified resonances in simplified fuel mixtures. The current study extends these efforts to higher temperatures and more complex systems to establish the first temperature-resolved MRR database for petroleum fuels. The focus is on small polar impurities such as, oxygen-, nitrogen-, and sulfur-containing compounds that make up less than 10% of fuels but have significant effects on combustion and emissions.

Rotational spectra of binary mixtures containing isooctane with ethanol or methanol were recorded at various pressures and temperatures using a K-band MRR spectrometer (18–26 GHz). At lower pressures, spectral peaks were sharper and more defined, while higher pressures caused broadening due to increased molecular collisions. Heating the mixtures to 200 °C produced new peaks not observed at room temperature, suggesting potential structural rearrangements, temporary bonding, or partial decomposition of components.

These results demonstrate MRR's sensitivity to intermolecular interactions and thermal effects in complex fuel mixtures. Future work will involve analyzing artificially engineered petroleum samples under oxidative conditions to investigate how temperature and composition influence MRR signatures. This research will provide foundational data for molecular-level diagnostics in petroleum processing, contributing to refining optimization, emission reduction, and the development of cleaner, more sustainable fuels.

Presenter: **James Addison III** [$]
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UG-S / Advanced
2025 SURF Project
Faculty Research Grant

Role of Group Test on STEM students' Success in Physics Class.

This study investigates how collaborative group test influence student learning and performance in an engineering physics course at Lamar University. We examined how peer interaction during group tests supports deeper conceptual understanding. Using a mixed-methods approach, we analyzed quantitative data from 24 groups (72 students) and their individual exams, alongside qualitative in class observations of group behaviors and dynamics. Student solutions were evaluated using validated problem-solving rubric (Docktor et al., 2016), supplemented with peer evaluations and group/ individual attendance records. Our findings reveal that students who actively participated in group discussions and maintained consistent attendance achieved higher scores on individual exams. While groups with poor communication or uneven participation struggled when taking their individual exam. These results support the formative assessment theory, which suggest that structured rubrics and collaborative learning environments promote greater engagement and improved learning outcomes in STEM classes.

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GR-S / In-Progress
Departmental Research

Investigating the Potential of an Amylose/Pectin Composite for Organic Contaminants Remediation.

The environmental impact of pollutants such as heavy metals, organic dyes, and industrial waste has prompted the development of advanced materials capable of detecting and removing contaminants efficiently. Biopolymer-based composites of polysaccharides have been shown to bind to heavy metals and could offer a sustainable method for the remediation of organic contaminants. In this study we explore the potential of a composite material composed of amylose, a linear polysaccharide derived from starch, and pectin, a Hetero polysaccharide found in plant cell walls, for the adsorption of environmental organic contaminants. This study investigated the thermal stability of amylose and pectin polymers, crucial components in plant-based materials, using (DSC).

Presenter: **Akbar Ali** [$]
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GR-S / In-Progress
National Science Foundation

Color-Turnable Perovskite Light-Emitting Electrochemical Cells.

Perovskite-based light-emitting electrochemical cells (PeLECs) present a promising route toward low-cost, solution-processable light-emitting devices with tunable emission across the visible spectrum. In this work, we report the fabrication and characterization of color-tunable PeLECs using halide perovskites with the composition CsPbBr3-xIx, enabling green, yellow, and red emission through systematic halide composition. Devices were fabricated by spin-coating CsPbBr3-xIx blended with polyethylene oxide (PEO) and lithium hexafluorophosphate (LiPF6) onto indium tin oxide (ITO)-coated glass substrates, followed by vacuum treatment and thermal annealing. Li/Al top electrodes were deposited to complete the device structure. Under applied bias, the migration of mobile ions established electric double layers at both electrodes, facilitating balanced charge injection and electroluminescence. The added Li^+ and PF_6^- ions redistributed more favorably than the intrinsic halide species, preserving the perovskite crystal structure and enhancing stability. Electroluminescence spectra and luminance–voltage characteristics were measured, and film morphology was analyzed using scanning electron microscopy. The devices exhibited strong, narrowband emission with a narrow full width at half maximum (FWHM), indicating high color purity. These results demonstrate effective color tuning and improved stability through compositional and ionic control, highlighting the potential of PeLECs for next-generation, low-cost, full-color lighting and display technologies.

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UG-H / In-Progress
Faculty Research Grant

Body Image and Eating Habits: Exploring How Body Image Perceptions Affect Nutrition Among Middle School Students.

Adolescence is a sensitive period when body image concerns can shape daily eating choices. This study examines how body image relates to eating habits and nutrition knowledge among middle school students in Southeast Texas. We administered a classroom-embedded, pre-mid-and-post assessments with students in grade six. Before instruction, an anonymous survey measures body image, eating habits, nutrition intake, and baseline nutrition knowledge with an instrument adapted from Partida *et al.* (2018). During a mid-lesson *"Healthy vs. Unhealthy* Influences" sorting activity, students group card prompts about peer and parent messages and social media cues to surface influences on body image and nutrition. After instruction, the same survey is re-administered to a change, and we compare scores to estimate impact. The preliminary findings reveal that while students bring a commendable level of prior knowledge. There are meaningful gaps that present valuable opportunities for targeted instruction and deeper engagement.

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*Generative Artificial Intelligence

UG-H / Advanced
McNair Scholars Research

From Expert Systems to GenAI: The Evolution of Internal Auditing.

This research examines how generative artificial intelligence (GenAI) is beginning to shape internal auditing. Using both survey data and interviews with professionals, five areas were targeted: awareness and adoption, perceived benefits, challenges and barriers, ethical practices and governance, and skills and training for the future. Results show that most internal auditors are familiar with GenAI, but adoption is still limited to initial phases and early applications such as reporting, data analysis, and risk assessment. Although it is still in its preliminary stages, GenAI is enhancing efficiency, improving reporting quality, and enhancing fraud detection, while also enabling internal auditors to dedicate more time to strategic work. Challenges remain in the form of governance gaps, transparency issues, privacy concerns, and the continuous need for human oversight. Training programs and Responsible AI frameworks are emerging. These are not applied consistently throughout organizations and the internal audit field at this time. The research concludes that GenAI's future value depends on internal auditors combining technical knowledge with human judgment, adaptability, communication skills, and ongoing training and education.

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UG-S / In-progress
Departmental Research
NASA Sponsorship

Degradation and Protection of Semiconducting Thin Films in Martian Atmosphere.

Organic semiconducting polymers, such as MEH-PPV (Poly[2-methoxy-5-(2-ethylhexyloxy)-1,4-phenylenevinylene]) are promising alternatives for current day semiconductors, as they are flexible and can be placed on any area of a spacecraft. One problem with MEH-PPV is that it degrades quickly under intense radiation in normal atmospheric conditions, rendering it unusable as a semiconductor. In our experiment, we see the effect of a Mars-like (CO2 rich) atmosphere on the degradation of MEH-PPV, and we have started the process of designing a protective layer to help combat the degradation of MEH-PPV while maintaining its flexibility. We study the effects of the CO2 atmosphere and the protective layer by analyzing the photoluminescence spectroscopy of degraded and non-degraded samples, as well as

through polarized light microscopy. From this, we saw that even in the Mars-like atmosphere, MEH-PPV degrades under intense UV illumination.

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UG-S / Advanced
Los Alamos National Lab Sponsorship

UV Triggered Two Color Interferometric Measurement of Electrostatic Discharge.

Understanding where energy is dissipated during electrostatic discharges (ESDs) and how much is transferred to a resistive ”victim” load is important in facilities like Los Alamos National Lab that must mitigate risks of damage or accidental triggering from such events. In this work, we use two-color interferometry to capture spatial profiles of the electron and neutral densities, retrieving quasi-3D radial distributions by means of an Abel transform. A key development of this work is the implementation of a UV trigger beam, which has enabled the capture of images at very early times in the spark’s lifetime. With this setup, we measured the time dependent radius of the conductive channel and the shock front across the entire lifetime of the spark. These values will be used to inform computational models of the spark, further advancing understanding of ESD dynamics.

In this talk, we detail the optical system that we have constructed, as well as preliminary conclusions drawn from our data. We also discuss progress in the development of a novel interferogram analysis methodology, inspired by iterative ptychographic computational imaging. We explore the theoretical function of our method through simulation and demonstrate a technique to create interference fringes at multiple angles simultaneously in our detector using a polarization grating. Further development of this new technique will allow us to dramatically improve the resolution of our retrievals, enhancing our understanding of the dynamics of electrostatic discharges

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UG-S / In-progress

Neural Network method used to improve the Bayesian analysis of neutron star models.

We explain the use of a machine learning model called Multi-Layered Perceptron Regression (MLPR) and its application to predicting values of neutron skins and dipole polarization values for Lead 208 and Calcium 48. Neutron skins are an excess layer of neutrons that form over the core nucleus due to the nucleus being rich in neutrons. The dipole polarizability is the measurement of how susceptible the protons in the nucleus to respond to an oscillating electric field. Experiments such as PREX and CREX have measured the neutron skin using parity-violating electron scattering, and the dipole polarizability has been measured by proton scattering experiments. These two properties are strongly correlated with neutron rich matter, and hence can be used to extrapolate properties of neutron stars such as their radius. In the modern approach we use Bayesian analysis to infer neutron star properties from neutron skin and dipole polarizability measurements. Performing the calculations directly for this task has become too computationally expensive as we require hundreds of thousands of samples of neutron skins and dipole polarizabilities which require time consuming microscopic calculations. Here is where we use the MLPR, trained on a few hundred sets of neutron skin and dipole polarizability data, to accurately and quickly predict tens of thousands of samples. We will discuss the development of this model, the validation of its performance and the results from the initial test runs performed on the models.

Presenter: **Justin Ford**[$]
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UG-H / Advanced
Departmental Research

The Misunderstanding of Batman: Arkham Origins.

The 2013 video game *Batman: Arkham Origins* has frequently been misinterpreted in relation to the Arkham video game series. The game's initial reception was poor, and many people wrote it off as a derivative prequel that lacked the originality and polish of *Arkham Asylum* and *Arkham City*. This view, however, ignores *Arkham Origins'* distinctive narrative, thematic, and design contributions to the franchise. *Arkham Origins* was created by WB Games Montréal instead of Rocksteady Studios and examines a pivotal period in Batman's career that was characterized by loneliness, distrust, and the psychological effects of vigilantism. The game gives the Dark Knight mythology more emotional depth by emphasizing Batman's early interactions with the police, his moral ambiguity, and his initial run-in with the Joker. The game also explores the relationship between Bruce Wayne and Alfred, and how the Batman persona not only interferes with Bruce's personal life, but how it affects the other people around him, and how they must come to terms with Bruce's crusade for vengeance. *Arkham Origins* offers one of the most engaging investigative scenes and boss fights in the series while improving several gameplay systems. This research makes the case that *Arkham Origins'* early misinterpretation results from expectations influenced by others before its initial release, as well as an inability to acknowledge its purposeful tonal and narrative changes. When re-examined on its own terms years later, the game becomes a vital narrative link in the Arkham tale, adding to the thematic and psychological richness of Batman's universe.

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GR-S / In-progress
Departmental Research

Graphene Quantum Dots: Types, Properties, Biomedical and Cancer Applications, Machine Learning Integration.

Graphene quantum dots (GQDs) are tiny carbon nanoparticles with unique near-infrared light emission, making them highly promising for biomedical applications such as imaging, drug delivery, and controlling reactive oxygen species. This study investigates how the atomic structure and surface chemistry of GQDs influence their optical behavior, stability, and biocompatibility. We analyzed GQDs with structural variations, including doping, surface functional groups, and edge defects, using computational methods such as Density Functional Theory (DFT), Time-Dependent DFT (TD-DFT), and semi-empirical sTDA-xTB. To connect computational predictions with experimental data, we propose a Cyber Twin framework, leveraging artificial intelligence and machine learning to relate predicted optical properties to real-world observations, accounting for potential noise and variability. Our findings indicate that structural design and surface modifications strongly affect fluorescence intensity, stability, and water compatibility. Semi-empirical methods like sTDA-xTB enable faster predictions while maintaining accuracy, supporting the screening of many potential GQD structures. This work provides a computational foundation for identifying promising GQD designs and demonstrates how combining advanced modeling with Cyber Twin approaches can guide future experimental studies and the development of nanocarbon materials for biomedical applications.

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UG-S / Advanced
Department of Energy

Bayesian Quantification of the Observability and Equation of State of Twin Stars.

The possibility of discovering twin stars, two neutron stars (NSs) with the same mass but different radii, is usually studied in forward modeling by using a restricted number of NS matter equation of state (EOS) encapsulating a first-order phase transition from hadronic to quark matter (QM). Informing our likelihood function with the NS radius data from GW170817 and using a meta-model with 9-parameters capable of mimicking most NS EOSs available in the literature, we conduct a Bayesian quantification of the observability and underlying EOSs of twin stars. Of the accepted EOSs, between 12-18\% yield twin stars, depending on the restrictions we place on the twin branch. We show that many of these twin star scenarios are observable with currently available levels of accuracy in measuring NS radii. We also present the marginalized posterior probability density functions (PDFs) of every EOS parameter for each of four

mass-radius correlation topologies. We find that the inferred EOS depends sensitively on not only whether twin stars are present, but also the category of twin stars, indicating that the observation of twin stars would provide a strong constraint on the underlying EOS. In particular, for two coexisting hybrid stars having QM cores at different densities, the PDF for QM speed of sound squared has two peaks, one below and another above the conformal limit predicted by perturbative QCD.

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GR-S / Advanced
National Science Foundation

Wireless Micropump and Pressure Monitoring System for Inducing Bone Formation Through Intramedullary Pressure Modulation.

Osteoporosis is a severe health issue in the aging population. It can be alleviated or delayed with proper medication as well as mechanical loading. Various studies showed that the oscillation of pressure inside the intramedullary cavity is an effective stimulus to initiate bone remodeling. Current in vivo methods designed to modulate intramedullary preFFssure involve infection-vulnerable external oscillatory equipment. We report a methodology that combines a wireless micropump and a wireless pressure monitoring system for new bone formation. A wireless magnetic micropump was used to oscillate the intramedullary pressure of the rat femur. Pressure variations inside the intramedullary cavity were recorded using a wireless pressure monitoring system. Following 10 min of applied pressure oscillations and seven days of recovery, bone formation in femora of rats tended to increase.

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UG-H / In-progress
2025 SURF Project

¡OYE! Abre tus ojos: To Hispanic/Latino Sign Language Interpreter Hardships.

Sign language interpreters, as representatives of the communities and cultures they serve, tend not to mirror the ethnic, racial, and cultural demographics of their consumers. The sign language interpreting profession in the U.S., however, is hardly diverse; most practitioners are non-diverse females (RID, 2022; Stewart, 2020). This pilot study explored themes relating specifically to the paucity of Hispanic/Latino sign

language interpreters in the field. This study aims to identify professional barriers, trials, and tribulations encountered by Hispanic/Latino sign language interpreters and acknowledge strategies these interpreters use to overcome said obstacles. Each participant completed an initial demographic survey confirm to eligibility to participate, then the researchers contacted them via email for a virtual interview. Given the goal of this investigation, the researchers used descriptive and In Vivo coding approaches. A content analysis approach examines communication artifacts to identify patterns and themes (Vaismoradi, et ai, 2026) shared by the participants. This investigation has determined barriers, trials, and tribulations that are possibly unique to Hispanic/Latino sign language interpreters. By identifying and understanding sources of hardship, the researchers seek to implement strategies for remediation and resolution during training. Additionally, this project seeks to understand how Hispanic/Latino sign language interpreters persevere despite said barriers. The results should highlight the need for modifications to interpreter curricula to better address the unique cultural and linguistic needs of this population. This investigation also seeks to expand diversity within the sign language interpreting community to mirror the ethnic and cultural communities in which interpreters live and work.

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UG-H / Early-phase
Departmental Research

The Psychological Benefits of Playing Chess.

This study uses a literature review approach to examine the psychological benefits of playing chess. Multiple peer-reviewed research papers were collected from academic databases focusing on studies related to chess, cognition, and psychological well-being. Each paper was reviewed to identify key findings about how chess influences factors such as problem-solving ability, confidence, focus, and emotional regulation. The selected articles were then compared and synthesized to highlight common themes and consistent results across studies. By compiling these findings, this project aims to provide a clear summary of the existing evidence on the psychological effects of chess and how strategic play supports mental development.

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UG-H / Advanced
2025 SURF Project

Elementary Children's Screen Time Effects on Sociometric Status.

Sociometric measures relationships among peers and identifies social preferences. A student's sociometric status can be "a predictor of future social and psychological adjustment" and can identify students at risk for social rejection (Hysa, 2016). Various factors that impact students' sociometric status have been studied. However, limited research explores impacts of smart device screen time, despite that "on average, children from birth to age eight use about two and a half hours of media a day" (Rideout & Saphir, 2015). This mixed-method study explores how screen time affects 1st-2nd Grade Students' sociometric scores and the frequency of their social interactions in the classroom using the picture sociometric scale and 5-Likert surveys. The research indicates that lower sociometric rankings and fewer social interactions were both associated with increased screen time. In response to these findings, it is best to advise educators and parents to create time frames students are allowed to play on their devices, decrease the number of social media apps students are allowed to have, and allow the student to personally own a minimal number of devices.

References: Hysa, X. (2016). Modeling student cohesiveness by waving the sociometric test with the picture apperception value test. International Journal of Social Sciences and Education Research, 2(1), 33-44. https://doi.org/10.24289/ijsser.279082. and Rideout, V. J., & Saphir, M. (2015). Zero to Eight: Children's Media Use in America 2013. San Francisco, CA, Common Sense Media.

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UG-S / Advanced
2025 Beck Fellowship Project

The Eye as a Window to the Brain: Advancing Neurovascular Disease Detection through Retinal and Corneal Imaging.

Cerebral small vessel disease (SVD) drives ischemic stroke, cognitive decline, and disability, yet early detection is limited by the sensitivity and availability of conventional neuroimaging. Because the retina is an extension of the central nervous system, its microvasculature may mirror cerebral pathology. Optical coherence tomography angiography (OCTA) provides rapid, non-invasive maps of retinal capillary networks. We hypothesize that OCTA metrics reflect MRI-defined SVD burden and functional status after stroke.

Prospective observational study of adults with recent ischemic stroke at Weill Cornell Medicine–Qatar (WCM-Q). Exclusions: ocular disease affecting microvasculature or poor image quality. OCTA will quantify vessel density, perfusion density, foveal avascular zone area, and choriocapillaris flow deficits in superficial and deep plexuses. Brain MRI will index SVD by STRIVE features (white matter hyperintensity volume, lacunes, microbleeds, enlarged perivascular spaces). Clinical measures: NIH Stroke Scale, modified Rankin Scale, and Montreal Cognitive Assessment. Multivariable regression and receiver-operating-characteristic analyses will test associations and discriminative ability while adjusting for age, sex, and vascular risk factors.

Primary outcome: correlation between OCTA metrics and composite MRI SVD burden. Secondary outcomes: relationships with disability and cognition, plus feasibility metrics (recruitment rates, scan quality). Interim analysis will be presented if available at the time of the meeting.

If retinal microvascular alterations measured by OCTA track cerebral SVD and clinical outcomes, OCTA could serve as a low-burden, non-contrast biomarker to complement MRI for early detection and longitudinal monitoring. Anticipated limitations include cross-sectional design for initial analyses, ocular comorbidities, and generalizability. Future work will evaluate longitudinal prognostic value, standardize acquisition/analysis pipelines, and explore integration with routine stroke follow-up.

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GR-S / Advanced
Octavo Systems

Thermal Modeling of Die-DRAM Stacked Multichip Packages Using 1D Thermal Resistance Network and Finite Element Analysis.

Vertical integration in electronic packaging, while enhancing performance and density, introduces complex three-dimensional heat flow paths and heterogeneous material interfaces that challenge conventional thermal modeling methods. This study presents a comprehensive thermal analysis of a die–DRAM stacked multichip package using a one-dimensional (1D) thermal resistance network model, and cross-verified with detailed 3D Finite Element Model (FEM).The analytical model employs the Effective Medium Approximation (EMA) theory to determine the effective thermal conductivity of the complex, multi-layer substrate composed of copper and FR-4 materials. The thermal resistance of the heat sink was estimated using classical fin theory, while the effective convective area of the PCB was determined through circumferential fin analysis to increase the model accuracy.

For the FEA validation, two modeling approaches were implemented: one applying an equivalent convective coefficient to represent the heat sink, and another explicitly modeling the physical heat sink geometry. This would show the accuracy of the simplified model when designing and modeling a complex heatsink is not feasible. Several practical cooling configurations were investigated, including a baseline package without a heat sink, and packages with top-mounted and bottom-mounted (PCB-side) heat sinks.

The results demonstrate good agreement between the 1D network model and FEA, validating the proposed methodology for rapid design-stage thermal estimation. The analytical and FEA results were cross verified with experimental results showing good agreement and demonstrating the effectiveness of the proposed modeling approach.

Acknowledgement:

This work was supported by Octavo Systems, whose funding and support are gratefully acknowledged.

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GR-S / In-progress
CICE & CMMS Lamar

Nanomaterial-Enhanced Superhydrophobic Coatings for Superior Corrosion Resistance, Mechanical and Tribological Durability: A Comprehensive Nanoscale Characterization.

Nanomaterials, defined as materials possessing structural components smaller than 100 nanometers in at least one dimension, are increasingly vital in applications such as combating corrosion, and understanding their behavior at the nanoscale is crucial for optimizing performance, extending lifespan, improving durability, achieving significant cost savings, and promoting environmental sustainability. Nanomaterials can be discrete structures, like nanoparticles or nanotubes, or patterned structures attached to the surface. Nanomaterials also include particles, tubes, sheets, and other structures with nanoscale dimensions. Nanomaterials are increasingly used in surface engineering—such as superhydrophobic coatings, thin films, and multilayered films—to significantly improve corrosion resistance, nanomechanical strength, and nanotribological properties. Integrating nanomaterials into superhydrophobic coatings creates more durable, protective, and multifunctional surfaces for metals and other materials. For the past decade, for example, researchers have focused on developing nanoparticles embedded with superhydrophobic coatings for corrosion prevention, improving surface mechanical and tribological performance. To get an in-depth understanding of how corrosion starts in the very early stages before propagation, investigations into corrosion should be carried out at the atomic or molecular scale or at a scale of a few nanometers up to the present day. Metals and alloys may be self-protected against corrosion by forming oxide layers, but how localized corrosion affects surface mechanical and tribological properties can be explained by multi-level characterization, especially at nanoscale. This research project describes a new superhydrophobic top coating (SHC) designed to protect A653 steel from corrosion. The coating is made from silane-modified silica (SiO_2) nanoparticles mixed into a Polydimethylsiloxane (PDMS) polymer matrix. This combination creates a micro/nano-textured surface that traps air, forming a physical barrier against corrosive substances. Electrochemical potentiodynamic polarization and impedance spectroscopy tests confirmed that the SHC provides significantly better corrosion protection than traditional zinc top coating. Nano-scale indentation and scratch tests showed that the coating has strong adhesion and scratch resistance, even after being exposed to accelerated corrosion. For a complete assessment of material reliability, the viscoelastic properties must be fully determined. Additionally, Nanoindentation Creep Testing is necessary to evaluate the material's long-term stability and resistance to sustained stress, yielding the creep strain rate and the strain rate sensitivity. The comprehensive investigation of this nanomaterial-enhanced system at the nanoscale is critical for advancing the development of multifunctional coatings that provide superior, long-lasting protection for metallic substrates.

Presenter: **Sadia Rahman Jhilik**[$]

GR-S / In-progress
Departmental Research

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First-principles study of point defects in SiC.

Silicon carbide (SiC) is a wide-bandgap semiconductor that has over 200 polytypes, according to the stacking pattern of Si–C bilayers. It can operate at high power, high temperatures, and high frequencies, making it useful for electronic and quantum technologies. Although SiC exhibits excellent material properties, point defects can significantly impact its performance. First-principles calculations were used to study the thermodynamic stability of several SiC polytypes, including 2H, 4H, 6H, 8H, 10H, 12H, and cubic 3C. Our results show that the cubic and 10H phases have the lowest formation energies, followed by 4H and 6H, which are the second lowest. Further analysis revealed that 4H-SiC is the most stable. We studied various point defects, including vacancies, anti-sites, and interstitials, in the 3C, 4H, and 6H structures. The results show that divacancies prefer the triplet (S = 1) spin state in the cubic structure, whereas only the carbon vacancy forms spontaneously in 6H-SiC. In 4H-SiC, the silicon vacancy V_Si and carbon interstitial C_i create deep defect levels, which align with experimental results.

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GR-S / In-progress
Faculty Research Grant

Anomaly detection in Graphene Quantum Dot Synthesis in Bio medical and Energy Applications using Isolation Forests and One Class SVM.

This research explores anomaly detection in the synthesis of Graphene Quantum Dots (GQDs), nanomaterials recognized for their potential in biomedical imaging and energy conversion systems. The quality and consistency of GQDs are highly sensitive to synthesis conditions, where even slight deviations in process parameters can affect their morphology, optical response, and performance. To capture these variations more comprehensively, this study uses GQT structure 284 as the foundational model to generate 10,000 related structures, creating a diverse dataset that reflects realistic chemical and physical variability during synthesis.

Two unsupervised machine learning algorithms—Isolation Forest and One-Class Support Vector Machine (SVM)—are employed to detect irregularities and assess the reliability of synthesis outcomes. The dataset incorporates measured synthesis parameters, sensor-based inputs, and simulated anomalies to enable rigorous model training and validation. Both algorithms demonstrate high precision in distinguishing normal from abnormal synthesis patterns, confirming their ability to flag process inconsistencies effectively.

By integrating large-scale structural generation with machine learning–based anomaly detection, this work offers a novel framework for ensuring reproducibility and process optimization in nanomaterial fabrication. The findings highlight how data-driven methods can contribute to safer, more efficient, and higher-quality GQD synthesis, ultimately supporting advancements in both energy and healthcare technologies.

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UG-S / In-Progress
McNair Scholars Research

Arbovirus detection in mosquitoes of Jefferson County, Texas.

Mosquito-borne diseases are a significant global health threat, causing substantial morbidity and over one million deaths annually. The risk posed by these diseases is escalating as climate change, urbanization, and global travel and trade accelerate shifts in vector ecology. Texas does not have a state-wide mosquito control program; individual jurisdictions or mosquito control districts allocate resources to routinely collect mosquitoes. Therefore, mosquito surveillance data in Texas are not a complete representation of virus transmission in the state. Moreover, the surveillance only takes place between May and November months. We hypothesize that Jefferson County, with its subtropical coastal climate, dense population, high precipitation, and recurrent flooding, combined with the constant movement of goods and people from across the globe in the neighboring Harris County, creates a conducive environment for the introduction and sustained transmission of mosquito-borne pathogens. The aim of this project is to detect the presence of arboviruses in mosquito samples in Jefferson County over a period of one year. RNA samples from each mosquito were extracted and subjected to RT-PCR, using specific viral primers to detect West Nile virus, Zika virus and Chikungunya virus. Results showed that 8 of the 12 months in the year showed the presence of West Nile virus in Culex species and a few Aedes species. These results follow the prediction for summer months showing more incidence of mosquitoes carrying the viruses. However, the prevalence of the infected mosquitos all year is alarming and calls for continuous surveillance of mosquitoes all through the year.

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GR-S / In-Progress
Departmental Research

Aerial Detection of Individuals in Flooded Regions.

In flooded regions, accurately detecting and locating individuals trapped in water remains a significant challenge. To improve situational awareness during flood emergencies, this study develops a dedicated aerial image dataset representing a wide range of flood conditions and human distress scenarios. The dataset captures variations in altitude, water turbidity, and background clutter to support robust detection research. Using this dataset, an enhanced detection framework is designed that emphasizes discriminative feature extraction, adaptive attention to human regions, and computational efficiency suitable for deployment on unmanned aerial systems. Comprehensive evaluation demonstrates that the proposed framework achieves significant improvements in detection accuracy, reliability, and generalizability across complex real-world scenes.

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UG-H / Advanced
Center for Resiliency

Exploring Digital Resilience in Elementary Preservice Teachers.

This mixed-methods study examined the development of digital resiliency among elementary preservice teachers over two semesters. Quantitative data from pre-mid-and post-semester surveys revealed significant gains in digital confidence, especially among those with initially limited digital skills. Qualitative analysis of open-ended responses identified key areas of growth, including improved digital literacy and increased integration of AI tools such as ChatGPT and Grammarly for lesson planning and language support. While 83% of participants reported using AI tools, concerns emerged around AI-assisted grading, particularly regarding nuance and transparency. Despite overall improvements in digital literacy, comfort with AI-based assessment remained low, underscoring the need for targeted support and further investigation in this area.

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GR-S / Advanced
VA Health Services Research & Development Service

Triglyceride-lowering Lipid-lowering-therapies in elevating HDL-cholesterol in patients with chronic kidney disease.

In patients with chronic kidney disease (CKD), dyslipidemia is characterized by elevated triglycerides and lowered high-density lipoprotein cholesterol (HDL-C) levels, resulting in poor clinical outcomes. The comparative effectiveness of triglyceride-lowering lipid-lowering therapies (LLTs), such as fibrates and niacin, versus standard treatment (statin) in changing HDL-C levels in patients with non-dialysis-dependent CKD is unclear. We leveraged data from Veterans' Affairs Corporate Data Warehouse (VA-CDW) to design a pharmacoepidemiologic study using a nationwide cohort of 3,562,882 US Veterans with normal kidney function enrolled between October 2004 and September 2006. Incident CKD was defined using longitudinal evaluation of estimated glomerular filtration rate (eGFR) and urinary albumin-to-creatinine ratio (UACR). We first identified LLT-naïve incident CKD patients without a history of LLT use within 1 year before the incident CKD date. From these patients, we defined de novo LLT exposure using pharmacy dispensation data. We used a mixed-effects model to compare HDL-C slopes in de novo fibrates and niacin versus statin users after up to 1 year of follow-up. We also compared the odds of having a clinically meaningful (>10%) increase in HDL-C following LLT initiation. From 247,270 LLT naïve incident CKD patients, 38,223 patients initiated de novo LLTs (statin [n=35,284], fibrate [n=1,805], and niacin [n=1,134]). We found the multivariable-adjusted annualized increase of HDL-C to be significantly higher in fibrate (1.15 mg/dL/year [95% CI: 0.43, 1.87]; p=0.002) and niacin (2.51 mg/dL/year [95% CI: 1.62, 3.41]; p<0.001) initiators, compared to that of statins. Niacin (odds ratio: 1.37 [95% CI: 1.07, 1.75]; p=0.012) was also more likely than statins to provide a clinically meaningful elevation in HDL-C. Further studies are warranted to investigate whether such differences have meaningful effects on clinical outcomes.

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UG-H / Early phase
Departmental Research

Mental Health Representation and Messaging in Summer 2025 Superhero Films.

The superhero genre has grown to the point of oversaturation, with every new release receiving mixed reviews. The question of how to create a unique and relevant entry into the genre has become a focal point. In this presentation, I explore how mental health messaging is being used in the superhero genre with three entries released in the summer of 2025, *Thunderbolts*, Superman, and The Fantastic Four: First Steps.* I also plan to analyze the audience's reception of these films to assess the impact of mental health messaging and media representation in these films. The superhero genre can be defined by stories featuring individuals with extraordinary abilities (Barton). Mental health messaging is how media artifacts frame and utilize mental health in storytelling. This study uses thematic and narrative analysis to identify how each film's messaging on mental health impacts storytelling and audience reception. *Thunderbolts** uses mental health to humanize both the protagonist and antagonist and highlight self-acceptance.

Superman shows the emotional toll of societal rejection, the weight of feeling the loss of purpose, and power of a support system. *The Fantastic Four: First Steps* shows the mental strain of not having a work life balance combined with the desire to protect and provide for the family. This project will compare these films to highlight the growing role of mental health representation in the superhero genre and its impact on audiences, in hopes of offering insight into how media shapes attitudes toward mental wellbeing.

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UG-S / In-progress
2025 SURF Project

Systematic Study of Silicone Elastomers: Formulation, Testing, and Open-Source Data Sharing.

Silicone elastomers play a key role in many engineering and biomedical applications, but most recipes are still proprietary. In this project, two transparent, platinum-cured formulations are documented, and the relationship between base-fluid viscosity and mechanical behavior is analyzed. A common hydride crosslinker and Pt catalyst were compounded with vinyl-terminated 100 cSt and 1000 cSt PDMS, and the mixtures were cast and heat-cured. To determine Young's modulus, tensile strength, and elongation at break, ASTM D412 dog-bones were subjected to uniaxial tensile testing to obtain stress–strain curves, from which the three parameters were calculated. Findings indicate a tradeoff between the systems: the 100 cSt formulation produced a stiffer, stronger elastomer with lower ductility, while the 1000 cSt formulation was more extensible and easier to handle. Replicate variance was low, suggesting uniform mixing and curing. These results support the hypothesis that lowering base viscosity (shorter chains) increases stiffness and strength at the expense of toughness.

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GR-S / In-progress
Departmental Research

Determining AfXPB's Dissociation Constant using DNA Electrochemistry.

Helicases play a central role in genome maintenance by unwinding nucleic acids and facilitating replication, repair, and transcription. The archaeal XPB helicase family operates through ATP-driven translocation and strand separation. "Molecular wrench" activity has been observed in the Archaeoglobus fulgidus XPB helicase (AfXPB), characterized by rapid exponential DNA unwinding triggered by a 170° ATP-induced

domain rotation. To investigate how DNA sequence integrity influences helicase–DNA binding affinity, we examined AfXPB interactions with a 17-nucleotide double-stranded DNA probe containing either a fully complementary sequence or a single mismatched base. Binding was quantified using helicase concentration titration experiments, from which dissociation constants were determined. Our results reveal that AfXPB exhibits a smaller dissociation constant when interacting with the mismatched DNA sequence compared to the well-matched control, indicating higher binding affinity. These findings suggest that even a single base mismatch can be recognized by AfXPB for better DNA repair. This work highlights the sensitivity of AfXPB to local sequence disruptions and provides insight into how mismatches may influence helicase activity in DNA repair pathways.

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UG-S / In-progress
2025 SURF Project

Bioremediation of Industrial Mine Wastewaters Using Galdieria sulphuraria.

Industrial activities have introduced high concentrations of heavy metals such as lead, cadmium, and mercury into aquatic systems. Owing to their toxicity and poor biodegradability, these contaminants threaten ecosystems and public health. Algal based bioremediation is emerging as an alternative to conventional physicochemical treatments (chemical precipitation, ion exchange, membrane separation), which are energy-intensive and can generate secondary wastes. This study evaluated the extremophilic red alga *Galdieria sulphuraria* for treating heavy metals in industrial mine wastewater. Cultures were grown for seven days in Acid Mine wastewater from Butte, Montana, under five initial conditions that varied wastewater and growth of medium proportions. The five growth conditions were growth medium control, mine wastewater, mine wastewater with growth medium, 50% concentration of wastewater with growth medium, and 25% concentration of wastewater with growth medium. Growth was monitored by optical density at 750 nm (OD750) and daily growth rate. The condition with growth medium added to 50% wastewater sustained growth through day 7 and achieved the highest final OD750 (1.989). Despite the acute toxicity of the wastewater, *Galdieria sulphuraria* maintained robust growth, demonstrating the feasibility of long term algal based bioremediation. The performance of fifty percent wastewater with growth medium provides a practical basis for subsequent experiments focused on heavy metal removal and informs testing of removal kinetics, hydraulic retention time, and scalability in continuous flow systems. Future work will quantify metal uptake and evaluate operational resilience under variable pH and temperature typical of mine effluents, and flow variability.

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GR-S / Advanced

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KY-INBRE - National Institute of General-Medical Sciences
WKU Graduate Research Grant

Molecular Profiling of Cathepsin L–Dependent Transcriptional Networks in Drosophila Wing Development.

Cathepsin L is a conserved cysteine protease with key roles in extracellular matrix (ECM) remodeling, tissue development, and cancer progression, yet its transcriptional influence during epithelial morphogenesis and tumorigenesis remains poorly understood. This preliminary study investigates how modulation of Cathepsin L expression alters gene activity in Drosophila melanogaster wing imaginal discs. Using the GAL4/UAS system, Cathepsin L was either overexpressed or silenced through RNA interference under ptc-GAL4 control. Third-instar larval wing discs were dissected, total RNA was isolated, and RNA sequencing was performed to generate global transcriptomic profiles. Overexpression affected 581 genes, whereas knockdown altered 385 genes, with limited overlap, indicating that Cathepsin L exerts distinct, context-dependent regulatory effects. Differentially expressed genes were enriched in pathways related to ECM organization, cellular stress response, and epithelial integrity, processes central to both normal development and tumorigenesis. Although preliminary, these findings suggest that Cathepsin L acts as a dosage-sensitive regulator linking proteolytic remodeling to transcriptional reprogramming. Because of its evolutionary conservation, this study lays the groundwork for future functional analyses exploring how Cathepsin L–mediated pathways contribute to epithelial morphogenesis and cancer progression in higher organisms.

Key words: Cathepsin L, Drosophila melanogaster, wing imaginal disc, RNA-seq, tumorigenesis

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UG-H / In-progress
Departmental Research

Stars, Style, and Controversy: How Ad Campaigns Influence Hard Hitting Conversations.

This study investigates the sociocultural impact of contemporary jean ads as sites of discourse on race, gender, and identity. Centering on three major campaigns—American Eagle's advertisement featuring Sydney Sweeney, Gap's campaign with international group Katseye, and Levi's collaboration with Beyoncé—this research analyzes how denim brands employ visual rhetoric and celebrity influence to shape cultural narratives of inclusivity and empowerment. Through a critical framework informed by

feminist theory, critical race studies, and media analysis, the paper examines how these advertisements simultaneously challenge and reproduce dominant ideologies surrounding beauty, power, and belonging. By deconstructing their imagery, messaging, and audience reception, the study demonstrates that jean advertising functions as a form of cultural communication that extends beyond consumerism. Ultimately, this research argues that such campaigns contribute to broader conversations about representation in American popular culture, revealing how fashion advertising participates in the ongoing negotiation of identity and social progress.

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UG-S / In-progress
Faculty Research Grant

Graphene Quantum Dots and Cyber Twins: AI-Driven Optimization for Sustainable Energy Systems.

Graphene Quantum Dots (GQDs) are nanoparticles made of carbon of minute size exhibiting striking optical and electronical characteristics due to its quantum confinement and edge effects. They have a tunable emission of light, great chemical stability and low toxicity thereby making them desirable in clean energy and smart electronics applications. The paper discusses the ways of classifying GQDs, techniques of their synthesis and real-time use of these materials, their applications in lithium-ion batteries and solar cells. GQDs enhance battery function through the promotion of conductivity, interface stabilization and capacity, whereas in solar cells enhance light absorption, charge transfer, and efficiency. One of the biggest contributions of this work is the invention of a so-called Cyber Twin construction, which is an intelligent digital model that applies machine control to emulate and maximize the behavior of GQDs within an energy system. This cyber twin will be able to predict performance, monitor the health of a device, and propose real-time actions to enhance safety and durability with help of regression and Bayesian optimization algorithms. Many issues associated with big scale production, consistency of materials, and ecological footprint, and ways to overcome them grounded in the paper are the large-scale production, material uniformity and environmental impact. The combined evidence indicates the possibility of eco-friendly nanomaterials accelerated through the integration of beneficial best-in-class computation and materials science to be utilized in next-generation renewable energy technologies.

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UG-S / Early Phase
Independent Research

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Design and Simulation of Patch Antennas and Arrays for Wireless Communications.

Patch antennas are commonly used in wireless communications because of their advantages such as low profile, light weight, low cost, and ease of manufacturing and integration with printed circuit boards. Multiple patch antennas can be used to generate an antenna array to achieve higher gain for stronger signal transmission and reception, higher directivity to generate a beam of signals in a specific direction, and beam steering. Hence, patch antenna arrays can satisfy the requirements of high gain, fast speed, high capacity, low latency, wide coverage and low interference for the 5th-generation (5G) cellular technology. Although this effort is presented at an early stage, it is aimed to investigate advantages and disadvantages of various types of patch antennas with different feed configurations. Patch antennas will be designed and simulated using Altair FEKO electromagnetic simulation software. Then, an array of a patch antenna will be designed and simulated using FEKO. It is also planned to optimize the configuration using FEKO to make the radiation of the patch antenna array more directional. Results will be generated for various performance indicators such as the radiation pattern, gain, directivity and input impedance of the patch antenna array.

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GR-S / Advanced
Faculty Research Grant

Analysis of DNA Electrochemistry with Electrochemical Impedance Spectroscopy.

DNA electrochemistry has proven beneficial for understanding fundamental charge transport features of DNA, DNA-protein interactions, enzymatic kinetics, and DNA-damaging anticancer drug activity. Still, fundamental insight on the overall electrical and electrochemical behavior of DNA electrochemistry is elusive due to the interplay of ionic and electronic effects. Electrochemical Impedance Spectroscopy (EIS) is a useful tool in analyzing the ionic and electronic features of electrochemical systems. Here, we use EIS with equivalent circuit modeling to develop a fundamental and consistent equivalent circuit to represent our DNA electrochemistry system. When analyzing a working electrode modified with electrochemically active DNA monolayers and a mercaptohexanol backfilling agent, key capacitive and resistive elements were identified. Additional insight was gathered by comparing equivalent circuit parameters for DNA duplexes with either no base-pair mismatches or a single base-pair mismatch. These experiments provide a different outlook on the ionic and electronic features of DNA.

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GR-S / In-progress
Center for Midstream Management and Science

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Integrated AI System for Data Forecasting, Disease Prediction, and Image-Based Analysis using Machine Learning and Deep Learning.

This project aims to develop a unified intelligent prediction system that combines data forecasting, disease prediction, and image-based analysis using machine learning and deep learning techniques. The system is designed to handle both structured and unstructured data through an interactive application built with Python and PyTorch. It currently supports time-series forecasting for datasets such as university key performance indicators, including enrollment, employees, graduates, and research expenditure, using Random Forest and LSTM models.

In addition, a disease prediction module has been implemented to analyze tabular medical datasets and identify possible conditions based on symptoms. The project also introduces an image processing module that supports both image classification and segmentation using pretrained convolutional neural network models. This allows the system to recognize and segment general images and will later be extended for medical image analysis.

The ongoing phase of the project focuses on improving model accuracy and extending the image module for tumor and cancer prediction using medical datasets. The final goal is to create a single, scalable platform that can support data-driven forecasting, disease diagnosis, and image-based analysis in one integrated system.

Keywords— Machine Learning, Deep Learning, Forecasting, Disease Prediction, Image Classification, Image Segmentation, PyTorch, Data Analytics.

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GR-S / In-progress
Center for Midstream Management and Science

Object Store for ML Storage Needs.

The project presents the design, deployment, and evaluation of a scalable, fault-tolerant, and S3-compatible object storage platform engineered to support data-intensive research in machine learning (ML), Internet of Things (IoT), and sensor-driven applications at the university level. Built on a distributed MinIO cluster architecture spanning four virtual machines, the system employs HAProxy as a central load-balancing layer to ensure consistent and reliable access to stored data. A complete observability stack is integrated through Prometheus and Grafana, enabling continuous collection, analysis, and visualization of key metrics such as node availability, latency, throughput, and resource utilization. This framework allows administrators and researchers to monitor the health and performance of the cluster in real time while maintaining transparency in data access and operational behavior. The platform enables unified, secure, and efficient management of heterogeneous research artifacts, including large datasets, ML model

checkpoints, and raw sensor outputs; types of data that are traditionally fragmented across individual storage silos. By consolidating these resources into a centralized object store, the system simplifies data sharing, accelerates experimentation, and promotes reproducibility in computational research workflows. Beyond the current deployment, the study envisions the integration of adaptive load balancing mechanisms powered by machine learning models capable of predicting access patterns, optimizing request distribution, and also include the exploration of federated multi-cluster architectures to enhance fault tolerance, availability, and scalability across diverse research environments.

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UG-S / Early-phase
Departmental research

Can We Exploit Abnormal Stock Returns from Effective Date Delays?

This study examines the effect of governmental policy shock and stock market reactions due to delayed effective dates. The Efficient Market Hypothesis (EMH) has dominated modern financial literature since the 1970s. This paper seeks to determine whether abnormal returns can be exploited in the energy sector through governmental policy delays in announcement dates and effective dates. The daily stock prices of two energy sector market leaders were extracted from the beginning of the year when the announcement was made and through the second half of the year of when the policy took effect. Energy market leaders were determined by the criteria of market capitalization (Stock Price x Number of Shares Outstanding). By testing the Efficient Market Hypothesis (EMH) through an analysis of variance (ANOVA) and t-testing, the expected finding is that the semi-strong form of the theory holds, as the information delay is only short-term, but not long-term. It is inferred that this is due to abnormal returns findings only occurring after the announcement date, but not the effective date. The overall implication that this study seeks to accomplish is to determine whether certain sectors are efficient, the degree to which they are more efficient, or if the overall market is efficient. As a result, this study paves the way for further research through sector analysis in different industries to examine market efficiency.

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UG-S / Advanced
URG Project

Can Changes in the Environmental Temperature Modify the Optical Characteristic of a Medium?

A material's curve of dispersion shows the dependence of the refractive index, *n*, verses frequency of light, f, and represents the optical signature of a medium. We are interested in understanding this dependence on the environmental temperature, T. Therefore, we study changes in the *n* of flint glass using the minimum deviation method, when the interaction between light and glass is assisted by background

energy that changes the T. For a medium in thermal equilibrium at T, the thermal energy kT (k = Boltzmann constant) adds to the energy of the incident light, hf. Thus, the dipoles of the material change their vibrational energy according to hf' = hf + kT. We added kT from a lightbulb placed near the material's surface. Also, we put the prism between two metal plates and sent voltage across. When the background energy is relatively small, the vibration of dipoles can be considered linear. Here, the light-matter interaction is nicely described by Lorentz's dipole oscillating model, where the variation of the *n* can be connected to a Cauchy parameter, C. We assess its changes by measuring the changes in the Cauchy parameter for voltages up to 10 volts. We observed that the value for C changes from 11180 at no voltage, to 11278 at 10 volts, which is about 0.88% change, while the error bar for C is only 0.49% in both cases. This result shows a significant change in C and proves the fact that T induces a variation of n.

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UG-H / Advanced
2025 SURF Project

Censorship?: An Analysis of Discourses of Kendrick Lamar's Broadcast Performances.

This essay is an analysis of Kendrick Lamar's broadcast performances, the discourses surrounding the performances, and how, if at all, these discourses change the viewing experience. Specifically, I discuss and analyze how discourses related to censorship shape and reflect Lamar's performances. The broadcast performances in question are Lamar's 2016 Grammy performance and his recent 2025 Super Bowl Halftime Show performance. In addition, I also discuss other instances of broadly considered censorship and critique throughout Lamar's career, specifically self-censorship, as well as censorship within other performances close in time to the 2016 and 2025 performances and how this affects these two performances. I determine if, at all, censorship changed how these performances were put on before, during, and after the performances. I conduct research into how these performances impacted their respective audiences over time. I also conduct research into whether or not the political imagery used in the performances was perceived as Lamar intended, and the effect that the imagery used had on audiences who watched the broadcasts. Additionally, I determine whether or not broadly considered censorship from audiences, governments, and corporations changes how performances, specifically politically charged performances like those of Kendrick Lamar, are viewed, discussed, and thought about overall in the public eye.

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UG-H / In-Progress
Departmental Research

How the Breaking Bad Universe Subverts "The Hero's Journey".

While in the past story structures were consistent with showing the path of a hero as they excel and become heroic, contemporary times have changed what a traditional story structure looks like for writers. Vince Gilligan's Breaking Bad Universe, often referred to as the Gilliverse, presents a story structure only found within contemporary times. While other story structures like The Hero's Journey tell a story in a more traditional way, focusing on how a character changes and grows, eventually returns to familiarity after this change, the Gilliverse's structure focuses more on how the characters adapt to this change and grow in their unfamiliar world.

Keywords: Breaking Bad, Hero's Journey, Joseph Campbell