**Undergraduate Poster Abstract Book**

# Session I

**Sajid Raihan Akash**

University of Nebraska-Lincoln

*Generalizing the Berry Phase from Spatial Topology to Space-Time Topology*

Co-Authors: Dr; Herman Batelaan, Affiliation: University of Nebraska-Lincoln; Dr; Pablo L; Saldanha, Affiliation: Universidade Federal de Minas Gerais;

Poster Number: 156

The Berry phase, a phase acquired by a quantum system during cyclic adiabatic evolution, reveals how quantum mechanics encodes spatial topology through phase. Well known examples are of this are the Aharonov–Bohm effect, the evolution of a spin-½ particle in a slowly rotating magnetic field, and the cyclic variation of nuclear coordinates around a conical intersection. In this project, we aim to extend the Berry phase from a pure spatial topology to a space-time topology. Building on the recently discovered electrodynamic Aharonov–Bohm effect, the first example of a space-time topological Berry phase, we study how temporally-abrupt spin-transitions in a slowly rotating magnetic field can generate Berry phases. Similarly, we are further exploring abrupt temporal variations in molecular conical intersections to find novel space-time topological Berry phases. Such new phenomena are, in principle, accessible to experiment and further our understanding of the Berry phase.

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**Gabriel Ambrose**

University of San Diego

*Differential Dynamic Microscopy in Light Field Microscopy for Quantifying Particle Dynamics in 3D*

Co-Authors: Dylan Gage, University of San Diego, Gabriel Ambrose, University of San Diego, Gildardo Martinez, University of San Diego, Zayda Kellogg, Bennington College and researched at the University of San Diego, Dr; Ryan McGorty, Chair of the Department of Physics and Biophysics at the University of San Diego, PI

Poster Number: 15

Quantitative measurements of a sample's dynamics observed under a microscope reveal insights relevant to disciplines from materials science to biophysics. Differential dynamic microscopy (DDM) and single particle tracking (SPT) quantify these dynamics. However, most video analysis algorithms are limited to quantifying motion in two dimensions. Here, we introduce a new microscopy method which integrates DDM with light field microscopy (LFM), a setup which uses a microlens array to capture 3D information in a single shot. While existing computational methods to extract 3D information from LFM data are complex and computationally expensive, we bypass those obstacles by developing novel methods for DDM and SPT to be applied to LFM data, directly determining 3D dynamics without the need to determine the 3D structure at each time point. We demonstrate how a relatively inexpensive microscope and computationally efficient workflows can extract 3D dynamics of diffusing and sedimenting micron-sized colloidal particles.

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**Tate Arrington**

Davidson College

*Solving The Double Well Using Classical and Quantum Mechanical Methods*

Co-Authors: Mario Belloni, Davidson College Physics Department

Poster Number: 206

I examined the behavior of particles in double wells using both classical and quantum-mechanical methods. Classically, we analyzed particle motion and observed chaotic behavior. Quantum mechanically, we solved the Schrödinger equation to determine energy eigenstates and wave functions. We explored wave packet dynamics through time evolution, quantum carpets, and Wigner functions, providing a comprehensive view of particle behaviors. Autocorrelation functions were employed to study wave packet coherence. Using Mathematica software, we modeled and solved equations to visualize

particle movement. This comprehensive study enhances our understanding of double well potentials, bridging classical and quantum perspectives to provide a detailed examination of particle dynamics.

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**Laura Austin**

Grove City College

*Observations of non-standard vibrational modes in accordion reeds*

Co-Authors: Nathan Nichols (Creighton University), James Cottingham (Coe College)

Poster Number: 91

Previous studies have found that when an accordion reed is excited by blowing, its frequency spectrum is dominated by transverse modes with torsional modes observed at relatively low amplitudes. In addition, unusual mode shapes and abnormally high amplitudes of certain transverse modes have been observed at high pressure. In this research, mode shapes were measured by mechanically driving the reed at the mode frequency, and then plotting velocity amplitude vs. position on the reed tongue. Torsional mode shapes were measured for several of the reeds studied. In addition, a mode that appears to be a fixed-hinged mode was observed in some low-frequency reeds which had a weight on the end. Odd behavior has also been observed for a number of accordion reeds when they are blown at higher than normal pressure. Observations of these interesting modes will be presented. [Funded by NSF grant MPS-PHY-REU-2349118]

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**Sarah Bach**

Lycoming College

*Creating a Catalog of Classified AGN*

Co-Authors: Mellisa Morris, Thane Goetz, Mia Benedetto (Lycoming College), Eric Hooper, Kaylan-Marie Achong, Verene Einwalter, Yjan Gordon (University of Washington-Madison)

Poster Number: 340

We created a catalog of 1800+ morphologically classified active galactic nuclei (AGN) focusing on those that possess a radio-bright core and jets. We found these sources across the Very Large Array Sky Survey (VLASS), a recent large coverage radio survey, using DRAGNHunter, a source identifying algorithm. We classified based on morphology, bending of the jets, and flags (issues with classification or the identification from DRAGNHunter, for example we used VLASS' "Quick Look" images for our classification, this led to the algorithm occasionally identifying imaging artifacts as AGN sources). We observed our sources across separate surveys/wavelengths, such as WISE and PanSTARRS to confirm DRAGNHunter's host galaxy identification. When published, this this catalog will provide a sample of 1800+ radio sources with well-defined morphologies, allowing astronomers to carry out larger studies of radio AGN morphology, and our recorded flags will help develop automated source detection algorithms for future radio surveys.

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**Keshav Badri**

Rutgers University - New Brunswick

*Quasiperiodic hopping on the honeycomb lattice*

Co-Authors: Kevin Lucht (Rutgers University), Justin H; Wilson (Louisiana State University) Jedediah H; Pixley (Rutgers University, Flatiron Institute - CCQ)

Poster Number: 236

In this work, we introduce a quasiperiodic tunneling model on the honeycomb optical lattice, which we refer to as "quasiperiodic hopping", and demonstrate its magic-angle behavior and diffusive dynamical properties in the weakly interacting ultracold Bose gas. We construct a tight-binding model, and treat interactions on the mean field level by solving the Gross-Pitaevskii equation. In the non-interacting limit, we compute the density of states to reveal a reentrant semimetallic phase with an intermediate metallic phase transition at a critical hopping strength. This transition is consistent with a magic-angle transition in the band structure, which is analogous to generating flat bands in twisted bilayer graphene. This transition is also shown using the structure of the eigenstates, which showcase an inversion of the positive and negative semimetal modes after the intermediate metallic transition. In the interacting case, dynamics of wavepackets are presented as the model goes through the magic-angle transition.

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**Ryan Bailey**

Berea College

*Researching Sputtering as a Deposition Method for Producing Silicon Photovoltaics*

Co-Authors: Alex D; Mullins, Ephraim H; Myers, from Berea College

Poster Number: 264

A vacuum chamber was constructed with the goal of researching sputtering deposition as a method of producing photovoltaic devices. Photovoltaic technology, specifically solar cells, are increasingly being adopted across the globe as cleaner and more sustainable energy alternatives to the finite reserves of fossil fuel sources, with solar energy generation experiencing the most rapid growth ever recorded in 2024. Over a three-month period, the vacuum chamber was assembled and made ready for sputtering. Upon completion an argon plasma was created at pressures of ~2.4x10^-3 Torr, and then used to sputter P-type silicon, N-type silicon, and ITO (Indium Tim Oxide, a transparent conductor) onto an aluminum foil substrate. This produced two working photovoltaic samples, one with a heavy-duty aluminum foil back contact and the other with a vacuum-grade aluminum foil back contact. These samples produced a maximum power output of 2.88x10^-6 Watts and 1.62x10^-12 Watts respectively.

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**Joseph Ball**

Cleveland State University

*Solvent Effects on the Interaction of Charged Nanoparticles*

Co-Authors: Sebastian Sensale Rodriguez

Poster Number: 61

Self-assembly is ubiquitous in nature, allowing for the bottom-up construction of ordered structures via non-covalent interactions. These mechanisms have found multiple applications in chemistry and materials sciences, providing low-cost, highly reproducible, highly tunable strategies for the construction of multidimensional structures with very high yield. The goal of this project is to computationally demonstrate a novel technique for tuning nanoparticle aggregation by controlling nanoparticle-solvent interactions at the molecular-level.

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**Patrick Barrett**

Cleveland State University

*The Dynamics of Microgels with Varying Crosslinker Concentration*

Co-Authors: Dr; Kiril A; Streletzky (Cleveland State University)

Poster Number: 51

Polysaccharide microgels are a widely studied class of materials which combine colloidal properties with the environmentally responsive nature of polymer gels. This combination allows for applications in targeted drug delivery, biosensing, and other medical applications. One candidate for such applications is hydroxypropyl cellulose (HPC) polymers crosslinked by divinyl sulfide (DVS). HPC microgels display a reversable volume phase transition at the critical temperature TV. Studies into other types of microgels (mostly PNIPAM) have shown that varying the amount of crosslinker (XL) used in the synthesis process alters the microgels' structure and behavior. We aim to study how HPC microgels respond to variation in XL concentration by using Dynamic and Static Light Scattering (DLS and SLS) measurements from HPC microgels across a wide range of XL concentrations, tested above and below TV. It was found that at low XL concentrations, HPC microgels followed standard behavior for homogenous crosslinking, becoming smaller and denser above TV and following Flory-Rehner theory. At high XL concentrations, however, the microgels displayed an increase in size and a decrease in density above TV. The differences between low and high XL samples are likely caused by inhomogeneous crosslinking, which becomes more pronounced at higher XL concentration. This conclusion was reached after light scattering results were compared to existing models for microgels found in previous studies.

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**Zeynep Bayraktar**

Miami University

*Extracting Spectroscopic Constants from Rovibrational Spectra: Insights into Molecular Behavior*

Co-Authors: Zeynep Bayraktar, Hannah Stevens, Ryan Renganeschi, Kshitiz Rai, Anusha Pokharel, Burcin Bayram, Miami University, Oxford, OH 45056

Poster Number: 117

The extraction of spectroscopic constants from rovibrational spectra provides valuable insights into the molecular structure and behavior of diatomic molecules. In this study, we focus on the lithium molecules in the first excited state. Using a pulsed laser, we measure the rovibrational transitions of lithium molecules in the A state, allowing us to extract key spectroscopic constants such as the fundamental vibrational frequency, bond strength, anharmonicity constant, and the depth of the potential well. Through the analysis of these constants, we gain a deeper understanding of the molecular potentials. The results are compared to theoretical predictions and values obtained for other alkali dimers, providing valuable benchmarking for molecular models. This work lays the groundwork for future studies in high-resolution molecular spectroscopy, quantum chemistry, and applications in quantum information science and molecular simulations.

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**Bethany Beavers**

Abilene Christian University

*90-Degree Monitor*

Co-Authors: Jonah Baird, Joshua Colleti, and Donald Isenhower; Abilene Christian University

Poster Number: 240

Spinquest is a Fermilab fixed-target experiment that utilizes an unpolarized proton beam with a polarized NH4 or ND4 target. The goal of this experiment is to determine how much the sea quarks impact the spin of the proton. The ninety-degree monitor measures the luminosity of the beam. Four photomultiplier tubes (PMTs) are aligned front to back, facing the target perpendicular to the beam. A coincidence counter is used to determine how many signals come from the beam instead of from elsewhere in the target cave. The outermost PMT shows signs of failure, which changes the coincidence counter and messes up the data. In this poster, we will discuss this failure and how it will be addressed.

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**Zoe Beris**

University of Delaware

*Pressure-Dependent Interactions of Osmolytes With Membranes*

Co-Authors: Zoe Beris (Department of Physics and Astronomy, University of Delaware), Sasiri Vargas-Urbano (Department of Physics and Astronomy, University of Delaware), Thomas R Shaw (Department of Mechanical, Aerospace and Biomedical Engineering, University of Tennessee), Stephen A Sarles (Department of Mechanical, Aerospace and Biomedical Engineering, University of Tennessee) and Edward Lyman (Department of Physics and Astronomy and Department of Chemistry and Biochemistry, University of Delaware)

Poster Number: 212

Osmolytes are small soluble molecules that influence osmotic pressure and help maintain cell structure. Trimethylamine N-oxide (TMAO) is a soluble small molecule found in many deep-sea animals at high concentrations (up to 386 mmol/kg) and is believed to be a key aspect of pressure adaptation in these organisms, but the mechanism is a matter of discussion and debate. In order to assess the pressure dependent properties of omolytes in molecular dynamics simulations, we performed a series of molecular dynamics simulations of osmolytes as a function of pressure. We implemented a method to determine the osmotic coefficients of NaCl and TMAO in the CHARMM forcefield. We have also performed simulations of simple membranes solvated by TMAO and water mixtures in order to assess pressure dependent effects of osmolytes on membranes.

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**Diana Berrios**

University of Puerto Rico-Rio Piedras

*Observing H-RRL's in W51*

Co-Authors: University of Puerto Rico-Mayaguez, University of Puerto Rico-Rio Piedras, University of Puerto Rico-Utuado, University of Central Florida, NSF Center for Advanced Radio Sciences and Engineering, ENCANTO: Enhancing and Nurturing Careers in Astronomy with New Training Opportunities

Poster Number: 238

Star formation occurs in clouds of gas known as the Interstellar Medium (ISM). The ISM consists of dust and molecules, ionized and atomic gas, and can be studied with radio telescopes. The data presented focuses on the massive star-forming region, W51, as a part of a larger pilot study of the galactic plane. The 12-m radio telescope at the Arecibo Observatory (AO) was used to compile data at 3GHz of ionized hydrogen, which emits a recombination line (H-RRL). Through RFI filtering and Python pipelines, the H-RRL are detected at 58.97 km/s and 57.61 km/s, respectively. This analysis represents a first step to understanding the kinematics of the ISM, such as the electron temperature, an indicator of the kinetic energy of the free electrons within the medium.

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**Jesse Bier**

University of Missouri at St Louis

*A Study on the Great Comet of 2024: C/2023 A3 (Tsuchinshan-Atlas) via Radio Interferometry*

Co-Authors: Dr; Nathan X; Roth, American University, NASA; Dr; Erika L; Gibb, University of Missouri - St Louis

Poster Number: 324

Our solar system is approximately 4.5 billion years old. Comets are remnants of its formation, serving as time capsules to give us an understanding of its natal heritage. Revealing our own solar system's history allows us to gain insights into other young stellar systems and the potential for life elsewhere. C/2023 A3 (Tsuchinshan--ATLAS) was a comet from the Oort cloud on its first and possibly only journey to the inner solar system. The comet grew in brightness to a visual magnitude of -4.9 on October 9, 2024, making it temporarily brighter than Venus and one of the brightest comets of the past century. Spectroscopic observations of comet A3 were conducted on October 1, 2024, using the Atacama Large Millimeter Array (ALMA) radio telescope located in the Atacama Desert in Chile. The Band 8 receiver centered near 460 GHz was used to sample thermal continuum emission from the nucleus and dust in the coma, as well as spectral line emission from CH3OH (methanol), SO (sulfur monoxide), and NH2D (ammonia). From analysis on the continuum, the nucleus size was estimated to be 4.3 +- 0.5 km. Dust mass was calculated based on a range of grain sizes, porosities and ice fractions consistent with a dynamically new (DN) Oort cloud comet. The dust masses ranged from (9.8 +- 3.5) x 10^7 kg to (1.1 +- 0.4)x10^8 kg. Spectral line emissions were not detected. We calculated 3 sigma upper bounds on molecular abundances for CH3OH and SO.

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**Alexina Birkholz**

University of Wyoming

*Red Buttes Observatory and the Search for Giant Exoplanets Around M-Dwarf Stars*

Co-Authors: Henry A; Kobulnicky (University of Wyoming), Ian Karfs (University of Wyoming), Alexander K; Larsen (University of Wyoming), Tera N; Swaby (University of Wyoming), Ethan G; Cotter (University of Wyoming), Brock A; Parker (University of Wyoming), Shubham Kanodia (Earth and Planets Laboratory, Carnegie Science), Lia Marta Bernabo (Institute of Planetary Research, German Aerospace Center (DLR), , The University of Texas at Austin), Caleb I; Canas (NASA Goddard Space Flight Center), Suvrath Mahadevan (Pennsylvania State University), Arvind F; Gupta (U; S; National Science Foundation National Optical-Infrared Astronomy Research Laboratory)

Poster Number: 270

Red Buttes Observatory is a 0.6 meter telescope owned by the University of Wyoming and operated by undergraduate students. The observatory primarily focuses on the confirmation of Jupiter-sized exoplanets orbiting M-Dwarf stars. These are the most common type of exoplanets discovered, and the most common type of star in the universe. However, we do not find many Jupiter-sized exoplanets around M-dwarf stars due to the complications of forming such large planets around small stars. Only a couple dozen have been found, and the discovery of more of these planets gives important insights into planet formation mechanisms. The discovery of three of these planets – TOI-6383Ab, with a period of 1.791 days and 1.040 MJ, TOI-7149b with a period of 2.65 days and 0.705 MJ, TOI-6034b with a period of 2.57 days and 0.798 MJ – show the variety of these kinds of planets, and raises questions on how these planets form.

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**Garner Boepple**

Furman University

*Simulation of Electron-Hole THz Dynamics in Semiconductor Nanowires*

Co-Authors: Rahul Ranjan Sah and Jeremy R; Gulley; Furman University Department of Physics

Poster Number: 166

Through the usage and alteration of ultrashort pulse propagation software, we examine the optical and plasmonic response of a semiconductor nanowire, modeled by the Semiconductor Bloch Equations (SBEs), to the introduction of laser and Terahertz (THz) fields. These simulations uniquely model the electron-hole dynamics by expanding the Maxwell-SBEs to simulate interactions with 3D laser fields. We upgraded our nanowire simulations from idealized, infinitely-wide "flat-gate" nanowire confined within 1D or 2D pseudo-spectral time-domain (PSTD) frameworks to a more realistic, transversely confined 3D nanowire. Specifically, we introduce ground-state Simple-Harmonic Oscillator envelopes for the transverse confinement quantum wavefunctions. By introducing an additional electromagnetic THz pulse into the nanowire 5 ps after the initial pulse, we monitor the resulting model electron-hole dynamics via changes in their energies, momenta, and currents.

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**Christopher Bonham - Janes**

East Carolina University


*A Molecular Dynamics Approach to Modeling Sperm Dynamics*


Co-Authors: Martin Bier, Professor of Physics at East Carolina University


Poster Number: 232

This project explores how sperm swim by modeling their movement through water using molecular dynamics. In the simulation, both the sperm and surrounding water molecules move according to the velocity Verlet method, which accurately tracks their positions and velocities over time. The water molecules interact through the Lennard-Jones potential, which captures how they attract and repel each other at short distances. The sperm propels itself forward by rhythmically beating its tail, pushing nearby water molecules aside and creating motion through the fluid. This approach provides a physically grounded way to study how microscopic swimmers interact with their environments at the molecular level. The final result is a real-time 2D simulation showing a single sperm moving through water, demonstrating how complex, lifelike motion can emerge from simple physical rules. This work highlights the potential of molecular dynamics for studying biological motion in detail.

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**Adriana Bonilla Romacho**

University of Puerto Rico

*Excision of Radio Frequency Interference via Spectral Kurtosis Estimators for the Arecibo 12-m Telescope: An Open-Access Package in Python*

Co-Authors: Adriana M; Bonilla Romacho, Emmanuel J; Morales Butler, Allison J; Smith, Computer Science and Engineering, The University of Puerto Rico at Mayagüez, Mayagüez, PR 00681, USA Department of Natural Sciences, The University of Puerto Rico at Utuado, Utuado, PR 00641, USA Department of Physics, The University of Puerto Rico at Mayagüez, Mayagüez, PR 00681, USA Center for Advanced Radio Sciences and Engineering, Mayagüez, PR 00681-9000, USA

Poster Number: 278

Radio Frequency Interference (RFI) mitigation has become increasingly critical as man-made transmissions contaminate astronomical observations. We are developing an open-access Python package that implements two Spectral Kurtosis (SK) estimators for the detection and excision of RFI, as per Nita et al. (2007) and Nita & Gary (2010a,b). One of them is single Generalized Spectral Kurtosis and the second is Multi-scale Generalized Spectral Kurtosis. The implementation has been created into a modular software architecture designed for reproducibility, maintainability, and scalability. The initial version of the package is functional and has been tested with commissioning data from the Arecibo 12-m telescope captured during the summer of 2023 (Roshi et al., 2024). Ongoing work focuses on expanding validation, optimizing performance for diverse datasets, and enhancing usability through improved documentation and open-source collaboration. Once completed, this tool will provide the radio astronomy community with a reliable framework to support current and future surveys, while promoting the best practices in scientific software development.

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**Svanik Bose**

Pullman High School

*Searching for Supermassive Binary Black Holes in Noisy and Sparsely Sampled Quasar Light Curves*

Poster Number: 136

We develop a method for detecting supermassive binary black holes (SMBHBs) from noisy and sparsely sampled quasar light curves from the Vera Rubin Observatory's large-scale survey of space time (LSST). The detection of SMBHB quasars may offer clues on how large scale structures, such as clusters and superclusters of galaxies, may have formed in our universe. We demonstrate the method's effectiveness using simulated quasar light curves, adding damped random walk (DRW) noise and matching the LSST's observation cadence of 1 sample every 4 days. We account for the fact that the binary orbital motion of SMBHBs may leave a periodic imprint on the light emitted by quasars harboring them. We explore the limits of SMBHB detectability in LSST data and investigate how the possible inspiral of SMBHB orbits due to gravitational radiation may affect our results.

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**Raymond Brown**

Angelo State University

*Determining a Modern Value of the Orbital Period of WASP-8b Using TESS Data*

Co-Authors: Kenneth Carrell, Angelo State University

Poster Number: 224

We present a modern determination of the orbital period of the transiting exoplanet WASP-8b. The accuracy of TESS data allows us to make a determination using a computational method that is consistent with most contemporary reports. A comparison between our value and those from the literature spanning 15 years is presented. In this presentation, we discuss the methods used in our procedure as well as potential improvements to be made in the future. Combining older and newer data will allow us to look for transit timing variations or other changes in the system over a longer period of time.

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**Michael Buccino**

SUNY New Paltz

*Assessing Photometric Accuracy and Limitations of the Seestar S50 in Stellar Observations*

Poster Number: 286

The Seestar S50 is an electronic telescope which captures long exposure, stacked photographs for enhanced astronomical imaging. While marketed for amateur astrophotography, this study aims to determine its potential as an affordable instrument for quantitative research. Scientific applications of the Seestar S50 haven't been widely explored, making it an attractive subject for analyzing its potential to bridge the gap between casual observing and research. By applying photometric techniques to stellar observations, the telescope's abilities were investigated by comparing the actual and calibrated apparent magnitudes by using AstroImageJ. This work highlights the strengths and limitations of the Seestar S50. It can pave the way for educators and students to gain access to astronomical imaging for performing data analysis for research and learning purposes. Technology like this can offer more opportunities for participation in astronomy and data-driven research.

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**Brigid Burke**

Xavier University

*Half-Life Matters: Modeling Chemical Persistence in and Around Fungal Hyphae*

Co-Authors: Dr; Kathryn Morris, Professor of Biology, Xavier University and Dr; Jonathan Morris, Associate Professor of Physics and Engineering, Xavier University

Poster Number: 204

Mycorrhizal fungal networks form between the roots of plants, allowing for a connection between them. MATLAB code was used to simulate the growth of these networks and keep track of the chemical being transported, providing a virtual model of the singular fungal network connecting the roots of two different plants in the same soil. This highlights if the fungal network is actively transporting the chemical introduced to the system, or if transportation of the chemical occurs inactively. The chemical looked at was considered internal when it was inside the hyphae and external when it was in the surrounding environment. Differing half-life values for the chemical were incorporated into the code for each environment: air, water, roots, and hyphae. By varying the half-life, differences in the internal chemical amount in the hyphae could be tracked. This analysis allowed for differentiation between the environments and a more realistic model to be presented.

Keywords: Mycorrhizal fungal networks, MATLAB code, half-life, model

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**Demi Butler**

North Carolina A&T State University

*Monte Carlo Block Method for Quantum Spin Chains*

Co-Authors: Shannon Starr, University of Alabama at Birmingham

Poster Number: 41

We use Monte Carlo Markov chain methods to simulate a quantum ferromagnet, with potential extensions to the anti-ferromagnet in order to study the energy spectrum precisely. Our Python-based code models the system's physical behavior and uses Chebyshev bounds to determine the optimal sample size for a 95% confidence interval with 99% accuracy. In order to analyze total spin, we use the Clebsch-Gordon coefficients for the spin Lie group SU(2), therefore we can take a system comprised of two large blocks and project onto the total spin 0 subspace. That is important for disproving a conjecture known as the Ferromagnetic Ordering of Energy Levels conjecture, due to Nachtergaele, et.al.

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**John Butler**

Saint Josephs University

*Exploring (4-Pyridyl)-Porphyrin–Peptide Conjugates in Photodynamic Therapy*

Co-Authors: Martyna Habdas, Christina King Smith, Piotr Habdas

Poster Number: 348

Photodynamic therapy is a treatment that targets cancer cells through photosensitizing agents that are selectively uptaken by cancer cells over healthy cells. The photosensitizing agents are excited into a higher energy state by corresponding wavelength to their conjugated systems. This higher energy state generates radical oxygen species which leads to cell death inside the cell. Photosensitizing porphyrins are a typical choice for the photosensitizing agents. In this study, we are testing novel porphyrin–peptide conjugates. Specifically, a porphyrin called (4-pyridyl)-porphyrin. We are focused on the efficacy of the porphyrin to kill B16F1 mouse melanoma cells.

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**Christopher Butsavage**

South Dakota Mines

*Stellar Body Evolutions and Analysis of Stable Carbon Burning in MESA*

Poster Number: 326

The primary goal of our research is to determine the lower stellar mass limit for stable carbon burning in massive stars, depending on the carbon fusion nuclear cross-section. This information carries profound consequences concerning how a star will evolve once it runs out of fuel. Despite tremendous experimental efforts, it is challenging to study processes that occur in the cores of stars. For this project, the open-source computational software known as Modules for Experiments in Stellar Astrophysics (MESA) is utilized. MESA simulates stellar evolution by taking in several adjustable parameters given by the user, such as the mass of the star, composition, and more. The program allows us to save the results graphically at set intervals. Moving forward, we would like to study the lifecycles of stars formed in the early universe and compare these to stars of the modern age.

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**Tea Caravello**

Massachusetts College of Liberal Arts

*Optimizing Gas Concentration Analysis and Safety Through Predictive Modeling and Sensor Integration*

Poster Number: 11

This project developed a predictive analytics tool to analyze and forecast gas concentration changes during fumigations, optimizing the use of costly and hazardous fumigation gases. Overuse can lead to pest resistance, safety risks, and environmental harm, while underuse reduces effectiveness. Using data from past fumigation jobs, I created an initial formula and a web application that collects real-time job data via REST API calls. The program predicts future gas concentrations, compares them to actual values for accuracy, and alerts fumigators when concentrations drop below safe thresholds or when the required concentration-time product (CxT) is met. Unlike existing tools that rely solely on environmental and chemical models, this system uses real-time field data for more accurate, adaptive predictions. It enables fumigators to maintain effective concentrations and prevent job failures, while ensuring that all work remains within regulatory guidelines.

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**Mason Chadwick**

University of Maine Orono

*Visualizing Stress, Strain, and Tensor of a Landslide in Virtual Reality*

Co-Authors: Dr; Luis Zambrano-Cruzatty (Assistant Professor, Department of Civil, Construction, and Environmental Engineering at NC State University), Mentor: RJ Perry (Laboratory Technical Manager of VEMI Lab)

Poster Number: 9

By placing a player in a world different from their everyday life with virtual reality, concepts and understandings of the world around them can be refined and improved. Landslides are known for their unpredictability and unprecedentedness. Visualizing a landslide, understanding its physical variables and characteristics, and gaining insight into the events leading up to a landslide is crucial to minimizing the chances they occur.

In this virtual reality simulation, 2-dimensional landslide data are utilized to create a 3-dimensional representation of a real landslide. Settings controlled by the player allows them to see the changes in volumetric stress and strain, deviatoric stress and strain, and a tensor component across twenty-four frames of landslide data.

In result, the player can place themselves in a virtual environment with the opportunity and capability to control the visualization of a landslide, hence experiencing virtual reality's ability to advance human perception of such a natural disaster.

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**Ari Chai**

Embry-Riddle Aeronautical University - Prescott

*Polarizer Characterization for Polarimetric Observations*

Co-Authors: Dr; Elizabeth Gretarsson, Embry-Riddle Aeronautical University Prescott; Dr; Noel Richardson, Embry-Riddle Aeronautical University Prescott; Atticus Bhat, Embry-Riddle Aeronautical University Prescott;

Poster Number: 133

This project characterizes six linear polarizers to within 0.5 degrees of uncertainty for use in polarimetric observations. To do so, we created an experiment to measure the polarization axis of the filters once they were mounted in a filter wheel. We intend to use this filter wheel as a polarimeter to take astronomical data on stars of interest. While spherical stars are naturally unpolarized, polarization can be induced by magnetic fields (including the Galactic magnetic field), binary stars, or circumstellar material.

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**Dennis Chunikhin**

University of Maryland, College Park

*Improving measurement of microwave qudits using millimeter wave photons*

Co-Authors: Akash V; Dixit [1], Dennis Chunikhin [1,2], Zachary Parrott [1,3], Bradley Hauer [1], Trevyn Larson [1,3], John Teufel [1]; [1] National Institute of Standards and Technology, Boulder; [2] Department of Physics, University of Maryland, College Park; [3] Department of Physics, University of Colorado, Boulder

Poster Number: 226

Superconducting qubits are a promising platform for quantum information. Their practical use, including the implementation of quantum error correction codes and dynamic circuits, requires accurate state measurement without perturbing the qubit. As qubit measurements are performed by encoding the qubit state on an RF carrier, a stronger readout tone improves the measurement accuracy. However, this simultaneously increases unwanted, measurement-induced transitions of the qubit. Recent work by Devoret et al. has shown that the dominant mechanisms causing measurement-induced transitions can be reduced by increasing the separation of the readout tone and qubit resonant frequencies. We thus experimentally probe measurement-induced transitions in the highly detuned regime by operating a microwave qudit in a cryostat cooled to 11mK with measurements performed using a 35GHz millimeter wave rather than a conventional microwave carrier. We set up infrastructure for full vector control and measurement at millimeter wave frequencies and perform qudit measurements with a readout tone calibrated to distinguish the qudit's ground and first 3 excited states with post-selection for 95% confidence in state assignment. We characterize the rate of measurement-induced transitions by measuring qudit state changes in response to a strong millimeter wave readout drive. We show that we can operate the qudit readout up to the critical photon number with no measurement-induced resonant transitions.

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**Ada Collins**

Rhodes College


*Imaging Parton Evolution with Three-Point Energy Correlators in pp Collisions at the LHC*


Co-Authors: CMS Collaboration


Poster Number: 49

High-energy collisions, like observed by the Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider, produce showers of hard scattered quarks and gluons, known as jets. The complex structure of jets holds information on parton evolution and aids in improving our understanding of quantum chromodynamics (QCD). Three-point energy correlators (E3C) relate the energy of three particles and their spatial configuration within the jet and provide a robust method of quantifying jet substructure. Projecting E3C into the Cartesian plane visualizes different triangle shapes that contribute to jet geometry and encourages a more intuitive understanding of how the jet evolves in vacuum and in heavy ion collisions. Preliminary results using proton-proton collision data from CMS are presented, studying projected and full E3C differentially in jet transverse momentum and jet radius. These studies help us understand QCD and also serve as a useful reference for larger systems, including proton-lead and lead-lead collisions.

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**Aiden Collura**

University of Mississippi


*Numerical Simulation of Particle Orbits in Schwarzschild Spacetime*


Co-Authors: Dr; Luca Bombelli

Poster Number: 39

In this project, I numerically simulated the motion of particles around a Schwarzschild black hole using the geodesic equations of general relativity. The goal was to explore how spacetime curvature affects the possible trajectories of massive particles. Including stable orbits, flybys, and falling into the black hole. By implementing these equations in Mathematica and using numerical integration techniques, I was able to visualize how extremely sensitive particle motion is near such an object. This work helped me gain a deeper understanding of general relativity, geodesics, and the behavior of matter in curved spacetime.

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**Nicholas Cox**

East Texas A&M University

*Effects of Solvent Vapor Annealing and Polarized Light on Organic Semiconductor Materials*

Co-Authors: Dr; Heungman Park

Poster Number: 108

Organic semiconducting materials have the potential to be used in flexible OLEDs and solar panels. Perylene diimide (PDI) derivatives and 3,4,9,10-Perylenetetracarboxylic dianhydride (PTCDA) are organic semiconducting materials that overcome some of the pitfalls in currently used materials, such as instability under exposure to intense radiation. In this work, for our first project, PDI aggregates were drop casted or spin coated on a layer of PMMA or block-copolymers. We then used solvent vapor annealing to attempt to align PDI aggregates, to get a more ordered film. In our second project, we drop cast or deposit PTCDA using thermal vapor deposition, and react the PTDCA with NH4 by solvent vapor under polarized light to try and form ordered PTCDI aggregates that would allow for efficient electron conduction. We determine whether or not these endeavors were successful by polarized light microscopy, UV-Vis spectroscopy, and photoluminescence spectroscopy.

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**Alan De Jesús**

UPR Mayagüez

*Pattern Recognition of Aurora Borealis Magnetic Fields Using Machine Learning And Artificial Intelligence Algorithms*

Co-Authors: M; Gerena López

Poster Number: 13

The implementation of Machine Learning (ML) and Artificial Intelligence (AI) algorithms aims_x000D_
to analyze magnetic sensors data from sounding rockets in the thermosphere, both inside and_x000D_
outside the Aurora Borealis. This research requires real-time ML-AI processing to compare live_x000D_
data against established auroral magnetic models. By leveraging rocket flights, this research_x000D_
seeks to enhance our understanding of auroral dynamics, driven by interactions between_x000D_
Earth's magnetic field and solar winds. The project focuses on data structures for pattern_x000D_
recognition and interpolation of nonlinear data. Magnetometers are measuring magnetic field_x000D_
signatures in real time. Using structures like K-Means Clustering, Random Forest, and Neural_x000D_
Networks aid us in analyzing trends in the magnetic field. The study will utilize NASA's_x000D_
RockSat launch platforms at Andøya Space in Norway. The payload is developed by students_x000D_
from the University of Puerto Rico at Río Piedras.

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**Lanie DeMarcay**

Davidson College

*Exploring Asymmetry in Phase Space through Wigner Quasi-Probability Functions of Biharmonic Oscillators*

Co-Authors: Dr; Mario Belloni, Physics Department Chair (Davidson College)

Poster Number: 71

A biharmonic oscillator is a spring-like system with a force and potential energy function that has different strengths for $x < 0$ and $x > 0$. This work uses the biharmonic oscillator system to study how asymmetry impacts an object's behavior in phase space for both classical and quantum mechanical systems. Using Mathematica, I modeled this system and analyzed how changing the left and right spring constants influenced the wave functions (eigenstates), energy levels (eigenvalues), and phase-space plots (Wigner functions). This preliminary work offers insight into how symmetry and asymmetry shape classical and quantum behaviors.

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**Logan Dempsey**

George Washington University


*Automation of Nematode Behavior Analysis*


Co-Authors: Nick Rothwein, Mark Reeves, Damien O'Halloran at GWU


Poster Number: 192

Understanding how genes control behavior requires connecting how modifying the nervous system alters what we can observe behaviorally. In C. elegans, we don't yet fully understand how the various neural pathways and parts of those pathways work together to produce thermal escape behavior. To address this gap, we developed an automated assay program to measure how different strains respond to heat. We compared normal strains to mutants that are missing specific genes related to temperature and mechanical sensing. Our approach allows us to test how these genetic changes alter behavior when worms encounter a localized heat source. Our findings reveal that mutants show escape responses when they are closer to the heat, while normal strains respond from farther away. This suggests these genes may control the temperature threshold that triggers escape or how the nervous system processes heat information.

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**Robert Devlin**

Davidson College


*Developing Simulations for Multi-Directional Neutron Detection*


Co-Authors: Dr; Grigory Rogachev - Texas A&M Cyclotron Institute

Poster Number: 77

The efficient detection of neutrons from fissile nuclear materials is important for security purposes. The neutron source direction is the direction calculated from an active detector to a neutron source placed somewhere outside the detector. A novel method of detecting the direction of fissile Californium 252 neutron sources was developed using TexAT, a time projection chamber built at the Texas A&M Cyclotron Institute. The neutron source direction is identified through a machine learning approach, using the distribution of proton streaks in the active volume generated from neutron-proton elastic scattering events. A Monte-Carlo simulation was developed to simulate TexAT neutron detection. Simulated neutron proton elastic scattering data was saved for the purpose of training the machine learning directional detection algorithm. In addition, an experimental setup using the TexAT detector was created to allow for a variety of neutron source locations. The data from this setup will ensure the accuracy of the simulations and directional detection algorithm. The machine learning method will allow for the efficient detection of sources placed in multiple directions by analyzing the distribution of neutron proton scattering events.

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**Luna Dole**

Angelo State

*Cellular Constrictions During Early Gastrulation in Drosophila: Mechanical Feedback Within Embedded 3D Space*

Co-Authors: Michael C; Holcomb, Angelo State University Department of Physics and Geosciences

Poster Number: 154

Recent studies of gastrulation in the Drosophila embryo have explored the potential role of stress-based mechanical feedback in both cephalic and ventral furrow formations. Although the prevailing model is based on chemical signaling, mechanical signaling between cells is yet to be ruled out. In fact, active granular fluid models with mechanical feedback mechanisms have been shown to work well within a flat periodic space, but this modeling approach has not been evaluated within embedded three dimensional spaces. Here, we present a force-center based model on a cylindrical surface with periodic boundary conditions along the longitudinal axis. With this model, we explore the implications of stress-based mechanical feedback upon the structures formed by groups of constricted cells.

Session I

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**Ethan Driscoll**

Colorado College

*Exploring LVM for Faint Signatures of the Warm Ionized Medium*

Co-Authors: Dhanesh Krishnarao, Colorado College

Poster Number: 194

Diffuse Ionized Gas (DIG), often referred to as the Warm Ionized Medium (WIM), makes up a substantial part of the Interstellar Medium. Using data from the Local Volume Mapper (LVM) as part of SDSS-V, we search for the faintest signatures of the WIM in the Milky Way at a previously unprecedented spatial resolution using integral field spectroscopy. We focus on strong optical emission line ratios including [OIII]λ5007/[H$\alpha$]λ6563, [SII]λ6717/[H$\alpha$]λ6563 and [NII]λ6583/[H$\alpha$]λ6563 as a function of height above the mid plane of the galaxy. Low-intensity flux values were selected to avoid inclusion of other interstellar features such as HII regions or supernova remnants. Ratio plots were constructed to help evaluate physical conditions in these low surface brightness regions. Ultimately, we have developed plotting tools to help identify the WIM in LVM data and see initial signatures of faint WIM-like emission at high latitudes. Work will continue to refine WIM identification in LVM as more observations are made and the pipeline for data reduction and analysis is improved in the SDSS-V collaboration.

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**Rosie Durland**

University of Utah

*What does inequity look like in our physics labs?*

Co-Authors: Kelby T; Hahn, Jordan Gerton, Lauren Barth-Cohen: University of Utah

Poster Number: 1

The benefits of group work are well known, but group interactions also introduce power dynamics that may be inequitable. In an effort to improve equity in our introductory physics lab, we explored students’ access to group discussions and lab equipment by qualitatively analyzing video data of five groups of students across two sections of our

Summer 2024 course. We found that not all students in our lab were able to access group discussions or lab equipment equally. Two contrasting case studies emerged that highlighted the range of access within a single lab section. We also found that teaching assistants can reinforce or disrupt inequitable dynamics through their body positioning when supporting a group during a sensemaking episode. Future work involves using examples of inclusive and exclusive dynamics to create a series of training videos. These videos will support TAs in recognizing inequitable dynamics, and help them leverage their physical position to disrupt these dynamics.

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**Aubin Vertueux Dzossa Bontse**

Furman University

*Using Web Scraping and Natural Language Processing Techniques to Identify Key Challenges in Building Energy Modeling (BEM)*

Co-Authors: Dipashreya Sur, Rishee Jain; Stanford University Department of Civil & Environmental Engineering

Poster Number: 168

Building Energy Modeling (BEM) applies physics concepts (e.g., thermodynamics and heat transfer) to predict and analyze building energy usage . Despite its importance, using BEM tools can be challenging due to their steep learning curve. To understand challenges encountered by modelers, we ethically scrape 13,012 questions from Unmet Hours (a Q&A platform for BEM) and analyze them using natural language processing techniques. Our analysis reveals that most modeling hurdles pertain to the tags of EnergyPlus and OpenStudio and that there are recurrent issues when modeling HVAC components and managing both input data and weather files. Our findings provide a foundation for more targeted future research aimed at improving the accessibility of BEM tools and expanding building decarbonization efforts.

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**Christopher Ezike**

Lamar University

*Impact of Multiple-Intelligences on Student Performance and Confidence in Preparatory Physics Course*

Co-Authors: Dr; Nainabasti Binod

Poster Number: 228

This study explores how multiple intelligences (MI) impact academic performance and confidence in the Preparatory Physics Foundation (PPF) Course. Using Howard Gardner's MI framework, 268 students were classified as analytical, introspective, or interactive. Findings show that over 51% of students identified as having introspective intelligence, 23% analytical and 26% interactive. By the end of the course, nearly half 47% experienced a decrease in confidence, 31% remained unchanged, and 22% reported increased confidence. Performance data revealed that analytical students excelled on early exams, whereas introspective and interactive learners scored lower initially. All groups experienced declines on the final exam. Statistical analysis, including Chi-square and Ordinal Regression, indicated no significant correlation between MI type and confidence change or overall performance. These findings suggest that while MI influences initial academic patterns, it does not serve as a reliable predictor of confidence or success, highlighting the complex nature of learning styles in PPF.

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**Erin Finley**

Rowan University

*Measuring Exchange Rate of Nanoparticles: A Study on Reverse Micelle Dependence on Composition*

Co-Authors: Jahni Williamson, Janine Mazahreh, and Nathaniel V; Nucci - Physics & Astronomy Department at Rowan University

Poster Number: 302

Reverse micelles (RMs) are thermodynamically stable nanoparticles where an aqueous pool is encapsulated within a non-polar organic solvent and stabilized by a surfactant shell. These nanoparticles can be used for drug delivery, serve as specific environments for protein studies, and act as nano-reactors for chemical catalysis. This project aims to measure the coalescence of RMs and study the rate of aqueous content exchange between RMs in different organic solvents under various surfactant conditions. To achieve this, terbium chloride (Tb(III)-Cl) and dipicolinic acid (DPA) are encapsulated in separate RM

populations. Stopped-flow coupled with a spectrometer allows for the fluorescence of the Tb(III)-DPA complex formation as RMs exchange their contents to be measured.

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**Gabrielle Forbes**

University of North Florida


*Exploring the Impact of Causal Language on Student Reasoning Using Online Reasoning Chain Construction Assessments*


Co-Authors: J; Caleb Speirs


Poster Number: 63


This research explores whether using causal language in Online Reasoning Chain Construction Assessment (ORCCA) tasks changes how undergraduate physics students build their reasoning. ORCCA tasks give students statements about the problem and ask students to build a chain of reasoning from these statements. Connecting words to link the statements are also provided. In this study, students were split into two groups, with each group getting the same question, but with the reasoning statements phrased in either causal or non-causal ways. We compared answering patterns as well as how often they used certain reasoning elements between conditions. This research aims to learn more about how casual language might shape in-the-moment reasoning and to find better ways to help students develop strong argumentation skills in physics.


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**Meghan Foster**

The George Washington University


*Monitoring Detector Stability for MUSE*

Poster Number: 248


"As one of the key components of all ordinary matter, one might expect that the properties of the proton would be well understood. However, in 2010, a new, precise measurement of the proton radius using muonic hydrogen spectroscopy disagreed with results established via electron-proton scattering and atomic hydrogen spectroscopy. This led to the creation of the MUon Scattering Experiment (MUSE) to simultaneously

measure and compare both muon and electron elastic scattering on the proton. To achieve the necessary statistical precision, the experiment is scheduled to take data for a total of fifteen months, spread out over three calendar years. Over this time, it is important to monitor and understand the stability of the measurement. To ensure the success of MUSE, my project is to monitor the experiment's performance by writing software to monitor measurement stability and participate in experimental running. This presentation will report on my studies of the stability of several key parameters of the MUSE measurements.

This material is based upon work supported by the National Science Foundation under NSF grant PHY-2310026 and a GWU Columbian College of Arts and Sciences Luther Rice Fellowship. The MUSE experiment is supported by the Department of Energy, NSF, PSI, and the US-Israel Binational Science Foundation."

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**Joshua Fulton**

East Texas A&M University

*Predictive Analytics in Photonics: Machine Learning for Dielectric Property Optimization*

Co-Authors: Joshua Fulton, under the guidance of Dr; Heungman Park and Dr; Pao Tai Lin, in contribution to the work of Jinghao Yang, Austin Caruso, Zhihal Lin, Junyan Li, and Dr; Pao Tai Lin

Poster Number: 190

Quantum sensing with Nitrogen-Vacancy (NV) centers in diamond uses the magnetic sensitivity of the NV center spin states to image high spatial resolution magnetic fields at ambient temperatures. Experiments are performed using a Quantum Diamond Microscope (QDM) with a laser and microwave pumping to initialize the NV spin states which are then read out by an optical microscope and camera to measure the fluorescence, with the sample placed near or in contact with the diamond. Continuous-Wave (CW) Optically Detected Magnetic Resonance (ODMR) is a common protocol used because of its simple implementation, however, pulsed ODMR protocols offer advantages such as greater magnetic field sensitivity and reduced sample heating. We quantify the CW sensitivity of our experiment to characterize our QDM performance and as a benchmark to compare to pulsed protocols. Quantum sensing with Nitrogen-Vacancy (NV) centers in diamond uses the magnetic sensitivity of the NV center spin states to

image high spatial resolution magnetic fields at ambient temperatures. Experiments are performed using a Quantum Diamond Microscope (QDM) with a laser and microwave pumping to initialize the NV spin states which are then read out by an optical microscope and camera to measure the fluorescence, with the sample placed near or in contact with the diamond. Continuous-Wave (CW) Optically Detected Magnetic Resonance (ODMR) is a common protocol used because of its simple implementation, however, pulsed ODMR protocols offer advantages such as greater magnetic field sensitivity and reduced sample heating. We quantify the CW sensitivity of our experiment to characterize our QDM performance and as a benchmark to compare to pulsed protocols. This project aims to characterize and optimize magnetic field sensitivity for CW and pulsed protocols on the QDM.

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**Mark Gamaghelyan**

University of San Diego

*From turbulence to soliton gas in a Bose-Einstein Condensate*

Co-Authors: Mark Gamaghelyan, Mark Gin, Peter Engels, and Sean Mossman

Poster Number: 45

Bose–Einstein condensates (BECs) provide a powerful platform for exploring the interplay between turbulence and solitons in quantum fluids. In our experiments, we drive counterflow between two spin components of a dilute-gas BEC using a magnetic gradient. This flow quickly generates three-dimensional quantum turbulence. Over time, the superfluid turbulence dissipates, leaving behind a random ensemble of solitons. Using Fourier analysis, we capture and characterize this striking transition from 3D turbulence to a 1D soliton gas. Our results open a new experimental avenue for studying nonlinear superfluid hydrodynamics, connecting turbulence to soliton gases.

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**Praise Gavi**

Grambling State University

*Synthesis and Analysis of Nanoparticles Using Dynamic Light Scattering and Spectral Characterization Techniques*

Co-Authors: Praise Gavi, Grambling State University , Dr; Yang, Grambling State University

Poster Number: 314

Nanoparticles have diverse applications in materials science and space engineering, yet their characterization requires precise control of synthesis and measurement conditions. In this project, we synthesized nanoparticles using laser ablation in liquid and analyzed their optical and size distribution properties. Dynamic Light Scattering (DLS) was employed to determine the hydrodynamic radius, while spectral data were analyzed using Full Width at Half Maximum (FWHM) calculations to evaluate particle uniformity. Variations in temperature and surfactant concentration were found to influence the measured size and distribution profiles. Our results highlight the importance of maintaining consistent environmental parameters to achieve reliable nanoparticle synthesis and characterization. This research, conducted under Dr. Yang's guidance at Grambling State University in collaboration with NASA and LaSPACE, contributes to the development of materials suitable for extreme environments such as lunar construction.

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**Abigail Gebremariam**

University of Colorado Denver

*Electron-impact excitation of Singly-ionized Neon atom using the B-Spline atomic R-Matrix code*

Co-Authors: Kathryn R; Hamilton, Klaus Bartschat; Drake University, University of Colorado Denver

Poster Number: 128

In the Bohr Model of the atom, positively charged protons group together with chargeless neutrons to form a nucleus at the center of the atom, and negatively charged electrons are distributed in shells, or roughly circular orbits, around this point. While the electrons have one particular shell they like to remain in, if we give them enough energy they can jump from one shell to another, a move which is referred to as a “transition”. In this project we seek to determine how likely it is that the electrons in singly-ionized neon atoms will make these transitions after they have received different amounts of energy. To do this, we will perform calculations using a world-leading atomic physics code called the B-Spline atomic R-Matrix (BSR) code. The calculations will be very computationally intense, and so we will use the Texas-based Frontera supercomputer to generate results more quickly.

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**Samuel Glandon**

University of Tennessee at Chattanooga

*A 3D-Printed Laser Autocollimator for Precise Angular Deviation Measurements*

Co-Authors: Landon Boone, Angel Fraire Estrada, Samuel Glandon, Noah Wyatt, Olivia Ziemer, Andrew Elder, Tatiana Allen

Poster Number: 55

Laser autocollimators are precision optical instruments for measuring small angular displacements. Commercial devices are complex, remain prohibitively expensive and largely inaccessible to student laboratories. To address this challenge, our chapter of the Society of Physics Students has constructed, calibrated and operated a compact cost-effective laser autocollimator based on an open-source design and software [1]. The project was funded through the SPS National Research Award to our chapter. The main body is a 3D-printed PLA structure, while the optical system incorporates a diode laser, beam splitter, achromatic lens, and Raspberry Pi camera sensor. Custom Python software running on a Raspberry Pi enables image-based angular readout and calibration. While the instrument's design was adapted from existing work, realizing the project provided students valuable hands-on experience in optics, instrumentation, and programming, while also improving our teamwork skills and fostering the sense of community at the department. The device will be used for demonstrations and recruitment at the university and local events.

References:

Q. Meng, J. Stirling, W. J. Wadsworth and R. W. Bowman, "ACute3D: A Compact, Cost-Effective, 3-D Printed Laser Autocollimator," in IEEE Transactions on Instrumentation and Measurement, vol. 71, pp. 1-11, 2022, Art no. 5012111, doi: 10.1109/TIM.2022.3174267.

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**Jacob Goldovitz**

University of Massachusetts Dartmouth

*Hydrodynamical Simulations of Supernovae in 3D : From Explosion to Remnant*

Co-Authors: Dr; Robert Fisher, Grace Katz

Poster Number: 282

The leading models for luminous transients, such as supernovae (SNe), are three-dimensional in nature, whereas the current understanding of supernova remnants (SNRs) comes almost entirely from spherically symmetric models. Due to this discrepancy, there has been a recent endeavor in the astrophysical community to connect these leading models to the remnant phase, comparing them with observational data of SNRs to provide a better understanding than that of the spherically symmetric models. Utilizing open-source astrophysical code framework FLASH-X, work has begun verifying the use of a comoving formalism for simulations of homologously expanding flows. The main advantage of using a comoving formalism is that the computational zones within the frame naturally expand over time, thereby simulating large dynamic ranges at a lower computational cost. The formalism is being tested on a Taylor-Sedov expansion to verify that the result produced is the same as from an inertial formalism. Once verified, techniques will be developed to apply the comoving formalism to leading three-dimensional models for Type Ia SNe.

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**Dominick Guadagno**

Adelphi

*Quantum Beats in Rb Fluorescence Signal*

Co-Authors: Amanda Bowen, M; J; Wright, John Lund; Adelphi University

Poster Number: 146

A short pulse is used to excite Rb atoms and observe light from the fluorescence signal as a function of time.  We detect optical beating within the fluorescence signal.  We are exploring how this signal depends on the details of the excitation pulse.  In particular we are exploring how amplitude of the beats depends on the length of the excitation pulse.

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**Hannah Hamilton**

Davidson College

*A Classical and Quantum Mechanical Exploration of Symmetry in Double Wells*

Co-Authors: Dr; Mario Belloni (Professor and Chair of Physics at Davidson College)

Poster Number: 87

Linear and non-linear oscillators can be modeled with both classical and quantum mechanics to determine characteristics based on their potential energy functions. This study explores both symmetrical and asymmetrical double-well potential energy functions of oscillating masses to determine the effect of symmetry on their motion with a focus on phase space (Poincaré and Wigner function) plots.

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**Zia Harrison**

Furman University

*Modeling Multi-Photon Superradiance in Protein Fiber Networks of Quantum Emitters*

Co-Authors: Hamza Patwa and Philip Kurian; Howard University Quantum Biology Laboratory

Poster Number: 178

Tryptophan is an essential amino acid found in networks throughout protein systems. Because of its biological ubiquity and its strong fluorescent response, tryptophan is useful as a reporter of biomolecular and cellular dynamics. Research into tryptophan networks could prove essential to understanding neurodegenerative diseases that inhibit important processes like intra-cellular transport and synaptic signaling. It has been experimentally demonstrated that networks of tryptophan, arranged in helical architectures in protein fibers, exhibit superradiant signatures in response to even a single-photon excitation of UV light. Using the Lindblad Equation, this work focuses on modeling superradiance beyond the single-excitation limit, to fully explore multi-photon superradiance in molecular networks of quantum emitters, as illustrated schematically in Figure 1. For this, we are creating extensions of codes for the general non-Hermitian Hamiltonian

matrix to explore the multi-excitation manifold, where there are two-level systems and photons.

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**Bianca Hassan**

Davidson College

*Solving the Double Well using the Spectral and Operator Method to Explore Effects of Asymmetry*

Co-Authors: Mario Belloni, Professor of Physics at Davidson College

Poster Number: 272

The infinite square well (ISW) and quantum simple harmonic oscillator (SHO) are well-known models with exact solutions to the Schrodinger equation. The double well has a pair of central potential energy wells whose depth and symmetry can be varied, but has no exact solution. In this work, we explored how the operator and matrix methods in quantum mechanics allow the solution for any double well by using the wave functions and Hamiltonian matrix elements of either the ISW or SHO. This research focused on using the SHO basis to better approximate the double well. In addition, the behavior of a wave packet in the well is visualized in different ways (Wigner function, quantum carpet, etc.) and comparisons are made between wave packet's motion in wells with different parameters.

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**Rashard Hawkins**

Washington State University

*investigating binary phase separation of organic materials for OPVs*

Poster Number: 316

The advancement of solar cell knowledge would allow for more efficient and sustainable energy technologies along with larger scaling and higher cost efficiency due to the printability of modern solar materials. The main issue holding the field back is that the thermodynamics of nano-phase separation is important but not thoroughly studied. To help solve this problem we would need to find out What is the thermodynamic phase

diagram between two hyper-performance molecules. I make films of different concentrations and anneal them at a variety of temperature, then I check them under the microscope for phase separation. Depending on the concentration and temperature it will either help or hinder phase separation. Upon establishing the thermodynamics of phase separation, we will be able to engineer the ideal phase separation for high performance devices.

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**Kate Hazelwood**

Rhodes College

*Setup Uncertainty of Pediatric Patients with Extracranial Tumors Receiving Proton Therapy*

Co-Authors: Kate Hazelwood, Rhodes College Department of Physics; Jinsoo Uh, St; Jude Children's Research Hospital Department of Radiation Oncology; Chia-ho Hua, St; Jude Children's Research Hospital Department of Radiation Oncology

Poster Number: 37

This study analyzed setup uncertainty in pediatric patients with extracranial tumors who received image-guided proton therapy. A total of 124 patients (median age at radiotherapy: 10 years) enrolled in the prospective study from 2020 to 2024; 64 patients (52%) were anesthetized. Cone-beam computed tomography (CBCT) was performed daily as standard of care to calculate and correct manual setup errors, once after image-guided correction to measure residual errors, and weekly following treatments to study intrafractional motion. A CBCT was performed immediately after an orthogonal radiograph for paired comparisons once per course for 34 patients. The setup uncertainty was reduced after image-guided correction by daily CBCT. The 95th percentile of the total magnitude of post-correction error was 1.6 mm with anesthesia and 3.1 mm without anesthesia. The 95th percentile of the post-treatment error was found to be 2.6 mm with anesthesia and 4.9 mm without anesthesia. Results will inform robustness optimization and immobilization practices.

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**Yi Le Hong**

University of Utah

*Quantum Sensing: Organic Light-Emitting Diodes and Magnetoresistance*

Co-Authors: Hong Yi Le, Bonaventure Odeke, Chanhyun Pak, Prashanna Poudel, Aysha Ahmad, Isaac Bentley, Derek J; Mansfield, Ryan M; Stolley, and Christoph Boehme

Poster Number: 352

Organic semiconductors are promising materials for room-temperature, spin-based quantum sensors, but their performance is limited by electron spin decoherence caused by hyperfine interactions (HFI) with hydrogen nuclei. Our research investigates a materials-centric strategy to mitigate this decoherence by synthesizing and characterizing a deuterated polymer, d-MEH-PPV, where hydrogen atoms ($^1H$) are replaced with deuterium ($^2D$), which has a smaller nuclear magnetic moment. We fabricated bipolar organic light-emitting diodes (OLEDs) using the novel d-MEH-PPV and a reference material, SY-PPV. The hyperfine field strength in each material was probed by measuring the magnetoresistance effect at low magnetic fields (-5 ~ 5 mT), where the resistance minimum corresponds to the local hyperfine field amplitude. Our results confirm a significant reduction of the hyperfine field in d-MEH-PPV. The measured ratio of the hyperfine field in SY-PPV to that in d-MEH-PPV is 2.85(46). This value, consistent with the theoretical factor of 3.25 between the proton and deuteron magnetons, validates the success of the perdeuteration process. This work experimentally verifies that isotopic engineering via perdeuteration is an effective method for reducing magnetic noise in organic semiconductors, a critical step toward enhancing spin coherence times and realizing the potential of low-cost, flexible organic materials for quantum sensing applications.

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**Abigail Hovorka**

The College of Wooster

*SI-RAFT Synthesis of Poly(methyl acrylate)-Grafted Gold Nanorods*

Co-Authors: Nehal Nupnar (Case Western Reserve University), Andrew Joyce (Saint Vincent College), Patrick Barrett (Cleveland State University), Kiril A; Streletzky (Cleveland State University), Michael J; A; Hore (Case Western Reserve University)

Poster Number: 111

Grafted polymers have a wide range of applications, including reducing energy consumption and altering the mechanical properties of materials. Much is known about the conformation and relaxation dynamics of polymers grafted to planar surfaces and spherical cores, but these properties are less understood for anisotropic shapes such as nanorods. To investigate this, poly(methyl acrylate) (PMA) was grafted from the surface of gold nanorods (AuNRs) using surface-initiated reversible addition-fragmentation chain-transfer (SI-RAFT) polymerization with functionalized chain transfer agents to control grafting density. Depolarized dynamic light scattering (DDLS) measurements of bare AuNRs and grafted nanorods (PGNRs) yielded translational and rotational diffusion coefficients, and thus AuNRs and PGNRs dimensions. Preliminary DDLS results suggest a PMA brush height comparable to predictions for polymers attached to spherical rather than planar surfaces. These results establish an SI-RAFT method that can be extended to different molecular weights, thermoresponsive polymers, and AuNRs with different aspect ratios.

Research supported by the NSF REU Site: Synthesis, Assembly and Characterization of Soft Matter Systems, Award #2244106.

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**Jaden Hubbard**

SUNY New Paltz

*Spectroscopy With a Seestar S50*

Poster Number: 276

Smart Telescopes have risen in popularity due to their low cost and high image quality. We set out to determine if spectroscopy could be performed effectively and accurately using the Seestar S50 telescope. Spectroscopy is performed by astronomers to detect elements within celestial bodies. To conduct spectroscopy, images are taken using the Seestar S50 software with a diffraction grating in front of the aperture of the telescope. After extracting these images, they are analyzed using AstroImageJ and RSpec. Spectra graphs are then compared to known spectral lines of stars to test if the Seestar S50 can be used as a cost-efficient tool for spectroscopy.

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**Yulian Humaran Humaran**

University of Puerto Rico at Mayaguez

*Modeling Non-Spherical Dust Grains in Evolved Star Environments*

Co-Authors: Dr; Angela Speck, Sean Dillon; University of Texas at San Antonio

Poster Number: 250

Dust surrounding evolved stars strongly influences their infrared emission, yet most radiative transfer models continue to assume spherical dust grains, limiting how well they reproduce observed spectra. In this project, we used the DUSTY radiative transfer code to test new dust input files that incorporate the effects of grain shape on light absorption and scattering. These inputs were generated using a new tool developed, which calculates optical properties for continuous distributions of ellipsoidal grains, allowing more realistic treatments of non-spherical geometries.

We modeled circumstellar dust shells around asymptotic giant branch (AGB) stars using both spherical-grain and ellipsoidal-grain inputs. The comparison revealed systematic differences in spectral slope, feature strength, and peak wavelength. In particular, the ellipsoidal models better reproduced infrared structures that are often underestimated by spherical models.

These results demonstrate that incorporating grain geometry improves the physical realism of radiative transfer simulations. The new input-generation code will be made publicly available to extend the versatility of DUSTY and enable more accurate modeling of dusty astrophysical environments.

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**Iminabo Roberts Iminabo Roberts**

Grambling State University

*Impacts of Temperature and Surfactant on the Size Measurement of Nanoparticles by Dynamic Light Scattering*

Co-Authors: Ka'Tra Winchester, Khaliq Brown, Tatenda Kasirori, Noble Agyeman-Bobie, Enoch Owoade, Praise Anwiman, Praise Gavi, Haeyeon Yang

Poster Number: 334

Dynamic Light Scattering (DLS) operates by analyzing fluctuations in the intensity of light scattered by nanoparticles undergoing Brownian motion. In this study, we examined how variations in temperature and surfactant concentration influence the hydrodynamic size of nanoparticles synthesized by laser ablation in liquid. Using MATLAB, R (ggplot2, hypothesis testing), and Numpy, we modeled temperature-induced viscosity

changes and surfactant micelle formation to interpret shifts in the DLS-measured particle size. Higher liquid temperatures and surfactant concentrations reduced solvent viscosity, resulting in faster Brownian motion and smaller apparent sizes. Experimental data were analyzed through regression modeling and validated against theoretical diffusion equations derived from the Stokes-Einstein relationship. Our results indicate that temperature and surfactant effects introduce measurable deviations in DLS readings, emphasizing the need for calibration when characterizing nanoparticles synthesized under variable liquid conditions. This study contributes to improving the accuracy and reproducibility of nanoparticle characterization for laser ablation research.

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**Pol Jarne Cupons**

Lawrence Technological University


*GEANT4 Tutorial: Simulations of Nuclear Reactions and Medical Isotope Applications*


Co-Authors: Dr; Jerry A; Nolen (Argonne National Laboratory); Amy Renne (Argonne National Laboratory);


Poster Number: 346


This research project, which has been carried out at Argonne National Laboratory (ANL), has two main objectives. The first objective has been to master the use of GEANT4 (G4), understanding the internal structure of the software and the main classes used to develop a G4 application. This work culminates with the elaboration of a tutorial document for G4 beginners, with applications in nuclear and medical physics. The second objective is the direct application of G4 in two significant areas of physics. One of them is the simulation of photonuclear reactions, such as the 197Au(γ,n)196Au reaction. These simulations allow us to calculate cross sections, produce distributions and compare the results with other software such as PHITS and experimental data. The second application is in the field of cancer radiotherapy, specifically the effects of the Auger electron (AE) emitter Tb-155 on a prostate cancer cell. Using the recent G4-DNA extension that includes a complete nuclear model, we are investigating the potential of Tb-155 AE emissions to produce DNA damage, both direct and indirect, in different cellular compartments. This damage is measured by energy depositions in DNA material, producing single and double-strand breaks. We also study how the condensation of chromatin into chromosomes, representing different cell cycles, affects DNA damage. These G4 applications will serve as practical examples in the tutorial document.


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**Keshav Jha**

Duke University

*Predicting Reactive Oxygen Species generated through photoactivation of targeted laser therapy in-silico*

Co-Authors: K; Jha, J; Farina, V; Radosova, P; Hughes, D; Alcorta, M; Oldham, T; Haystead

Poster Number: 201

This study attempts to simulate the activation of targeted photodynamic molecules using visible laser light and characterize the direct Reactive Oxygen Species (ROS) generated by Cherenkov and laser radiation for aggressive cancer lines. HS583, a novel photodynamic molecule composed of an HSP90 inhibitor bound to Verteporfin, was manufactured in-house. Optical properties of HS583 were characterized using a spectrophotometer and fluorometer, and a TOPAS Monte Carlo simulation was created to model HS583 photoactivation under visible light. Beam sources at wavelengths matching HS583 absorption peaks were simulated on a polypropylene vial filled with 100 μL of water. A 0.1 μL scoring phantom within the vial was divided into 50 nm voxels with 1 μM of HS583 randomly distributed. Photon fluence, energy absorbed by HS583, and fluorescence of 10 million photons were scored for the molecule for each wavelength and compared to the biological effect of HS583 in cells when exposed to light. The data was adjusted to a 1 J/cm^2 beam and analyzed using Python. Absorption measurements confirmed a maximum absorption peak of HS583 at 425 nm and a single emission peak at 700 nm. Simulations demonstrated that for a 1 J/cm^2 incident beam, 2.1E13±0.83E12 eV is absorbed at 425 nm. Assuming an energy required to hydrolyze water of 1.23 eV, this corresponds to 1.1E-11±0.04E-11 moles ROS generated, which is sufficient to drive activation of HS583 and toxic ROS generation in aggressive cancer lines.

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**Shwetlana Jha**

Yale University

*Correcting for Y Errors with the Bacon Shor Code*

Co-Authors: Kaavya Sahay, Harshvardhan K; Babla, Shruti Puri; All affiliated with: Yale Quantum Institute, Yale University

Poster Number: 122

Quantum computers have the potential to unlock a new era of human innovation across various fields. However, their reliability is severely constrained by experimental imperfections and hardware errors. Quantum Error Correction (QEC) is the most critical challenge toward enabling the real-world utility of this technology. To address this challenge, various QEC codes have been developed to detect and correct different types of errors present on hardware. The Bacon-Shor code is a QEC code that attempts to protect quantum information by detecting and correcting bit flip and phase flip errors. It focuses on local error detection, reducing its complexity and making it practical for checking quantum computations. This research, conducted in Prof. Shruti Puri's lab at Yale, investigates the Bacon-Shor code's robustness and error threshold under Y errors. The project uses combinatorial analysis and numerical simulations to identify structural error patterns and explore decoder optimizations for more fault-tolerant quantum computing systems.

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**Zachary Jimerson**

Arkansas Tech University


*Evaluating Physics-Informed Neural Networks for Modeling the Lorenz-63 Chaotic System*

Poster Number: 222

This project investigates the predictive performance of data-driven and physics-informed machine learning models on the Lorenz–63 chaotic system. Chaotic systems, characterized by their sensitivity to initial conditions, present unique challenges for accurate long-term forecasting. To address this, the study compares a baseline neural network and a physics-informed neural network (PINN) in modeling the Lorenz equations, evaluating each model's ability to reproduce system trajectories, maintain stability, and recover physical parameters such as $\rho$, $\sigma$, and $\beta$.

Performance is assessed through trajectory error, stability over time, and parameter estimation accuracy. The goal is to determine whether embedding physical laws into machine learning architectures can improve interpretability and predictive reliability for nonlinear dynamical systems. While results are still being developed, this work aims to demonstrate the potential of hybrid approaches to bridge the gap between traditional numerical methods and modern data-driven modeling in the study of chaotic behavior.

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**Sofia Jolley**

Florida State University

*Magnetic Actuation and Low Reynolds Number Propulsion of Ceramic Nanostructures for Bio-Hybrid Micro-Robots*

Co-Authors: Sophie Jermyn, Jamel Ali, Department of Chemical and Biomedical Engineering at FAMU-FSU College of Engineering, National High Magnetic Field Laboratory

Poster Number: 290

Magnetically actuated helical microswimmers offer a promising strategy for controlled locomotion on the nanoscale, particularly for biomedical applications such as targeted delivery and diagnostics. Inspired by the propulsion mechanisms of prokaryotic organisms, these swimmers convert wireless magnetic inputs into motion through rotation-translation coupling in viscous fluids.

At low Reynolds numbers, propulsion requires breaking time-reversal symmetry, achieved here using helical geometries. A uniform rotating magnetic field applies torque to the swimmer's magnetic moment, producing directional motion without chemical fuel.

We fabricated hollow magnetic microswimmers by templating flagella-like biostructures with amorphous silica, a ceramic material valued for its mechanical rigidity, biocompatibility, and surface tunability. The silica provides structural stability under torque, while a thin nickel layer enables magnetic responsiveness. This bottom-up approach yields scalable, geometry-controlled swimmers suitable for precise actuation in fluidic environments.

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**Brooke Jones**

Rowan University

*Sensitivity Enhancement of a Low-Frequency Atomic Electrometer Using the Ponderomotive Effect*

Co-Authors: Sofia Capitillo-Villasmil, Dr; Michael Lim

Poster Number: 83

A study of utilizing the ponderomotive effect to improve the signal detection of a low-frequency electric field using an atomic electrometer. A three-color, all-diode laser excites Rydberg levels in Rb atoms held in a glass vapor cell causing them to be sensitive to low-frequency E-Fields. Faraday shielding proves to be an obstacle as the Rb atoms create a metallic monolayer on the inner wall of the vapor cell, allowing for external E-fields to be screened out from the cell. Applying an oscillating electric signal to electrodes placed around the vapor cell creates areas of high ponderomotive potential hindering the ability of the free electrons to redistribute themselves, improving signal detection. The atomic response resulting from a periodic pulsed E-field was recorded for different electrode configurations, beam positions, amplitudes, and frequencies of the electric signal applied to the electrodes. This response was fit to a two-component exponential decay with decay constants $\boldsymbol{\tau}$ characterizing how quickly the external field was screened out. The results showed the configuration and beam position greatly impact the dynamics of Faraday shielding. Additionally, applying a signal with a high voltage and low frequency to the electrodes yields the highest $\boldsymbol{\tau}$ values among all configurations and beam positions. This is evidence that the free movement of electrons is impacted by ponderomotive potential.

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**Andrew Joyce**

Saint Vincent College

*Characterization of Bare and Grafted Gold Nanorods (AuNRs) Using SEM and DDLS Techniques*

Co-Authors: Patrick Barret, Dr; Kiril Streletzky, Ph; D; : Cleveland State University Physics Department, Abigail Hovorka: College of Wooster Physics Department, Nehal Nunpar, Dr; Michael J; Hore, Ph; D; : Case Western Reserve University Department of Macromolecular Science and Engineering

Poster Number: 138

Polymer-grafted gold nanorods (AuNRs) are on the cutting edge of polymer technology. Grafting polymer to AuNRs allows for controlled diffusion and uses ranging from cancer detection and treatment to plasmonics. In this project, we sought to understand the diffusive behavior of bare and PMA-grafted (Surface Initiated) AuNRs by characterizing their dimensions. To do this, we used Scanning Electron Microscopy (SEM), Depolarized Dynamic Light Scattering (DDLS), and UV-Vis Spectrophotometry. We faced several challenges. Using SEM imaging, we obtained reliable size distributions for bare AuNRs, but not grafted AuNRs as they were damaged by the electron beam. For DDLS, we used two setups with laser wavelengths of 488nm and 637nm. Results were inconsistent between setups, making our DDLS sizing data difficult to interpret. A possible reason for these inconsistencies is significant absorbance, particularly at 637nm. Next steps include working to understand the effect of absorption on our data and refining sizing results.

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**Draven Kaminsky**

Weber State University

*Quasi-normal Mode Analysis around a Black Hole using Finite Differencing*

Poster Number: 150

When discussing a quantum mechanical system, one of its most important features is the allowed energy levels. Finding these energy levels can be done for various systems, but the focus of this research is on a scalar field in spacetime around a Schwarzschild black hole. Scalar fields have a scalar value at every point in spacetime, and a Schwarzschild black hole is non-rotating, spherically symmetric, and is not electrically charged. The scalar field and black hole interaction leads to quasi-normal modes, which are the energy eigenstates of the scalar field of the system that have dissipative properties due to the black hole. However, finding these energy eigenstates requires certain computational techniques such as the use of finite differencing, so the methods of computation will be discussed as well as how they can be applied to the system.

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**Kara Kanetis**

University of Hawai'i at Manoa

*Formation and Aqueous Alteration in Carbonaceous Chondrites*

Co-Authors: Kara B; Kanetis, Department of Physics and Astronomy, University of Hawaiʻi at Mānoa

Poster Number: 152

CM chondrites, a subgroup of carbonaceous chondrites, record extensive low temperature aqueous alteration on their parent body. The alteration modifies primary minerals and organic matter, leading to the formation of secondary phases such as phyllosilicates, carbonates, oxides, and sulfides. These alteration features reflect fluid chemistry, thermal conditions, and water rock interactions on the parent body, providing information on early solar system processes during the first few million years after accretion, as indicated by isotopic dating and the presence of short-lived radionuclides like Aluminum-26. This study looks at carbonate grains in seven meteorite samples, Boriskino, Cold Bokkeveld, Murchison, Bells, Sutter's Mill, and Jbilet Winselwan, using scanning electron microscopy to see how aqueous alteration influenced carbonate abundance, distribution, and textures. Using methods established by Dobrică et al. (2024), carbonates were mapped and classified by type, showing variations linked to aqueous alteration. The results show widespread phyllosilicate formation, carbonate zonation, and deformation features suggesting multiple stages of alteration. These provide a framework for studying the chemical evolution of fluid systems and the processes that modified them. Future work will aim to connect these features with shock classification, creating a mineralogical record of the alteration histories in CM parent bodies.

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**Manveer Kang**

CSU Sacramento

*Chemical Separations of Rare Earth Elements for Isotopic Analysis of an Asteroid sample*

Co-Authors: Quinn Shollenberger, Jan Render, Greg Brennecka, Christopher Hodges, Lawrence Livermore National Labs, CSU Sacramento

Poster Number: 218

Understanding solar system formation requires precise chemical and isotopic analyses of materials that preserve its earliest history. Before analyzing the pristine sample returned from the near-Earth asteroid Bennu, laboratory techniques must be optimized for element separation and purification. During my internship with the Cosmochemistry Group at Lawrence Livermore National Laboratory's Space Institute, I worked to improve ion-exchange chromatography methods for separating rare-earth elements (REEs). Although widely used, ion-exchange chromatography remains challenging for heavy REEs due to their similar chemical properties. My work focused on refining separation efficiency and reproducibility using LN-spec resin and controlled acid molarity gradients to enhance recovery and minimize cross-contamination. These improvements support more accurate isotopic analyses of Bennu and other extraterrestrial materials, contributing to a better understanding of the chemical and isotopic processes that governed the early solar system.

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**Tatenda Kasirori**

Grambling State University

*Effects of Nanoparticles on Laser Sintering of Metal Powders*

Co-Authors: Khaliq Brown, Ka'Tra Winchester, Jovana Latinovic , Haeyeon Yang

Poster Number: 210

Nanoparticles (NPs) suspended in fluid, or nano fluids, have shown remarkable properties , including heat transfer between liquids, mediated by the NPs. The enhanced thermal conductivity of these fluids with small-particle concentration was surprising and could not be explained by existing theories as micrometer-sized particle suspensions exhibit no such dramatic enhancement. The enhanced thermal conductivity in nano fluid can be utilized to yield better performing material properties from laser sintered material. This is because enhanced thermal conductivity by NPs during the laser melting period, which would make them more uniform in composition, improving the quality of the melts. During the melting period, the melt can be viewed as nano fluid if "embedded" NPs are still in solid phase, suspended in the liquid. It is noted that the nano fluid can be achieved in any melting/sintering processes including the melting of large elements of lunar regolith either by a laser or concentrated sunlight [1] on the Moon. We discuss the laser melting of powders such as SmCo5 with various NPs and the physical properties including the hardness.

[1] J.-C. Ginés-Palomares et al., "Laser melting manufacturing of large elements of lunar

regolith simulant for paving on the Moon," Scientific Reports, vol. 13, no. 1, p. 15593, 2023/10/12 2023.

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**William Keener**

Austin Peay State University

*Influence of Ionization Balance on the Fe XXVI Ly a Doublet in Recombining Plasmas*

Co-Authors: Justin Oelgoetz; Department of Physics, Engineering and Astronomy, Austin Peay State University

Poster Number: 306

The Fe XXVI Ly α1 / Ly α2 ratio is a sensitive diagnostic of plasma conditions. Extending previous analyses that explored electron density and temperature dependency in coronal equilibrium, we now examine the influence of ionization balance on this ratio by manually adjusting the ionization fractions of the plasma in order to simulate plasma that is not in coronal equilibrium such as a plasma that has been ionized and is now recombining. We used a collisional-radiative model with an assumed set of ionization fractions that we artificially varied. We assess how the relative populations of adjacent ion stages alter the emissivities and Ly \alpha ratio for a given set of conditions. This controlled inclusion of ionization balance effects reveals departure from the typically expected ratio of 2 for optically thin plasmas. The results emphasize the importance of fine structure resolved atomic data in modeling in and interpreting astrophysical spectra.

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**Kaden Kelly-Pojar**

The Pennsylvania State University

*The Pea doesn't fall far from the Pod: Untangling the Relationship between Planet Formation and System Uniformity*

Co-Authors: Lucas Brefka (Penn State Department of Astronomy and Astrophysics, Penn State Center for Exoplanets and Habitable Worlds), Eric Ford (Penn State Department of Astronomy and Astrophysics, Penn State Center for Exoplanets and Habitable Worlds)

Poster Number: 308

Numerous close-in, compact multi-planet systems discovered by the Kepler mission demonstrate remarkable intra-system uniformity in size and orbital spacing (akin to "peas-in-a-pod"), a configuration not mirrored in the Solar System. Understanding trends within the architectures of these systems gives insight into their dynamical histories, illuminating the processes that govern their formation. In this work, we apply system-level measures of uniformity to simulated systems of super-Earth-sized planets to investigate how changes in initial disk parameters affect system-wide mass distribution and orbital morphology. Using these global uniformity metrics, we can more quantitatively describe system architectures as well as compare our simulated results more directly with the Kepler catalog. Exploring the complex interplay between formation conditions and resulting architectures is vital for creating a more complete picture of how planetary systems evolve and diversify.

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**Caroline Kilian**

Central Connecticut State University

*Investigating Stellar Evolution: Dynamical Mass Measurements for 49 Ceti, HD 32297, and HD 110058*

Co-Authors: Joshua Grajales (Wesleyan University), Eric Rumsfeld (UC Irvine), Meredith Hughes (Wesleyan University), Kevin Flaherty (Williams College)

Poster Number: 230

To infer the masses of stars, astronomers typically rely on photospheric measurements of luminosity and effective temperature. However, with the accuracy and precision of distance measurements provided by Gaia and the angular resolution of the Atacama Large Millimeter/submillimeter Array (ALMA), it is possible to make direct dynamical mass measurements of stars that host gas-bearing debris disks. Kepler's third law is used to derive the stellar mass from the orbital velocity of gas as a function of distance from the star. We model the archival molecular gas spectral line emission in the CO J=2−1 or J=3-2 transitions using a ray-tracing code (Flaherty et al. 2015), and compare our models with the visibilities using GALARIO (Tazzari et al. 2018). We use the MESA Isochrones and Stellar Tracks (MIST) database to compare our dynamical masses with expected values. Here we present results for 49 Ceti, HD 32297, and HD 110058.

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**Claire Klein**

High Point University

*Construction and Characterization of a Low-Cost Anechoic Chamber*

Co-Authors: Eric Rokni, High Point University

Poster Number: 342

Accurate acoustic measurements require a controlled environment where sound can be captured without reflections or external noise. Anechoic chambers provide this by isolating sound and using foam wedges to absorb echoes. However, these rooms can be extremely expensive, making it difficult for some groups to perform quality acoustic research. This project presents the design and characterization of a low-cost anechoic chamber built to support acoustics research at High Point University. We will outline the construction parameters, a detailed bill of materials, and measurement techniques used to evaluate performance, including transmission and reverberation time. This project offers a scalable model for other institutions with limited resources to perform high-quality acoustic experiments.

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**Damien Koon**

Florida Institute of Technology

*Violating the CHSH Inequality: Empirical Evidence of Quantum Nonlocality*

Poster Number: 85

The Clauser–Horne–Shimony–Holt (CHSH) inequality provides an experimentally testable framework for Bell's theorem, leading to John Clauser's pioneering Bell tests which were recognized by the 2022 Nobel Prize in Physics. This paper acts as a pedagogical exposition aimed at undergraduate students and simultaneously replicates and extends CHSH experiments to explore quantum nonlocality across three computational settings: (1) an ideal (noiseless) simulation, (2) a noisy simulation (to emulate decoherence), and (3) execution on IBM quantum hardware. In each case, entangled Bell states are prepared and measured with optimized settings, leading to the demonstration of violations of the classical bound, $|S| \leq 2$. Our results empirically validate Bell's theorem and demonstrate that quantum correlations remain robust even under realistic noise. This work serves as a practical guide for educators, students, and

researchers who wish to reproduce this foundational experiment in quantum information in their own environments.

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**Madelaine Kreisel**

Lycoming College


*Growth of Arabidopsis Thaliana in Lunar Simulant*

Poster Number: 256

For plants to grow outside of Earth's atmosphere, material is necessary for them to thrive, whether that material is Earth soil or water for in hydroponics. Following the Apollo 11 and 12 missions, studies were conducted which suggested lunar material could viably be used as a supporting medium for plant growth. The main objective of the experiment outlined in this poster was to measure plant growth both directly in lunar simulant and using lunar simulant as a support medium. Germination rates and number of leaves were tracked and counted as a measure of the growth of Arabidopsis thaliana over time. The data and observations collected showed that lunar simulant placed under potting soil resulted in the plants growing faster, visibly thriving, and using water more efficiently. Using lunar material in plant growth outside of Earth's atmosphere could reduce the amount of Earth material and water necessary to produce thriving plants.

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**Jacqueline Kuroda**

Ohio University


*Geant4 simulation to study High-purity Germanium detector response*


Co-Authors: Jacqueline Kuroda, Andrea Richard


Poster Number: 96

Understanding the origin of elements in the Universe and everything seen around us is the main goal of nuclear astrophysics. More than half of the elements on the periodic table are created in explosive stellar environments, such as supernovae and neutron star mergers. In the field of experimental nuclear astrophysics, specific measurements are made that allow us to shed light on how specific elements are synthesized in stars. This work focuses on commissioning a High-purity Germanium (HPGe) detector for neutron activation analysis experiments at the Edwards Accelerator Laboratory. This new experimental set up will then be used to perform a neutron activation on a sample to investigate reactions of astrophysical interest.

A detailed simulation of the HPGe detector has been developed to investigate the detector's sensitivity to background radiation. Preliminary tests of the detector show that it is sensitive to background radiation. During the tests the detector was shielded from background radiation using a lead house that was built, but even with the lead, the detector was still too sensitive. To better understand and suppress the contributions of the background seen by the detector a Geant4 simulation of the detector has been created, the simulation models both the detector geometry and the environmental background sources. Through this, the simulation provides insight into the detector response and demonstrates how background radiation contributes to experimental data.

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**Darshan Lakshminarayanan**

Rutgers University - New Brunswick

*Search for QCD instantons using the CMS B-Parking dataset*

Co-Authors: John Paul Chou (Rutgers University), Amandeep Kaur (Rutgers University), Darshan Lakshminarayanan (Rutgers University), Joseph Reichert (Rutgers University)

Poster Number: 244

The Instanton process is a non-perturbative QCD effect that has been theorized but not yet observed experimentally. This analysis searches for Instantons using proton-proton collision data collected in 2018 from the CMS experiment at the CERN Large Hadron Collider. The instanton signal is produced using Monte Carlo methods and existing theoretical parameters, which have high uncertainties. The final state of the instanton process is characterized by isotropically distributed and displaced charged tracks. Since this final state does not correspond to a trigger at CMS, we use a dataset with a high number of “pileup” vertices and low transverse momentum tracking, where we reject the triggered vertex. Using a data-driven background estimation technique, we establish a signal region and compare the counts of Montecarlo Instanton signal to the estimated background. While the analysis is still underway, we do not expect to see a significant excess of Instantons. However, we do expect to place an upper bound on the Instanton cross-section.

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**Sean Lam**

Colorado College

*QuScope: Quantum Algorithms for Advanced Electron Microscopy*

Co-Authors: Dr; Roberto dos Reis, 1; Department of Materials Science and Engineering, Northwestern University; 2; NUANCE Center, Northwestern University

Poster Number: 296

Electron microscopy generates vast, complex datasets that increasingly challenge classical computational methods. We present QuScope, an open-source Python framework integrating quantum computing algorithms with electron microscopy analysis and simulation. The package aims to implement pure quantum approaches across three domains: (1) image denoising and filtering, (2) electron energy-loss spectroscopy (EELS), and (3) electron diffraction patterns. The current release includes hybrid quantum-classical implementations for image denoising and EELS feature extraction. Ongoing development focuses on fully quantum implementations for transmission electron microscopy (TEM), electron diffraction, and EELS simulation and analysis. QuScope provides a foundation for exploring quantum-enhanced materials characterization. The framework is publicly available at github.com/QuScope.

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**Karson Lamar**

East Texas A&M University

*Physics students' geometric conceptions of complex analysis:  A comparative case study.*

Co-Authors: Rebecca Dibbs, PhD; Mehmet Celik, PhD; East Texas A&M University

Poster Number: 188

While there has been extensive research conducted about students' mathematical thinking, there has been little to no research on how physics students adapt to an advanced mathematics course. The purpose of this study was to examine the thought processes of physics students in a complex analysis course using Tall's (2013) three worlds of mathematics as a theoretical perspective. This poster highlights some of the mathematical strategies possessed by physics students who take an advanced course such as complex analysis, including their differences in mathematical thinking, and ways they go about solving complex mathematical problems.

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**Layla Lammers**

Rhodes College


*Spatiotemporal Double Machine Learning*


Co-Authors: Layla Lammers (presenting), Anika Arifin (Smith College), Duncan DeProfio (Williams College), Benjamin Shapiro (University of Florida)


Poster Number: 31


Environmental policy evaluation frequently requires thoughtful consideration of space and time in causal inference. We use novel statistical methods to analyze the causal effect of land concessions on deforestation rates in Cambodia. Standard approaches, such as difference-in-differences regression, effectively address spatiotemporally-correlated treatments under some conditions, but they are limited in their ability to account for unobserved confounders affecting both treatment and outcome. Double Spatial Regression (DSR) is an approach that uses double machine learning to address these scenarios. DSR resolves the confounding variables for both treatment and outcome, comparing the residuals to estimate treatment effectiveness. We improve upon DSR by considering time in our analysis of policy interventions with spatial effects. We conduct a large-scale simulation study using Bayesian Additive Regression Trees (BART) with spatial embeddings and find that, under certain conditions, our DSR model outperforms standard approaches for addressing unobserved spatial confounding. We then apply our method to evaluate the policy impacts of land concessions on deforestation in Cambodia.


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**Braedon Larsen**

Carthage College


*Microgravity Ullage Trapping Technology (MUTT)*


Co-Authors: Owen Bonnet (Carthage College), Dr; Kevin Crosby (Carthage College), Juliana Alverez (Carthage College), Sema'je Farmer (Carthage College),

Poster Number: 318

Long-term, sustainable space exploration requires reliable in-space refueling, but the absence of gravity complicates propellant transfer. During propellant transfer, excess pressurant gas must be vented to maintain proper tank pressure. In microgravity, however, liquid propellant adheres to the tank walls, leaving a central ullage gas bubble whose uncontrolled position makes targeted venting unreliable. To address this challenge, the Microgravity Ullage Trapping (MUT) experiment seeks to form and trap ullage bubbles at designated vent ports using acoustic excitation. MUT is a companion project to Carthage College's Microgravity Ullage Detection (MUD) experiment and builds on recent advances in acoustic manipulation of gas bubbles.
MUT uses ultrasonic transducers to grow micron-scale bubbles from dissolved pressurant gases and steer them via acoustic pressure gradients. The experiment exploits both primary and secondary Bjerknes forces to achieve bubble migration and coalescence. We have demonstrated proof of concept in ground-based testing with a single transducer, confirming bubble growth and translation under controlled conditions. Based on these results, we are developing a suborbital payload featuring a phased array of transducers to enable group manipulation of ullage bubbles. By precisely nucleating and steering bubbles toward the vent port, this approach facilitates reliable, targeted ullage venting during microgravity propellant transfer.

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**Colin Lathwell**

Cleveland State University

*Characterizing the Dielectric Properties of Biomolecules through Molecular Dynamics Simulations*

Co-Authors: Sebastian Sensale-Rodriguez (Indiana University, Carlos Castro (Ohio State University), Wolfgang Pfeifer (Ohio State University)

Poster Number: 115

Terahertz (THz) spectroscopy is emerging as a promising, cost-effective, non-invasive tool for analyzing both inorganic and organic materials. Recent advancements have made it possible to integrate THz sensors with microfluidic chips, opening new opportunities for point-of-care diagnostics. While THz spectroscopy has been well-established for examining the dielectric properties of inorganic substances, there is growing interest in its use for the fast, sensitive, and reliable quality control of drugs and biomaterials, especially in commercial, industrial, and clinical settings.

Our research aims to study the dielectric properties of biomolecules and develop protocols for characterizing and predicting their response to AC electric fields, providing a foundation for THz sensor calibration. We specifically investigate whether THz spectral fingerprints can differentiate between DNA origami molecules of varying geometries in aqueous solution.

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**Nadine Lauffer**

Grove City College


*Shifting the Narrative of AI in Undergraduate Physics Education*


Co-Authors: Grove City College


Poster Number: 3

Artificial intelligence is shifting everything. The effects of AI in the classroom are hard to avoid but equally challenging to confront. How these challenges are addressed by professors and students alike has the potential to radically shift physics education into a new age. Students tend to live in fear of AI and how it will impact their studies and careers. Undergraduate programs need to shift and equip students to see AI as a tool: a way to enhance their abilities and press the envelope of science. Like any new technology, AI will either encourage or detract from human learning. Which path we choose all hinges on our perspective and approach. AI has the potential to enhance the field of physics if we are willing to shift our perspectives.

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**Walker Law**

Coe College


*Kinematic Optimization of SHMS and HMS using Hydrogen Elastic Reactions for Deuteron Electro-Disintegration Studies at Jefferson Lab*


Co-Authors: Walker Law, Pramila Pokhrel (Catholic University of America), Dr; Carlos Yero (Catholic University of America)


Poster Number: 47

Deuteron electro-disintegration (D(e,e'p)n) is a nuclear reaction in which an electron beam collides with a deuteron nucleus, ejecting the proton and causing the neutron to recoil. The D(e,e'p)n experiment tests various theoretical frameworks, such as Final State Interaction (FSI) and Plane Wave Impulse Approximation (PWIA). To study the (D(e, e'p)n) reaction at Thomas Jefferson National Accelerator Facility (JLab), we optimized the kinematic measurements of the Super High Momentum Spectrometer (SHMS) and High Momentum Spectrometer (HMS) using chi-squared optimization on a hydrogen elastic scattering reaction (H(e,e')p) using experiment reconstruction (data) and Monte Carlo simulation (SIMC). The chi-squared optimization method implemented calculates the optimal global spectrometer offsets to best align the SIMC and data histograms. This study prepares the SHMS and HMS for accurate kinematic measurements during future D(e,e'p)n studies at JLab.

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**Christopher Leary**

Bridgewater State University

*Trapping Single Molecule DNA with Optical Tweezers*

Poster Number: 186

Optical Tweezers are a powerful tool used for Biophysics research. They work by using laser beams to trap tiny objects. The goal of this research project was to isolate a single molecule DNA with the Optical Tweezers at BSU. This was accomplished by trapping micron-sized polystyrene beads with the lasers inside a “flow-cell” (a custom-built chamber with a channel, a micropipette tip, and inlet/outlet tubes). Once the beads were trapped, DNA was introduced into the flow-cell and chemically tethered between the two beads. Once trapped, the DNA could be stretched by using a stage to move the flow-cell. The broader impact of this is related to cancer research. By adding anticancer drugs to the flow-cell, stretching DNA, and examining the change in strength of the DNA molecule, we can calculate the binding affinity of anticancer drugs.

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**Lili Leatherman**

Augustana College

*Characterizing Photon Response to Neutron Interactions in a Prototype SiPM-Scintillator Detector*

Co-Authors: In collaboration with The Modular Neutron Array - Dr; Nathan Frank

Poster Number: 354

The Modular Neutron Array (MoNA) Collaboration is developing a new detector array to improve neutron detection for experiments involving fast neutrons in the range of 100-200 MeV. 6mm2 Silicon photo-multipliers (SiPMs) chips along with plastic scintillators are being used to detect light produced from neutron interactions. A test of a prototype detector was performed at Triangle University's Nuclear Lab (TUNL). The physical model used for testing is a 240mm x 240mm x 2.5mm array with both a sparsely and densely packed half section of SiPMs regions. Analysis of these data has been done by utilizing Python and C++ programming alongside ROOT, a data analysis software. The observed photon behavior in experimental data acts as a foundation for validating and refining simulation models. Current results will show the behavior of the particular setup from the sparse/dense array, along with comparisons to simulation.

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**Rupert Lim**

Haverford College

*The Effect of Hydrogen on the Photoconductivity of Porphyrin Nanowires*

Co-Authors: Walter Smith

Poster Number: 67

Nanowires that are self-assembled from Tetrakis(4-sulfonatophenyl)porphine (TPPS4) have shown a remarkable range of photoelectronic behaviors, including slow growth of photoconductivity over several days of illumination and high sensitivity to atmospheric oxygen[1]. Preliminary experiments in our group have shown that atmospheric hydrogen gas dramatically increases the conductivity and photoconductivity of the nanowires. We propose that the increase is due to a lowering of the height of Schottky barriers formed at the junctions of the nanowires with the AuPd electrodes. However, more recent experiments showed a surprisingly complex behavior, in which, after introduction of the hydrogen, the conductivity first went up slightly, then down slightly, then (after a delay of a few hours) up dramatically, and finally down dramatically. We propose that this complex behavior is due to a combination of the hydrogen and residual oxygen which outgasses from our sample chamber.

1- C.K. Riley, J. Phys. Chem. C 2010, 114, 19227–19233

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**Grant Lindell**

Florida Institute of Technology

*CMS Inner Tracker – Phase 2 Modules Upgrade*

Co-Authors: Dr; Souvik Das, Scott Demarest, Alex Dumbell

Poster Number: 246

The Phase 2 Upgrade to the CMS Inner Tracker (IT) will consist of about 4,000 silicon detector modules with a total of 2-billion-pixel data channels instrumenting a surface area of 4.9 m2 around the proton-proton collision point. Each module will undergo about 33 tests to evaluate and calibrate every pixel. Modules are being fabricated and tested across 24 institutions internationally, which makes tracking their performances and grading them uniformly for quality control a formidable challenge. The Panthera database, developed by students at Florida Tech, is the quality control system adopted by the IT that meets this challenge with a structured database, an intuitive web-interface, integration with testing software across institutions, and a programmable grading system. This poster describes the IT modules test-stand at Florida Tech that was used to develop the Panthera platform. We also describe the architecture of Panthera and some of the key module tests that inform grading.

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**Elena Lotti**

University of MA Dartmouth

*Breakdown Voltage of Hexagonal Boron Nitride Parallel Plate Capacitors*

Co-Authors: National Science Foundation Award 2244130, Dr; Hugh Churchill, Michael Mastalish, Dr; Jin Hu, Santosh Karki Chhetri, Dr; Takashi Taniguchi, and Dr; Kenji Watanabe

Poster Number: 268

Hexagonal boron nitride has multiple qualities that makes it extremely useful in 2D electronics. However, there is only one industry standard, which is difficult to obtain and replicate. This study looked at the electronic properties of two different growth methods of hBN when used as a dielectric material in capacitors. In particular, the breakdown voltage was assessed by supplying a sweeping voltage to the device until a current was measured and the hBN no longer acted as a dielectric. The two different growth methods acted similarly to each other, especially during the demolition phase of breakdown, with one growth producing a ratio of 0.97 ±0.07 V/nm and the second being 0.93 ± 0.05 V/nm. The observed positive linear relationship is attributed to the increased distance the defects need to travel as the thickness of the hBN flake increases, thus allowing for a higher tolerance to voltage. These results lay the groundwork for future applications of and easier access to hBN in 2D electronics.

**Christopher Lowe**

Lamar University

*Dependence of the Refractive Index for Flint Glass to an Energy Background*

Co-Authors: Jason Withers

Poster Number: 260

We study the dependence of the refractive index, n, for flint glass with the change of energy background. An increase in the energy background increases the vibrational frequency of the electric dipole constituents. For low energies, the vibrations are quasi-linear and the interaction between light and matter is described by Lorentz's oscillatory model, where n depends on the Cauchy parameter, C. We assess the changes of index n for flint glass by measuring changes of C when the background energy set up across the glass is below the first excitation threshold of 131.33nm.

When we measure the change in n using the reflection of a 650 nm laser beam near the Brewster angle assisted by a low voltage between 0 and 2.4volts, we observe that the C value remains practically the same, of 11254. So, we decided that we need to add more voltage. However, for assisting energies larger than 2.4eV, the surface dipoles vibrate nonlinearly. Therefore, we changed our focus of study from the reflection of light at surface to the transmission of light throughout glass, using the vibrations of bulk dipoles. Using the minimum deviation method, we observe a measurable change in C close to 9.5volts, where C becomes 11280. This result proves that an additional energy background can induce a measurable change in the refractive index of glass. We acknowledge The Office of Undergraduate Research's URG program for funding this research project.

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**Ella Luking**

Rhodes College

*RHOK-SAT: Characterizing Novel Photovoltaics with a 1U CubeSat*

Co-Authors: Rhodes College RHOK-SAT

Poster Number: 202

RHOK-SAT is a 1U nano satellite with the primary goal of characterizing and measuring the performance of the novel "Perovskite" photovoltaic cells while in Low Earth Orbit. Although a novel material, Perovskite has shown enhanced power production capabilities as compared to more commonly known photovoltaic materials. Additionally, the RHOK-SAT project seeks to offer real-world engineering experience to students at Rhodes College, which does not have a formal engineering program. The construction of the satellite began in 2019, and students from various majors and class years have contributed to the design, manufacturing, and testing of the satellite. RHOK-SAT launched in September 2025, as part of an International Space Station resupply mission. RHOK-SAT will be in orbit for one year, during which time Perovskite performance will be monitored by Rhodes students via an on-campus ground station.

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**Xavier Maple**

Morgan State University

*Exploring Carbon Allotropes Across Dimensions: Band Structures and Electronic Behavior*

Co-Authors: Xavier Maple, Ismail Buliyaminu, Dr; Jose Mendoza

Poster Number: 35

Accelerating the discovery of functional 2D materials is critical for clean energy, next-generation electronics, and nanoscale devices. Traditional screening methods are slow, error-prone, and difficult to scale. This study asks: Can an automated, high-throughput Density Functional Theory (DFT) workflow reliably identify carbon-based 2D materials with properties for energy and electronic applications? We hypothesize such a workflow will improve reproducibility, reduce error, and accelerate discovery. Focusing on graphene and related allotropes, we investigate tunable band gaps, high conductivity, and mechanical strength key for semiconductors, batteries, and sensors. The workflow combines CRYSTAL23 with Snakemake, Python, and Bash scripting on High-Performance Computing Clusters. Initial manual efforts showed variability, underscoring the need for automation. Preliminary results suggest automation reduces error and improves reproducibility. The workflow enables systematic classification through property-based filtering and automated post-processing of DFT outputs. Metrics such as band gap and conductivity will identify candidates, validated where possible against reference data. By optimizing design, this framework supports the development of next-generation energy storage and electronic systems.

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**Valeria Mateo Morales**

Carnegie Mellon University

*AutoPDR: Automating the Analysis of Photodissociation Regions in Star-Forming Clouds*

Co-Authors: Dr; Mayra Lebrón – University of Puerto Rico, Río Piedras Campus

Poster Number: 350

Photodissociation regions (PDRs) are crucial for understanding the interplay between far-ultraviolet (FUV) radiation and interstellar gas in star-forming environments. To facilitate the analysis of PDRs, we developed AutoPDR, a Python-based tool that automates workflows within the PDR Toolbox utilizing spectral FITS data. AutoPDR verifies essential FITS header parameters, prompts users for any missing values, and executes selected PDR models to calculate gas density and FUV field strength. We applied AutoPDR to analyze the PDR surrounding the young stellar object BD305 in the Perseus molecular cloud, utilizing [C II] 158 µm and [O I] 63 µm emission maps from SOFIA and Herschel. The derived physical parameters align well with existing literature values, confirming the tool's reliability. By enhancing accessibility and reproducibility in PDR research, AutoPDR enables efficient analysis while promoting undergraduate involvement in astrochemistry and studies of the interstellar medium.

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**Matthew McGrath**

Saint Joesph's University


*Direct Visualization of Fluidized Region around a Sphere Moving in non-Newtonian Liquids*


Co-Authors: Micheal V; Serio, Shayna Bucey, and Piotr Habdas


Poster Number: 312

The movement of a solid object through a complex liquid is a common situation in both daily life and fluid mechanics. This project is an attempt to better understand the flow around a dragged sphere in a complex yield-stress shear thinning liquid. For the project, we dragged a metal sphere at various veolcities through a solution of Carbopol and water. Particle Image Velocimetry was used to measure the flow field around the sphere. We found that the area which experienced the most amount of flowing increased linearly with the sphere velocity. The average velocity of the liquid flow decreased non-linearly with increasing velocities.

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**Olivia McGrew**

Washington State University


*Using M-line spectrometry and white light interferometry to calculate the thickness and refractive indices of thin film samples.*


Co-Authors: Garrett Compton (WSU) Mark Kuzyk (WSU)


Poster Number: 328

We endeavor to measure the refractive index and thickness of polymer thin films using m-line spectroscopy. M-line spectroscopy involves coupling the beam of a CW laser to a Fabry-Perot resonance of the thin film. We show that a high refractive index medium containing the incident beam facilitates coupling. This is achieved by squeezing a prism onto the top of the thin film, depleting the air-gap and creating a direct interface between the prism and film called a wet spot. When the beam is aimed at the wet spot and oriented at the coupling angle, a dark line called the m-line is visible in its reflected image. The manuscript develops a theory of the reflection spectrum of this configuration. By measuring the reflectivity coefficient at critical points in the m-line using different colored beams we deduce the refractive index and thickness of the thin film to high precision.

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**Samantha McLean**

Northern Arizona University

*Modeling Stellar Population Spectra: Exploring Parameter Space for The Largest Balmer Break*

Co-Authors: Samantha McLean; Northern Arizona University, Michael Maseda; University of Wisconsin-Madison

Poster Number: 343

JWST's recent discovery of luminous, compact, red objects in the high-redshift universe, nicknamed Little Red Dots (LRDs), exhibit unusually large Balmer break strengths. This project uses the same method of measuring Balmer break strengths as in De Graaff et al. 2025, where the LRD RUBIES-UDS-15418 is found to have a break strength of 6.9. These peculiar LRD sources pose the question of whether there could exist an ordinary stellar population capable of reproducing similarly impressive Balmer break strengths. This project first performs a comprehensive sampling of spectra in Prospector of parameters such as age, metallicity, and dust attenuation. It was found that any dust attenuation on the models would increase the break strength monotonically, so in final samplings, the dust attenuation parameter was set to 0. After creating a finely meshed grid of 60,000 models, the maximum break strength of 2.926 was found to occur at dust=0, log(Z⊙)=0.5, and age=356.4 Myrs. The project continues its search by executing a Markov Chain Monte Carlo (MCMC) sampling of Star Formation History (SFH) parameters using Python's emcee. In this search, dust, log(metallicity), and age are set to 0.0, 0.5 Z⊙, and 350 Myrs, respectively. The MCMC search results in a best-fit model with a measured break strength of 2.7573; however, the probability distributions for parameters tau, const, and fburst suggest these might be degenerate.

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**Macie Medes**

University of San Diego

*Probing the Physics of the Weak Decoupling Epoch with Big Bang Nucleosynthesis*

Co-Authors: Macie Medes and Chad Kishimoto

Poster Number: 57

Big Bang Nucleosynthesis (BBN) is the formation of the first nuclei, just a few minutes after the Big Bang. The nuclei are a relict of an epoch in the history of the universe where the expanding universe consisted of a hot and dense plasma and neutrinos played a notable role in the dynamics of the expanding universe and, importantly, in the nuclear content of the universe. As cosmological observations become more precise, we can use BBN as a tool to ask questions about the state of the early universe during the BBN epoch. We simulate BBN, probing the effects of non-standard physics during the weak decoupling epoch, where non-equilibrium changes in the neutrinos may affect the expansion of the universe and the interconversion between neutrons and protons. We explore how these non-standard physics models affect the BBN yields, which allow astrophysical observations to constrain these models.

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**Gerally Medina Rivera**

University of Puerto Rico - Mayagüez

*Spectroscopic Observations near 3.3 GHz in the Trifid Nebula*

Co-Authors: Dr; Allison J; Smith, University of Puerto Rico – Mayagüez | Dr; Emmanuel J; Morales Butler, University of Puerto Rico - Utuado | Dr; D; Anish Roshi, University of Central Florida

Poster Number: 292

The Interstellar Medium (ISM) refers to the regions that lie between stars and consists primarily of gas and dust particles. One of these gases is the Methylidyne (CH) molecule, whose hyperfine, ground state transition produces three spectral lines near the 3.3 GHz radio frequency. We simultaneously observed CH along with two hydrogen radio recombination lines (RRLs), H125 alpha and H126 alpha, which offer essential insights into the properties of the gas in the ISM, tracing both molecular and ionized regions,

respectively. Using the upgraded 12-meter radio telescope at the Arecibo Observatory (AO) site, we observed the Trifid Nebula (cataloged as M20 and NGC 6514) with a single-pointing, as part of a survey of Star Forming Regions along the Milky Way's galactic plane. We present here our spectra for the molecular cloud and discuss their interpretation, motivating future studies of these interesting regions.

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**Omar Mendoza**

University of Colorado Denver

*Hand-held Lidar Viewer*

Co-Authors: Michael "Bodhi" Rogers

Poster Number: 330

This project addresses limited access to cultural heritage sites by developing a portable, cost-effective augmented reality (AR) device. Powered by a Raspberry Pi, the device provides an interactive solution for remote exploration, targeting individuals with mobility limitations or those affected by site fragility. The core development centers on the physical prototype, integrating displays and sensors within a functional, ergonomic casing designed with 3D modeling. This process prioritizes robust hardware integration and user-friendly design to ensure reliability.

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**Isabel Micus**

Angelo State University

*Spin Stabilized Magnetic Levitation  with an Electromagnet*

Co-Authors: Eddie Holik

Poster Number: 160

Spin-stabilized magnetic levitation occurs when a spinning magnet traps another magnet in its magnetic field, enabling stable levitation. Previous research explored this phenomenon using mechanical rotation. This study aims to achieve the same phenomenon by replacing mechanical rotation with an electromagnetically driven system, controlled via an Arduino. Alternating magnetic fields will induce and sustain levitation, while measurement techniques will quantify levitation height, tilt angle, and restoration force.

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**Dylan Miller**

East Carolina University

*Direct Measurement of the Gelation Transition in an Active Biopolymer Network*

Co-Authors: Aravind Elangovan (East Carolina University, Department of Physics), Nathan E; Hudson (East Carolina University, Department of Physics), David M; Hart (East Carolina University, Department of Computer Science)

Poster Number: 332

In the formation of a blood clot, fibrin polymerizes longitudinally and laterally as it matures into a fiber. A 3-dimensional, branched network forms whose structure is known to be relevant in hemostatic conditions. Using light sheet microscopy, 3-dimensional volumes of the fibrin polymerization process were captured. Automated analysis via a custom computational pipeline, which combined an AI-based fiber classifier with skeletonization algorithms, enabled the robust tracking of individual fibers and the evolution of network connectivity within dense, active gels. This provided the first direct measurements of single-fiber diffusion and length growth rates. We quantified the gelation timeline by analyzing the development of a connected path across the volume, a microscopic metric that was then compared with bulk gelation times from dynamic light scattering. This work directly links the dynamics of individual fibers to the emergent mechanical properties of clot gelation, bridging microscopic protein assembly and macroscopic function.

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**Carol Miu**

University of Washington Bothell

*Designing and Building Pulsed Laser and Photodetector Circuits for a Speed of Light Measurement Device*

Co-Authors: Joey Del Gianni, University of Washington Bothell

Poster Number: 135

The goals of our research are to design and build high speed printed circuit boards for an inexpensive and portable speed of light time of flight measurement device and to develop curricula and learning materials to aid future students in introductory physics lab courses. We plan to open source our KiCad files so that instructors from all over the world can have a speed of light measurement device in their classrooms for under $200. Our pedagogical training consisted of analog circuits logic and components, circuit design, prototyping, and practical physics applications of analog circuits. Technical lab responsibilities include learning KiCad, ordering the printed circuit board (PCB) and soldering components onto the PCB, testing the circuit boards and the device, measuring the speed of light, and measuring the refractive index of different mediums. Physics education tasks include developing a pre-lab quiz and lab manual, as well as providing documented guidance for students on learning objectives, instructions on use of the new speed of light device, lab extensions for final projects, and research topics for advanced undergraduates. Currently we have finished the design, wiring, and PCB layout for the photodetector and pulsed laser circuits. We have tested an early model and measured the speed of light through air as 2.97 x 10^8 m/s. We plan to complete building the final device and testing through air, acrylic, and borosilicate glass by December 2025.

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**Richard Morales**

UTEP

*Iron Carbide Magnetic Nanoparticles and their Potential for Magnetic Hyperthermia*

Co-Authors: Richard Morales, Hailey Kapetan, Luz A; Martinez Marquez, Marcos Garcia, Ahmed A; El-Gendy

Poster Number: 284

Iron-carbide (FexCy) magnetic nanoparticles (MNPs) have been synthesized and investigated as potential candidates for magnetic hyperthermia treatment of cancer. Due to the superparamagnetic properties, these FexCy MNPs can be effectively directed by an external alternating magnetic field, producing localized heating at targeted tumor sites. The MNPs are synthesized through a chemical reduction method, which promotes improved crystallinity and optimized magnetic saturation. Magnetic characterization of the most promising sample performed with magnetometry at 50 K and 300 K demonstrated a high magnetic saturation value of 130 emu/g, along with a nearly closed hysteresis loop indicative of superparamagnetic and soft ferromagnetic behavior. These findings confirm the suitability of FexCy MNPs for magnetic hyperthermia and highlight their strong potential as effective therapeutic agents for cancer treatment.

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**Eduardo Moreno De La Paz**

Westminster University

*Regenerative Energy on an Airbus A320*

Poster Number: 242

Greenhouse gases are produced from automobiles, aircraft, mines, AC, fires, animals, and rotting food. These gases disrupt the global climate, destroying wildlife, the environment, and crops. The transportation sector alone contributes 29% of emissions in the U.S, with one third of that from aircraft alone. If commercial planes were electric, we could reduce the amount of transportation emissions from the U.S, a study shows an estimated 93% reduction in emissions when replacing a jet from a Cessna 460XL with an electric one. This effectively gives insight into what every plane could be like. The primary challenge with developing electric commercial airplanes is overcoming the battery to weight ratio required for functionality. Determined to create a way to reduce the weight to energy ratio for a commercial plane battery, I've designed 3 different regenerative generators for the Airbus A320 wing. The generators use induction motor, Newton's blade-less motor, and pneumatic motor. These generators convert wind that hits the plane mid-flight into electricity, recharging the battery, effectively reducing the need for a large battery. To test how effective these generators would be on a plane, I tested the weight difference, drag, and electrical efficiency of the wings with electric generators compared to a scaled down version of an unchanged A320 wing. These designs demonstrate some promising results for some of the designs and the possible future for electric planes.

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**Emmanuel Moses**

University of Maryland, Baltimore County

*Finite-Difference Drift-Diffusion Modeling of III/V Photodetectors: Temperature Dependence and Avalanche Photodetector Simulation*

Co-Authors: Ergun Simsek, Department of Computer Science and Electrical Engineering, University of Maryland, Baltimore County (UMBC)

Poster Number: 144

This research aims to investigate the performance variations of III/V photodetectors under
different thermal conditions and extend the modeling framework to simulate avalanche photodetectors (APDs) for single-photon detection in quantum applications. Our focus will be in
two key areas. First, we want to successfully simulate Avalanche Photodetectors by properly
implementing impact ionization, and then analyze potential design optimizations for the creation
of future APDs. Next, we want to analyze APD performance under non-constant temperatures.
Our goal is to see its effect on Quantum Efficiency, bandwidth, phase noise, and mechanisms
such as recombination, and see how well our simulation stacks against real APDs created and
used in literature.

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**Zach Moughamian**

University of Missouri St. Louis

*Cross-Sectional Analysis of Bond Interface Roughness in Silicon-on-Insulator Specimens*

Co-Authors: Phil Fraundorf, University of Missouri St; Louis

Poster Number: 254

The semiconductor industry has limited consistency in manufacturing devices, including those made from Silicon on Insulator wafers. This study aims to provide a reproducible process by which one can inexpensively check preferred layer-dependent properties that could otherwise vary with different wafers, such as the material’s density, etch rate, or dopant type. These kinds of properties can be revealed through cross-sectional atomic force microscopy (AFM) analyses. This analysis method involved mounting wafer specimens on their side using superglue and a magnetic hex nut. Topography collected from the cross-section of a polysilicon sample revealed RMS roughness values of ~25 nanometers and ~1.5 nanometers at the polysilicon and cleaved silicon layers respectively. ~2.1 nanometers and ~1.7 nanometers were measured for the RMS roughness values of the respective donor silicon and silicon dioxide layers. The collected data for these specimens can suggest AFM as a new strategy for characterizing cross-sectioned amorphous, as well as crystalline SOI wafers.

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**Lucas Mural**

University of Colorado Denver


*Variational Quantum Eigensolvers*


Co-Authors: Lucas Mural and Kathryn R; Hamilton, Department of Physics, University of Colorado Denver, Denver CO 80204


Poster Number: 288

Quantum computing is a powerful new tool still in its infancy, but it can be used along with classical computing methods to efficiently solve certain types of problems. One method that uses this hybrid approach are Variational Quantum Eigensolvers (VQEs), which are a class of algorithm that calculates expectation values or eigenvalues of an operator, usually the Hamiltonian. VQEs function on noisy intermediate-scale quantum devices, which are quantum computers with a small number of qubits. VQEs operate via the variational principle, where a “guess” wave function is used and progressively tuned until the aforementioned eigenvalues are minimized. These are mostly used to acquire the ground-state energy of a system, but can be used for excited states as well. In this work we will explore how laboratory parameters affect the performance of a VQE algorithm, with the goal of minimizing both solution time and error.

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**Diya Naik**

Yale University


*Simulating Dual Rail Erasure Errors on Quantum Error Correcting Codes*


Co-Authors: Larry Chen (UC Berkeley), Ravi Naik (Lawrence Berkeley National Lab)


Poster Number: 131

Session I

Quantum computers exploit the properties of matter at small scales to solve problems that classical computers cannot easily solve. However they suffer from many sources of noise. Quantum error correcting codes (QECCs) redundantly store the information of physical qubits so that errors can be checked and corrected without interfering with the quantum states. Erasure errors are when the qubit is no longer within the computational subspace spanned by {|0> and |1>}} Erasure errors are easier to detect than other errors, so by converting other errors to erasures, we can improve the fidelity of quantum error correcting codes. Dual rail qubits are particularly well suited for detecting erasure errors because they are two transmons coupled so that only one transmon can be in the physical excited state at a time. If both are in 0, it is an erasure error. The Quantum Nanoelectronics Laboratory's dual rail transmons have a worst case physical error rate of 1e-2 so we characterize the lambda–the improvement increasing distance of a code provides–at that rate

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**Juliana Nanni**

Rowan University


*A High-Throughput Study of Advanced Catalysts for Oxygen Evolution Reaction: Structural Properties*


Co-Authors: Juliana Nanni, Mark Smeltzer, Adrian Garlic, & Samuel Lofland Rowan University: Department of Physics and Astronomy


Poster Number: 81


X-ray diffraction (XRD) was employed to study the structural characteristics of Ta–Nb–Ir–Pd alloy thin-film electrocatalysts for the oxygen evolution reaction (OER). Across the compositional space, a distinct amorphous phase was identified within the Ta-rich region. Interestingly, this amorphous regime coincides with enhanced OER activity, suggesting a strong correlation between structural disorder and catalytic performance. These findings highlight the potential of amorphous multi-element alloys as tunable and efficient electrocatalysts for oxygen evolution.


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**Taytum Nelson**

Minnesota State Moorhead

*Low-Energy Cooling: Investigating the Efficiency of Indirect Evaporative Systems*

Co-Authors: Mateo Rodriguez (University of Rochester), Brandon Liu (University of Rochester), Luheng Tang (University of Rochester), Subhash Singh (University of Rochester), Chunlei Guo (University of Rochester)

Poster Number: 140

As the demand for cooling systems rises, there is a growing need to reduce the carbon footprint associated with them. Currently, vapor compression systems dominate the market, but they consume significant energy. In contrast, evaporative cooling presents an energy-efficient alternative. This project investigates the performance of an indirect evaporative cooling system, which cools air through evaporation without adding humidity. We designed and constructed a novel cooler that incorporates phase change material for thermal energy storage and wicking metal surfaces to allow for further cooling past traditional indirect evaporative cooling limits and reduces the amount of required energy. This system is tested with a setup that allows for precise control of temperature, relative humidity, and flow rate, enabling us to measure the cooler's performance under a variety of conditions. We aim to demonstrate that indirect evaporative cooling, with this enhanced design, offers higher energy efficiency than traditional methods.

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**Wesley Nielsen Dick**

New York University

*Tensor Networks in Stellarator Optimization*

Poster Number: 300

The intractable problem of dispersion in stellarator fusion reactions is a significant obstacle in the quest for sustainable nuclear fusion. Optimizing the shape of magnetic surfaces within plasma to avoid reaction-terminating processes is a critical step in overcoming this obstacle. Tensor networks have shown significant promise in condensed matter and quantum applications, recreating the benefits of some machine learning models with less compute. Here we explore the possibility of using tensor networks to aid in finding optimal parameters and surfaces.

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**Phansit Nimsrinuan**

Furman University

*pH Optimization of RE-doped Chelate and Nanoparticle Film Coatings*

Co-Authors: John Taylor and Courtney J Kucera; Furman University Department of Physics

Poster Number: 170

Rare-earth-doped chelate and nanoparticle synthesis will be examined for the incorporation of the particles into a variety of matrix materials for identification purposes discussed later. The main focus of this work is to analyze the effect of varying pH in order to optimize the synthesis of chelates and nanoparticles. These chelates and nanoparticles will be examined using x-ray diffraction (XRD), ultraviolet-visible (UVVIS) spectroscopy and photoluminescence (PL) for structure analysis and rare earth incorporation into each system. Each system includes examination of the dried chelates or nanoparticles, along with the original supernatant from processing. Once optimization has been completed, these systems will be combined in a polymer matrix to be used for coating. These coatings will be used in real world applications such as rescue missions and evidence of tampering.

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**Olivia Nippe-Jeakins**

George Washington University

*Probing Short-Range Correlations Via Omega Meson Photoproduction*

Co-Authors: Axel Schmidt - George Washington University

Poster Number: 74

Short-range correlations (SRCs) are a universal feature of nuclear structure, where nucleon pairs come into close proximity and undergo an intense repulsion. This extreme manifestation of the strong force results in the high relative momenta of the nucleons, exceeding the nuclear Fermi momentum. Much of what is known about SRCs has come from electron scattering experiments, which rely on a set of assumptions about the

reaction mechanisms in order to interpret the results. To test the impact of these assumptions, a high-energy photon beam experiment was conducted using the GlueX Detector at Jefferson Lab to study SRCs using photoproduction reactions. My research focuses on the photoproduction of ω mesons off a deuterium target, and reconstructing the momentum transferred to the proton during the reaction. My primary observable is the beam spin asymmetry, Σ, in ω production from nucleons in SRC pairs and in quasi-free kinematics.

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**Timothy Palmer**

Arkansas Tech University

*Bayesian Grid Search*

Poster Number: 336

Search behavior is fundamental across the animal kingdom, serving various purposes such as foraging, hunting, and locating a mate. While the inner workings of the animal brain remain largely mysterious, the process of searching follows a discernible pattern: exploring probable locations, revising assumptions, and iteratively refining the search strategy. This process mirrors a process called Bayesian inference, where beliefs are updated as more evidence becomes available. In this study, the aim is to develop a program that emulates this algorithmic search behavior. The program generates a grid containing a target object, systematically explores the likely routes, employs Bayes' theorem to update the search grid, and uses this updated grid to adjust the strategy. Through this program, strategies for searching are analyzed, considering factors such as search area size and shape. I found that the shape of the map has far more impact on the length of the search than the size. The resulting insights enable predictions regarding search duration, which are vital in scenarios like search and rescue operations. The paper is structured into three sections: the first describes the algorithms's search process, the second presents findings from the analysis, and the third explores potential applications, future work, and offers a personal anecdote illustrating the algorithms's utility.

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**Dominic Pang**

University of Southern California

*Forecasts for Dark Matter-Radiation Interactions with the Rubin Observatory's LSST*

Co-Authors: Wendy Crumrine, PhD Student at USC

Poster Number: 184

Interactions between dark matter (DM) and photons in the early Universe suppress structure formation on small scales. In particular, elastic scattering transfers heat and momentum from photons to DM, ultimately reducing the abundance of low-mass DM halos and the dwarf galaxies they host. This small-scale suppression ensures that populations like the Milky Way (MW) satellites are ideal laboratories for constraining such cosmologies. In this work, we consider temperature-independent interactions parameterized by DM mass (mχ) and DM–photon interaction cross section (σχ–). We forecast bounds on this DM–photon cross section based on the expected sensitivity of the upcoming Rubin Observatory's Legacy Survey of Space and Time (LSST). Using the results of Nadler et al.—that LSST's MW satellite observations are expected to yield a thermal relic Warm DM (WDM) mass cutoff of 12.9 keV—we map this mass scale onto photon scattering parameter space. By requiring that the linear matter power spectrum be less suppressed than in the case of this thermal-relic WDM cutoff, we predict that LSST will impose the following 95% upper limit at m=1 MeV: -<1.2510-39cm2. Our bounds on photon-DM cross section depend linearly on DM mass for m1 MeV. This dependence approaches m3 at lower masses due to the effects of DM sound speed. Across all masses, our forecasted upper limit on cross section is 1 order of magnitude more stringent than previous explorations of MW satellites using pre-LSST WDM cutoffs.

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**Shreya Pasupuleti**

University of San Diego

*Dissipation and Energy Transport in Global Accretion Disks Simulations*

Co-Authors: Albert Ogrodski, Theodore Dezen, Department of Physics and Biophysics at the University of San Diego

Poster Number: 266

We present Athena++ global three-dimensional magneto-hydrodynamic simulations of accretion flows onto stellar mass black holes. We conducted calculations with several initial magnetic field configurations to investigate energy transport processes. We paid particular attention to the spatial distribution of dissipation rates to assess if and how the disk can dissipate a significant fraction of accretion power in its upper-layers away from the midplane. Finally, we discuss our findings in context of the hot corona over cold disk geometry postulated to explain observed steep power law (SPL) state spectra.

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**Zack Pearlman**

Coe College

*A Physical Properties Study of the Sodium Germanate Glass Family*

Co-Authors: Zack Pearlman1, Maxwell Deacon1, Luci Green2, Rebecca Gabrielsson1, Steve Feller1 1Coe College Department of Physics, Cedar Rapids, IA 2University of South Carolina Department of Chemistry and Biochemistry, Columbia, SC

Poster Number: 105

The research conducted is the most complete study of glass transition (Tg), onset of crystallization (Tx), glass stability (Ts), and density in the sodium germanate [xNa2O · (1-x)GeO2] system. The study connects the thermal events, density, and packing fraction was observed. The coordination changes (Qn) where n is the number of bridging oxygen correlate to properties. Carbonate retention is studied near the end of the glass forming range (x > 0.6) due to the reagent sodium carbonate (Na2CO3) used during the glassmaking process.

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**Mariel Peczak**

Carnegie Mellon University

*DNN-based ID for scouting electrons*

Co-Authors: Florencia Canelli, Raffaella Tramontano (University of Zurich)

Poster Number: 103

The Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider (LHC) is a general-purpose detector which collects information about proton-proton collisions at 13.6 TeV and records them using different data-taking strategies, one of which is scouting data. Scouting data transmits events in reduced data format, allowing us to record significantly more events by storing only high-level information per event and enabling exploration of previously inaccessible regions of phase space. In standard data-taking, electron identification algorithms are already used to suppress background and retain genuine electrons. However, these algorithms depend on full detector information; this project aims to develop a novel multivariate electron identification algorithm that can operate using only the limited high-level event content available in scouting data. We implement this algorithm using the Kubeflow framework, for the first time in a scouting context, to create a streamlined training and inference pipeline for Run 3 CMS scouting data.

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**Marlena Pegolo**

George Washington University

*Simulation-Based Optimization of xpDIRC Geometry for Next-Generation PID*

Co-Authors: Dr; Gregorz Kalicy (Catholic University of America), Md; Imran Hossain (Catholic University of America)

Poster Number: 216

Progress in nuclear physics hinges on the ability to collect precise experimental data, necessitating the use of multi-technology particle detectors with comprehensive capabilities. The DIRC (Detection of Internally Reflected Cherenkov light) is one such technology, utilizing the spatial pattern of Cherenkov photons produced by charged particles to support their identification. The hpDIRC, a state-of-the-art detector currently under development, operates effectively at momenta up to 6 GeV. Building on the hpDIRC design for the ePIC detector at the future Electron-Ion Collider (EIC), the next-generation xpDIRC aims to extend performance up to 10 GeV. The xpDIRC introduces a hybrid optical system that combines improved focusing optics, a wide-plate light guide, and support for alternative photosensor technologies. My research employed a sophisticated Geant4-based DIRC simulation framework to analyze critical features such as plate thickness impacting xpDIRC performance and to optimize design parameters for enhanced separation power and detector capabilities.

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**Christopher Piatnichouk**

Davidson College

*Analytical and Experimental Validation of Finite Element Magnet Simulations for a New Medical Imaging Modality*

Co-Authors: Christopher Piatnichouk, Benjamin Grear, Henry Russell, Niels van Dujinhoven, and Dr; Benjamin E; Levy (Davidson College)

Poster Number: 262

Blood clots represent a significant cause of mortality in the United States, underscoring the critical need for precise diagnostic techniques. Among these, magnetomotive ultrasound emerges as a promising method. By applying a sinusoidal force via magnetic fields and measuring blood clot motion with ultrasound, we hope to determine the resonance frequency of a clot, serving as a proxy for its Young's modulus and stiffness. However, a challenge arises in generating the necessary frequencies to resonate certain blood clots. The resonance frequencies of certain small clots may exceed 150 Hz, while our current capability is limited to ~45 Hz. We used finite element analysis, a powerful and time-saving tool, toward the goal of designing effective magnets for a magnetomotive ultrasound medical imaging system. To validate our methods, we compared our finite element simulations against analytical solutions and experimental data. Our results indicate agreement between simulation and experiment in models without known analytical solutions.

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**Dennis Pradhan**

University of Colorado Denver

*Comprehensive Overview of Fabrication Process Development for SQUID on Tips*

Co-Authors: Dennis D; Pradhan, Lucas W; Schaab, Matthew A; Crane, Lincoln Doney, Aritra Mazumder, Neil D; Quines, David Mann, Bruce A; Hines, Daniel S; Dessau, Martin E; Huber; University of Colorado Denver, University of Colorado Boulder

Poster Number: 322

We present a comprehensive overview of the nanoscale SQUID-on-Tip (SOT) from fabrication to characterization being implemented at University of Colorado Denver. A quartz pipette of 1mm O.D. is drawn down to a pointed capillary with diameters ranging from 85–150 nm. The pipette undergoes three stages of thermal vacuum deposition to create two electrical leads along the side profiles connected by a lead (Pb) coated nanoscale superconducting ring at the apex. A successful composition will then produce a magnetically quantized flux pattern within the ring. SOT's are then characterized at low temperatures by a process of sweeping currents and magnetic fields through the ring while recording a voltage state response. This will generate a 3D graph which we will use to identify the most sensitive state achieved by the SOT. The SOT itself is then ready to be used in an effort to measure and model magnetic vortices.

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**Rohit Raj**

Center for Astrophysics | Harvard & Smithsonian

*Wolf-Rayet Stars in M33 and a Few Other Unusual Emission-Line Stars in M31, M32, and M33*

Co-Authors: Rohit Raj(1,5); Puragra Guhathakurta(2); Zhuo Chen(3); Robert E; Williams(2,4); 1; Center for Astrophysics | Harvard & Smithsonian 2; University of California, Santa Cruz 3; University of Washington 4; Space Telescope Science Institute 5; Juniata College, PA

Poster Number: 158

We conducted comprehensive photometric and spectroscopic surveys of M31, M32, and M33 using the Keck/DEIMOS. We identified three types of unusual emission-line stars, including five Wolf-Rayet (WR) stars in M33. Using HST photometry from the PHATTER survey and 2D Gaussian analysis, we confirmed the majority of M33's 124 known WRs within PHATTER, deriving their physical properties from six-filter color-

magnitude diagrams. Our analysis provides precise locations and robust photometry for 110 WRs within PHATTER. Keck spectra provide detailed information on line widths and P Cygni profiles to probe stellar wind properties. We also report on two new symbiotic stars in M31 and two unclassified H alpha/Ca-triplet emission-line stars in M32/M33. These rare objects offer important clues into stellar evolution and galactic processes.

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**Udbhav Ram**

University of Alabama at Birmingham

*Evaluation of Ethos 2.0 High-Fidelity Mode for Multi-Met, Single-Isocenter Stereotactic Radiotherapy: A Semi-Automated Comparative Analysis*

Co-Authors: Joel A; Pogue, Joseph Harms, Natalie N; Viscariello, John B; Fiveash, Richard A; Popple, Dennis N; Stanley, and Carlos E; Cardenas

Poster Number: 21

This study assessed the Ethos 2.0 high-fidelity (HF) mode's impact on single-isocenter stereotactic radiotherapy plans for brain metastases. Fifty patient cases, previously treated with SRS, were imported into an Ethos 2.0 emulator. Fifteen cases tuned planning templates, applied to 35 test cases, each prescribed 30Gy in 5 fractions with 2mm PTV margins. HF mode, enhances target dosing and dose fall-off. Four templates, HF mode with/without control rings (CR) and standard mode with/without CR, were compared using PTV V100%, Brain-PTV V24Gy, Paddick Gradient Index, and RTOG Conformity Index. Enabling HF mode with CR yielded superior results on average: PTV V100% of 99.4%, Brain-PTV V24Gy of 24cc, CI of 1.17, and GI of 4.0. Statistical analysis showed significant improvements in Brain-PTV V24Gy and CI with CR in HF mode ($p<0.01$). This HF mode analysis suggests high-quality plans with minimal edits, pending further validation.

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**Kazi Uzayr Razin**

Augustana College

*Optimizing the PlanktoScope for North American Studies of Harmful Algal Blooms*

Co-Authors: Augustana College

Poster Number: 25

Harmful algal blooms (HABs) are a growing environmental concern threatening water quality and aquatic ecosystems. This project aimed to replicate and optimize the PlanktoScope, a low-cost, open-source imaging instrument for quantitative enumeration and identification of harmful algae, specifically targeting the common cyanobacterium Microcystis aeruginosa. Traditional microscopy techniques for studying Microcystis HABs are limited by logistical challenges and require extensive technical training. The PlanktoScope addresses these challenges by capturing algal images of field samples, which can be uploaded and identified using the open-source EcoTaxa software. Although the PlanktoScope was designed to be easily fabricated by potential users with minimal design experience, PlanktoScopes were not fully accessible for North American researchers due to a reliance on custom mechanical parts primarily sourced from Europe and a lack of a Bill of Materials (BOM) tailored to the U.S. market. A new BOM with locally available parts was developed, and mechanical components were redesigned to use off-the-shelf stepper motors. The new BOM was shared with PlanktoScope users, and a new PlanktoScope was fabricated using these modifications, offering a more practical and scalable tool for North American HAB research.

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**Casey Reeder**

Weber State University

*Electrochemical changes of nonstoichiometric nickel oxide due to lower annealing temperatures*

Co-Authors: Brandon Burnett (Advisor)

Poster Number: 294

Nonstoichiometric nickel oxide shows significant durability and water resistance while also maintaining conductive capabilities making it a valuable material for hole transporting layers (HTL) in solar cells. Recent research has found that nickel oxide HTLs outperform the commonly used, hygroscopic poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) HTL in both power conversion efficiency (PCE) and durability to weathering conditions. Unfortunately previous studies use annealing temperatures 275 °C and above. [1] Here, lower annealing temperatures of 260 °C, 250 °C and 225 °C were investigated for the preparation of nickel oxide HTLs. Energy-dispersive X-ray analysis (EDX) confirmed comparable elemental composition, while thermogravimetric analysis (TGA) verified similar phase transitions to those observed in higher-temperature treatments.

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**Raisa Rahman Richi**

Franklin and Marshall College


*Energy Efficiency Analysis of The Madgraph Event Generator for High Energy Physics*

Poster Number: 102

The objective of this project is to study the performance and energy consumption of Monte Carlo event generators used in high-energy physics simulations. The project builds upon ongoing efforts to optimize event generators such as MadGraph, evaluating their performance across various computational technologies, including GPU acceleration and CPU-based acceleration using vector instructions. The work involves the use of monitoring tools to gain insights into hardware utilization, memory efficiency, and power consumption. This research has broader implications for the high-energy physics community, addressing the need for sustainable computational practices and optimized computing infrastructure. It also offers the opportunity to contribute to cutting-edge research at the CERN IT department, collaborating with a team of experienced researchers.

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**Jaxon Riley**

Cleveland State University


*Pacemaker Control in Jellyfish using Computational Fluid Dynamics*


Co-Authors: Tyler Semenik, Brett Gucker, Trinity Blum, Alexander P Hoover


Poster Number: 29

Jellyfish are one of the earliest examples of how multicellular organisms are organized. With no “brain” or central nervous system, jellyfish use randomly-firing pacemakers to activate their musculature and drive their motion, such that the firing events can be modulated to allow for a variety of different gaits and turning maneuvers. With simulations run on the Viking Supercomputer Cluster, we look to analyze the important role that pacemakers will play in the biomechanics of jellyfish locomotion. Using computational fluid-structure interaction framework, a model jellyfish is employed to explore the fluid and structural mechanics associated with in jellyfish locomotion. In this study, stresses mimic the role of two pacemakers that are firing concurrently. Our goal is to analyze the resulting kinematics based on pacemaker placement when two pacemakers are co-activating.

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**Desiree Robinson**

Embry-Riddle Aeronautical University

*Comparative Analysis of Hα and OIII emission for Planetary Nebulae and Supernova Remnants*

Poster Number: 304

The purpose of this project is to perform a comparative analysis on the Hα and OIII composition for two Planetary Nebulae (Helix and Dumbbell Nebulae) and a Supernova Remnant (Crab Nebula). Photometric analysis was performed on the Dumbbell Nebula and the Crab Nebula to determine the amount of Hα and OIII present in their structures while Spectroscopic analysis was performed on the Helix Nebula to compare with the Crab Nebula to determine OIII emission. The results point to Hα being more present in planetary nebulae in comparison to the Crab supernova remnant, with OIII emission being more prevalent for the Crab Nebula in comparison to the planetary nebulae.

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**Ryan Rodriguez**

East Texas A&M University

*PTCDA-Based Thin Film Light Sensors from Thermal Evaporation*

Co-Authors: Dr; Heungman Park

Poster Number: 214

Light sensing technology has its applications in consumer gadgets and industrial automation. Organic semiconductors offer a solution to limitations of conventional metallic semiconductors. This research explores the potential of 3,4,9,10-perylenetetracarboxilic dianhydride (PTCDA) as a core material for fabricating highly effective and affordable light sensors through thermal evaporation.

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**Reeves Rogers**

Ohio University

*Construction of an Upgraded Focal Plane Detector for Use with the SE-SPS*

Co-Authors: Catherine M; Deibel, Jeffrey C; Blackmon, Molly E; McLain, Cullen M; Domangue; Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA, United States

Poster Number: 174

Many nuclear reactions critical to understanding stellar nucleosynthesis involve unstable isotopes. While direct measurements of such reactions are ideal, sometimes only indirect studies, such as transfer reactions, are possible. The Super-Enge Split Pole Spectrograph (SE-SPS), located at the John D. Fox Accelerator Laboratory at Florida State University, is well-suited for such measurements of transfer reactions. In these measurements, light reaction products are momentum-analyzed by the SE-SPS and detected at the focal plane. A new focal plane detector, the Upgraded Position-sensitive Ionization Drift Chamber (UPIDC), has been designed and is under construction. Compared to its predecessor, the UPIDC features approximately doubled length, guard wires for the anode, and an internal scintillator apparatus. Design decisions have also been made to accommodate ease of assembly and repair, to improve physical robustness, and to integrate modernized materials and technology. This research was partially funded by NSF #2447783 and DoE #FG02-96ER40978.

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**James Rolston**

William Jewell College

*Designing and Installing Solar Lights on Campus*

Poster Number: 79

Our SPS chapter is working with the Center for Justice and Sustainability on campus to clear a hill side and install solar lights for safety. I am designing the solar lighting system and installing the solar lighting system.

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**Gabe Rosen-Turits**

New York University


*Frequency-Selectable Laser Source (FLS) for Cosmic Microwave Background Experiments*


Co-Authors: Supervisor: Dr Lauren J Saunders, Fermi National Accelerator Laboratory


Poster Number: 198


Cosmic Microwave Background (CMB) experiments measure remnant radiation from the early universe and use that data to determine fundamental properties of the universe. We can constrain key parameters, such as r, the cosmic tensor-to-scalar ratio, and Neff, the effective number of relativistic species, by analyzing the CMB power spectra. Improving our measurements of the CMB requires improving our instrument systematics, one of the most important of which is detector bandpass. Current experiments use a Fourier Transform Spectrometer (FTS) to measure bandpass. However, the FTS is systematics limited, and cannot achieve the accuracy needed to make improved CMB measurements. For this reason, we are developing a new instrument, the Frequency-Selectable Laser Source (FLS) to decrease the uncertainty in bandpass by an order of magnitude. We describe work completed to support the version 2 upgrade to the FLS. Using ray-tracing software, we modeled the FLS optics to set physical tolerances for the new design. We also discuss the laser calibration, and future work to be completed in further development of the FLS upgrade.


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**Savannah Russell**

Rhodes College


*Star Formation and Black Hole Accretion in z~3 “Step” Protocluster Galaxies*


Co-Authors: David Rupke - Rhodes College, Caroline Bertemes - Heidelberg University, Dominika Wylezalek - Heidelberg University

Poster Number: 124

The Extremely Red Quasar J1652 at z~3 is surrounded by a massive and dense protocluster (13.3 < log Mhalo/M⊙ < 13.8). We modeled JWST/NIRISS spectra of 14 galaxies in the possibly-merging protocluster. With grism GR150, NIRISS provides low-resolution spectra from 1.3-2.2 μm. We used q3dfit, a program designed to fit JWST spectra of galaxies. In the rest frame wavelength range containing the Balmer lines, we combined stellar population synthesis models to estimate the ages of the stellar populations. Most of the protocluster galaxies show strong emission lines, so we also fit [OII] 3726, 3729 Å, Hβ, and [OIII] 4959, 5007 Å. We used line ratios to distinguish between black hole accretion and star formation, and to estimate metallicity. Most of the galaxies show evidence for black hole accretion, while a few point to young star formation. We then compared the results from q3dfit to those from the grizli software. Support was provided by NASA for program JWST-GO-03807 from a grant through the Space Telescope Science Institute. We also acknowledge support from the Mac Armour Fellowship from Rhodes College.

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**Rahul Sah**

Furman University

*Simulation of Electron-Hole THz Dynamics in Semiconductor Nanowires*

Co-Authors: Garner M; Boepple and Jeremy R; Gulley; Furman University, Department of Physics

Poster Number: 172

Through the usage and alteration of ultrashort pulse propagation software, we examine the optical and plasmonic response of a semiconductor nanowire, modeled by the Semiconductor Bloch Equations (SBEs), to the introduction of laser and Terahertz (THz) fields. These simulations uniquely model the electron-hole dynamics by expanding the Maxwell-SBEs to simulate interactions with 3D laser fields. We upgraded our nanowire simulations from idealized, infinitely-wide "flat-gate" nanowire confined within 1D or 2D pseudo-spectral time-domain (PSTD) frameworks to a more realistic, transversely confined 3D nanowire. Specifically, we introduce ground-state Simple-Harmonic Oscillator envelopes for the transverse confinement quantum wavefunctions. By introducing an additional electromagnetic THz pulse into the nanowire 5 ps after the initial pulse, we monitor the resulting model electron-hole dynamics via changes in their energies, momenta, and currents.

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**Fanny Salas**

University of Texas at El Paso

*Challenges, Opportunities, and Strategies to Promote Physics in a Border City.*

Co-Authors: Federico Alvidrez (University of Texas at El Paso), Diana Galan (University of Texas at El Paso)

Poster Number: 17

The Society of Physics Students at the University of Texas at El Paso (UTEP) distinguishes itself from other chapters because we are committed to adressing underrepresentation of Hispanics/Latinos in physics. Being located in the U.S.–Mexico border with an 84% Hispanic student body and nearly half of undergraduates being first-generation college students, UTEP offers a unique background to tackle this issue. We are compromised to inspire future scientists within our border community by organizing fun outreach events such as the Physics Discovery Day, which promotes excitement in physics and college with high school students, or monthly workshops at La Nube, a cutting-edge STEAM discovery center where through hands-on demonstrations with our Physics Circus we engage K–12 students with topics like thermodynamics, electromagnetism, and kinematics. Complemented by study sessions, social gatherings, and application workshops, these initiatives reflect our mission to ignite curiosity, promote inclusivity, and strengthen the presence of physics along the border.

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**Aubyn Sallee**

Rhodes College

*Rhodes College Pumpkin Drop: Tradition and*

Poster Number: 19

For SPS, Pumpkin Drop is a uniting tradition across chapters to combine Halloween spirit with the joy of physics outreach. It is an event that is explosive for the pumpkins and the community. At Rhodes College, Pumpkin Drop is not only a night of fun, but a cornerstone of the Rhodes experience. The Rhodes Pumpkin Drop represents tradition for the campus and as an SPS chapter. This October will mark the 27th year of our Pumpkin

Drop, marking the event as one of the longest-standing Rhodes College traditions and one of the longest continual SPS pumpkin drops. Each year, the pumpkins are frozen with liquid nitrogen and launched off of the physics tower, in hopes of one day witnessing triboluminescence, the light produced by mechanical stress. Yet, the honest heart of Pumpkin Drop lies within the collaboration it inspires across the Rhodes community. Through these volunteering efforts and the creative drive of our SPS chapter, the Pumpkin Drop lives on as a Rhodes celebration of physics and tradition.

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**Riya Sandhu**

California State University, Sacramento

*Actin Mechanics and Localization in PEG/DEX Aqueous Phase Separated Droplets*

Co-Authors: Jasmine June Doyle (CSU, Sacramento), Riya Kaur Sandhu (CSU, Sacramento), Lynne Usanase (Kenyon College), Victor Hernandez (CSU, Sacramento), Archan Vyas (UC Davis), Christopher Carnahan (UC Davis), Atul Parikh (UC Davis), Eliza Morris (CSU, Sacramento), Mikkel Herholdht Jensen (CSU, Sacramento)

Poster Number: 65

In the cytoplasm of cells, volume-exclusion effects lead to aqueous transient phase separation (ATPS). This liquid-liquid phase separation is a key process in cells' internal, membrane-less organization of proteins and metabolites.
We study ATPS in a model system using poly-ethylene glycol (PEG) and dextran (DEX). While entropically mixed at low concentrations, PEG and DEX form two separate aqueous phases. We emulsify PEG and DEX, stabilizing DEX-rich droplets in a PEG-rich phase with small unilamellar vesicles to form a Pickering emulsion; confocal fluorescence microscopy confirms a stable ATPS system. Rheology shows the PEG and DEX-rich phases behaving as Newtonian fluids with viscoelastic properties, confirming actin network formation. We observe destabilization and coalescence of DEX-rich droplets upon actin polymerization, suggesting that a filamentous biopolymer network can affect the stability of ATPS domains.
Our results demonstrate ATPS as a mechanism both influencing and influenced by cytoplasmic protein interactions and organization.

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**Jack Schiavo**

Saint Joseph's University

*Physics Wonder Girls Camp*

Co-Authors: Dr; Roberto Ramos, Sarah Koh, Christian Ottesen

Poster Number: 5

The Physics Wonder Girls camp, on its twelfth year, is a comprehensive summer program that stimulates and sustains interest in physics among female students in middle and high school. Consisting of two intensive, week-long day camps on the campus of Saint Joseph's University in Philadelphia, Pennsylvania, this year's program saw the participation of 35 campers selected from a pool of students nominated by STEM teachers from 18 schools in the Philadelphia-New Jersey-Maryland region. Campers were engaged in hands-on physics and renewable energy-themed projects, building energy conversion devices such as solar-powered cars, solar-powered fidget spinners, solar cookers, and wind turbines, and used infrared cameras to audit energy loss. Campers presented two "Equity-in-Energy"-themed Posters Sessions where they researched on and showcased the lives and contribution of women physicists. The campers were mentored by a camp crew consisting of the PI and five Physics majors. Accomplished female physicists from a national lab, a nuclear reactor plant and academia visited the camp to talk about their STEM career trajectories. Participants also toured the local R&D and manufacturing facilities of a multinational food company, and gave capstone presentations of their favorite energy projects to an audience of family and friends. We report and reflect on the products of the camp, and the successes and challenges of the program.

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**Calleway Schmidt**

Austin Peay State University

*Novel glasses with antimicrobial properties*

Co-Authors: Calleway Schmidt (Department of Physics, Engineering, and Astronomy, Austin Peay State University, USA), Magda Lewandowska (Department of Biotechnology, University of Rzeszow, Poland), Valeriia Levchenko (Department of Sensor and Semiconductor Electronics, Ivan Franko National University of Lviv, Ukraine), Roman Golovchak (Department of Physics, Engineering, and Astronomy, Austin Peay State University, USA), Malgorzata Kus-Liskiewicz (Department of Biotechnology, University of Rzeszow, Poland), Bohdan Mahlovanyi (Institute of

Physics, University of Rzeszow, Poland), Yaroslav Shpotyuk (Department of Sensor and Semiconductor Electronics, Ivan Franko National University of Lviv, Ukraine and Institute of Physics, University of Rzeszow, Poland)

Poster Number: 258

To study antibacterial properties of glasses, we used a melt-quenching technique to synthesize twelve samples based on ($P_2O_5$)-($Fe_2O_3$/SrO/$SiO_2$)-(CuO/ZnO). Staphylococcus aureus was used as the model organism for antimicrobial testing. The bacteria was incubated with powder samples at concentrations of 1 mg/mL and 5 mg/mL for 24 hours at 37 °C. The bacterial suspensions were then serially diluted 1:9 in phosphate-buffered saline (PBS) and plated on agar plate. Colony-forming units (CFUs) were counted to assess antimicrobial activity. The results indicated that samples containing $SiO_2$ and $B_2O_3$ exhibited the weakest antimicrobial effects, whereas the most effective samples contained Zn, with two comprising a combination of Zn and Cu. For future work, nano powder and bulk forms may show different behavior due to varied surface areas.
This work was performed within the framework of the IMPRESS-U project supported by the NSF (Grant # OISE-2106457), NAWA (Grant # BPN/NSF/2023/1/00002/U/00001), and NAS (STCU Grant # 7112).

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**Keira Scott**

Austin Peay State University

*Comparing Five Methods for Determining the Refractive Index of a Glass Prism Using a Multi-Wavelength Laser and a Versatile Optical Setup*

Co-Authors: Thomas Campagna, Keira Scott, Jair Martinez, Michael Graff, and Eugenii U; Donev (Affiliations: Department of Physics, Engineering, and Astronomy, Austin Peay State University)

Poster Number: 310

We present an update on our research's progress to include measurements and fits of rotating analyzer ellipsometry (RAE) to compare with previous methods for determining a glass prism's refractive index dispersion, focusing on their accuracy and pedagogical value for undergraduate physics. Methods include minimum deviation, Fresnel reflectance, fitting to the minimum deviation curve, and Brewster's angle. The angle of minimum deviation was the most accurate (≤0.03% error), while the Fresnel method

showed the largest inconsistency (0.05%−1.54% error). The minimum deviation fitting results are consistently lower due to an unknown systematic error, while the Brewster's angle results can be made to match by mixing in fractions of s-polarization. Future steps involve total internal reflection and further research into RAE. RAE appears to be a viable, but less accurate method. This method has proven to be very sensitive, where contaminants and minor human errors can introduce considerable errors in our results.

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**Isabelle Sealey**

Florida State University

*Raman spectroscopy of van der Waals antiferromagnet MnPS3*

Co-Authors: Dmitry Smirnov- National High Magnetic Field Laboratory

Poster Number: 164

Two-dimensional (2D) van der Waals (vdW) antiferromagnets (AFM) have recently emerged as novel, exfoliable, quantum materials interesting as both model systems for fundamental physics in condensed matter physics and promising functional materials for spintronics applications. Among the various 2D AFMs, the transition-metal based MPX3 family (M=Mn, Ni, Fe; P=phosphorus, X=S, Se) has emerged as a strongly correlated AFM with complex interactions among spins, electrons, phonons, and magnons. As a part of a large research team investigating dynamic, THz optical field-driven control over atomic and magnetic degrees of freedom in a prototypical vdW magnet MnPS3 with AFM ordering below TN=78K, our group studied static spectral response of MnPS3 using Raman spectroscopy. Throughout this summer research, we measured the temperature-dependent (T=5K-300K) and magnetic-field dependent (0-14T) Raman spectra of MnPS3 enabling differentiating of non-equilibrium lattice vibration modes driven by strong THz optical field from more conventional equilibrium phonons.

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**Larom Segev**

Harvard University

*A Broadband Data Acquisition System for Next-Generation Dark Matter Detectors*

Co-Authors: Stefan Knirck (Harvard University Department of Physics), Nathan Felt (Laboratory of Particle Physics and Cosmology)

Poster Number: 127

Dark matter constitutes most of the universe's mass yet remains undetected through direct observation. We present the development of a next-generation broadband receiver and data acquisition system designed to extend the sensitivity and spectral coverage of axion and axion-like particle (ALP) dark matter searches. Axions are well-motivated dark matter candidates predicted to convert into photons under a strong magnetic field. Unlike resonant cavity experiments, the Broadband Reflector Experiment for Axion Detection (BREAD) uses a metallic parabolic reflector to convert axions into photons and focus the resulting faint signals, enabling searches over a broad mass range. The receiver chain captures ultra-weak ($\sim 10^{-11}$ W) signals while minimizing added noise. A cryogenic front-end amplifier operating near 4.7 K achieves system noise temperatures around 5 K. The digital backend, implemented on a Xilinx RFSoC FPGA, provides real-time spectral processing with FFTs, drift compensation, and dual I/Q sampling, expanding BREAD's operational bandwidth beyond 2 GHz and establishing a foundation for one of the most broadband, low-noise axion detection systems in this mass regime.

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**Nistha Sheth**

Rutgers University - NB

*Photometric decomposition of a new catalog of polar ring galaxies in the HSC-SSP found with deep learning*

Co-Authors: Nistha Sheth, Dr; Benjamin Rosenwasser, Professor Marc Seigar

Poster Number: 148

Polar ring galaxies (PRGs) are a rare multi-spin S0/lenticular type galaxy with a polar disk component orbiting orthogonally to the host galaxy. The very large catalog sizes of PRGs in the Hyper Suprime-Cam Subaru Strategic Program require some form of automation to find the PRG candidates. Here, we present a successful effort to train a machine learning algorithm to automatically identify classical PRG candidates and apply it to the HSC-SSP. We present our methods, the new catalog of so far over 600 new PRG candidates, and then methods and results for a follow-up study of the photometric properties of the new PRGs.

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**Joy Skaggs**

Arkansas Tech University

*An Analysis on the Time Effectiveness of Speeding while Driving a Vehicle*

Poster Number: 89

Speeding is responsible for roughly a third of all crashes, most with a deadly cost. Despite many negative consequences, such as a greater likelihood of loss of vehicle control, reduced protection equipment effectiveness, increased stopping distance, and crash severity, drivers continue to speed. In fact, in our fast-paced world, speeding is so normalized that it's uncommon to encounter a driver following the speed limit. Hawaiian psychology professor Leon James explains it best: people have twisted their definitions of speeding to 20 miles over the original limit, making it more acceptable to go 15 miles more (HiRoad.com 2022). The essence of speeding is a desire to 'save time,' but how much time is really saved? According to a study by the US Army—not much. Curiously, they found that the higher the original speed limit, the less time speeding actually saves (Beckman 2022); a fascinating conclusion that seems to defy the laws of physics. Using the methodology from the Army, this study sought to reproduce their calculations to determine the reason behind the surprising conclusion. Comparing all the possible speeds a car could travel revealed a logarithmic graph trending to a 50% time reduction, no matter the distance. Considering these calculations were also an idealized model, the irony of how little time is saved is truly impactful. These findings further support the conclusions the Army made: It's better to be a minute late than to lose your life in a minute.

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**Jack Slavin**

Sacramento State University

*Optimizing Performance of SQUID based Microcalorimetry*

Co-Authors: Lawrence Livermore National Laboratory, Geon-Bo Kim, Michael Ray

Poster Number: 182

The Nuclear and Chemical Sciences Division at Lawrence Livermore National Laboratory partners with the International Atomic Energy Agency to develop high

precision energy detectors utilizing SQUID signals and cryogenic magnetic microcalorimeters. These detectors are capable of distinguishing the decay energy of different isotopes used in nuclear applications, but their high resolution is also applied to search for the presence of sterile neutrinos. This talk will cover the design of the sensor which exploits quantum scale effects and the progress towards characterizing the shape of the SQUID response signals in order to model the microcalorimeter's magnetothermal dynamics and optimize performance.

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**Jestina Smith**

Morgan State University

*Measuring J/psi from UPCs with sPHENIX: From Starlight Simulations to RHIC Run Predictions*

Co-Authors: Dr; Stacyann Nelson, Department of Physics and Engineering Physics Morgan State University Baltimore, MD, 21251 Dr; Mickey Chiu, Brookhaven National Laboratory, Upton, NY, 11973

Poster Number: 27

Ultra-peripheral collisions (UPCs) occur when two ions pass near each other without direct contact, interacting through electromagnetic and photonuclear exchanges. These processes can produce vector mesons, such as the J/ψ, and provide opportunities to study hadronic structure and strong QED fields through dilepton production.

This study, conducted with the sPHENIX detector at Brookhaven National Laboratory’s Relativistic Heavy Ion Collider (RHIC), uses STARlight, a Monte Carlo event generator, to simulate UPC events in the dilepton channel. Events are then processed through the sPHENIX Fun4All GEANT4 framework to model detector effects and assess UPC reconstruction.

From simulations, we reconstruct J/ψ mesons from dimuon pairs and analyze their invariant mass, transverse momentum, and rapidity distributions. Comparing these results with theoretical predictions allows us to evaluate detector resolution, selection efficiency, and expected yields for the 2025 RHIC run. A custom analysis module was also developed to process real UPC data, enabling direct comparison between simulation and experiment.

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**Marcus Smith**

Pennsylvania State University

*The Preparation and Identification of Rhombohedral Graphene for the Exploration of Strongly Correlated Phenomena*

Co-Authors: Zachary Jernigan, Prof; Jun Zhu; Pennsylvania State University, Department of Physics

Poster Number: 98

Graphene is a single layer of carbon atoms arranged in a hexagonal lattice. Multilayer graphene can form different stacking orders, which are defined by the orientation of the sublattice sites between adjacent layers. When aligned with hexagonal Boron Nitride, rhombohedral (ABC) graphene hosts a variety of emergent phenomena, including superconductivity and Chern insulators. A major limitation in studying this system is caused by the ABC stacking order being metastable and occurring less frequently than the stable Bernal (ABA) stacking order. The fabrication of devices containing ABC graphene requires both its identification and preservation, which are the objectives of this project. We utilize Scanning Kelvin Probe Microscopy (SKPM), to identify different stacking domains, exploiting the differing work functions of ABC and ABA stackings. Domains found via SKPM were confirmed using Raman spectroscopy. We present results from SKPM measurements and subsequent dry transfer towards the fabrication of dual-gated rhombohedral graphene devices.

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**Maddox Spinelli**

University of Washington

*Double spin asymmetries at small-x from exclusive vector particle production*

Co-Authors: Sanjin Benić (University of Zagreb), Adrian Dumitru (Baruch College), Swagato Mukherjee (Brookhaven National Laboratory), Farid Salazar (Temple University, Brookhaven National Laboratory)

Poster Number: 73

A chief aim of the Electron-Ion Collider (EIC) is to probe the origin of the proton's spin. Decades ago, experiments revealed that the proton's total spin cannot be explained by a

simple three-quark model. This “spin crisis” suggests that gluon dynamics play a critical role in generating proton spin, especially at small-x where gluons dominate the proton’s structure. Exclusive vector meson (VM) production from polarized electron-proton collisions provides a clean probe of gluons in this regime. To uncover the spatial distributions of these gluons and how they contribute to proton spin, we analyzed double-spin asymmetries in exclusive VM production, a novel observable sensitive to Generalized Parton Distributions (GPDs). We isolate helicity and polarization structures, compute the asymmetries, and map different structure functions to GPDs in the leading-twist approximation. This work lays the foundation for future numerical predictions to assess the experimental feasibility of these measurements at the EIC.

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**Korbin Stacey**

Weber State


*Exploring Metallic Thin Film Morphology and Thickness on Manufactured Surfaces*


Co-Authors: Dr; Kristin Rabosky and Weber State University


Poster Number: 119

Thin films are important in many technologies, from electronics to protective coatings. The way these films grow can change depending on the shape of the surface they are deposited on. In this project, we studied how a metallic thin film deposited onto three different surfaces: a flat plate, bolts, and a screw. Using scanning electron microscopy (SEM), we examined the overhead surface morphology and measured film thickness through cross-sectional imaging. Energy dispersive X-ray spectroscopy (EDS) was also used to determine the chemical composition of the film. Comparing a cross-section of the flat plate to the deposition on more complex surfaces, we observed differences in how the thin film covered the surfaces and how its thickness varied. This study shows how surface geometry influences thin film growth and provides insights for improving thin film deposition on non-flat materials.

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**Sawyer Star**

Embry-Riddle Aeronautical University

*Rindler Coordinates in Lorentz-Symmetry Breaking Motion*

Co-Authors: Dr; Quentin Bailey, Embry Riddle Aeronautical University - Prescott

Poster Number: 162

This poster will show motion with constant acceleration in flat spacetime. We consider the effects when Lorentz-symmetry breaking occurs. The framework uses a background field to describe the degree of symmetry breaking in the equations of motion for an accelerating mass. We will show properties of the trajectory with different forms of the field, and compare the standard case. We discuss analytical forms of the trajectories, and the relationship to motion in the standard case, without symmetry breaking. Evidence of nonzero symmetry breaking could point to the nature of an underlying unified theory.

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**Ryne Starnes**

Florida State University

*Predicting a di-Higgs mass through the use of Neural Networks*

Co-Authors: Dr; Harrison Prosper, Florida State University

Poster Number: 100

The Higgs boson is a recently discovered particle that implies the existence of a Higgs field, which essentially grants mass to every elementary particle in our universe, with the amount of mass being determined by how strongly a particle interacts with the field. This research intends to predict a measured ‘di-Higgs cross-section’. Using a neural network, we model 5 different couplings capable of producing two Higgs bosons simultaneously. Given a dataset of these and the possible di-Higgs cross-sections associated, we train a neural network model to then give us a theoretical di-Higgs cross-section when we input values for these parameters. This could be experimentally tested, but the LHC at CERN is currently unequipped for such an experiment, and needs until 2030 to complete the necessary upgrades. Until then, our model can be used to predict possible results of a di-Higgs cross-section, which we will later cross-reference with the LHC.

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**Brendan Steck**

Grove City College

*Multi-Layer Reflector in the Six-Spotted Tiger Beetle*

Co-Authors: Andrew Vahlberg (Grove City College)

Poster Number: 196

The Six-Spotted Tiger Beetle (Cicindela sexguttata) is an iridescent species native to Pennsylvania, characterized by its striking coloration. In this study, we investigate the presence of a multi-layer reflector (MLR) in the beetle, which is hypothesized to contribute to its iridescence. Utilizing Scanning Electron Microscopy (SEM), we aim to identify the MLR within the elytra of the beetle. Based on previous studies of the Jewel Beetle (Chrysochroa fulgidissima), where the MLR has been well-documented, we hypothesize that the reflective structures may reside in the surface layers of the elytra. Preliminary findings suggest the presence of potential MLR regions, informed by the knowledge gained from the Jewel Beetle. Further analysis will focus on confirming the location and structure of these reflective layers in the Six-Spotted Tiger Beetle.

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**Alex Steensland**

CSU Sacramento

*Light Signals of Neutron Star Kilonovae*

Co-Authors: Erika Holmbeck, Lawrence Livermore National Lab; Rodolfo Barniol-Duran, CSU Sacramento

Poster Number: 208

Stars, and the nuclear fusion at their cores, are responsible for the formation of most matter. Elements with heavier nuclei, however, output less energy than the is produced through their fusion. The mechanisms for the formation for these so-called “heavy elements” can only exist in the universe’s most extreme conditions. My work with the Nuclear Data and Theory group at Lawrence Livermore National Lab describes and analyzes the predictions from models of neutron star mergers which are responsible for

forming these heavy elements. Differences among these theoretical models are derived from key changes in their formulation, changes which are valuable in determining the behavior of real neutron stars.

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**Ming Tang**

Worcester Polytechnic Institute

*The cross-membrane trainsport protein-substrate charge interactions and cell mechanical anylysis*

Poster Number: 320

The TRPA1 protein is a key component of a $Ca^{2+}$-permeable ion channel, which is also one of the largest cross-membrane protein human have. which triggers multiple downstream responses.

This ongoing investigation utilizes multiple interdisciplinary methods, including the theoretical force analysis, molecular protein concentration, and fluorescence microscopy. This research is expected to reveal the functional role of TRPA1 in cellular physiology.

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**Panagiotis Taoulas**

Old Dominion University

*Design, Assembly, and Characterization of a Helical Resonator*

Co-Authors: Don Solomon, Matt Grau, Old Dominion University

Poster Number: 220

This project describes the design, assembly, and testing of a helical resonator for ion trap experiments. Resonators amplify input signals to provide the stable voltages needed to confine ions. The device was designed using Python and Cad software, built from copper components, and tested under various capacitive loads and antenna designs. The final resonator operated at 12.3 MHz, with a gain of 20 and a Q factor of 98. While lower than the calculated maximum for the Q factor -which is due to internal resistances from the material, imperfections and solder-, these results demonstrate that the resonator is reliable and effective for its intended use.

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**James Taton**

Cleveland State University

*Computational Modeling of Mass Transfer in Paper-Based Analytical Devices*

Co-Authors: Chandrasekhar Kothapalli and Petru S; Fodor

Poster Number: 33

Using computational fluid dynamics, the concentration distribution of fluid samples flowing through porous media is investigated in order to support research on simple, automated microfluidic paper-based analytical devices. Finite microliter volume liquid samples are driven through the porous device material by capillary forces. The flow process is modeled using the Richard's equation for fluid movement through an unsaturated medium. The fluid flow solution is coupled with the convection-diffusion equation to monitor the transport of diluted species through the paper membranes. This is important to visualize the concentration distribution profiles through the test devices as a function of time, in order to determine the relevant time scales for analytical applications.

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**Joseph Temple**

Arkansas Tech University

*Adaptive Vortex Beam Shaping*

Poster Number: 180

We have developed an automated, interactive pipeline for generating and optimizing optical vortex beams using dynamic holographic modulation. A Python-based interface allows real-time adjustment of beam parameters--including topological charge (l) and spatial sampling (n_x, n_y)--and continuous translation of the hologram across a spatial light modulator (SLM). The system integrates camera control and live image acquisition to automate data collection, incorporating a preview window and brightness feedback. Acquired images are analyzed algorithmically to locate the vortex center and extract intensity profiles along orthogonal axes, which are then parametrically fitted to Gaussians. Minimization of a loss function, defined by comparing similarity between parameters of the four Gaussians, provides us with the optimal pixel offset for the SLM produce a pure vortex beam. Together, these developments establish a robust framework for automated optical beam shaping and quantitative analysis, with applications in optical trapping, communications, and precision measurement.

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**John Tichenor**

University of Washington


*Machine Learning to Predict Spectral Anisotropy in Valence-to-Core X-ray Emission Spectroscopy*


Co-Authors: Charles A; Cardot, Seth M Shjandemaar, Josh J; Kas, Fernando D; Vila, Gerald T; Seidler, John J; Rehr∗ University of Washington


Poster Number: 338


Polarization analysis in x-ray spectroscopy provides an orientation dependent sensitivity to local bonding environments. For a cluster of atoms, polarization sensitivity is most often discussed through the lens of point group symmetries. However, this is a discrete, qualitative method of classifying clusters, and it does little to indicate the degree of spectral anisotropy. Here we adopt a random forest model for quantitative prediction of spectral anisotropy. Its input relies on simplified local geometric and chemical information that can be obtained from any crystal structure file. The model is trained on over 10,000 experimentally realized transition metal structures from the Materials Project, with the target being VtC-XES calculated using the real space Green's function code FEFF. We find that the model can strongly predict the degree of spectral anisotropy, with the primary factors being derived from the spatial moments of ligands in a cluster.


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**Kayla Turner**

Morgan State University


*Brightest Cluster Galaxies and the Search for the Universe's Biggest Black Holes*


Co-Authors: Marc Postman, Space Telescope Science Institute and Tod Lauer, NIORLab

Poster Number: 23

This research investigates the largest black holes in the nearby universe using imaging from the DESI Legacy Surveys (DLS). We focus on brightest cluster galaxies (BCGs), modeling their light profiles in 2D with custom software and applying deconvolution to ground-based data for improved resolution. A key aim is to measure core sizes, as extended cores (≥1 kiloparsec) are linked to the most massive black holes. Our work represents the first systematic census of BCGs in the local ($z \leq 0.08$) universe designed to identify such extreme systems. From a preliminary sample of 387 BCGs, only a few percent show kiloparsec-scale cores, confirming their rarity. To ensure robust results, we require each galaxy's half-mass width to exceed 2.5 times the point spread function. By focusing on this well-resolved subset, we can reliably identify candidate galaxies most likely to host extremely massive black holes and highlight targets for future high-resolution studies.

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**Skyler Turner**

Weber State University

*Sub and Super Solution Based PINNs for Nonlinear Boundary Value Problems*

Poster Number: 252

Physics-Informed Neural Networks (PINNs) offer a promising framework for solving nonlinear boundary value problems (BVPs), but they often struggle with convergence and accuracy in the presence of nonlinearity and stiff boundary conditions. In this work, we propose a PINN architecture for a nonlinear steady-state reaction-diffusion equation, where the solution is constrained using analytically derived sub- and super- solutions from a linearized eigenvalue problem. This bounding guarantees physical admissibility and significantly improves training stability. We also introduce periodic activation functions to enhance smoothness in higher-order derivatives, which are critical for enforcing PDE residuals via automatic differentiation. The network's performance is benchmarked against a high-precision quadrature method, showing excellent agreement across a range of parameter values. Our results demonstrate that embedding classical analytical structure into neural architectures can improve the reliability of PINNs in solving nonlinear PDEs with complex boundary interactions.

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**Wyatt Urbanek**

Coe College

*Physical Properties of Alkaline Earth Vanadates over an Extended Range of Compositions*

Co-Authors: Öykü Barlin - American Collegiate Institute- Konak, İzmir, Türkiye 35290, Joshua Yi - Physics Department, Coe College - Cedar Rapids, IA, USA 52402, Doruk Dogular - TED Rönesans College- Maltepe, İstanbul, Türkiye 34854, Steve A; Feller - Physics Department, Coe College - Cedar Rapids, IA, USA 52402

Poster Number: 121

The alkaline earth vanadate glasses [RMCO3 + V2O5] → [RMO・V2O5] + RCO2 glass forming range was thought to stop at R = 1.5 and we were able to increase that to R = 1.9. where R is the molar ratio of strontium oxide to vanadium pentoxide in the glass. Glasses were made from R=0.2 all the way to R=1.9 in increments of 0.2 in the middle and 0.1 towards the end and the beginning of our range. The results on the low range of R have matched those of the previous experiments while the higher R values have extended the range of information available on the alkaline earth vanadate glasses. The Tg was measured using a TA200 differential scanning calorimeter (DSC). The results we've gathered have been consistent with previous experiments with a max Tg in the range of R = 1.1 to R = 1.3. Expanding on this range has allowed us to witness the Tg drop after reaching its maximum. Density measurements were taken on compositions using a helium pycnometer this has led to finding the molar volume and packing fractions. Structural ideas are reviewed and applied to the data.

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**Donald VanGilder II**

Ohio University

*Plotting Simulated Data for the MOLLER Experiment*

Co-Authors: Dr; Julie Roche, Department of Physics and Astronomy, Ohio University, Athens, OH, United States

Poster Number: 274

The Measurement Of a Lepton-Lepton Electroweak Reaction (MOLLER) experiment at Jefferson Lab, scheduled to begin in March 2026, aims to make a precise measurement of

the results of parity-violating electron scattering. To assist with early data analysis, a comprehensive set of reference plots was developed that uses data from existing simulations of the detectors and beam monitors. These plots allow the on-site shift crew to compare the data they receive with the expected results for real-time troubleshooting. Simulated data was produced using GEANT4 and was then plotted in ROOT using C++. The resulting directory of histograms provides the necessary information for assessing detector and beamline performance during the experiment. This work was supported by the National Science Foundation (NSF-PHY-2209199).

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**Naazneen Shafeer Vemmerath Kulangara**

University of Southern California

*Simulating Effects of Dynamical Friction in a Supermassive Black Hole Binary Merger*

Co-Authors: Naazneen Shafeer V; K; , Mya Do, Kris Pardo - University of Southern California

Poster Number: 280

Supermassive black hole binaries (SMBHBs) are expected to be found at the center of galaxies that have recently merged. After galaxies merge, the main mechanism that brings supermassive black holes to their centers is dynamical friction, a drag force that comes from the gravitational interactions of these supermassive black holes with field stars. The interactions from the distribution of stars incrementally slow down the SMBH, causing the binaries to come closer together over a timescale. We present a simulation model of dynamical friction that seeks to explore how various orbital and galaxy properties can affect the expected separation distribution of SMBHBs. We then investigate how these results compare to known dual active galactic nuclei (AGN) samples. This work could help constrain and refine future models of the gravitational wave background.

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**Timothy Villarreal**

Angelo State University

*Simulating Bremsstrahlung Production in Carbon Allotropes Using PENELOPE*

Co-Authors: Angleo State University, Scott Williams

Poster Number: 53

Bremsstrahlung is electromagnetic radiation (typically X-rays) emitted by charged particles (typically electrons) as they are accelerated. Most studies of bremsstrahlung focus on the effects of the incident electron energy and the atomic number of the target material with which the incident electron interacts. In this study, we investigate bremsstrahlung emission by 10-keV electrons incident on carbon allotropes, which have the same atomic number but differ in other characteristics. Using the Monte Carlo code, PENELOPE, we studied how mass density, mean excitation energy, and the number of conduction electrons per atom independently influence the bremsstrahlung produced by 10-keV electrons incident on a carbon substrate. Results of simulations suggest that the higher density and mean excitation energy of diamond lead to a slightly increased bremsstrahlung yield compared to graphite.

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**Patrick Weglinski**

Weber State University

*Simulating New Models of Dark Matter at the Large Hadron Collider*

Co-Authors: Students: Julian Martinez, Skyler Turner, Patrick Weglinski; Advisor : Jonathan M; Cornell

Poster Number: 298

Dark Matter is one the largest mysteries in physics today. Given that Dark Matter cannot interact with the electromagnetic field, we cannot see it nor touch it. Certain hypotheses suggest however that Dark Matter could be comprised of Weakly Interacting Massive Particles (WIMPs) which could plausibly be created at a particle collider with an energetic enough collision. The proposed Dark Matter particles would show up as missing energy after the collision, which would need to be discerned from the many other background particles that were created as well. To improve our chances at finding Dark Matter, scientists are proposing a new particle collider which will collide muons. The collisions will be less messy overall and require less energy since muons are fundamental point-like particles. This project aims to confirm the proposed benefits of the proposed muon collider by running particle collision simulations in a program that simulates the LHC called Madgraph. We are currently testing various configurations of proton collisions at higher energies to demonstrate that increased collision energy can make it easier to identify potential Dark Matter signatures. Our simulation framework could be used to study possible dark matter signatures at a future muon collider.

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**Bryce Willems**

NC State University

*Photodetector Device for Atom-Cooling Optical Trap*

Co-Authors: Dr; Jiazhen Li, Dr; Qing Gu Department of Electrical and Computer Engineering

Poster Number: 43

The magneto-optical trap is a large contraption that uses laser beams and magnetic fields to simultaneously force atoms into a small area and slow them down, significantly decreasing their temperature. The lasers cause excitations in the atoms of a gaseous sample while the magnetic fields ensure the atoms don't leave a small volume. I built a photodetector that uses a photodiode to measure the power of incoming light by converting it to electrical current, which will be used to find the power of an incident laser that passed through the sample. This will tell us if the atoms in the sample made the intended energy transitions. The ultra-cold atoms have applications in hyperfine measurements and for qubits in quantum computing. By the end of this project, we hope to scale the MOT down to chip-scale by incorporating a diffraction grating to create the different directions of laser propagation.

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**Caitlyn Wingeart**

High Point University

*Textured PDMS Surfaces: A Promising Approach to Biofilm Prevention*

Co-Authors: Aubrey Fessler, Megan Muller, Lauren Rumble, Dr; Meghan Blackledge (High Point University, Chemistry Department), Dr; Briana Fiser (High Point University, Physics Department), Dr; Jacob Brooks (High Point University, Physics Department)

Session I

Poster Number: 234

Bacterial and fungal biofilm formation poses a significant threat in medical environments, leading to increased patient morbidity and higher healthcare costs. One promising approach to mitigate biofilm-related infections involves engineering textured surfaces that resist microbial attachment. Previous studies have demonstrated some success using laser-textured surfaces to reduce biofilm growth. We focused on investigating how variations in microscopic circles' feature size and spacing influence the effectiveness of these surfaces in preventing biofilm formation. Specifically, we varied the diameter size across 4 different spacings within a triangular lattice. Using photolithographic processes, new micro-pattern arrays were designed and written into a positive photoresist layer on large silicon wafers using the μMLA Heidelberg maskless aligner. When developed, these substrates created depressions to be used as molds. By systematically exploring geometric parameters, this work aims to identify design principles that improve surface resistance to microbial colonization and offer new pathways for reducing device-related infections.

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**Trevor Winter**

Millersville University of Pennsylvania


*Study of Energy Flow in Electric Dipole Radiation Interference*


Co-Authors: Dr; Xin Li, James Fox


Poster Number: 176

When analyzing the radiation emitted from dipoles, we can use time-averaged Poynting Vectors to observe the energy flow associated with electric dipole radiation. The Poynting Vector
represents the directional energy flux density of the electromagnetic field produced by the dipole,
which is the rate of energy transfer per unit area. In this study, we will be looking at the energy
flow for the electromagnetic field produced by two dipoles oscillating at different angles relative
to the y-axis. We are particularly interested in areas where the energy flow pattern results in
vortices, or where the magnitude of the Poynting Vectors in the x-y plane becomes zero.

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**Jared Wyetzner**

Yale University

*Stochastic Physical Neural Networks*

Co-Authors: Jinchen Zhao, Logan Wright (both Yale Applied Physics)

Poster Number: 109

Neural networks are mathematical tools which can perform tasks from function fitting to natural language generation to classification. The current methods of employing digital computers for neural networks is particularly expensive in terms of energy. The goal of physical neural networks is for a physical system to replicate the mathematical transformation of a neural network. This work focuses on implementations of stochastic physical neural networks. The stochastic aspect can either come from inherent noise (such as measuring the output of a quantum circuit) or from choosing to trade off coherence for further energy savings. We present theory on training stochastic physical neural networks with arbitrary continuous and discrete noise. We benchmark these training methods on a single photon detection neural network and a variational quantum algorithm, as well as present plans to benchmark with an optical dot product setup using homodyne detection and coupled digital oscillators on a stochastic FPGA.

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**Medina Yessenaliyeva**

Juniata College

*NASA Proposal Writing and Research Evaluation ExperienceDuring the Fall 2024 semester, I participated in the NASA Proposal Writing and Research Evaluation Experience (NPWEE), an immersive program introducing students to professional research and proposal development at NASA. I collaborated in a team of seven students from different schools on a project titled ACS3 Thrust Vector Reorientation Via Servo Motor Actuators, for which we received $10,000 in funding to develop our concept. Throughout the program, I gained hands-on experience in writing research proposals, designing experiments, and evaluating technical projects, under the mentorship of NASA engineers. Our proposal focused on improving solar sail technology by making sails more flexible and efficient, enabling spacecraft to change direction with greater control* *without relying on extra fuel or complex systems. This approach has the potential to save resources, reduce mission costs, and extend the lifespan of space missions. Participating in NPWEE strengthened my teamwork, scientific communication, and critical thinking skills, while inspiring my future aspirations in aerospace engineering and research.*

Poster Number: 8

During the Fall 2024 semester, I participated in the NASA Proposal Writing and Research Evaluation Experience (NPWEE), an immersive program introducing students to professional research and proposal development at NASA. I collaborated in a team of seven students from different schools on a project titled ACS3 Thrust Vector Reorientation Via Servo Motor Actuators, for which we received $10,000 in funding to develop our concept. Throughout the program, I gained hands-on experience in writing research proposals, designing experiments, and evaluating technical projects, under the mentorship of NASA engineers. Our proposal focused on improving solar sail technology by making sails more flexible and efficient, enabling spacecraft to change direction with greater control without relying on extra fuel or complex systems. This approach has the potential to save resources, reduce mission costs, and extend the lifespan of space missions. Participating in NPWEE strengthened my teamwork, scientific communication, and critical thinking skills, while inspiring my future aspirations in aerospace engineering and research.

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**Kiyah Young-Wilson**

Gonzaga University

*Studying the Evolution and Formation of Elements in Stars*

Co-Authors: Fritsch Lab: Mally Panek, Irena Langer, Kiyah Young-Wilson, Dr; Adam Fritsch, Gonzaga University/Independent Research: Kiyah Young-Wilson, Dr; Joshua Shields, Ryan Groneck

Poster Number: 113

The Fritsch Lab research focuses on analyzing the proton evaporation reaction between an Aluminum-27 target and an incident Carbon-12 beam. The cross section of proton evaporation was studied by comparing models of this reaction, generated using the simulation code EMPIRE, with experimental data. These comparisons can determine which theoretical models describe the reaction and extract the nuclear structure information. In 2024 and continuing this summer, the Kerzendorf Lab studied two stars approximately 5pc away from Sagittarius A* that had abnormal metallicities. To do this, theoretical absorption spectra were compared with observed stellar spectra to measure the amount of Sc, V, and Y. In 2024, STARDIS, a radiative transfer code developed by Dr. Joshua Shields, was used to validate the original findings from a 2018 paper that reported the abnormal stars. In 2025, STARDIS was used to measure the metallicity while taking into account the effect of rotational broadening calculations.

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**Iffat Zarif**

Yale University

*Beam Monitor Trigger Selection for the Mu2e Experiment*

Co-Authors: , Sarah Demers, Michael MacKenzie, Gianantonio Pezzullo, Matthew Stortini; Mu2e Experiment, Fermilab, Yale University

Poster Number: 94

The Mu2e experiment will search for a beyond-Standard-Model process: neutrinoless muon-to-electron conversion. If it exists, the process would be incredibly rare and measuring it at a high confidence level would require our detector to be highly sensitive to fluctuations in the muon beam. Standard Model muon decays in the Inner Proton Absorber (IPA) quantify the muon beam quality as their decay products leave predictable detector signatures when the beam is nominal. When I started, the reconstruction efficiency for these trajectories was below 1%. By studying the behavior of the reconstruction algorithm and retuning the selection criteria on the governing parameters, I increased the efficiency by more than a factor of 50 while verifying that there were no adverse effects on overall selection efficiency, processing time, or data rates. The improved reconstruction enables reliable, real-time beam quality monitoring with minimal cost.

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**peleen najmadeen**

University of Duhok

*The Impact of Participants' Motivations for Engaging in Physical Activity on Their Reaction Time*

Co-Authors: Dindar S; , Ahmed M; , Haval Y; Yacoob, Ali R; , Zilan Z; , Ranya S;

Poster Number: 69

Reaction time (RT) is a measure of the time elapsed between the application of a stimulus and the subsequent response. it is influenced by various factors, including human body weight, physical activity, etc. Another factor no one has investigated before is the effects of motivations in physical activity on motor reaction time by measuring simple reaction time and the recognition scores by the number of hits. Thus, the current study aimed to examine the impact of motivation in physical activity on RT and the number of hits. The study was conducted on 60 healthy volunteers in the age group of 18–60 years (mean ± SD; 27.66±8.31 years) who participated in regular physical activity. Headset for the virtual reality base station, controllers, and the Rezzil game were used to determine RT. In addition, the participants' motives for the physical activity were recorded using the Leisure Motivation Scale list. It was found that the RT of participants was influenced by different leisure motivation categories, particularly for males. Body mass index (BMI) also affected the RT of participants, especially in normal and overweight groups. However, the number of hits was not influenced by such motivations. These results showed that the RT of individuals who participate in physical activity could be influenced by their motivations in such activities. Intrinsic motivations for physical activity, like personal enjoyment, reported slower RT than extrinsic motivations like ego or competition.

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## Session II

**James Addison III**

Lamar University

*Role of Group Test on STEM students Success in Physics Class*

Co-Authors: Dr Binod Nainabasti

Poster Number: 329

The intention of our study was to see how each student's performance in group work reflected in their individual exam performance. To measure performance, We used the validated Physics problem solving grading rubric to grade their performance during the group work and exam. We then analyzed this data and compared the scores to see how much has changed for each group from their first exam to their final exam. Following this, we turned to the in-class observation notes and looked at the scores to see if we could determine a pattern of a certain type of characteristics which influenced the group dynamics and overall group performance.

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**West Allen**

SUNY New Paltz

*Making HR Diagrams Using Data From a SeeStar S50 Telescope*

Poster Number: 287

The SeeStar S50 is a portable, inexpensive imaging telescope for amateur astrophotography. It is a viable option for a wide range of astronomers as it takes images with pristine quality considering its price. The goal was to assess whether the SeeStar S50 could be used for amateur research purposes. The SeeStar was used to collect data to form a plethora of HR diagrams of multiple star clusters because they're of the same distance from Earth. So, their apparent magnitudes can be approximated consistently. Python-based analysis was used to synthesize the diagrams and they were compared to HR diagrams created through research-grade based equipment. Through comparison analysis, the efficacy of the SeeStar S50 was investigated. It's vital to provide affordable

sources for those who have a passion for astronomy, so that they can extract meaningful, scientific data.

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**Gabriel Ambrose**

University of San Diego

*Differential Dynamic Microscopy in Light Field Microscopy for Quantifying Particle Dynamics in 3D*

Co-Authors: Dylan Gage, University of San Diego, Gabriel Ambrose, University of San Diego, Gildardo Martinez, University of San Diego, Zayda Kellogg, Bennington College and researched at the University of San Diego, Dr; Ryan McGorty, Chair of the Department of Physics and Biophysics at the University of San Diego, PI

Poster Number: 211

Quantitative measurements of a sample's dynamics observed under a microscope reveal insights relevant to disciplines from materials science to biophysics. Differential dynamic microscopy (DDM) and single particle tracking (SPT) quantify these dynamics. However, most video analysis algorithms are limited to quantifying motion in two dimensions. Here, we introduce a new microscopy method which integrates DDM with light field microscopy (LFM), a setup which uses a microlens array to capture 3D information in a single shot. While existing computational methods to extract 3D information from LFM data are complex and computationally expensive, we bypass those obstacles by developing novel methods for DDM and SPT to be applied to LFM data, directly determining 3D dynamics without the need to determine the 3D structure at each time point. We demonstrate how a relatively inexpensive microscope and computationally efficient workflows can extract 3D dynamics of diffusing and sedimenting micron-sized colloidal particles.

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**Ian Ashcroft**

Pennsylvania State University (Penn State)

*Linearity Improvement of the Small-Pixel-1024 Hybrid CMOS Detectors through changing VCASC settings*

Poster Number: 259

The Small-Pixel-1024 X-ray hybrid CMOS detector (HCD) exhibits non-linear behavior at low signal values. This is due to an overcompensation of a charge injection scheme meant to restore the pixel's full well after a pixel reset. I will focus on improvements in linearity that result from adjusting the VCASC (Cascode Voltage) setting on these detectors. Linear behavior across the soft X-ray bandpass (0.1-10 keV) is important in order to ensure the correct conversion between signal level and X-ray energy. Any non-linear behavior must be corrected for. In this work, I will present the current state of correcting this non-linearity through the adjustment of the cascode voltage on the high-gain capacitive transimpedance amplifier (CTIA), with promising results that a lower cascode voltage improves the linearity of these detectors.

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**Elijah Avery**

University of San Diego


*Quantifying Transport in Crowded, Complex Systems Modeled by Holographic Optical Tweezers through Differential Dynamic Microscopy*


Co-Authors: Elijah Avery, Dr; Ryan McGorty


Poster Number: 333

Drug delivery, vesicular transport through cellular and extracellular compartments, and even the movement of certain cells themselves rely of thermally driven motion through complex, crowded systems. Investigation of particle transport behavior in crowded and complex systems can be experimentally challenging to distinguish and characterize due to size. Here, we model the heterogenous energetic landscape encountered by a thermally driven particle by using holographically generated optical traps to create a speckle field. By using differential dynamic microscopy (DDM) and image analysis, we can characterize both ergodic and nonergodic transport dynamics of our model system and use it to characterize particle transport in biological contexts.

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**Mirza Barlas**

Central Connecticut State University

*Thermal Effects of Silica Optical Nanofibers*

Co-Authors: Sylvie Lebrun, Pierre Jeunesse

Poster Number: 237

This project investigates the thermal effects in silica optical nanofibers for their application as water pollutant sensors. Optical fibers were fabricated from SMF-28 using the Pull-and-Brush technique and stretched until their diameter approached visible light wavelengths. At this scale, light propagates with a strong evanescent field that extends beyond the fiber, enabling interaction with the surrounding medium. Stretching introduces dangling silica bonds at the surface that absorb light energy and cause localized heating, potentially affecting sensing performance. Distributed and static thermal measurements were performed using 1480nm (infrared) and 532nm (green) lasers. Results showed a symmetric temperature profile along the fiber for the infrared laser and an asymmetric one for the green laser, with higher temperatures near the input. Thinner and shorter fibers exhibited greater heating, consistent with theoretical predictions. Ongoing work focuses on calibrating absolute temperature measurements to improve the reliability of nanofiber-based pollutant sensors.

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**Ryan Barros**

University of Massachusetts Dartmouth

*Calculating Diffusion Faster with Color Force*

Co-Authors: Dr; Hartwin Peelaers, University of Kansas

Poster Number: 283

This research focused on the development of a calculator within ASE (Atomic Simulation Environment) implementing a new 'color force' in order to speed up the diffusion process in a system. With the utilization of non-linear molecular dynamics, we can calculate the diffusion coefficient in a system with an external field without much extra calculation or computational difficulty, while also making diffusion occur more often. The broader scope of this research is to develop batteries that won't cause fires on exposure to oxygen, and this calculator will help with the theoretical calculations for what elements should be experimentally tested for use in the field.

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**Nick Beres**

Ohio University

*Process of Growing 2-Dimensional Materials and Investigation of Heat Distribution Techniques using Graphite Powder*

Co-Authors: Dr; Stinaff, Ohio University, research funded by Intel

Poster Number: 75

The process of creating semiconductor devices involves many steps such as photolithography, sputtering metal onto photolithography patterns, and growth of crystals. One process for growth is chemical vapor deposition(CVD) and proves to be very effective for crystal growth. Challenges arise from growing crystals, however, such as heating distribution throughout the substrate and consistency of effective growth. I investigated the effectiveness of graphite powder under the sample in order to ensure more uniform samples.

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**Emma Biskie**

Augustana College

*Radio Observations of the Eclipsing Cataclysmic Variable LX Serpens*

Co-Authors: John Cannon (Macalester College), Naysha Jain (Knox College), Lauren Wittry (Knox College), Joshua Reardon (Coe College), William Murillo (Augustana College) , Ava Schilling (University of Iowa), and the MACRO Consortium

Poster Number: 30

We aim to investigate the presence of radio variability in the eclipsing cataclysmic variable system LX Serpens. Our observations were made possible through the NRAO's Observing for University Classes program. Using the VLA, LX Ser was observed on May 16th, 2025, during the array's transition from C to D configuration over approximately 3.75 hours. Data were processed with the TCLEAN task in CASA, which grids the visibilities, performs Fourier inversion, and applies deconvolution algorithms to reduce artifacts. The outputs include a reconstructed model image, a residual image, and a restored image that combines both the model and residual components convolved with the synthesized beam.

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**Tyrel Boese**

Colorado Mesa University


*Progress Towards a Quantum-Accurate Classical SNAP Machine Learning Interaction Potential for Gold*


Co-Authors: Tyrel Boese[1], Ian Anderson[2], James Goff [3], Jarrod Schiffbauer [1] [4] Colorado Mesa University Department of Physical and Environmental Sciences[1], Colorado State University School of Materials Science and Engineering[2], Sandia National Laboratories[3], University of Colorado Boulder[4]


Poster Number: 107


Classical molecular dynamics is a powerful method of theoretically describing the properties of a material but is often inconsistent with quantum molecular dynamics. Quantum molecular dynamics while more accurate are much more computationally intensive and not feasible for systems of more than 1000 atoms. Machine learning is used to bridge the gap between quantum accuracy and the scalability of classical interatomic potentials. Here, we report on progress made testing the performance of a quantum-accurate classical interatomic potential for gold against state-of-the-art classical potentials in describing experimentally verified properties of gold using LAMMPS (Large Scale Atomic/Molecular Massively Parallel Simulator) Preliminary results show close agreement with quantum molecular dynamics simulations, while being computationally less expensive. Future work includes extending this study to simulate rare events in a large, such as the herringbone reconstruction of the Au(111) surface, that are not accurately described by current classical potentials.


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**Gabrielle Bolfing**

University of Kansas


*Influence of C, N, O, and S Abundances on the Atmospheric Composition of HD189733b Using VULCAN*

Co-Authors: Dr; Ian Crossfield, University of Kansas

Poster Number: 66

Sulfur is a relatively new element in observing and simulating atmospheric compositions, and has significant impacts on the composition of exoplanetary atmospheres. S complicates the calculations needed to reach chemical equilibrium, but it is also a crucial element to consider when modeling exoplanet atmospheres due to its effects on other elemental abundances. The Volume Mixing Ratios (VMRs) throughout the atmosphere of exoplanet HD189733b of C, N, and O relative to H were charted using the photochemical kinetic code VULCAN. Each ratio was changed by roughly an order of magnitude, respectively, and the supported molecules were charted ($H_2O$, $CO_2$, $CH_4$, $NH_3$). The results of each simulation were compared to simulations of atmospheric conditions with identical parameters plus the introduction of S, which allowed for the charting of molecules with S content, including $S_2$ and $SO_2$. Results demonstrate that the concentration of $S_2$ is consistently higher than $SO_2$ in exoplanet atmospheres. However, both $S_2$ and $SO_2$ were typically more abundant than $NH_3$ (except for when concentrations of O and S were low), which was downshifted from its abundance plotted without accounting for S. In some instances, it was also less favorable than $S_2$. Further investigation of this topic would investigate the unexpected dip and return of $CH_4$ and $NH_3$ in the variable S plot, as well as charting closer values and a wider range of supported molecules.

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**Meghan Bonham**

University of Missouri - St. Louis

*Specimen Characterization through Gamma Ray Spectroscopy*

Poster Number: 289

Gamma ray spectroscopy is a powerful method for characterizing radioactive specimens by their decay energy. The resulting spectra display predictable features due to scattering effects in the detector medium, including Compton scattering, back scattering, and pair production. Using a multichannel analyzer, seven samples are analyzed and their spectrums, where appropriate, are labeled according to the effects. In addition, the half-life of Ba-137m is determined using multichannel scaling mode detecting the gamma ray counts as a function of time. The measured half-life of $148.27 \pm 8.06$ seconds was found to be in good agreement with the accepted value, 153.12 seconds, demonstrating the effectiveness of this technique in nuclear analysis.

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**Jordan Bopp**

Carthage College

*Characterization of Lyman-Alpha Absorption for Calibrating DIII-D's LLAMA Diagnostic*

Co-Authors: Laszlo Horvath, Raul Gerrú

Poster Number: 245

We present experimental studies of the effects of environmental parameters on the calibration of DIII-D's Lyman-α neutral hydrogen density diagnostic, LLAMA [1]. Lyman-α (121.6nm) light is readily absorbed by air, therefore the Krypton calibration source (123.6nm) that mimics Lyman-α plasma edge emissions is housed in a dedicated vacuum chamber. During calibration, unexpected Lyman-α absorption in the chamber results in ~25% variation in the intensity measurement of the calibration source. Vacuum causes a coating of unknown composition to form on the magnesium fluoride entrance window of the Krypton source, which is avoided by taking measurements in atmospheric argon pressure [2]. However, impurities (namely oxygen) accompany venting, and the chamber walls outgas trapped moisture. Minimizing the concentration of these impurities, and thus their associated absorption, is key to maintaining a consistent calibration environment. We find that this environment requires a vacuum pressure of at least 10^−4 torr in both the chamber and vent lines prior to argon venting. Environmental consistency yields higher precision calibration, and thus improved neutral density measurements with LLAMA.

[1] Rosenthal RSI 92, 033523 (2021)
[2] Towle APS DPP, CP12.00038 (2025)

Work supported by US DOE under DE-FC02-04ER54698, DE-AC02-09CH11466, DE-SC0014264 and the SULI program.

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**Trent Boritz**

Florida State University

*Microstructural Feature Identification Using Shannon Entropy in Niobium for Superconducting Radiofrequency Applications*

Co-Authors: Shreyas Balachandran/Applied Superconductivity Center and The Department of Mechanical Engineering, FAMU-FSU, Santosh Chetri/Applied Superconductivity Center, and Peter Lee/Applied Superconductivity Center

Poster Number: 114

Residual trapped magnetic flux reduces the quality factor of superconducting radio frequency (SRF) niobium cavities. Microstructural features that trap flux, such as grain boundaries and lattice dislocations, are therefore important for improving performance. Electron backscatter diffraction (EBSD) mapping can quantify these features, but it is slow and costly for large areas. Backscatter electron (BSE) imaging offers a faster, lower-cost alternative, though conventional analysis struggles with the heterogeneous lattice distortions in cold-worked Nb. Here, we investigate the use of entropy maps of BSE images to quantify Nb microstructures produced by different processing paths. We report (1) entropy measurements of BSE images from Nb samples ranging from cold-worked to fully recrystallized after annealing at 900 °C for 3 h, (2) comparisons between recrystallized fractions derived from EBSD and BSE entropy data, and (3) further analysis to obtain quantitative insight about the microstructure.

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**Brynn Bortree**

Pennsylvania State University

*Optimization of a Precision Pointing System for Calibration of the BlackCAT CubeSAT*

Co-Authors: Brynn Bortree, Dr; Abraham D; Falcone, Mitchell Wages, Laurel O'Neill, Killian M; Gremling, Ian T; Ashcroft, William A; Bevidas, Zachary E; Catlin, Joseph M; Colosimo, Sierra Deppe, Timothy Emeigh, Dennis Hartmann, Md; Arman Hossen, Katie McWhirter, Kadri M; Nizam, Abigail A; Raytsis, Lukas R; Stone

Poster Number: 351

The ability to localize point sources to a confident degree of accuracy is critical to the BlackCAT CubeSAT mission, which relies on rapid source identification to alert ground-based observatories for follow-up and redshift determination of X-ray transients such as gamma ray bursts. Testing the ability of our detectors to localize sources within mission requirements is essential. A key part of this effort is developing an accurate and repeatable positioning system for payload testing in our beam line. My work involves enhancing the accuracy and repeatability of a precision pointing device, the Newmark GM-12 Gimbal, to operate within an error of 20 arcseconds. The planned improvements

include refining motor control through encoder feedback and implementation of a PID loop, as well as optimizing the test stand to minimize excess torque in the positioning apparatus caused by LN2 cooling lines within the vacuum chamber.

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**Nathan Burns**

Yale University

*Measuring Parameters for the SiPM-on-Tile Hadronic Calorimeter*

Co-Authors: Helen Caines (Department of Physics, Yale University), Prakhar Garg (Department of Physics, Yale University)

Poster Number: 99

The Longitudinally Segmented Forward Hadronic Calorimeter (LFHCal) of the electron-proton/ion collider (ePIC) detector in the electron-ion collider (EIC) will be used to detect particles that fragment from quarks and gluons, such as pions and protons. This will enable us to further investigate the substructure that comprises nuclei. The LFHCal introduces a new method involving scintillating tiles coupled with silicon photomultipliers (SiPMs) on tiles to measure produced debris and characterize their properties. Tests were conducted to ensure the SiPMs were functioning within required parameters, following test beam data stating a discrepancy between its high and low gain readouts. While a perfect answer was not found, similar data was discovered that merits further exploration. Then the tiles' dimensions were measured using a translational stage to ensure they were within design tolerances. This was shown to be possible using a modified translational stage setup to work with 200 tiles.

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**Ryan Cantz**

South Dakota School of Mines & Technology

*Optimizing Time-Zero in Germanium Detectors of LEGEND-200*

Co-Authors: Cabot-Ann Christofferson ORNL, Dr; Ian Guinn ORNL

Poster Number: 215

LEGEND-200 is searching for neutrinoless double-beta decay (0vBB) in germanium-76 using high-purity germanium (HPGe) detectors submerged in an active liquid argon veto system. The discovery of 0vBB would prove that the neutrino is a majorana particle (i.e., its own anti-particle) and provide a possible explanation for the imbalance of matter and anti-matter in the universe. Accurate signal start time (t0) determination in HPGe detectors is crucial for precise data analysis of events in LEGEND-200. The current t0 in HPGe detectors is subject to uncertainties arising from signal propagation effects and electronic noise, among other factors. To improve timing accuracy, the t0 provided by the silicon photomultipliers (SiPMs), which exhibits superior timing resolution compared to the HPGe detectors, will be utilized. By comparing the HPGe t0 to the SiPM t0, the error in the HPGe t0 measurement can be directly determined. Additionally, other parameters are investigated that are affecting t0 in HPGe detectors, including pulse shape, energy, and drift time. Correlating these relationships through statistical analysis can, in later work, improve the precision of LEGEND's analysis parameters used to separate signals from backgrounds.

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**Sofia Capitillo-Villasmil**

Rowan University

*Comparative Gelation Analysis of a (Meth)Acrylate Resin*

Co-Authors: Sofia Capitillo-Villasmil, Zachary Jess, Robert Chimenti; Department of Physics & Astronomy, Rowan University; Advanced Materials and Manufacturing Institute, Rowan University

Poster Number: 307

A previous study investigating the relationship between refractive index and conversion index in 3D printing consistently observed a distinct “kink” in their data that this study further examines and will continue to explore in future work. The resin system used here consists of Pentaerythritol Triacrylate with 10% phenyl methacrylate and 0.05% TPO photoinitiator, cured at 365 nm with a light intensity of 0.06 mW/cm². Measurements are taken using three instruments: the Anton Paar Abbemat Multiwavelength digital refractometer, the TA Instruments Discovery Hybrid Rheometer (Discovery HR-2), and a home-built Raman spectrometer. These methods allow for the characterization of different physical properties of the resin as it cures. The collected data is processed in MATLAB and analyzed through parametric plotting to reveal trends and correlations. Preliminary results indicate that the change in slope observed in the triacrylate resin has the same behavior seen in the earlier study, suggesting a strong correlation between the conversion rate and refractive index. The cause behind this behavior could be due to gelation or vitrification. To determine this, future work will include data from two additional resin systems, diacrylate and tetraacrylate, to compare how different resin functionalities influence this behavior.

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**Colin Carey**

Saint Joseph's University


*From Forces on a Dielectric to Forces on a Water Droplet in Digital Microfluidics*


Co-Authors: Sergio L; S; Freire, Department of Physics, Saint Joseph’s University


Poster Number: 171

Lab-on-a-Chip platforms not requiring pumps, tubes, or valves can be implemented using digital microfluidics (DMF). DMF is a technique for manipulation of droplets using electric fields, with applications in the studies of nucleic acids, proteins and cells.

The objective is to assemble a model, using COMSOL Multiphysics, to capture relevant parameters of a droplet under an electric field. Using a parallel plate capacitor, we recently evaluated the forces on a partially inserted dielectric.

Currently, mimicking a realistic device, the model considers droplet shape, electrode spacing and a thin dielectric layer between droplet and bottom electrode. We will show results of the electric potential variation, the associated electric field and generated forces for different liquids.

The goal of this project is to research the physical principles governing device design, particularly for biomedical applications. This research highlights the importance of basic physics principles for the development of modern technologies.

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**Alexander Castillo**

University of Colorado Denver

*Machine Learning Assisted Data Labeling for Dipole Allowed and Forbidden Transitions in Ytterbium*

Co-Authors: Katherine; R; Hamilton Research Advisor

Poster Number: 145

To what extent can classical machine learning models represent quantum systems? In this research project, we will use supervised machine learning for classifying dipole allowed and forbidden electron transitions in Ytterbium atoms. High-accuracy labeling of these transitions speeds up research and lowers computational cost. To begin, we calculate electron collision cross sections with neutral Ytterbium using the atomic B-Spline R-matrix code. These calculations were performed on the Frontera supercomputer at Texas Advanced Computing Center. We will first use a Neural Network architecture to classify cross sections representing dipole allowed and forbidden transitions. We are currently acquiring a sufficient amount of quality data in order to train our classification model. Our ultimate goal is to develop a general [Atom Independent] model that can accurately determine transition types based on cross sections. This could have a wide-ranging impact on current AMO research.

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**Jason Castro**

Texas Lutheran University


*Design of an Automated Liquid Nitrogen Filling System for Germanium Clover Detectors*

Co-Authors: Phil Adsley, Ph; D , John Santucci

Poster Number: 247

High-purity Germanium (HPGe) clover detectors offer high resolution for gamma ray detection and identification. To prevent leakage current caused by thermal excitation, these detectors must be kept at cryogenic temperatures using liquid nitrogen. At the Cyclotron Institute at Texas A&M, the Hyperion HPGe detector employs 14 dewars arranged around the system. These must be manually filled every 4 hours using a funnel, which poses safety risks and is physically impractical. To improve safety and reliability, this project introduces an automated $LN_2$ filling system. Using an Arduino Mega, PT-100 temperature sensors, solenoid valves, and cryogenic tubing, the system detects fill completion via thermal feedback. Custom PCBs and a Python-based GUI were developed to enable remote operation, offering both manual and automatic control with real-time monitoring and built-in safety interlocks. This design reduces the need for overnight labor and ensures consistent thermal conditions across the detector array. Alongside the system development, preliminary testing was conducted on a separate HPGe detector to evaluate its suitability for future spectroscopy experiments.

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**Hannah Crumby**

Minnesota State Universtiy Moorhead


*Finding periods of varible stars within already taken MSUM data*


Co-Authors: Dr; Matthew Craig


Poster Number: 209


A variable star is a star that changes in brightness over time. Gaia recently released over a million new variable stars. Our goal was to analyze these star periods using already available data. Using TESS data, we are able to find variable star periods. One such period was possibly found for the variable star Gaia DR3 1015815157698560512. This star is in two 28-day sectors of TESS data, with each sector's period approximately 9.5693 days and 9.5877 days. The regular sinusoidal shape of the light curve indicates the star is either an eclipsing binary or a low-amplitude pulsating variable star. Future work will include combining data taken by MSUM of the star over the last 14 years with the TESS data for this star, and investigating an additional four stars in this field.


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**Grace Daja**

Carnegie Mellon University


*Discovering Binary Black Hole Systems*


Co-Authors: Xander Hall and Ekaterine Dadiani - Carnegie Mellon University Mcwilliams Center for Cosmology & Astrophysics


Poster Number: 273


Massive Binary Black Hole systems (MBBH) may hold key information about galaxy formation and supermassive black hole seeding. However, only a handful of convincing candidates are known. Utilizing two complementary methods, we compiled a list of

MBBH candidates. The first method used the Dark Energy Spectroscopic Instrument (DESI), analyzing variable objects reported to the Transient Name Server (TNS) to identify the unique spectral signature of MBBH targets. These targets were cross-matched with corresponding spectra from the Sloan Digital Sky Survey (SDSS) to search for broad line shifts. The second method entailed examining light curves to identify periodicity. The DESI and SDSS spectra along with corresponding light curves were analyzed to identify periodic behavior. Through this, we determined a list of possible MBBH that, under further evaluation, could serve as potential progenitors for sources that will be detected with the upcoming LISA mission or be detected with the ongoing Pulsar Timing Array experiments.

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**Carlos Davila**

East Texas A&M University

*The use of machine learning for fast predictions of neutron skins and dipole polarizabilities of nuclei to use in Bayesian inference of neutron star properties.*

Co-Authors: Dr; William Newton, East Texas A&M University

Poster Number: 199

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.

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**Sabina Day**

University of Arkansas

*Microgravity Simulation of Solanum tuberosum Growth in Martian Regolith*

Co-Authors: Sabina Day, Will Dockery, Dr; Arturo Ferrer, Department of Physics - University of Arkansas

Poster Number: 297

Future human space exploration missions will require self-sufficient food production systems in both low and no-gravity environments. A 3D-printed clinostat was used to simulate micro-gravity by constantly reorienting the overall gravity vector on potatoes (Solanum tuberosum) within a gel-nutrient agar matrix to study the effects on roots and shoots without the aid of gravitropism. Cloned potato cultures of the widely consumed Russet Burbank variety were placed in a low temperature growth chamber to investigate the feasibility of cold storage plant growth and pathogen responses. Preliminary results show successful anchoring and growth within the media and resistance to multiple biologic stressors. Future trials will investigate multi-month micro-gravity plant viability and transfers to lunar and Martian regolith simulants.

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**Michael Angelo De La Cruz Ortiz**

Cleveland State University

*The Time-Dynamics of Alpha Particle Trajectories in Rutherford Scattering*

Co-Authors: Dr; Ulrich Zürcher (Dept; Physics, Cleveland State University, OH, 44115)

Poster Number: 56

Rutherford scattering is a well known physical phenomenon which helps us study the structure of atoms. Experiments consisting of a stream of high energy particles emanating from the decay of a radioactive source, focused towards a thin sheet of material (several atoms thick). Then, by measuring the outgoing scattering angles of high energy particles (such as ɑ-particles) incident onto the material we can determine information such as the size of atomic nuclei. Here, a geometric method of analysis under classical physical laws

for the time dynamics of α-particles' motion along their trajectories is showcased. Purpose of which to provide a theoretical foundation towards probing perhaps unknown or undiscovered qualities of atoms dependent on time and thereby extending the experimental applications from this phenomenon.

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**Brayden Dean**

Angelo State University


*Bremsstrahlung produced by 10-keV electrons incident on carbon allotropes*


Co-Authors: Timothy Villarreal, and Scott Williams, Angelo State University, Grant from the national labs


Poster Number: 130

When charged particles are accelerated toward a substance, they interact with the atoms and typically emit radiation in the form of X-rays. We call this bremsstrahlung. Experiments were performed to investigate how differences in mass density, mean excitation energy, and the number of conduction electrons per atom cumulatively affect the bremsstrahlung produced when 10-keV electrons are accelerated toward allotropes of carbon, specifically thick diamond and graphite. Results of the experiments were found to be in good agreement with the simulated results of the Monte Carlo code, PENELOPE. The results suggest that the bremsstrahlung produced in experiments involving the diamond substrate were of greater intensity than that produced in experiments involving the graphite substrate.

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**Joseph Del Gianni**

University of Washington Bothell


*Speed of Light, Time of Flight Measurement Device*


Co-Authors: Carol Miu, UW Bothell


Poster Number: 137

The goals of our research are to design and build high speed printed circuit boards for an inexpensive and portable speed of light time of flight measurement device and to develop curricula and learning materials to aid future students in introductory physics lab courses. We plan to open source our KiCad files so that instructors from all over the world can have a speed of light measurement device in their classrooms for under $200. Our pedagogical training consisted of analog circuits logic and components, circuit design, prototyping, and practical physics applications of analog circuits. Technical lab responsibilities include learning KiCad, ordering the printed circuit board (PCB) and soldering components onto the PCB, testing the circuit boards and the device, measuring the speed of light, and measuring the refractive index of different mediums. Physics education tasks include developing a pre-lab quiz and lab manual, as well as providing documented guidance for students on learning objectives, instructions on use of the new speed of light device, lab extensions for final projects, and research topics for advanced undergraduates. Currently we have finished the design, wiring, and PCB layout for the photodetector and pulsed laser circuits. We have tested an early model and measured the speed of light through air as 2.97 x 10^8 m/s. We plan to complete building the final device and testing through air, acrylic, and borosilicate glass by December 2025.

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**Ruby Devaisher**

Coe College

*Using Transfer Learning to Predict Molecular Affinities of Metal-Organic Frameworks*

Co-Authors: Ruby Devaisher1, 2, Fernando Fajardo-Rojas1, Diego Gomez-Gualdron1
1Department of Chemical and Biological Engineering, Colorado School of Mines, Golden, CO, 80401 2Department of Physics, Coe College, Cedar Rapids, IA, 52402

Poster Number: 129

Metal-Organic Frameworks (MOFs) are a class of highly tunable porous materials that have the potential to remove large amounts of carbon dioxide from the atmosphere and store volatile compounds such as ammonia. Prior research has already found MOFs that could theoretically be implemented to remove up to 90% of carbon dioxide from a power plant's flue gas exhaust and safely collect ammonia, which is currently kept in costly and unsustainable storage tanks. Neither of these solutions are cost-effective, which necessitates the discovery of new MOFs. However, it is difficult to make efficient predictions of their properties with conventional techniques. Since they have infinitely many configurations, it is necessary to use computational methods such as machine learning to predict their properties. Predictions for molecular affinities are particularly important since they measure the extent to which a MOF can capture a given molecule, but current predictions require large amounts of data and cannot effectively generalize information. Nevertheless, researchers have recently developed new machine learning methods that can generate accurate predictions from low amounts of data; transfer learning is one particularly promising method. This project explores the implementation of transfer learning techniques to predict the molecular affinities of CO2, NH3, N2, and H2O to MOFs.

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**Paula Diaz Pumará**

Berea College

*Analysis of Scintillator Response for ePIC Detector Forward Hadronic Calorimeter*

Poster Number: 261

The Electron-Ion Collider (EIC) is a next-generation facility under development to explore the internal structure of protons and nuclei with unprecedented precision. The ePIC detector will be the first experiment at the EIC, and is designed to provide high-resolution measurements of energy deposition and tracking. This work focuses on analyzing data from a September 2023 ePIC forward hadronic calorimeter prototype test beam.This test was conducted in a configuration without absorber plates to study the scintillator response. The analysis required the implementation of a new routine to process previously converted ROOT files. Energy deposition plots were generated and evaluated to determine whether Landau-Gaussian fits accurately described the observed distributions. ROOT-based tools were used to visualize and inspect the signal behavior across multiple runs. This poster will present results from this ongoing analysis that shed light on the scintillator performance in the ePIC forward hadronic calorimeter (LFHCal) prototype and inform calibration strategies for future detector development

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**Mariane Diby**

Adelphi University

*Exploring Relativistic Collisionless Shocks with Simulations and National Ignition Facility Experiments*

Co-Authors: Dr Naseri, Adelphi University

Poster Number: 48

Exploring Relativistic Collisionless Shocks with Simulations and National Ignition Facility Experiments, Mariane Diby and Dr. Neda Naseri, Adelphi University, Physics Department, One South Ave, Garden City, NY 11530.
We study the formation and evolution of relativistic collisionless shocks using Particle-in-Cell simulations. Our focus is on understanding how plasma instabilities, particularly the Weibel instability, generate shocks and accelerate particles. The results offer new insight into the structure of shocks and the mechanisms behind particle energization in high-energy-density environments.

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**Peter Downey**

Virginia Tech

*Analysis of Defects in Silicon Crystals via a Graph Neural Network*

Co-Authors: Vsevolod Ivanov, Alexander Ivanov, Jacopo Simoni, Prabin Parajuli, Boubacar Kanté, Thomas Schenkel, Liang Tan;

Poster Number: 325

Solid-state color center defects are attracting an increasing amount of attention for applications in quantum information science, due to their potential to be integrated with existing architectures for on-chip photonic circuits and fiber optic networks. An isolated defect in a semiconductor forms localized states that act as a spin qubit, allowing for the storage and transfer of quantum information. In this work we have performed high-throughput calculations of over 50,000 point defects in various semiconductors including diamond, silicon carbide, and silicon. Focusing on quantum applications, we characterize the relevant optical and electronic properties of these defects, including formation energies, spin characteristics, transition dipole moments, zero-phonon lines. However, this dataset constitutes only a small fraction of the trillions of combinatorically possible defects. To reduce the computational load and accelerate defect discovery, we explore using a graph convolutional neural network to take features of defect structures and predict hard-to-compute defect properties. This AI based approach can be used to quickly iterate through novel defect structures and discover defects that are ideally tailored to specific applications.

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**Jan-Christoph Dueppe**

Drury University

*Quantum Algorithms*

Co-Authors: Mentor: Dr; Ying Cao - Drury University

Poster Number: 353

This project investigates the mathematical and computational foundations of Fourier analysis in both classical and quantum contexts. Beginning with the Fourier Transform and its discrete counterpart (DFT), the study establishes a framework for understanding how signals and data can be decomposed into frequency components. Building on this foundation, the project explores the Quantum Fourier Transform (QFT), a cornerstone of quantum algorithms such as Shor's and phase estimation. The QFT's ability to achieve exponential speedup over classical algorithms through quantum superposition and interference is examined both conceptually and computationally. By comparing implementation strategies, computational complexity, and underlying principles, this research highlights the advantages and limitations of quantum methods in transforming and analyzing information. The goal is to provide a clear conceptual bridge between classical signal analysis and its quantum extension, illustrating the profound implications of Fourier analysis in quantum computation.

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**Arianna Duven**

The University of Utah

*An Application of Machine Learning Techniques to Energy Reconstruction in IceTop Cosmic Ray Events*

Co-Authors: Tony Kravka, Dennis Soldin, affiliation for both is The University of Utah

Poster Number: 279

In order to understand the origins of cosmic rays and their interactions, determining their energies is essential. While the cosmic ray energy estimation with IceTop achieves adequate precision, its accuracy is affected by systematic uncertainties arising from hadronic-interaction models, different-mass primaries, and shower-to-shower fluctuations. In this contribution, we benchmark the performance of gradient boosting models for energy reconstruction using Monte-Carlo simulations, structured with features including arrival time of the signals, signal charges detected, and arrival direction of the air shower. We test four different element groups on these models: proton, helium, oxygen, and iron. The measured reconstruction accuracy is quantified by measuring the correlation coefficients and mean squared error of true and reconstructed energies. We will demonstrate how each element group performs individually and combined.

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**Jason Ebat**

Colorado Mesa University

*Pinned in Microgravity: How Colloidal Suspensions Inhibit Droplet Jumping*

Co-Authors: Jason Ebat (Colorado Mesa University), Veronica Keith (Colorado Mesa University), Dr; Alicia Boymelgreen (Florida International University), Dr; Boris Khusid (New Jersey Institute of Technology), Dr; Jarrod Schiffbauer (Colorado Mesa University)

Poster Number: 301

Droplets resting on superhydrophobic surfaces can exhibit spontaneous "jumping" behavior upon release into free fall, driven by rapid conversion of surface energy into kinetic motion. The introduction of colloidal particles, however, can suppress this detachment by modifying the droplet's effective viscosity, reducing interfacial tension, and enhancing contact line pinning. In this study, aluminum substrates coated with multilayer carbon soot (contact angle ≈163° ± 1.5°) served as test surfaces for deionized and polystyrene colloidal droplets (100 nm and 1000 nm particles; 0.001 and 0.01 volume fractions). Each 2 mL droplet pair was released under microgravity using NASA Glenn Research Center's 2.2 s drop tower. Among seven deionized tests, three droplets exhibited successful jumping, whereas none of the colloidal droplets detached. High-speed video analysis revealed distinct oscillatory modes in the inhibited droplets, which were quantified via discrete Fourier transform (DFT/FFT) spectral analysis. These preliminary results indicate that colloidal additives strongly damp droplet oscillations and inhibit detachment through increased viscous losses and contact line pinning. Future work will incorporate controlled bounce testing, receding-angle characterization, and enhanced videography to refine predictive models of droplet–surface interactions and compare with numerical simulations of puddle-jumping dynamics.

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**Andrew Edler**

University of Tennessee at Chattanooga

*Methods of Analyzing the Physical Properties of Topical Analgesic Patches*

Poster Number: 10

Understanding the physical properties of topical analgesics is essential for advancing product performance and consumer satisfaction. To support this goal, we collect data on key material characteristics using fundamental principles of physics such as Hooke's Law, tension, and force–distance relationships. These scientific data points reflect the consumer experience and guide product improvements. As a brief overview, topical analgesics are products that are used to target joint, nerve, and muscle pain through active ingredients interacting with the skin, thus the term "topical". The variety of topical analgesics focused on for this research was patches, which have a plastic or cloth backing and a layer of cooling hydrogel that contains our active ingredients. These patches are a key focus for our company as it is believed that an improvement in our formula is vital to staying competitive. We have developed three testing methods for these patches that give valuable insight into the physical properties of new formulations: adhesion, elasticity, and patch removal, using a texture analyzer to evaluate both our products and those of competitors. Texture analyzers are a common instrument in cosmetic in pharmaceutical laboratories, used for measuring textures and physical properties of products. These tests provide valuable insights that enable product comparison and optimization, ultimately enhancing the user experience.

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**John Edwards**

Ohio University

*Experimental Studies of a Large Split-Annulus NaI Detector at the Edwards Accelerator Laboratory*

Co-Authors: Maddie Nicholas, Andrea Richard, Gregory LeBlanc, Don Carter

Poster Number: 277

There are various methods for detection and spectroscopy of high energy photons, of which a popular approach is to use crystal scintillators. These detectors receive ionizing radiation which interacts with the crystal creating charged particles that move through the crystal medium, which then produces light. This light is intercepted by a photocathode which converts the photon into some number of electrons and creates a signal amplified by a photomultiplier tube. A common choice for scintillator crystal medium is sodium iodide(NaI) because of the relative ease with which it can be produced as well as price. The John D. Edwards Accelerator Laboratory at Ohio University is in possession of a large, more exotic shape of NaI detector referred to as the Large Split-Annulus NaI Detector, which is comprised of two large half cylinder crystals and four photomultiplier tubes(PMTs) to create a well-detector. This detector has gone largely unused and uncharacterized for approximately fifty years. Factors such as proper operating conditions and the behavior of one of the PMTs have been rediscovered through extensive experimentation and these aspects of the detector will continue to be studied as it offers potential uses in low energy nuclear physics done at Edwards Accelerator Lab.

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**Josh Elbertson**

High Point University

*Design and Setup of a Focused Ultrasound Apparatus to Generate Cavitation Bubbles*

Co-Authors: Dr; Rokni, (High Point University)

Poster Number: 235

Ultrasound is a high-frequency pressure wave that can be used both diagnostically and therapeutically. Low-intensity, unfocused ultrasound can be used as a diagnostic tool by processing contrasting signals from reflected sound waves to create images. High-intensity, focused ultrasound, specifically histotripsy, can be used as a non-invasive therapy that liquifies and breaks down diseased tissue through acoustic cavitation. Acoustic cavitation is the physical process of microbubbles violently expanding and collapsing as a result of high-pressure ultrasound waves, thus damaging cells. Histotripsy requires a high-frequency, and high-voltage setup to generate the power necessary to cause cavitation; however, these setups can be costly, necessitating an inexpensive alternative. In this study, we present our cost-effective apparatus used to create and study cavitation. This setup includes a piezoelectric transducer which operates at 750 kHz and a high-voltage amplifier capable of amplifying signals up to 600 V. We detail the design, construction, and function of each component, explaining why each device is necessary to generate cavitation. With our completed apparatus, future studies could investigate the physics of cavitation in different environments as well as applying it to different scenarios such as disrupting biofilms, treating neurodegenerative diseases like Alzheimer's, or alleviating symptoms of cystic fibrosis.

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**Isabella Estes**

University of Kansas

*Investigating Matter-Antimatter Asymmetry at Future Muon Collider*

Co-Authors: Dr; Ian M; Lewis, University of Kansas Department of Physics and Astronomy

Poster Number: 76

Baryon asymmetry is one of the few major phenomena that remain unexplained by the Standard Model of particle physics. Among the many possible explanations for this perceived state of the universe, there could be undiscovered particles that satisfy the conditions for creating the observed matter-antimatter asymmetry. In particular, these extremely heavy particles would exist at high energies, beyond what is currently attainable at the world's most energetic particle accelerators. A solution to this would be building a proposed muon collider, which would operate at higher energies and subsequently produce particles with much higher mass. Utilizing MadGraph5, a Monte-Carlo simulation software for high-energy physics, we simulated particle collision events at this future muon collider and determined which processes would be most likely to occur. We then decayed the processes with the highest cross sections and reconstructed them in order to identify how these processes might be detected in the future collider.

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**Gavin Farley**

University of Utah

*The Tidal Disruption of a Star in the Center of a Merging Galaxy*

Co-Authors: Tanmoy Laskar, University of Utah, Coleman Rohde, University of Utah, Collin Christy, University of Arizona

Poster Number: 249

Tidal disruption events (TDEs) are an inherently dramatic category of astronomical transients where a star is torn apart by a supermassive black hole (SMBH). Studying these events is crucial in gaining a fuller understanding of black hole accretion physics

and inactive SMBH populations.

We investigate thirteen epochs of data obtained by the Giant Metrewave Radio Telescope (GMRT) and Very Large Array (VLA) radio telescope arrays of the TDE AT2022wtn, which sits in the nucleus of a currently merging galaxy. This project focuses on the reduction (calibration and imaging) of the data, along with modeling of the brightness per observing frequency for each of the epochs. We find that the modeled spectrum is characteristic of synchrotron radiation (produced by electrons rotating in a magnetic field), which could highlight the mechanism behind the observed radio emission.

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**Timothy Fay**

William Jewell College


*Modeling A Pendulum Accelerating Upward*

Poster Number: 78

Lagrangian Mechanics is typically covered in Intermediate Mechanics courses. One typical example problem is a pendulum that is accelerating upwards at a constant rate. I built a model of the system using an Atwood machine with a pendulum attached to one mass. Using video analysis, I measured the position of the pendulum versus time. This is compared to a computational model in MATLAB. I used an Euler-Cromer model and incorporated terms for friction and air resistance to better match the data.

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**Logan Finke**

Embry-Riddle Aeronautical University Prescott


*Measurement-Induced Entanglement Entropy of GW Detections*


Co-Authors: Preston Jones


Poster Number: 253

Research on the detection of singular gravitons over time has gone to support Freeman Dyson's conclusion that the individual measurement of the graviton is physically impossible. Despite this, the signature of the graviton could still be possible to observe through the bipartite measurement-induced entanglement entropy of a pair of detectors. If this quantum mechanical effect can be observed through gravitational waves, it could be used as evidence of the non-classicality of gravitational waves, suggesting the existence of the graviton. If multiple gravitons are incident on multiple detectors, it is possible to calculate the normalized measurement-induced entanglement entropy. This calculation demonstrates the potential to develop signs of quantum mechanical effects of the incoming gravitational wave. Unlike the single-point detections that Freeman Dyson suggested would be impossible, this result suggests bipartite detections of signatures of the graviton might be feasible.

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**Boone Fleenor**

University of Mary Washington

*Particle Tracking Velocimetry in the field: observations of turbulence at 800 Hz*

Co-Authors: Boone Fleenor, University of Mary Washington, Christy Swann, RCoast, and Sarah Trimble, Naval Research Laboratory, Stennis Space Center

Poster Number: 281

Particle velocimetry experimentally tracks the complex motions of a fluid through laser scattering from seeded particles. In this study of near-surface wind turbulence, we present the first field-deployed Particle Tracking Velocimetry (F-PTV) to examine wind-blown sand movement. With a proof-of-concept design, the F-PTV system resolves three-dimensional flow variability in the bottom 1.5 m of the natural atmosphere to capture the intricate motions of wind-blown sand. The F-PTV configuration includes (1) a dual-head pulsed Nd:YLF laser, (2) helium-filled soap bubbles as neutrally buoyant tracers, and (3) four high-speed cameras. Two 32 Hz sonic anemometers provided comparative wind-speed measurements. The F-PTV data, sampled at 800 Hz, revealed greater resolution in velocity components relative to sonic observations. Corresponding variability in Reynolds stress, turbulent kinetic energy, and shear velocity indicates that F-PTV captures fluctuations under-resolved by conventional instruments. Thus, demonstrating that optical tracking can enhance our understanding of local turbulent trends in terrestrial environments.

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**Sierra Focazio**

Appalachian State University

*Physics in the World Around Us: The Connections Between Physics and Religious Studies*

Poster Number: 70

Science and religion are often portrayed as opposing forces, creating polarization that hinders constructive dialogue and collaboration on global issues such as climate change. Yet closer examination reveals shared themes, particularly when comparing modern physics with spiritual traditions rooted in nature. This thesis explores the intersections between physics concepts-such as cosmology, relativity, and quantum mechanics-and the worldviews of Hinduism, Buddhism, Taoism, and Paganism. These traditions emphasize cycles, balance, and interconnectedness, offering meaningful parallels to physical laws governing matter, energy, and the universe.

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**James Fox**

Millersville University

*Study of Energy Flow in Electric Dipole Radiation Interference*

Co-Authors: Dr; Xin Li, Trevor Winter

Poster Number: 175

When analyzing the radiation emitted from dipoles, we can use time-averaged Poynting Vectors to observe the energy flow associated with electric dipole radiation. The Poynting Vector represents the directional energy flux density of the electromagnetic field produced by the dipole, which is the rate of energy transfer per unit area. In this study, we will be looking at the energy flow for the electromagnetic field produced by two dipoles oscillating at different angles relative to the y-axis. We are particularly interested in areas where the energy flow pattern results in vortices, or where the magnitude of the Poynting Vectors in the x-y plane becomes zero.

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**Angel Fraire Estrada**

University of Tennessee at Chattanooga

*Dual-State Entanglement Distribution Across a Metro-Scale Quantum Network*

Co-Authors: K; Reaz[1,2], M; M; Hassan[3], J; E; Humberd[1], M; L; Boone[1,3], A; Fraire Estrada[1], R; Mukherjee[1,2], H; R; Sadeghpour[4], G; S; Agarwal[5], G; Siopsis[3], and T; Li[1,2]; [1] Dept; of Physics & Astronomy, Univ; of Tennessee at Chattanooga, Chattanooga, TN 37403, USA; [2] UTC Quantum Center, Univ; of Tennessee at Chattanooga, Chattanooga, TN 37403, USA; [3] Dept; of Physics & Astronomy, Univ; of Tennessee, Knoxville, TN 37996, USA; [4] ITAMP, Center for Astrophysics | Harvard & Smithsonian, Cambridge, MA 02138, USA; [5] Inst; for Quantum Science & Engineering and Dept; of Physics & Astronomy, Texas A&M Univ; , College Station, TX 77843, USA;

Poster Number: 101

Quantum networks aim to connect distant nodes by distributing entangled photons, forming the foundation for secure communication, distributed computation, and advanced sensing. In this work, we demonstrate entanglement distribution on Chattanooga's EPB–IonQ Bohr-IV quantum network, a commercial fiber system spanning several kilometers. Using a fiber-coupled photon source, we generated four-photon entangled states. By performing polarization measurements on two photons retained locally, we prepared the remaining two in distinct quantum states: a Bell state, representing particle-particle entanglement, or a N00N state, representing mode-mode entanglement. These states were then transmitted across the deployed network and verified experimentally, even in the presence of significant photon loss and noise. Our results illustrate that complex entanglement protocols can be implemented using existing telecom infrastructure, marking an important step toward scalable quantum networking and future multi-node quantum communication systems.

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**Paola Frunzio**

Worcester Polytechnic Institute

*Optimization of Measurement Protocols for Quantum Sensing*

Co-Authors: Jacob Myers, Jacob Feinstein, Natalie Frey, and Raisa Trubko (Department of Physics, Worcester Polytechnic Institute)

Poster Number: 344

Quantum sensing with Nitrogen-Vacancy (NV) centers in diamond uses the magnetic sensitivity of the NV center spin states to image high spatial resolution magnetic fields at ambient temperatures. Experiments are performed using a Quantum Diamond

Microscope (QDM) with a laser and microwave pumping to initialize the NV spin states which are then read out by an optical microscope and camera to measure the fluorescence, with the sample placed near or in contact with the diamond. Continuous-Wave (CW) Optically Detected Magnetic Resonance (ODMR) is a common protocol used because of its simple implementation, however, pulsed ODMR protocols offer advantages such as greater magnetic field sensitivity and reduced sample heating. We quantify the CW sensitivity of our experiment to characterize our QDM performance and as a benchmark to compare to pulsed protocols. This project aims to characterize and optimize magnetic field sensitivity for CW and pulsed protocols on the QDM.

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**Aaniyah Gamble**

Oglethorpe University

*Creating Heterostructures of 2-D Materials*

Co-Authors: Oglethorpe University, University of Oklahoma- Steven M; Raybould, Nadeem Hilbi Akbar, Hadi Afshari, Madalina Furis, Lloyd A; Bumm

Poster Number: 239

This project focuses on creating heterostructures made from flat gold nanoparticles (FGNPs)/gold thin films and an organic semiconductor called $H_2OBPc$. Using mechanical exfoliation and PDMS transfer, thin $H_2OBPc$ flakes were successfully placed onto gold thin films made of Au/Ti/Si. The FGNPs were prepared from a 2006 solution, centrifuged onto ITO, rinsed, and dried before imaging. Optical and atomic force microscopy (AFM) were used to observe the surface and measure thickness. The flakes ranged in size from approximately 65nm to 270nm before the transfer and 85nm-270nm after, indicating that multiple stacked layers formed during the transfer process. The results confirm that $H_2OBPc$ sticks well to gold, forming a structural heterostructure. This is an important step toward understanding how organic and metallic 2-D materials interact. Next, I plan to take more AFM images, explore conductance mapping, and use Kelvin probe measurements to study their electronic properties and potential for nanoscale device applications.

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**Skyler Gangestad**

High Point University

*Simulated Uncertainties In The Monte Carlo Fitting Method*

Co-Authors: Dr; Adam Anthony

Poster Number: 349

Fission is a nuclear reaction where a single, heavy nucleus splits into two massive daughter particles. In 2020, an experiment was performed to measure the fission properties of nuclei near 196Pb by fusion-fission with 4He. Previous work has been done to measure the element number of the fission fragments and the energy of the nucleus just before fission. Both of these tasks were completed using a Monte-Carlo based fitting method. While effective, the method does not allow for the quantification of errors. To better understand these uncertainties, we performed a Monte-Carlo fit on simulated data with a fixed mass-splitting and decay angle; from there, we will vary the decay angle and mass distribution to examine how that changes the uncertainty in the fitting method. Initial results on the uncertainty will be presented.

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**Edmund Garcia**

University of Mary Washington

*Intermediate-Scale Outflow  Dynamics of Eta Carinae*

Co-Authors: Edmund J; Garcia & Matthew C; Fleenor, PhD; University of Mary Washington Department of Chemistry & Physics

Poster Number: 118

Eta Carinae (η Car) is a binary system, with the larger star being a luminous blue variable (LBV) beyond the Eddington Limit. Surrounding the η Car system, numerous multi-wavelength imaging campaigns reveal axisymmetric structures with the expanding bipolar Homunculus Nebula (~0.1 pc). Our initial intermediate-scale imaging revealed axisymmetric structures (1-5 pc) in alignment with Homunculus. To gain a more expansive view of how the small scale structure connects to panoramic imaging of the η Car region, we constructed a deep, optical, narrowband mosaic of 189 images utilizing the PROMPT-6 telescope in Chile. Now with a contiguous view of the region, we utilized a bulk fluid dynamical approach with Rankine–Hugoniot jump conditions to probe the potential interconnectivity of these structures. Using a constant, strong shock condition and an angular dependence on the expansion velocity, we found that the evolved lemniscate (∞) envelope plausibly filled the observed intermediate-scale structure on a timescale of 4700 years. Given this promising first-order rendering, we have proceeded to account for second-order effects involving geometric projection, energy injection, and non-ideal gas conditions. We probe the plausibility of episodic eruption events contributing to the structures we see today. In establishing an effective model for the history of LBV mass loss, we look forward to investigating systems with similar intermediate structures.

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**Valeria Garcia Lopez**

Furman University

*A Search for Radio Technosignatures from Interstellar Object 3I/Atlas with the Allen Telescope Array*

Co-Authors: Sofia Sheikh, James R; A; Davenport, Wael Farah, Isabel Gerrard, Blayne Griffin; SETI Institute, Berkeley SETI Research Center and University of Wahington Department of Astronomy and the DiRAC Institute

Poster Number: 42

In July 2025, the third-ever interstellar object, 3I/Atlas, was discovered on its ingress into the solar system. Some authors have theorized that artifact “technosignatures” -e.g., science probes analogous to the Voyager missions - could be sent by extraterrestrial life to explore other stellar systems, potentially including our own. In this campaign, we used the SETI Institute's Allen Telescope Array to observe 3I/Atlas from 1-9~GHz. We discovered over 75 million narrowband signals in 7.25 hours of data using the cutting-edge search pipeline bliss. We then applied blanking in frequency and drift rate to mitigate radio frequency interference (RFI) in our dataset, narrowing the dataset down to ~2 million hits. These hits were further filtered by the localization code NBeamAnalysis, with the remaining 211 plots evaluated manually. We did not find any signals worthy of additional follow-up. When accounting for the Doppler drift correction ($\beta = 0.113$), this

non-detection sets an upper limit of 103 W/Hz on radio technosignatures from 3I/Atlas. The limits across the observed 1–9 GHz band range from 103 to 297 W.

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**Soumay Garg**

UC Berkeley

*Developing an Analysis Framework in Julia for Bayesian Uncertainty Quantification for the Mu2e Experiment*

Co-Authors: Soumay Garg (Department of Physics, University of California Berkeley), Dr; Yury Kolomensky (Department of Physics, University of California Berkeley), Dr; Vivek Singh (Department of Physics, University of California Berkeley), Dr; Sophie Middleton (Department of Physics, California Institute of Technology)

Poster Number: 112

The Mu2e experiment at Fermilab aims to observe the extremely rare process of muon-to-electron conversion in the presence of a nucleus, without the emission of neutrinos, a signal of physics beyond the Standard Model. With a predicted probability lower than 1/(10^16), detecting such an event is a major challenge, requiring precise statistical tools to differentiate true signals from large background noise sources. We develop a Bayesian analysis framework in Julia using BAT.jl (Bayesian Analysis Toolkit), which employs Markov Chain Monte Carlo (MCMC) methods to perform parameter estimation in the Mu2e dataset(s). Our model incorporates the key signal and background components of the energy spectra of electrons. We specifically focus on the role of the nuisance parameters in evaluating the discovery sensitivity or upper limits on the muon-to-electron conversion rate.

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**Hanna Gebremariam**

Augustana College

*Testing and Development of Vibratory Equipment*

Poster Number: 6

Industrial vibratory feeders often rely on brute-force drives, which use oversized motors to directly excite the trough and compensate for inefficiencies. While effective, this design consumes excessive energy and performs poorly under varying load conditions. This project focused on converting an existing brute-force feeder into a more efficient two mass system, in which an exciter and trough are coupled through springs and tuned near the system's natural frequency.

The design process involved modeling and testing multiple prototype drive brackets and exciters, progressively improving alignment, stiffness, and manufacturability. Calculations and finite element analysis (FEA) guided structural refinements, while experimental stroke testing and tuning validated system performance. The finalized design, powered by a 0.37 hp motor at 1200 rpm, achieved a ~0.25-inch stroke output to the original brute-force system, but with over a 4×reduction in current draw during operation.

A cost-benefit analysis confirmed similar initial production costs between the brute-force and two-mass designs, but the significant electrical efficiency gains highlight the two-mass system as a sustainable and scalable solution for future vibratory equipment. This work demonstrates how the two-mass system can transform industrial machinery into more energy-efficient and adaptable systems.

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**Elitza Georgieva**

Davidson College

*Ms.*

Poster Number: 88

We report new measurements of the separation and position angle of STF 1679 (WDS 12460+4949) taken on 2025 May 23 with a 0.35 m telescope of the Las Cumbres Observatory. For the STF 1679 AB pair, we measured a position angle of 207.0° and a separation of 5.88". For the STF 1679 BC pair, our measurements yielded an average position angle of 36.1° and a separation of 74.82". These results, combined with historical data and Gaia measurements, suggest that the stars in the AB pair may be related, although conclusive results require additional measurements. The stellar components in the BC pair are an optical double, supported by their disparate parallaxes and inconsistent relative proper motions.

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**Jack Ghirardelli**

California State University Sacramento

*Modeling Star Formation in Disk Galaxies: Testing Turbulence-Sensitive Criteria with SPH Simulations*

Co-Authors: Alexander Pettitt, California State University Sacramento, College of Natural Science and Mathematics' (NSM) Summer Undergraduate Research Experience (SURE) Award

Poster Number: 299

The conditions under which stars form in the interstellar medium (ISM) of disk galaxies can be modeled in large-scale astrophysics simulations using key physical factors such as density, temperature, and velocity convergence. To match observed star formation rates (SFR) in disk galaxies, these models can be analyzed and refined to test theoretical predictions and determine their validity. Turbulent gas in the ISM, i.e. chaotic, fast-moving gas, is predicted to influence the likelihood and therefore efficiency of star formation within a given region. The present research will showcase ongoing work on the analysis of a turbulence-based star formation model using the Smoothed Particle Hydrodynamics (SPH) code Gasoline2.

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**Kylie Goldade**

Adelphi University

*Creating a Planetarium Show for the Cradle of Aviation Catholic Health Sky Theater*

Co-Authors: Kylie L; Goldade, Matthew J; Wright, Kerri Kiker, Daniel Burke, Adelphi University1, Cradle of Aviation Museum2

Poster Number: 7

Stories Behind the Stars is an original planetarium program developed for the Cradle of Aviation's Catholic Health Sky Theater, designed to integrate astronomical education with cultural storytelling. The program begins with an introduction to the celestial sphere, star naming conventions, and the role of the International Astronomical Union (IAU).

The second segment features a randomized selection of one of the 88 IAU-recognized constellations, allowing for the narration of its historical and cultural significance. This randomized structure ensures unique experiences for returning audiences and highlights lesser-known constellations. Content development draws from academic astronomy coursework, scholarly research, IAU materials, and diverse cultural sources. The program is implemented using Digistar 7, a hybrid Lua–Python environment, presenting both technical and pedagogical challenges. By blending scientific accuracy with narrative engagement, this project aims to enhance public understanding of astronomy through immersive, repeatable experiences.

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**Michelle Goodman**

Rowan University

*Establishing the equivalence of short tests of physics quantitative literacy*

Co-Authors: Riley Campbell (Rowan University Physics & Astronomy Department), Nathaniel Clark (Rowan University Physics & Astronomy Department), Michelle Goodman (Rowan University Physics & Astronomy Department), & Trevor Smith (Rowan University Physics & Astronomy Department, College of Education)

Poster Number: 285

Our purpose was to examine how students are quantitatively reasoning through a standardized test. This test, known as the GERQN, is a 16 item multiple choice test that examines three categories of reasoning: covariational, proportional, and negativity reasoning. Our goal was to split this test into 2 statistically equivalent ‘testlets', known as GERQlets, to reduce the length of the test and testing fatigue. The statistical equivalence was measured using score correlation, factor analysis, and Wright maps.

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**Elizabeth Goreth**

The University of Mississippi

*Monitoring and Modeling Orphan Flares in Blazars*

Co-Authors: Dr; Nicholas R; MacDonald / The University of Mississippi

Poster Number: 40

Blazars shine across the entire electromagnetic spectrum (from low-frequency radio waves to high-energy gamma-rays). There are a growing number of Blazar jets which exhibit Orphan gamma-ray flares (with little or no variability detected at longer wavelengths including the optical).

The Ole Miss Blazar Group has recently established a new partnership with the Boston University (BU) Blazar Group to extend optical polarimetric monitoring of a sample of gamma-ray bright Blazars targeted by NASA's Imaging X-ray Polarimetry Explorer (IXPE). My REU project aimed to examine the Blazar 3C 120, which has recently entered a period of Orphan gamma-ray flaring. Using the BLAZE code (MacDonald, et al. 2015, 2017), I am currently carrying out inverse-Compton calculations of gamma-ray emission in order to mimic the high-energy variability observed in 3C 120. I will present the results of my modeling efforts during the SURGG Research Program.

In addition, as a member of The Ole Miss Blazar Group, I have been actively helping to monitor optical polarization in the BU Blazar sample, and have made several trips to the Perkins Telescope Observatory (PTO) in Flagstaff, Arizona. The data we obtain at the PTO is crucial in ascertaining whether gamma-ray Blazar flares detected by the Fermi Gamma-ray Space Telescope are indeed Orphan in nature.

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**Gabriel Grant**

Minnesota State University Moorhead

*Investigations of binary neutron star range oscillations at LIGO Livingston*

Co-Authors: Jane Glanzer, Caltech, LIGO Lab

Poster Number: 243

The Laser Interferometer Gravitational Wave Observatory (LIGO) is composed of two interferometers that detect gravitational waves from coalescing black hole and binary neutron star mergers. The binary neutron star inspiral range (BNS) is a metric used to monitor detector sensitivity. This project focused on characterizing the source of unusual noise that has been occurring since the start of the fourth observing run (O4). In particular, the BNS range at the LIGO Livingston detector frequently oscillates with a 30-

minute period that produces noise in the main gravitational wave data channel from 30 to 50 Hz. Many auxiliary sensors have also been exhibiting oscillations, making it difficult to understand the behavior and source of this noise. Using cross-correlation across O4, we have seen that select temperature sensors, relative humidity sensors, accelerometers, and seismometers are highly correlated with the gravitational wave strain. This suggests that there are multiple coupling mechanisms in the detector.

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**Asaf Greenfield**

NYU


*Glassy Phase Transitions of Binary PMMA Particles*


Co-Authors: Sean Jeon - NYU Chaikin Lab; Asaf Greenfield - NYU Chaikin Lab


Poster Number: 293


Phase transitions of monodisperse PMMA suspensions on Glycerol droplets have been well characterized. We investigate glassy solid to liquid transitions of 1:1.6 polydisperse distributions. PMMA particles are dispersed in a CHB-Dodecane solution, then placed on the interface of a glycerol-water droplet. The particles induce polarization charges in the glycerol-water droplet, with particle-image pairs behaving as dipoles. Different particle concentrations are induced by tilting the slide, and the dynamics are observed by video microscopy. We characterize the state of the glassy dynamics using Mean Squared Displacement and Voronoi diagrams.


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**Jordan Grey**

Oglethorpe University


*Comparative Swimming Performance in Acheta domesticus and Gryllodes sigillatus (House and Banded Crickets)*


Co-Authors: Jordan Grey, Dr; Kelimar Diaz


Poster Number: 185

Locomotion is an essential behavior of many living organisms. Specifically, crickets have developed larger hind legs better suited to jumping (their primary form of defense). Their jumping biomechanics have been studied in many environments, but little is known about other forms of locomotion (i.e., swimming). Here, we investigated how two species (Acheta domesticus & Gryllodes sigillatus) traverse fluid environments. We challenged these crickets to swim on the surface of water and investigated their swimming performance across species and sexes. We hypothesized that morphological differences between sexes and species lead to differences in swimming performance. A. domesticus exhibited swimming speeds of 5.1 ± 1.2 body lengths per second (BL/s) and 4.8 ± 1.4 BL/s for female and male crickets, respectively. G. sigillatus exhibited swimming speeds of 5.9 ± 2.3 BL/s and 7.6 ± 3.8 BL/s for female and male crickets. Results showed that different species and sexes can achieve distinct swimming performances

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**Xavier Grundler**

East Texas A&M University

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

Co-Authors: Bao-An Li at East Texas A&M University

Poster Number: 159

The possibility of discovering twin stars, two neutron stars (NSs) with the same mass but different radii, is usually studied in forward modelings 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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**Chelsie Hadley**

Western Illinois University

*Automated Generation of Quantum Error Correction Circuits for CSS Codes*

Co-Authors: Kishor T; Kapale, Western Illinois University; Pradip Bhattarai, Southern Illinois University; Claire Wen and Jay Gonzalez, Illinois Mathematics and Science Academy

Poster Number: 26

Quantum error correction circuits, essential for preserving quantum state fidelity, vary as widely as the hardware currently being implemented. Each scheme is unique, often tailored to specific hardware and designed manually, slowing the scalability of quantum devices. To address this critical issue, this research presents an algorithm that automates quantum circuit generation for Calderbank-Shor-Steane (CSS) error correction codes. Given an encoding circuit as input, the algorithm generates the stabilizers, error detection circuit, and error correction circuit for any Pauli error (X, Y, Z), with the goal of providing a versatile tool for researchers to test novel encoding schemes without requiring deep expertise in quantum error correction. The algorithm produces circuits which yield full state preservation, up to a global phase, for arbitrary logical states. Simulations and hardware tests on 3-qubit, 7-qubit, and 9-qubit codes achieved approximately even superposition state preservation for logical qubits, showing high fidelity even on noisy systems.

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**Nathaniel Hamme**

The Pennsylvania State University

*The OGRE's Prophecy: Predicting the Off-Plane Grating Rocket Experiment's Performance*

Co-Authors: [Nathaniel Hamme, Alexandra Higley, James Tutt, Randall McEntaffer, Bridget O’Meara, Jeffery De Lucca, Ross McCurdy, Joshua Wang]-(The Pennsylvania

State University), Benjamin Donovan-(Northrop Grumman), Casey DeRoo-(The University of Iowa)

Poster Number: 303

The Off-Plane Grating Rocket Experiment (OGRE), a collaborative mission led by The Pennsylvania State University, is a sub-orbital rocket payload that will demonstrate next-generation technology for soft X-ray spectroscopy. During its few minutes in flight, OGRE will observe the binary star system Capella, a bright X-ray source commonly used for calibration of modern X-ray telescopes. Capella makes a great calibration source for X-ray astronomy because its emission is dominated by a dense forest of narrow atomic emission lines in the soft X-ray bandpass. Here we present our progress on simulating the Capella spectrum taken during OGRE's pathfinder flight, as well as the laboratory techniques implemented thus far to benchmark key performance characteristics of the whole OGRE assembly.

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**Fahd Hatoum**

University of Chicago

*How To Balance: Demographic Attributes of Train-Test Sets and their Impact on AI Performance: Medical Imaging Applications*

Co-Authors: Fahd Hatoum1*; Robert Tomek1; Heather Whitney1; Maryellen Giger1
1University of Chicago

Poster Number: 217

Artificial intelligence (AI) systems in medical imaging may show variable performance across demographic groups due to distributional differences between training and test datasets, known as data shifts. This study investigates how demographic balancing affects AI model performance under two types of mixed data shifts which we defined: the inter-setting mixed prevalence shift and intra-setting mixed prevalence shift. Using chest X-ray data for COVID-19 diagnosis, we compared random and stratified sampling approaches based on demographic and disease attributes across 25 repeated trials. Model performance was assessed using AUC-ROC and Wilcoxon rank-sum tests. Results showed no statistically significant differences between methods overall. However, stratifying by disease alone minimized performance variability, particularly under inter-setting shifts. Findings suggest that stratification on disease or correlated demographic attributes may reduce subgroup performance disparities, though results were limited by dataset size and potential representation shifts. These outcomes highlight the need for cautious dataset balancing in developing equitable medical AI models.

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**Emily Hatten**

Furman University

*Using Maxwell's Equations to Study Laser–Nanowire Interactions on the Nanoscale*

Co-Authors: Garner Boepple, Rahul Ranjan Sah, and Jeremy Gulley; Furman University Department of Physics

Poster Number: 177

We investigate the interaction between ultrashort laser pulses and semiconductor nanowires by numerically solving the 3D Maxwell's equations. This method uses a Pseudospectral Time-Domain (PSTD) method with a leap-frog approach for timeevolving the fields. We use Total Field / Scattered Field boundary conditions for clean pulse injection and a Perfectly Matched Layer to absorb outgoing waves without reflection. When solved simultaneously with the Semiconductor Bloch Equations (SBEs) for the nanowire response, this framework enables a self-consistent treatment of light–matter interactions, including longitudinal plasmonic fields resulting from electron-hole dynamics in the semiconductor [1–3] . Our goal is to characterize the ultrafast response of these longitudinal fields on neighboring nanowire components in novel optoelectronic sensors. These results further knowledge of nanostructures exposed to high-field, multi-chromatic laser pulses and inform the design of future nanoscale sensors and optoelectronic devices.

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**Sarah Heller**

Montana State University

*Modeling the Electromagnetic Structure of Deuteron Using Low Energy Nuclear Theory*

Co-Authors: Alex Gnech, Old Dominion University and Thomas Jefferson National Accelerator Facility

Poster Number: 123

Deuteron, the simplest possible nucleus consisting of a proton and neutron, is often used as a target in particle scattering experiments. In cases where the internal substructure of the nucleons is negligible to the interaction, such as elastic scattering, a simplified low energy theory may be used to describe the deuteron. The goal of this project was to calculate the deuteron wave function and physical electromagnetic observables using a simplified interaction potential starting from the three-dimensional Schrodinger equation. This was accomplished using both analytical and computational methods. The resulting observables, including the ground-state binding energy (-2.2245 MeV), rms matter radius (1.908 fm), and magnetic moment (0.854 μN), all align with experimental measurements. These results indicate that the interaction potential and low-energy assumptions used are valid and model the deuteron accurately. This model could then be extended to calculate theoretical particle-deuteron cross sections for elastic scattering experiments.

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**Gunner Hodges**

Arkansas Tech University

*Improving DESI's Dark Energy Contraints via Redshift Rebinning of the Bright Galaxy Survey*

Poster Number: 181

One of the leading methods of measuring and understanding cosmic expansion is baryon acoustic oscillations (BAO), which serve as a standard ruler to trace through the universe’s expansion history. The Dark Energy Spectroscopic Instrument (DESI) is at the forefront of this eGort. DESI measures galaxy clustering and determines the location of the BAO feature within pre-selected redshift bins. Each redshift bin contains quantifiable information that can inform the constraints on dark energy equation-of-state parameters. The current binning structure favors a dynamical dark energy model, though there remains statistical evidence for a cosmological constant model. This project investigates whether a new binning scheme can improve the discriminatory power between these models. The primary approach was splitting the one-dimensional bright galaxy survey (BGS) redshift bin into new bins of equal eGective volume. Further explorations into the re-binning of the two-dimensional BGS bin were conducted to explore additional constraining potential. A Markov-Chain Monte-Carlo method was used to sample the posterior likelihoods over parameters w0, the present-day value of the equation-of-state, and wa, the time-dependence parameter of the equation-of-state. We compared the area and position of the resulting contours to evaluate the constraining power of each new binning structure.

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**Treyana Holiday**

Massachusetts College of Liberal Arts

*Planetary Gelogy and the NASA MIRAGE Rover*

Co-Authors: Tyler Foote

Poster Number: 50

The NASA L'Space program is a summer academy that partners with the Lucy Mission that trains students to work on mission style projects.

As a planetary geologist, I compiled atmospheric and soil data on the planet Mars and selected instruments for the MIRAGE (Mars Ice Recon and Geophysical Explorer) rover that will best acquire atmospheric and soil data so those data could be sent back to Earth.

I conducted literature reviews of published research and technical specifications of various instruments. Based on this research, I selected instruments best suited to find features in Mars' composition, such as a ground penetrating radar to search for underground ice and a Sherlock Spectrometer to detect organic molecules and biosignatures in rocks, that stayed within the technical weight and size restrictions for the rover.

I compiled all my suggestions into a written Preliminary Design Review to be presented to the L'Space Program directors.

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**Ethan Hood**

University of Utah

*Optimizing Calibration and Data Quality for the IceCube Upgrade Project*

Poster Number: 347

With the anticipated IceCube Upgrade project installing over December, the need for optimized data collection and measurement procedures is paramount. Working with the University of Utah's IceCube Calibration Team, I developed automated tools to evaluate and optimize camera operating parameters to maximize usable image information while avoiding pixel saturation. These tools analyzed images from our darkbench laboratory by generating human-readable images from raw data, quantifying image quality metrics, plotting saturated pixel distributions, and producing color-channel (blue, green, red) histograms. My analysis focused on characterizing optical behavior across a variety of parameters, particularly exposure time, to determine where illumination is maximized without data corruption. The results identified optimal conditions for observation that will be applied at the IceCube South Pole Observatory to fine-tune the operation of digital optical modules. This work contributes to improved data collection at IceCube and supports the broader mission of neutrino astroparticle physics research.

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**Kaden Hunter**

Millersville University of Pennsylvania

*Guided by the Force: Modeling Charged Particle Motion in Varying EM Fields*

Co-Authors: Alexandra Ziegler, Peyton Haroldson; Advisors: Dr; Baoling Ma, Dr; Xin Li;

Poster Number: 24

This research is a systematic study of charged-particle dynamics in various electromagnetic field settings with increasing complexity, which represents both laboratory and natural environments. The motion of the charged particles is modeled using ordinary differential equations for different scenarios. Beginning with the study of a classical case where a charged particle is placed in uniform magnetic field without electric field, analyzing the resulting helical trajectory. The model is expanded by the inclusion of a uniform electric field, which displays a drift phenomena.

Realistic environments often involve energy dissipation, this paper illustrates the mechanism by the adding linear and nonlinear damping terms to the Lorentz model. Linear and nonlinear dissipation is used to mimic resistive media or collisional interactions. The final model will illustrate what the particle's trajectory would look like under a time-varying electric field, thus a nonuniform field is introduced. Both analytical and numerical solutions are obtained for our cases to predict the motion of the particle. Our results provide significant insight into the charged particle behavior across a range of EM settings, with applications in plasma confinement to auroral dynamics.

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**Sara Huszar**

Florida State University


*Raman Spectroscopy of Na3Co2SbO6*


Co-Authors: Nikolai Simonov (Georgia Institute of Technology), Naipeng Zhang (National High Magnetic Field Laboratory), Long Chen (University of Tennessee Knoxville), Hailing Zhou (University of Tennessee Knoxville), Zhigang Jiang (Georgia Institute of Technology), Dmitry Smirnov (National High Magnetic Field Laboratory); Additional, Affiliations: Florida State University Women in Math Science and Engineering, Florida State University, National High Magnetic Field Laboratory


Poster Number: 225


Quantum Spin liquid (QSL) is a state of matter where the spins are disordered and entangled down to absolute zero temperature. Kitaev introduced a solvable QSL model in 2006 where Na3Co2SbO6 (NCSO) was identified as a good candidate in testing this model. To determine if this material can present experimental realization for Kitaev physics, accurate spectroscopic data for magnetic, lattice and charge degree of freedom can provide insightful information. This presentation is a part of a group effort on analyzing these characteristics where it presents the study of phonons in NCSO using Raman spectroscopy.


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**Ethan Huyghe**

Oglethorpe University


*How flames react to increasing magnetic fields.*

Poster Number: 313


We aimed to model the transits of exoplanet TOI-1811 b to derive planetary and transit data and compare it to previous research. Our findings include: Impact Parameter =

0.7600, Inclination(degrees) = 86.47, Planet Radius(Jupiter Radii) = 1.008, Ratio of Planet Radius to Stellar Radius = 0.1349, Ratio of Semi-Major Axis to Stellar Radius = 12.34, Total Transit Duration(Days): 0.0810, and Ingress/Egress Duration(Days) = 0.0206. 5 out of 7 values show agreement with previously published values.

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**Isabel Jackson**

Lycoming College

*Hot Subdwarfs as Potential Progenitors for Type Ia Supernovae*

Co-Authors: Eric Stringer, Hamburger Sternwarte, University of Hamburg, DAAD, Lycoming College

Poster Number: 62

Type 1a supernova are known to be caused by the explosion of a white dwarf, but the exact mechanism of detonation is not known. One potential pathway is the double-detonation scenario, where a white dwarf accretes material from a helium-rich star until a runaway chain reaction occurs on the surface, detonating the star. The project is to study one possible type of progenitor system for double detonation supernovae, which are helium-rich hot subdwarf stars with a close white dwarf companion. Using spectral analysis and Gaia data to calculate the galactic orbits of these systems to determine if they are candidates for creating these supernovae based on where they reside in the Milky Way.

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**Julian Jackson**

University of California San Diego

*You're a (Nu)STAR - Investigating Serendipitous High-Energy Transients with NuSTAR*

Co-Authors: Dr; Murray Brightman, Dr; Fiona Harrison, CalTech

Poster Number: 110

Transient astronomical sources, which appear suddenly and unpredictably, provide unique insights into the most extreme, awesome, and spectacular physical processes in

the universe. These phenomena, which include gamma-ray bursts (GRBs) and other high-energy events, are critical for understanding stellar evolution, black hole formation, and the physics of relativistic jets. NuSTAR (Nuclear Spectroscopic Telescope Array) offers complementary high-energy X-ray observations. It is also suited to follow up transient sources detected by observatories such as Swift, for longer exposures. In other words, we'll have a longer exposure to specific targets to get more information. This project aims to leverage NuSTAR's extensive archival data to identify and characterize serendipitous transient sources.

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**Anastasia James**

NYU

*How does growing flax in NYC's urban environment affect local soil health and the linen produced?*

Poster Number: 223

The goals of this flax to linen project are to:
-Discover the relationship between the micro-environment of my urban NYC garden and flax.
-Show the results of flax grown in this environment via linen production.
-Educate myself and others about the flax to linen process and the unique environmental concerns of gardening in an urban environment.

One of the largest environmental problems in NYC is lack of greenspace. This can be exacerbated by poor soil nutrition and soil contamination. Urban soils often have higher concentrations of heavy as a result of past human activity. Heavy metal presence in soil not only negatively affects plant growth but also human health.

A possible solution to poor soil is to remove soil contaminants. This can be done using plants through a process called phytoremediation. In an urban setting phytoremediation is more cost effective and prevents the spreading of pollutants when compared to physical and chemical removal methods.

Flax has been shown to remove heavy metals from the soil and is a good candidate for phytoremediation. Mainly lead, copper, zinc, nickel and cadmium absorption have been shown. The chemical composition, pH of the soil, temperature, and weather all impact how heavy metals are absorbed by flax.

I aim to test the soil in my backyard, located in Queens, NYC and see how two successive flax harvests impacts the soil. I will then process the flax into linen fabric to see the results of my home-grown flax.

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**Katie Kaake**

North Carolina State University


*Illuminating Photosystem I: Time-Resolved Serial Femtosecond Crystallography*


Co-Authors: Nathan Henderson, Gihan Ketawala, Petra Fromme


Poster Number: 82


Photosystem I (PSI) is a photosynthesis protein complex responsible for converting light into chemical energy, yet no molecular "photo" has captured what happens the instant light strikes. Traditional X-ray methods destroy PSI crystals before a complete image can be recorded, leaving its earliest conformational changes unknown. This study investigates whether faster images: femtosecond X-ray pulses at the European XFEL scatter from PSI microcrystals before radiation takes hold, a technique known as serial femtosecond crystallography. Using a new time-resolved approach, we not only obtained higher-resolution structures but also reconstructed atomic models before and after PSI first encounters light. Of six datasets processed, five refined into reliable structures, including the first light-activated PSI model. These reveal subtle side-chain shifts and cavity-opening events near the reaction center—the earliest steps of photosynthesis. This framework demonstrates how ultrafast crystallography can capture protein dynamics in action, opening the door to studying other light-driven molecular processes.


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**LaDonna Kalala**

Grambling State University


*Beyond the Mask: Supporting Autistic Scholars of Color in STEM*


Co-Authors: LaDonna Kalala


Poster Number: 2

Autistic scholars of color in Science, Technology, Engineering and Mathematics face compounded barriers such as underdiagnosis, limited culturally competent assessments, masking, and mentorship gaps which harm wellbeing and professional visibility. I performed a systematic literature synthesis of peer-reviewed studies, policy reports, and advocacy materials to organize evidence on diagnostic disparities, masking, access to accommodations, and institutional obstacles within STEM education. Findings show racial and ethnic disparities in diagnosis, prevalent masking linked to elevated anxiety and reduced disclosure, and systemic practices including dependence on formal diagnosis for accommodations and lack of targeted funding that impede opportunities. Reviewed works identify effective strategies: culturally informed diagnostic outreach, Universal Design for Learning, targeted funds, and neurodiversity-aware mentorship. This presentation summarizes thematic evidence, includes illustrative quotations and policy examples, and offers a practical chapter toolkit to sustainably increase visibility, reduce attrition, and catalyze cultural shifts toward equitable inclusion of autistic scholars of color in STEM.

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**Margaret Keith**

Furman University

*The Watermelon Project: Transforming Watermelon Rind into a Functional Food*

Co-Authors: Rinky Ghosh, Hrithik Shetty, Akinola Stephen, Parag Subhash Padekar, Bernd Weiss, Thaddeus Ezeji, Thomas Knobloch, Mark H; Weir,Osvaldo Campanella,and Yael Vodovotz; The Ohio State University, College of Food, Agricultural and Environmental Sciences

Poster Number: 34

The study investigates the biotransformation of watermelon rind into a functional food with increased total polyphenol content (TPC) and L-citrulline through solid-state fermentation using Rhizopus oryzae and Rhizopus oligosporus, followed by extrusion to produce bioactivity-rich puffed snacks. Fermentation enhanced bioactive availability, as seen from an increase in TPC. L-citrulline was derivatized for improved selectivity before HPLC analysis. Fermentation monitoring revealed pH reduction and robust fungal growth, with R. oryzae + R. oligosporus achieving the highest biomass and acidification over time. These findings highlight the potential of fermentation to improve the nutritional profile of watermelon rind while optimizing it for extrusion. The results demonstrate that combining fermentation with extrusion can yield a sustainable, bioactive-rich functional food product, reducing food waste and promoting health benefits associated with polyphenols and L-citrulline. This approach aligns with global sustainability initiatives and offers a promising solution for converting agricultural waste into value-added food products.

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**Samaha Khan**

Rhodes College

*Geometric Control of Particle Transport: Analyzing Critical Frequency on Patterned Magnetic Arrays*

Co-Authors: Samaha Khan, Chaiya Emmanuel, Dr; Gregory Vieira

Poster Number: 132

The manipulation of microscopic particles using patterned magnetic arrays is a powerful technique with applications in biotechnology and materials science. This research investigates the influence of magnetic trap geometry on particle transport efficiency. While previous methodologies have successfully utilized arrays of circular permalloy disks under an external rotating magnetic field to induce sequential particle movement, we hypothesized that the disk geometry itself is a critical parameter. To test this, we fabricated chips with triangular permalloy disks spaced 10 μm apart and propelled superparamagnetic beads using a constant vertical field (~50 Gauss) and a rotating horizontal field (~35 Gauss). To isolate the effect of geometry, all experimental parameters were kept identical to prior experiments that used circular disks. We observed two distinct transport regimes: a "locked" regime at low frequencies where beads moved in synchrony with the field, and a "slipping" regime above a critical frequency, characterized by chaotic movement and failed jumps. Our results show that the critical frequency for the triangular disks was significantly lower than that observed for circular disks, indicating a breakdown in transport efficiency at lower speeds. This finding confirms that trap geometry plays a crucial role in determining the limits of particle transport.

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**Armaan Khanuja**

University of Washington

*BOBCat - Cataloging Supermassive Binary Black Holes*

Poster Number: 331

One of the main sources of gravitational waves is binary black hole systems. Signatures detected so far correspond to stellar-mass black holes, but we expect there to be a lower frequency spectrum of gravitational waves produced by supermassive black hole binaries (SMBHBs). Observing these binaries has proven difficult, and while there are many SMBHB candidates, none have been confirmed. BOBCat—the Black holes Orbiting Black holes Catalog—aims to create a better organizational system for tracking these candidates for future observations and research. It will be a searchable, public-use database that is fully referenced and comprehensive. BOBCat will contain relevant queryable information about the candidate, such as redshift, location, proposed models, and limitations on orbital parameters such as individual masses, frequency, and orientation. As gravitational waves detectors such as the Laser Interferometer Space Antenna and Pulsar Timing Arrays become more prevalent, BOBCat will be able to provide better access to predicted or detected multi-messenger signals.

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**Gyeongmin Kim**

Carnegie Mellon University

*Raman Spectroscopy and Device Fabrication for the Study of Rhombohedral Graphene at Cryogenic Temperatures*

Co-Authors: Hryhoriy Polshyn (PI, Institute of Science and Technology Austria)

Poster Number: 200

Rhombohedral trilayer (ABC – stacked) graphene is a 2-dimensional (2D) material that has gate-tunable bandgaps. As a result, it allows us to probe into fundamental phyiscs, such as spontaneous ferromagnetic polarization. This project aims to exfoliate and determine the stacking order of trilayer graphene, as well as to design and assemble a cold filter for probe for the dilution fridge in which the measurements with graphene devices will take place.

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**Amelia Koff**

Davidson College

*Attainable Plasma Configurations for the Columbia University Tokamak for Education using TokaMaker*

Co-Authors: A; Koff1, C; Hansen2, C; Paz-Soldan2 1 - Davidson College 2 - Columbia University

Poster Number: 207

TokaMaker, an open-source time-dependent Grad-Shafranov tool for the design and modeling of axisymmetric fusion devices, is utilized to investigate operating scenarios for the Columbia University Tokamak for Education (CUTE)[1]. CUTE is a flexible low-aspect ratio tokamak currently being refurbished as an education and training focused tokamak platform. Exploration of attainable plasma configurations will be presented including static and time-dependent effects, including flux consumption and eddy currents. Optimization of breakdown and startup, including null formation, will also be presented. Examples for all workflows will be added to the TokaMaker repository for community use.

1 - C. Hansen et al., CPC 298, 109111 (2024)

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**Emmery Kovalcik**

Abilene Christian University

*Construction of a JWST Demonstration for Abilene ISD Planetarium*

Co-Authors: Othy Caroe, Jayden Smith, Lucia Sexton-Ashwell, Joshua Fischer, Larry Isenhower

Poster Number: 14

We present the work taken to plan and build a display for the local Abilene Independent School District Planetarium. Several students and our faculty advisor planned, designed, and built a demonstration focused on the JWST that includes poster displays, an enclosed display table, and a motorized 3 segment mirror display. The mirror display shows how

JWST controllers have independent control of the alignment and focusing of each mirror and will demonstrate the focusing process for planetarium visitors.

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**Saniya Leslie**

Georgia State University

*Centering Student Feedback In Order To Improve Support Given by TEAM-UP Together and AAS*

Co-Authors: Saniya Leslie: Georgia State University, Dr; Tom Rice: American Astronomical Society

Poster Number: 4

The American Astronomical Society was founded in 1899. It is an organization of professional astronomers, students, and educators. They have engaged in science communication and advocacy for astronomy. As a lead partner of TEAM-UP Together, AAS works to foster diversity and inclusion within physics and astronomy community. At the AAS 246 summer meeting in Alaska, 18 undergraduate physics and astronomy students were interviewed about their academic experiences and their experience at the AAS conference. AAS will use this feedback to improve conferences, resources, and student support. TUT focuses on supporting African American students through programs like its $10,000 annual scholarship, and TUT surveyed scholarship recipients from 2022–2024 to evaluate programs impact. This poster showcases student perspectives gathered through interviews and surveys, in order to create future efforts to cultivate inclusive and supportive academic spaces.

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**Jason Li**

University of Illinois Urbana-Champaign

*Efficiency Droop Contributors in Indium Gallium Nitride Green Light-Emitting Diodes*

Co-Authors: Jason Li, Phuvit Thirasuntrakul, Jaekwon Lee, Yu-Chieh Chiu, Can Bayram (Department of Electrical and Computer Engineering, Grainger College of Engineering, University of Illinois Urbana-Champaign)

Poster Number: 341

Conventional white light LEDs rely on phosphor down-conversion, which limits efficiency. A theoretically more efficient approach combines red, green, and blue LEDs to create white light, which could increase efficiency by up to 60%. However, InGaN green LEDs are limited by significant efficiency losses at high optical powers, a phenomenon known as efficiency droop. In this work, we identify the main causes of droop in green LEDs by decoupling and quantifying different efficiency loss mechanisms. Using a combined modified ABC- and optical-electrical-thermal-model, we decouple the effects of inherent Auger-Meitner recombination, polarization-induced effects, thermal effects, and light extraction. It was found that inherent Auger-Meitner recombination and polarization-induced effects consisted of 49% and 35% of the droop respectively. These results indicate the need to develop new materials with a low Auger recombination effects or polarization fields to create droop-free InGaN green LEDs, setting a roadmap for future LED development.

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**Gavin Libby**

University of Maine at Orono


*Further Developing a Bio-Derived Lobster Shell Composite Material*


Co-Authors: Gregory Simms, David Neivandt


Poster Number: 271

The Neivandt research group has developed a bio-derived material composition, primarily composed of gelatin and lobster shell, for temporary structural applications replacing construction lumber or even concrete. My role in the project is to design and build a scaled model to evaluate load capacity in outdoor testing. The work has included CAD drawings, finite element analysis and the production of a composite and a wood structure for test comparison. Tests and designs are with respect to the material's properties such as the Young's modulus, solubility, manufacturing idiosyncrasies, adhesion effectiveness, etc. The outdoor test aims to take these individual properties and situate them together in a practical application of the material for qualitative testing.

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**Dawei Liu**

Worcester Polytechnic Institute

*Photothermal properties of Ti3C2Tx and Silk Fibroin Composite Films*

Co-Authors: Rachael Speckhard, Quinsigamond Community College

Poster Number: 251

MXenes, a class of two-dimensional nanomaterials, have attracted much attention in the field of biomedical engineering. Ti3C2Tx, a type of MXene, has demonstrated excellent photothermal conversion properties, making it a promising candidate for drug delivery and antimicrobial applications. However, Ti3C2Tx decays rapidly via oxidation under ambient conditions. Prior work by Krecker et al., showed that silk fibroin can be used to stabilize the aqueous Ti3C2Tx colloidal solutions. However, Ti3C2Tx MXene properties after forming into composite silk materials (e.g., films) for biomedical applications have been limited. In a previous study, it was confirmed that the addition of silk to Ti3C2Tx affects its electric properties, diminishing DC conductivity while leaving AC conductivity unchanged. In this study, we will be characterizing the thermal properties of the MXene silk composites and investigating how silk crystallization will affect those properties. We used an FLIR IR camera to investigate the thermal properties by shining collimated broad spectrum light onto samples. The IR camera allowed us to plot the change in temperature of the sample when light was heating it and after it was shut off through live imaging feeds. We used THz time-domain spectroscopy to characterize the AC conductivity of the samples, and used time-resolved THz spectroscopy to investigate the excitation dynamics.

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**Wanqing Liu**

Carnegie Mellon University

*Testing the Young FRB Progenitor Hypothesis: A Crossmatch of Catalog-1 CHIME Bursts with Historic Local Universe Supernovae*

Co-Authors: Mohit Bhardwaj (Assistant Professor), Ben Marglit (Assistant Professor)

Poster Number: 28

Fast radio bursts (FRBs) are powerful, enigmatic radio transients, with growing evidence linking them to newborn, highly magnetized neutron stars formed in core-collapse supernovae (CCSNe). A definitive spatial association with a historic CCSN would confirm this and constrain young neutron star models. We cross-match 886

spectroscopically classified CCSNe at $z \leq 0.043$ with 241 CHIME/FRB Catalog 1 events using spatial, dispersion measure (DM), and scattering time ($\tau$) criteria. Four overlaps are consistent with chance, though one pair (FRB 20190412B–SN 2009gi) also satisfies independent host DM and $\tau$ constraints, making it a strong candidate for follow-up. We then search for persistent or transient radio emission at all matched SN sites using multi-epoch VLASS data, detecting none. Treating every CCSN sight line as a non-detection, we derive Poisson upper limits on FRB burst rates, which fall well below those of the most active repeaters unless suppressed by beaming, intermittency, or free-free absorption. Finally, we develop a galaxy-integrated FRB rate model including spectral index, magnetar activity decay, and free-free opacity. Matching observed CHIME/CRAFT rate ratios requires a steep decline in magnetar burst rates with age. Our work highlights the need for sub-arcsecond localizations and multiwavelength follow-up to test the young neutron star hypothesis.

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**Simon Lyon**

William Jewell College

*Testing Air Foils in an Inexpensive Wind Tunnel*

Poster Number: 80

I constructed a wind tunnel using parts from around our department. This includes plastic straws to achieve a laminar flow, a basic desk fan to pull the air through the body of the tunnel, a fog machine for visible air streams, and the body itself is made from sheets of wood. The goal is to take aerodynamic measurements on small air foils I fabricated out of planter's foam.

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**Angelina Madonna**

Lycoming College

*Machine Learning Applied to Control Loop Systems for Advanced LIGO*

Co-Authors: Mari Strong and Gabriela Gonzalez, Louisianna State University

Poster Number: 68

The Laser Interferometer Gravitational-Wave Observatory, also known as LIGO, has been detecting gravitational waves for nearly a decade with advancing technology and sensitivity every year. Minimizing noise leads to increased sensitivity for acquiring gravitational wave signals, specifically in low frequency ranges. To maximize the sensitivity, the two control loop systems within the interferometer, Length Sensing and Control (LSC) and Angular Sensing and Control (ASC), need to be enhanced to avoid cross coupling between degrees of freedom and sensors. For less interference between the degrees of freedom, this project will apply the machine learning algorithm Independent Component Analysis (ICA): a code that is used to separate mixed noise into independent signals. The objective is to use ICA to create an optimal input matrix for each set of degrees of freedom in the LSC and ASC control loop systems.

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**Jacob Mailhot**

Minnesota State University Moorhead


*The Effects of SMoke on Photometry*

Poster Number: 255

With the increase of wildfires across North America, the purpose of this research was to determine how influential the smoke produced would be on photometric data. Using data from the American Association of Variable Star Observers. (AAVSO) standard field of NGC 7790, we compared the instrumental color (B - V) of each standard star with the color from the AAVSO measurements. A linear relationship  was determined through a least squares fit. The slope and intercept of these fits were compared on nights with and without smoke. The amount of smoke on each night is estimated based on records of daytime smoke cover from the U.S. National Oceanic and Atmospheric Administration. Nights which are smoky cause a shift in the y-intercept indicating that these colors have been shifted to become more red on smoky nights.

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**Pritisha Malla**

Augustana College


*Integrating SiPM Signal Analysis and ML using Random Forest Regression for Neutron Detector Optimization*

Co-Authors: Pritisha Malla, Augustana College

Poster Number: 44

Fast neutron detection plays a critical role in nuclear physics, medical imaging, and homeland security. This project, part of the MoNA Collaboration's effort to construct a next-generation neutron detector at FRIB, focuses on improving spatial resolution by applying machine learning to silicon photomultiplier (SiPM) signal data. Photon signals from ROOT files were converted into structured datasets and then processed with Python to train a multi-output random forest regression model. This model was then used to predict the neutron beam impact positions. Photon and SiPM gating strategies were applied to reduce noise and enhance accuracy. This poster highlights the machine learning workflow, data preparation, gating, training, and evaluation, along with comparisons of predicted versus actual beam locations. These results show how gating improves spatial resolution and demonstrate the potential of Machine Learning to optimize neutron detector performance.

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**Able Martinez**

Colorado Mesa University

*Showing Color-Kinematics Duality with Feynman Diagrams*

Co-Authors: Advisor: Dr; James Mangan

Poster Number: 319

Scattering refers to the process of particles interacting and changing states or positions. The probability of a scattering process is determined by the squared magnitude of its scattering amplitude, and this study will demonstrate calculations of amplitudes with Feynman Diagrams. Furthermore, this study investigates Yang-Mills scattering amplitudes, i.e. gluon-gluon scattering. We show how the Color-Kinematics Duality of certain Yang-Mills systems relates these amplitudes to gravity amplitudes, which lie beyond the Standard Model.

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**Adrian Martinez**

Texas Lutheran University

*Energy Distribution of Proton Beams Degraded by Rotating Aluminum Foil Wheel for Space Radiation Simulation*

Co-Authors: Dr; Henry Clark(Advisor), Dr; Gabriel Tabacaru(Advisor)

Poster Number: 163

The TAMU Cyclotron Institute provides simulated space radiation using proton beams across a wider energy range. To minimize downtime when changing beam energies, a rotating degrader-wheel is used to lower the energy of a fixed high-energy proton beam (e.g. 45MeV) by passing through aluminum foils of varying thickness. While this method offers faster turnaround for users, it results in broader energy distribution, especially at lower final energies, which may impact experimental precision.
This project aims to characterize the energy distributions resulting from proton beam degradation at selected energies (e.g. 30MeV, 15MeV, 7MeV). Calibration was performed using known peaks from a Thorium-232 source.
Findings agree that lower energy degradations (e.g. 45MeV to 7MeV) result in significantly broader energy distribution. These results provide critical insight into the tradeoff between speed and energy resolution, informing TAMU Cyclotron users whether the convenience of the degrader-wheel use outweighs the uncertainty introduced by the energy spread.

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**Allison Mata**

Washington State University

*Searching for supermassive black hole binaries in time-domain surveys*

Co-Authors: Allison Mata (1), Maria Charisi (1, 2), Niccolò Veronesi (1), Lorenzo Bertassi (3), Ethan Partington (2); (1) Department of Physics and Astronomy, Washington State University; (2) FORTH Institute of Astrophysics; (3) University of Milan-Bicocca

Poster Number: 231

Detecting supermassive black hole binaries (SMBHBs) through electromagnetic signatures is a key challenge in time-domain astronomy. A promising method is identifying periodic variability in quasar light curves. This study investigates how the statistical significance of a periodic signal—measured via the Bayes Factor (BF)—evolves with increasing observational baselines. We generate simulated quasar light curves containing both a periodic signal and stochastic variability modeled as a damped random walk (DRW), with realistic photometric noise. Observation lengths range from 1 to 10 years, emulating the cadence of future surveys such as the Legacy Survey of Space and Time (LSST). Using Bayesian model comparison, we assess the algorithm's ability to recover injected periodicities and analyze how detection confidence improves with additional data. To estimate false-positive rates, DRW-only simulations are used. Our results provide a statistical framework for SMBHB detection and identify parameter regimes where periodicity can be confidently confirmed.

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**Katarina Matic**

University of San Diego

*Rigidity governs entrainment of bacteria cells in biopolymer scaffolds*

Co-Authors: Katarina Matic (University of San Diego), Nimisha Krishnan (Syracuse University), Moumita Das (Rochester Institute of Technology), Michael Rust (University of Chicago), Megan Valentine (University of California, Santa Barbara), Jennifer Ross (Syracuse University), Rae Robertson-Anderson (University of San Diego)

Poster Number: 52

Biological tissues are composites comprising cells that are integrated into a biopolymer scaffold or network, i.e., the extracellular matrix. Inspired by this design, efforts have been made to use cells to impart functionality and tunability into materials. Cells can be engineered to respond to various stimuli, which can in turn trigger responses that enable drug delivery, scaffold degradation, or control cell fate. These composites of cells and biopolymer networks are studied for tissue engineering and the development of living engineered materials, such as bio-cement. The ability of cells to tune material properties relies on the physical properties of the biopolymers and their interactions with each other and the embedded cells. Here, we investigate how biopolymer stiffness and crosslinking influences cell entrainment within the network, and how the network is restructured by the embedded cells. We design composites of E. coli cells and cytoskeleton filaments, either semi-flexible actin or rigid microtubules. We find that entropically-driven depletion interactions between cells and filaments leads to emergent filament bundling, which is more pronounced for actin. Moreover, crosslinking filaments in softer networks causes enhanced clustering of cells and colocalization of cells and filaments. Our work highlights the ability of biopolymer stiffness and connectivity to selectively tune composite properties and cell entrainment for use in diverse applications.

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**Nikita Mazotov**

Yale University

*Mu2e Helix Finding Energy Deposition Flagging*

Co-Authors: Matthew Stortini, Gianantonio Pezzullo, Michael MacKenzie, Sarah Demers (Yale University, Physics Department)

Poster Number: 95

The Mu2e experiment at Fermilab will search for evidence of neutrinoless muon-to-electron conversion – a charged lepton flavor-violating process that has never been experimentally observed before. To maximize Mu2e's sensitivity to this rare process, the experiment will produce much more data than can be recorded, and therefore a trigger algorithm will be used to decide which events to save. The trigger will have only milliseconds to make these decisions, meaning that its timing performance is crucial to guarantee high quality of data. By introducing an energy deposition cut on particles reconstructed in the Mu2e tracker, my project improved the mean processing time per event by 33% within one of the modules in the trigger, leading to a 15% overall timing improvement in the trigger algorithm with no loss of efficiency on the signal process. This improvement has been adopted as the new default for Mu2e.

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**Sean McDonald**

Abilene Christian University

*Molecular Modeling of Glycine Adsorption on a Nickel Electrode*

Co-Authors: Joe Gauthier, Texas Tech University

Poster Number: 149

The electrochemical double layer is the crucial interface at which electrochemical reactions occur. However, the physics of the electrochemical double layer is poorly understood. Because of this, molecular simulations can offer valuable insight into mechanisms governing electrochemical systems, particularly catalysis. Experiments have shown that the electrolysis of glycine with a nickel electrode under conventionally oxidizing conditions (1.6-2V applied potential vs SHE, alkaline electrolyte) results in the evolution of ammonia (NH3), a reduction product. Previous work has suggested that this

is due to the presence of a strong dipole moment in neutral glycine when adsorbed on a gold surface. Density Functional Theory (DFT) was used to verify the presence of a substantial dipole moment in glycine on a nickel surface. The stability of the system under an applied potential (0-2V vs SHE) was also verified.

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**Ruby McDuffie**

Lawrence Technological University


*Applied Physics of Light Through Architectural Design Phenomenology*


Co-Authors: Ruby McDuffie, Author


Poster Number: 305


This research examines the dual nature of light as both quantifiable and experiential within architectural design. It positions light as a technical resource, a material for spatial articulation, and a perceptual condition that shapes how environments are felt and understood. By integrating applied physics with phenomenological theory, the study argues that light must be considered not only for its physical behaviors, such as reflection, refraction, and energy conversion, but also for its capacity to influence atmosphere, cognition, and experiential engagement as a language. Ultimately, it calls for architectural practices and pedagogies to treat light as a dynamic force capable of contributing to the sustainment of both environmental performance and ethereal conditions. Precedent design of the Al Bahr Towers in Abu Dhabi, designed by Aedas Architects is used to examine technologies to illustrate the importance of reframing wave and particle properties of light as also a choreographer of space, time, and experiential language.


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**Tori McNeece**

Colorado Mesa Univerity


*The Raman Spectra of Strontium Titanate ($SrTiO_3$)*


Co-Authors: Dr; Brian Hosterman, Colorado Mesa University


Poster Number: 197

Raman spectroscopy is a method of characterizing materials. Every material scatters light in a unique way, so each Raman spectrum acts as a material's fingerprint. We observed the temperature-dependent Raman spectra of strontium titanate ($SrTiO_3$) by cooling a sample from room temperature (20°C) to liquid nitrogen temperature (-190°C). Strontium titanate transitions from the cubic phase to the tetragonal phase around -160°C. Its Raman spectrum is entirely second-order with broad and indistinct peaks.

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**Aliaksandr (Alex) Melnichenka**

Berea College

*Recovering 3-D Magnetic Turbulence from a Single Polarization Map*

Co-Authors: A; Lazarian (University of Wisconsin–Madison); D; Pogosyan (University of Alberta)

Poster Number: 321

Can we measure the inertial-range spectrum of interstellar magnetic turbulence from just one polarization map at one wavelength? I present an observer-ready statistic—the polarization-angle directional correlation—that extracts a “directional spectrum” from a single Stokes-Q/U image and cleanly separates emission-dominated and Faraday-screen–dominated structure via a simple, physical crossover criterion. I validate the method on synthetic Faraday screens and Athena MHD simulations spanning sub- and super-Alfvénic regimes, recovering expected slopes and tracking the wavelength-dependent transition where rotation becomes order-unity. Because the estimator operates on angle directions (cos 2χ, sin 2χ), it is robust to interferometric high-pass filtering and does not require angle unwrapping. I’ll share a minimal, reproducible pipeline (one-command figure regeneration from a tagged commit) so observers can apply this immediately to LOFAR/MeerKAT/VLA archives and prepare for SKA bands with sparse spectral coverage. This undergrad-led project was developed with A. Lazarian and D. Pogosyan and is being submitted to The Astrophysical Journal.

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**Jaden Mensah-Kennedy**

Lamar University

*Improving the performance of colored filters using polarizers*

Co-Authors: Jaden Mensah-Kennedy and Mentor: Cristian Bahrim and TEAM-UP

Poster Number: 179

The photoelectric effect provides the cut-off frequency and kinetic energy of the least bound electrons for any photodetector. Our device has a work function of 1.72 ± 0.05 eV and a cut-off wavelength of 729 nm. Using a mercury lamp and narrow-band filters at 365, 404.7, 435.8, 546.1, and 577 nm, we measured the stopping potentials (Vs) where the photocurrent drops to zero. With apertures of 2, 4, and 8 mm, our voltage precision is two decimals (e.g., for 365 nm, Vs = −1.81 V vs. theoretical −1.83 V). Our goal is to evaluate commercial optical filters by determining the transmitted wavelengths from the characteristic V–i curves and Vs analysis. Knowing filter bandwidths is essential for spectroscopy and optical data acquisition. Some filters showed a much wider transmitted range than their apparent color. For instance, a blue filter exhibited Vs = −1.55 V, indicating transmission of UV photons with $\lambda > 379$ nm. When a polarizer was added, Vs increased to −1.19 V, shifting the transmitted band to $\lambda > 426$ nm and effectively blocking higher-energy UV photons (~70 nm range). Our study demonstrates that polarizers can enhance filter performance by suppressing unwanted energetic photons, improving precision in optical measurements.

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**Jaden Minnick**

Virginia Tech

*Design and Analysis of Small Angle Monitors for the MOLLER Experiment*

Co-Authors: Mark Pitt, Devi L; Adhikari, Daniel Valmassei, Andrew Gunsch, Evan Miller

Poster Number: 257

The MOLLER experiment aims to make the most precise measurement to date of the parity-violating asymmetry in electron–electron (Møller) scattering, providing a sensitive determination of the weak mixing angle at low energies. Such precision offers a unique probe of physics beyond the Standard Model, complementing searches at high-energy colliders like the LHC. Achieving this goal requires tight control of systematic uncertainties, where the Small Angle Monitors (SAMs) play a central role. Strategically placed to minimize expected physics asymmetries relative to the main detectors, the SAMs serve as sensitive monitors of false asymmetries. My work has focused on SAM design, calibration, and performance verification. I will present results from photoelectron lightguide testing, single-photon calibrations, and photomultiplier tube (PMT) characterizations, along with more recent contributions including scintillator construction and the development of a self-triggering PMT high-voltage scan system. These efforts demonstrate that the SAM detectors are meeting their stringent performance requirements, thereby ensuring the precision of the MOLLER measurement.

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**Anjali Mital**

Florida State University

*Burst Mode Effects on Electron Density and Gas Temperature in a Continuous Gas-Liquid Nonthermal Plasma Reactor*

Co-Authors: Radha Krishna Murthy Bulusu, Robert J; Wandell, and Bruce R; Locke; 2Department of Chemical and Biomedical Engineering, FAMU-FSU College of Engineering

Poster Number: 221

We build upon previous work to examine how the delivery mode of nanosecond pulses influences electron density, electron temperature and gas temperature using time-averaged optical emission spectroscopy (OES) in a nonthermal plasma gas-liquid flow reactor with argon and deionized liquid water. The electron density was estimated using the full width half maximum (FWHM) of H_α at 656.28nm. The gas temperature was estimated using a two-temperature fitting of N2(C-B) band at 337 nm. A custom-made power supply (Advanced Energy Industries, Inc.) was used to vary three burst mode parameters: inner burst frequency (the time between the bursts), burst period (1 over the time between the pulses in the burst), and N-cycles (number of pulses in a burst). The inner burst frequency was varied between 100kHz-1MHz, and the average electron density varied between 8×1015 cm-3 – 1.6×1016 cm-3, with the peak observed at 100kHz. The burst period was varied between 0.1ms-1ms, and the average electron density varied between 7×1015 cm-3 – 8×1015 cm-3, with the peak observed to be constant between 0.25ms-1ms. N-cycles were varied from 1-20 cycles, and the average electron density varied between 6×1015 cm-3 – 1.8×1016 cm-3, with the peak observed at 1 N-cycle. Studying these plasma properties helps improve plasma-based degradation of persistent pollutants like Perfluoroalkyl substances (PFAS), which are difficult to break down and pose environmental risks.

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**Merna Morcos**

Ohlone College

*LeadLaser*

Co-Authors: Aarav Garg, Adam Freed, and Anhminh Pham

Poster Number: 46

Lead contamination in drinking water is a serious health problem that can cause lifelong harm, especially for children. Our team designed LeadLaser, a compact faucet attachment that uses a silver nanoparticle colorimetric reaction to detect lead as low as 10 parts per billion. The system automatically mixes tap water with a safe, non-toxic reagent, and a camera module takes a picture of the sample. An ESP32 microcontroller analyzes the image for a color change and sends the result to a phone app, which displays a simple pass/fail message. We built a prototype for under $25, with testing solution costs of about $5 for 60 tests, making it affordable and scalable. LeadLaser empowers households to test their water on demand and contributes results to a global contamination map, helping communities and researchers track and address lead pollution faster and more effectively.

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**Brehm Moritz**

Grove City College

*Novel Approach to optimizing an effective potential to model low energy electron CO2 Interactions*

Co-Authors: Dr; Michael Falcetta from the Department of Chemistry, and Dr; Mark Fair from the Department of Physics

Poster Number: 97

Electron-CO2 interactions are important in atmospheric chemistry. Inelastic scattering at low energies is dominated by the 2Pu temporary anion. The calculation of properties of the anion as a function of molecular geometry is vital in accurately modeling the outcome of low-energy electron-CO2 scattering. In addition to quantitative predictions, it is important to elucidate the fundamental physics of the electron-CO2 interaction. One high level electronic structure approach is the stabilization method in which the energy differences between the anionic and neutral systems are calculated. The stabilization

graph plots these energy differences as a function a scaling parameter applied to the exponents of the most diffuse functions in the basis set. In the present work, least-squares methods are used to adjust the parameters of the model potential to maximize agreement between the data in the stabilization graph and the analogous energies generated from determining the energy eigenvalues using the model potential.

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**Matthew Motuz**

Lycoming College

*HI Analysis of Luminous Infrared Galaxies with the Green Bank Telescope*

Co-Authors: David Frayer, Green Bank Observatory

Poster Number: 139

The IRAS mission in 1983 led to the discovery of a new type of galaxies, called luminous infrared galaxies (LIRGs). The Great Observatory All-sky LIRG Survey (GOALS) team has continued observing these LIRGs, allowing us to have multi-wavelength observations to conduct different studies. Using the Green Bank Telescope (GBT), we observed the neutral hydrogen within these galaxies, ultimately adding a new wavelength that can be used for the GOALS sample. We present findings that show statistical changes in the neutral hydrogen, and could point towards the theory that LIRGS are the progenitors of quasars and large elliptical galaxies. To understand this more, we compared the neutral hydrogen to the molecular hydrogen, alongside the merger state in these galaxies. This helped support the hypothesis that LIRGs are the progenitors to quasars and large elliptical galaxies.

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**Samantha Muller**

Rutgers University

*Search for nonresonant pair production of dijet resonances in proton-proton collisions at the LHC*

Co-Authors: Eva Halkiadakis (Rutgers University), Divya Gadkari (Rutgers University), and thank you to all CMS collaboration members

Poster Number: 267

Expansions of the Standard Model predict the pair production of new heavy particles that themselves decay into pairs of jets, a cone-shaped spray of particles. A search for pair production of dijet resonances was previously performed using data from the CMS detector in proton-proton collisions at the CERN Large Hadron Collider (LHC) in Run 2 and is continued for the Run 3 data-taking period. For such non-resonant production, we explore supersymmetric scenarios in which top squarks decay to pairs of quarks via R-Parity Violation. This work helps expand the search for new physics in such multi-jet events, and studies are ongoing with Run 3 data.

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**Audrey Murphy**

Ohio University

*How Enforcing a Positive Prior Constraint on the Coefficients of a Toy EFT Expansion impacts the Resulting Mixed Model Posterior Predictive Distribution*

Co-Authors: Name: Daniel R; Phillips, Affiliations: Institute of Nuclear and Particle Physic (INPP) at Ohio University, American Physical Society (APS)

Poster Number: 203

Effective Field Theories (EFTs) tend to break down at high momentums and in the presence of many positive coefficients. Bayesian parameter estimation and Bayesian Model Averaging (BMA) allow for efficient determination of EFT expansion coefficients and their uncertainties, along with a reasonable method for combining the predictions and errors of multiple models, respectively. Using a toy function whose taylor series coefficients are known to be all positive, two posterior functions, both with gaussian likelihood, but one with gaussian priors, and the other with truncated (only positive) gaussian priors, were defined and sampled using MCMC parallel tempering. Two mixed BMA Posterior Predictive Distributions (PPDs) were generated for models of order 1-5 of the toy EFT expansions, one for each prior. While the gaussian prior mixture failed to capture the true function at extrapolated momentums, the positive gaussian mixture did extrapolate to predict the true function within 68% error bounds.

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**Kigozi Musazi**

Morgan State University

*Fabrication and Characterization of Boride Nanocomposites*

Co-Authors: Grace Farrell, Yucheng Lan

Poster Number: 36

Thermoelectric materials can convert heat into electricity and vice versa. In recent decades, thermoelectric devices have been applied in power generators from waste heat, refrigerators/coolers, and thermocouples. In this project, we fabricated boride-based thermoelectric nano-composites. Boride nano-powders were consolidated into bulk disks using the spark plasma sintering (SPS) technique. The resulting microstructures, including grain size and morphology, were examined using scanning electron microscopy. This investigation provided a foundation for developing boride-based devices such as thermal sensors, offering excellent thermoelectric properties, electrical stability, and chemical durability.

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**Ephraim Myers**

Berea College

*Photovoltaic cell manufacturing with thin film deposition*

Co-Authors: Alex D; Mullins - (Department of Physics, Berea College, Berea, KY 40404)

Poster Number: 265

Photovoltaic solar cells have become a staple in the world of renewable energy. They offer energy anywhere there is light to expose them to. Photovoltaics operate by layering two different types of semiconductors: one designed to have an excess of electrons (n-type silicon), and the other a with a deficiency of electrons (p-type silicon). These materials must be applied in layers usually scaling in the micrometer. Such thicknesses are achieved via a process called physical thin film deposition. Using this, solar cells may be manufactured on the scale of not just micrometers, but nanometers. This research project tries to understand the fundamentals of physical thin film deposition with a focus on thermal evaporation. The results of these tests were examined using a variety of methods, including X-ray diffraction (XRD), vibrating sample magnetometry (VSM), and scanning electron microscopy (SEM). Work was also done on constructing a plasma sputtering vacuum chamber which would allow for greater precision of deposition than

thermal evaporation. This process required a number of tests for chamber integrity and general performance.

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**Maahi Naik**

North Carolina State University

*Silicon Detector Characterization: Constraining Nitrogen Isotopes in Supernovae*

Co-Authors: Richard Longland, North Carolina State University and Triangle Universities Nuclear Laboratory; Caleb Marshall, Univerisity of North Carolina at Chapel Hill and Triangle Universities Nuclear Laboratory; Briana Strickland, North Carolina State University and Triangle Universities Nuclear Laboratory

Poster Number: 93

The violent death of massive stars, known as core collapse supernovae, can produce many elements heavier than iron in our solar system. In order to fully understand the production of these elements and their origin, it is crucial to have accurate stellar models. In particular, models of nitrogen production are of interest as nitrogen isotopes play an important role in determining the origin of presolar grains. The purpose of this project was to characterize a silicon detector in order to evaluate the efficiency and energy resolution before performing measurements at the TUNL ENGE split-pole spectrograph. An Am-241 source was used to collect initial data on the performance of the silicon detectors. The results and conclusions from these measurements will be presented.

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**Pragya Natarajan**

George Washington University

*Simulating Thermal Effects in Rate-of-Rise Standards using COMSOL*

Co-Authors: Mentor: Aaron Johnson, NIST Fluid Metrology Group

Poster Number: 141

The NIST Semiconductor Low Flow Standard (SLowFLowS) uses the Rate-of-Rise (RoR) method to measure mass flows from 0.025-1000sccm of process gases. In Rate-of-

Rise, a steady flow of gas enters an evacuated vessel of known volume, and the mass flow rate is determined from the linear increase in gas density in the vessel as a function of pressure and temperature over time, assuming constant temperature. Pressure can be measured using fast-response transducers, however work-of-compression may increase temperature during filling. The SLowFlowS collection tank's long, slender tubes and forced-convection air bath encourage conductive heat transfer, allowing NIST to derive the gas temperature using an experimentally verified conduction-based thermal model for this geometry. COMSOL's Computational Fluid Dynamics(CFD) simulations can further verify the model, simulate various flow rates and gas species, and provide guidance for future geometries. With COMSOL's CFD, I confirmed the thermal model and gained insight on the model's limitations.

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**Madeline Nicholas**

Ohio University

*Recommissioning and Characterization of an NaI(Tl) Split-Annulus Detector*

Co-Authors: John Edwards of Ohio University, Andrea Richard of Ohio University

Poster Number: 153

Sodium iodide (NaI) scintillation detectors are renowned for their relative versatility and high efficiency. NaI scintillators function in room temperature conditions, have good energy resolution, and high light output. These traits make them critical in many applications, such as nuclear medicine, environmental monitoring, and nuclear security. A split-annulus form of one of these detectors has been recommissioned in the Edwards Accelerator Lab (EAL) at Ohio University, to be used in future laboratory experiments where other detectors may not function or are not practical for the experiment at hand. The detector has not been used in upwards of 30 years, so testing its functionality was our primary concern. In this poster, I will discuss the setup, calibration, and testing of this detector.

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**Danielle Nunez**

Randolph College

*Developments of software for the quality control of the HGACAL scintillator tile-modules*

Poster Number: 38

The High-granularity calorimeter (HGCAL) is a major upgrade of CMS, which is necessary to maintain calorimetric performance in the endcaps during the HL-LHC (High Luminosity Large Hadron Collider) operation (2027-2040). This new endcap calorimeter is designed to have a higher radiation tolerance, better 3D granularity, precise timing. At Fermilab, the Scintillator Tile detector Modules (Tile- Modules) of the Hadronic Compartment will be assembled using a robot pick and place machine. A post assembly quality control test will be performed for electrical validation using a multi- module test stand. I developed the first prototype of the cosmic ray trigger system of this test stand.

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**Jacquelline Nyakunu**

Davidson College

*INCREASING MAGNETOMOTIVE ULTRASOUND FORCE USING PERMANENT MAGNETS: A FINITE ELEMENT ANALYSIS STUDY*

Co-Authors: Dr Ben E Levy

Poster Number: 157

Blood clots are a major contributor of deaths in the United States. Hence, there is need for more precise and accurate diagnostic techniques such as magnetomotive ultrasound (MMUS) which may be able to utilize magnetic nanoparticle (MNP) contrast agents to enhance clot detection. Research has shown that by applying a sinusoidal magnetic force on an MNP-labelled clot, the resonance frequency, and thus the stiffness can be determined. This can aid in making treatment decisions. However, small clots have higher frequencies, which MMUS cannot currently detect. Therefore, there is need to design a setup that optimizes MMUS magnets to generate adequate force at higher frequencies. We created a simulation that matched the existing system and used finite element analysis (FEA) to predict a configuration that enhanced magnet performance. By adding permanent magnets of different sizes and varying the position of the magnets relative to an existing pair of solenoids, the forces imparted were evaluated. FEA predicted that a specific permanent magnet placement could increase the force by a factor of 1.8, and experimental validation showed a similar value of 2.3. These promising results suggest that integrating permanent magnets in our planned MMUS system design holds significant potential for improving performance.

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**Caitlin O'Neil**

College of Wooster


*Crystal Growth Control of SU-101 Metal-Organic Framework on Cotton Textile*


Co-Authors: Caitlin O'Neil (College of Wooster), Zhuoran Zhong (Dartmouth College), Dr; Katherine Mirica (Dartmouth College)


Poster Number: 195


Metal-organic frameworks (MOFs) consist of metal cations bridged with rigid organic molecules. Due to their porous structures, MOFs like SU-101 can be used as wearable filters for certain toxic gases when grown on textile. SU-101 was grown on cotton textile using a layer-by-layer (LbL) method and a hydrothermal method. MOF structure was then analyzed with pXRD, BET surface area analysis, a structural tape test, and SEM imaging. Based on the pXRD plots, more SU-101 may be present on the LbL than the hydrothermal samples. Out of the four conditions grown by LbL, the condition with the second highest metal ion concentration is most optimal. Attempts to upscale the LbL process for manufacturing using a thin film applicator has begun. If this process is refined in the future, it would be possible to synthesize large quantities of material at a time to manufacture wearable SU-101 filters.


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**Albert Ogrodski**

University of San Diego


*Sterile Neutrino Decays in the Early Universe*


Co-Authors: Albert Ogrodski, Blake Hawkins, and Chad Kishimoto


Poster Number: 60


Sterile neutrinos are hypothetical massive particles that do not experience Standard Model interactions. While they cannot be studied in the laboratory, the hot and dense

early universe provides an intriguing "laboratory" that can probe the existence of sterile neutrinos and their physical properties. With the right properties, sterile neutrinos could be created moments after the Big Bang and later decay into Standard Model particles. We simulate the early universe, roughly a second after the Big Bang, to explore the possibly-observable consequences of this model. In particular, we study the evolution of the active neutrino distributions to elucidate the consequences of these sterile neutrino decays that produce a population of highly out of equilibrium neutrinos at an epoch in the early universe where the active neutrinos begin to thermally decouple from the rest of the universe.

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**Luis Otero**

Lycoming College

*Tracing Dual AGN Evolution Across Cosmic Time: Galaxy Mergers and SMBH Growth in IllustrisTNG-50*

Co-Authors: Antonio Porras-Valverde, Yale University

Poster Number: 143

Supermassive black holes (SMBHs) are generally located at the centers of all massive galaxies. Their formation and growth remain a key unanswered question. In general, SMBHs grow through cold gas accretion and mergers with other black holes (BHs), which produce dual active galactic nuclei (AGN) during galaxy mergers. We use the high-resolution IllustrisTNG-50 hydrodynamical cosmological simulation to analyze dual AGN across cosmic time from redshifts $z = 2$ to $z = 0$ in galaxies that undergo major mergers (stellar mass ratios $\mu \geq 0.25$). To construct our catalog, we cross-matched the galaxy merger catalog from Bottrell et al. 2024 to IllustrisTNG's public BH mergers catalogs. Our catalog includes the host galaxy's dark matter halo mass, star formation rate, stellar mass, as well as the infall BH mass, accretion rate, and separation. Our results show how galaxy mergers affect galaxy and BH properties across cosmic time. When dual AGN coalesce, they are some of the most powerful precursors of gravitational waves. Our results can help constrain the massive end of the black hole mass function and explain the effects we lay out as observable by future space-based interferometers, such as the Laser Interferometer Space Antenna (LISA).

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**Christian Ottesen**

Saint Joseph's University

*Chaotic synchronization and its applications to global economy and economic networks*

Poster Number: 205

This project explores chaotic synchronization within nonlinear dynamical systems, focusing on its application to global economic networks. Using the Rössler oscillator as a model system, we investigate how different coupling schemes between chaotic oscillators can produce coordinated or periodic behavior, despite each system's intrinsic unpredictability. Through theoretical and computational analysis, we study how synchronization depends on coupling strength and system parameters, and identify the mechanisms that allow order to emerge from chaos. Building on the work of Richard Goodwin and subsequent researchers, we extend the Rössler framework to model interacting economic agents—where variables such as wages, profits, and policy factors exhibit chaotic yet potentially synchronized fluctuations. By simulating networks of coupled Rössler systems, this research aims to shed light on how different local economic instabilities can become globally coordinated. These insights may inform future approaches to understanding complex synchronization phenomena in economics, neural systems, and engineering.

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**Thomas Owens**

High Point University

*Feasibility of a Gas Degrader at FRIB for Fission Studies*

Co-Authors: Thomas Owens, Addam Anthony

Poster Number: 339

One major challenge when studying the fission of heavy nuclei is controlling the reaction energy. In a previous experiment at the National Superconducting Cyclotron Laboratory (NSCL) studying the fission of heavy nuclei, a thin sheet of iron was used to degrade the beam energy. The nonuniformity of the sheet led to an uncertainty in the reaction energy. To this end, we tested the possibility of creating a gas-based energy degrader. This gas degrader would feature a tube with two thin pressure windows, one on each side, and a high-density gas on the inside. This setup would allow ions to pass through while being

slowed down by the gas. Simulations guided gas selection, and a test chamber assessed film strength, confirming the degrader's feasibility.

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**Francisco Pacheco**

University of Puerto Rico Mayaguez

*CH Detections in W3 Molecular Cloud*

Co-Authors: Allison Smith, University of Puerto Rico Mayaguez

Poster Number: 295

Methylidyne (CH) is a key tracer of molecular hydrogen in the interstellar medium (ISM), offering valuable insight into galactic evolution and star formation. To investigate CH emission in the W3 molecular cloud—a dense, active star-forming region in the Perseus arm—we analyzed observations from the 12-meter telescope at the Arecibo Observatory. Using position-switching techniques, we detected CH spectral features near 39.5 km/s, consistent with the velocity components observed in previous CO studies. The CH and CO detections occur in the same regions of W3, indicating that both molecules trace similar molecular gas structures. Derived CH column densities provide further constraints on the molecular composition of W3 and reinforce the role of CH as a complementary probe of dense, star-forming environments.

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**Elliot Parker**

Florida State University

*Quality Control Testing of Silicon Sensors for the CMS High Granularity Calorimeter Upgrade*

Poster Number: 227

The Compact Muon Solenoid (CMS) experiment at CERN is being upgraded with a new High Granularity Calorimeter (HGCAL) to prepare for the increase in luminosity of the High Luminosity Large Hadron Collider (HL-LHC). This upgrade will improve data collection and event reconstruction, allowing for more accurate measurements. My research focuses on the quality control testing of the silicon sensors that will be used in

the upgrade of the HGCAL. We test multiple structures on the sensors to measure key parameters such as leakage current, breakdown voltage, and capacitance. Using these measurements, we can evaluate sensor performance and ensure they meet the strict requirements for long term operation in the high-radiation environment of the HL-LHC. By keeping the same standards for all sensors, we can verify the consistency across sensors to ensure reliable detector performance and support the successful upgrade of the detector for future projects in high energy physics.

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**Kay Peli**

Juniata College

*Emergence of Magnetism in Two Dimensions*

Co-Authors: Dr; William Blades, Department of Physics and Engineering Physics, Juniata College; Chengye Dong, Anthony R; Richardella, & Joshua A; Robinson, Department of Materials Science and Engineering, Pennsylvania State University

Poster Number: 233

Monolayer (ML) metals show magnetic behaviors unlike their bulk forms, offering exciting potential for spintronic and quantum technologies. SiC substrates are often used to stabilize these low-dimensional materials, acting as templates for ML growth. A magnetic ML-Fe layer on SiC bonds at distinct adsorption sites, effectively creating a strained γ-Fe(111) surface. Using first-principles density functional theory (DFT) in QuantumATK, we modeled (i) bulk γ-Fe(111), (ii) isolated ML-Fe, and (iii) SiC/ML-Fe under both compressive and tensile strain. Tensile strain consistently increases the magnetic moment. Projected Density of States (PDOS) analysis shows a shifted d-band center and greater spin-up/spin-down splitting, revealing stronger exchange interactions. This strain-driven response produces a higher magnetic moment per atom. Our results deepen understanding of magnetism in monolayer transition metals and highlight how strain can be used to tune their quantum and magnetic properties for future experimental design.

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**Jocelyn Pellegrino**

Morgan State University

*Distributed Air Traffic Management Via a Nash Equilibrium*

Co-Authors: Dr; Ufuk Topcu, Jaehan Im, Surya Murthy

Poster Number: 58

As global airspace grows more congested, robust conflict-resolution in air traffic management (ATM) is essential. This research presents a distributed, game-theoretic framework where aircraft act as autonomous agents with quadratic utility functions reflecting three objectives: avoiding conflicts by maintaining safe separation, efficient routing, and fair priority management. Initially, scenarios with two agents are demonstrated, but the model also scales to multiple agents using Nash equilibrium for decentralized coordination. Simulations show agents can adjust their paths to ensure safety and efficiency, while the fairness component ensures all agents share responsibility for conflict resolution—crucial for practical ATM systems. The Nash-equilibrium-based approach proves effective for distributed conflict management but reveals challenges when urgency or traffic density increases. These limitations highlight the need for future studies, including three-dimensional simulations, drone or aircraft testbeds, and investigations with non-compliant agents, to enhance robustness and applicability to more complex airspace environments.

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**Trey Pepper**

Nebraska Wesleyan University

*Predicting the Atmospheric Composition of Exoplanets with Neural Networks*

Co-Authors: Ian Crossfield, University of Kansas

Poster Number: 275

We developed neural network models to predict abundance profiles of ten separate molecules in exoplanet atmospheres. Each network or model takes carbon, oxygen, and sulfur abundances in a planet's atmosphere as inputs and then predicts the abundance of a single molecule in 150 atmospheric layers. Training and evaluation were conducted using atmospheric data for the exoplanet WASP-39b, with total abundances measured by JWST and molecular abundance profiles generated by the VULCAN photochemical kinetics code. The neural networks required 43.5 minutes total for training and only 2.1 seconds to predict all molecular profiles - approximately 3% of the computational time needed by a full chemistry network. The models achieved a mean squared error of 0.096 on the test set, demonstrating that machine learning can efficiently and accurately reproduce

atmospheric chemistry models for exoplanets, providing a much faster alternative to traditional computational models.

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**Andre Peterson**

University of North Florida

*Tracking Dark Matter in Minerals using EBSD*

Co-Authors: Dr; Gregory A; Wurtz, Dr; Chris Kelso

Poster Number: 187

The long-term objective of this project is the direct detection of dark matter through measuring tracks dark matter particles leave behind when interacting with the physical world. Evidence of dark matter interactions is more readily identified in pristine crystalline materials, where tracks are associated with local, nanometer-scale disruptions to the crystalline order. In this work we plan on using a combination of Scanning Electron Microscopy (SEM), Focused Ion Beam (FIB) milling, and electron diffraction in both reflection (EBSD: Electron BackScatter Diffraction) and transmission (t-EBSD) to detect and analyze "calibration tracks" that were created with a beam of gold ions as well as other fiducial markers in a variety of mineral samples. An analysis of the potential of the proposed approach in the pursuit of dark matter detection will be presented.

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**Jack Peterson**

Ohio University

*Construction and Characterization of Scintillating Neutron Detectors Using Silicone Pad Coupling at Edwards Accelerator Laboratory*

Co-Authors: C; E; Parker, T; N; Massey

Poster Number: 72

Maintaining and calibrating neutron detectors for use in experiments is an essential aspect of Edwards Accelerator Lab (EAL) operations. Historically, neutron detectors at EAL have been coupled with optical-quality silicone grease, which is messy and deteriorates

over time. Two new scintillating neutron detectors have been constructed with 1-mm-thick optical-quality silicone pad coupling to improve detector assembly by offering a cleaner alternative. Each detector was built using an Eljen EJ-301 liquid scintillator (5" by 2") coupled to a Hamamatsu photomultiplier tube and base. The neutron and gamma pulse shape discrimination (PSD) was tested for each detector using a sealed PuBe source and quantified using a 1D figure of merit (FOM). An energy calibration was performed using three sealed radioactive sources (137Cs, 22Na, 207Bi).

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**Conner Petty**

Texas Lutheran University

*Brain-To-Text Translation: The Ability to Predict Text From EEG Data*

Co-Authors: Dr; Ridwan Noel, TLU Department of Math and Computer Science, National Science Foundation

Poster Number: 263

Brain-to-text translation is a relatively new concept within the fields of machine learning and neuroscience. It employs machine learning models to capture complex patterns in brain signals and translate brain activity into text. Most earlier studies used electroencephalography (EEG) data for this purpose, while others relied on functional magnetic resonance imaging (fMRI) or magnetoencephalography (MEG). In this work, we aim to determine whether brain-to-text translation can be achieved using end-to-end convolutional neural network (CNN) and attention models trained entirely from scratch. Our motivation stems from the fact that earlier work in this field often relied on pretrained models, and some employed teacher forcing during training. We used the ZuCo 2.0 dataset, specifically the natural reading portion, to train our models. Due to computational and time limitations, we used only 5 samples per subject (90 total) to train two models with identical architectures. One model used an unbalanced split of the dataset and achieved a word error rate (WER) of 71.88%, while the other used a balanced split and achieved a WER of 79.37%. The techniques employed show that it is possible to translate EEG data into words using basic CNN-Attention architecture with connectionist temporal classification (CTC) loss. These results provide evidence that meaningful patterns are captured by the model within EEG data and that the model is not merely guessing or hallucinating its predictions.

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**Catherine Porter**

The George Washington University

*A 5-DOF Stand Allowing Multiple Needle Trajectories in Stereotactic Breast Biopsy*

Co-Authors: Catherine Porter1,2, Priyash Singh1, Andrew Maidment1; 1Department of Radiology, The University of Pennsylvania, Philadelphia, PA; 2The George Washington University, Washington, D; C;

Poster Number: 219

One in eight women in the US will develop breast cancer during their lifetime. Stereotactic breast biopsies under Digital Breast Tomosynthesis (DBT) guidance are commonly used for diagnosing cancer. They involve advancing a needle toward a suspicious breast lesion and extracting tissue samples for radio-histological analysis to confirm the diagnosis. Commercial biopsy stands typically offer only two degrees of freedom, restricting flexibility in needle approach angles . We have developed a biopsy stand with five degrees of freedom, that enables a broader range of needle trajectories and improved adaptability to both patient anatomy and clinician preference. The complete design, modeled in SolidWorks, incorporates both commercial components and custom-fabricated parts, including appropriate motion constraints. Once fabricated, we will conduct mock breast biopsy experiments using physical phantoms to assess clinical feasibility. Upon successful validation, we aim to proceed with clinical implementation to advance the current standard of DBT-guided breast biopsy.

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**Krupa Pothiwala**

Florida Institute of Technology

*Krupa Pothiwala*

Co-Authors: Dr; Warren, Damien Koon, Abhor Rahman, Aakansha Sharma, Giulianna Hartsell

Poster Number: 86

Gamma-ray bursts (GRB) are violent explosions in deep space which are followed by a long-lived “afterglow.” Some are “orphan afterglows” which are afterglows without the detection of a GRB. The Rubin Observatory is expected to observe over 1,000 orphan

afterglows a year. We are working towards a method to extract the physical parameters of these orphan afterglows to get a better understanding of the progenitor systems. We start by choosing the physical parameters, such as the energy of the burst or environment around the burst, and then computing the flux and frequency over time. We will then feed that simulated data as a model to train a neural network to emulate these results in a fraction of the time. This reduced computational costs allows us to solve the inverse problem: obtaining the physical parameters from the flux and frequency over time.

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**Ariana Potorski**

Washington State University

*Exploring Characteristics of Binary Black Hole Inspirals*

Co-Authors: Sukanta Bose

Poster Number: 315

Using data from the Laser Interferometer Gravitational-wave Observatory (LIGO) network, we can detect gravitational wave signals from binary black hole (BBH) mergers. The inspiral phase of a BBH merger produces a chirp signal that increases in frequency and amplitude over time. Using Fourier transformations and the Markov Chain Monte Carlo method we can fit sinusoidal data to the expected waveforms and analyze their characteristics. By comparing the change in frequency and amplitude we can draw conclusions about the masses and orbits of the BBHs. Thus far, we are focusing on computational methods of analysis on synthetic sinusoidal waveforms.

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**Dimitra Protopapas**

University of San Diego

*Ligase-Mediated Gelation of Dynamic DNA Networks*

Co-Authors: Emma Riggle, Kaden Chang, Ashlee McGovern, Rae M Robertson-Anderson, University of San Diego

Poster Number: 155

DNA ligase catalyzes the formation of phosphodiester bonds, joining strands of linear DNA and playing an essential role in replication, repair, and the formation of entangled structures. In systems of highly concentrated, concatenated linear DNA, such connectivity can significantly affect diffusion and conformational dynamics. Here, we investigate a system of 3075 base pair linear DNA molecules enzymatically linked by ligase to form concatenated structures, in which linear DNA is probed to assess the system behavior. Using gel electrophoresis, fluorescence microscopy, and differential dynamic microscopy, we analyze the diffusivity of DNA undergoing active linking. We demonstrate that DNA diffusivity decreases with ligase activity across varying conditions, depending on enzyme digestion rate and entanglement. Future work will expand this bio-based approach by integrating additional enzymes and photoactive molecules to explore active DNA linkage, which could have applications across biomedical, industrial, environmental, and technological fields through the development of dynamic, self-altering materials.

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**Kobe Ramirez**

University of California Sacramento

*Relativistic Jet Analysis*

Co-Authors: Rodolfo Barniol Duran, California State University Sacramento

Poster Number: 269

In this poster we will analyze relativistic jets that are emitted by black holes in numerical simulations. We performed analysis on jets physical quantities such as magnetization, Lorentz factor, and energy. We use HARMPI and H-AMR, which are GRMHD codes that numerically approximate differential equations that describe the proprieties of the jet. We want to know how these proprieties change throughout the simulation as function time and radius.

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**Abigail Raytsis**

The Pennsylvania State University

*Simulating Charge Diffusion in a Low-Noise Small-Pixel X-Ray Hybrid CMOS Detector*

Co-Authors: Lukas R; Stone, Abraham D; Falcone, Kadri M; Nizam, Ian T; Ashcroft, Killian M; Gremling, Katie B; McWhirter

Poster Number: 335

Charge diffusion, in X-ray detectors, is the lateral expansion of a charge cloud created by an incident photon in the photosensitive volume as it migrates toward the potential wells by a substrate voltage, which can result in charge spreading across multiple pixels. The size of the charge cloud depends on X-ray energy, absorbing bulk thickness, magnitude of the substrate voltage, and detector pixel pitch. Minimizing charge diffusion optimizes the number of single-pixel events, which is necessary to accurately reconstruct the energy of a detector X-ray from each pixel with charge. Pixel noise in the detector causes poorer energy resolution in multi-pixel events compared to single-pixel events. We report on charge spreading simulations of an X-ray HCD exposed to Mn Kα and Kβ X-rays at 5.9 and 6.5 kev, respectively. With this, we can improve our current X-ray energy reconstruction pipeline for X-ray HCDs to optimize grading and thresholding.

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**Catherine Rexer**

Furman University

*Hidden Binaries as the Source for Spitzer Microlensing Systematics*

Co-Authors: Amber Malpas, Alexander P; Stephan; The Ohio State University Department of Astronomy, Vanderbilt University Department of Physics and Astronomy

Poster Number: 191

The Spitzer Space Telescope has been used in conjunction with Earth-based instruments to observe microlensing events, which are important in the study of stellar and exoplanet populations. However, some of the Spitzer microlensing data contain correlated errors in the lightcurves, over-predicted parallax and under-predicted mass. We attempt to explain the cause of these systematic uncertainties through the presence of “hidden” binary source stars, systems in which the primary source appears lensed from both Earth and Spitzer, but the secondary source appears lensed from Spitzer only. We found that up to 50% of the systematic uncertainties can be explained in this way. This effect broadens predicted baseline flux and affects parallax precision, altering the interpretation of lens system parameters. This same phenomenon will also occur in future microlensing observations from both Earth- and space-based observatories, offering a way to constrain source distances or study demographics of sources on the far side of the galactic center.

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**Grace Reyelts**

Carnegie Mellon University

*Signal Versus Background Discrimination in the Light Dark Matter eXperiment (LDMX)*

Poster Number: 134

The Light Dark Matter eXperiment (LMDX) is an advanced particle physics experiment that seeks to form a greater understanding of the composition of dark matter. LDMX explores the possibility that dark matter is made up of light particles, specifically with masses less than a few GeV, that may have been formed as thermal relics in the early universe. To do this, the experiment uses a fixed-target setup where high energy electron beams are directed onto a thin tungsten target. If dark matter particles are produced from the collisions, then scattered electrons with low momentum would result from the interaction. It is important to distinguish this potential signal from background events that could also occur to identify real dark matter events. Therefore, a machine learning algorithm is developed to separate the dark matter signals and these background events using simulated data. The performance of the algorithm is evaluated by checking how many simulated signal events the algorithm successfully identifies and how many background events it incorrectly labels as a signal. In doing so, we hope to contribute to the larger LDMX collaboration's search for dark matter.

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**Jashaun Richard**

Lamar University

*Simulation Study of Pair Spectrometer Luminosity Detector for the ePIC experiment at EIC*

Co-Authors: Jashaun Richard, Asher R Tariq, Alysa Patteson (Lamar University); Advisor: Dr; Philip Cole & Zhaozhong Shi; (University of Houston); Advisor: Dr; Rene Bellwied

Poster Number: 229

Precise luminosity measurements are vital for accurate cross-section determinations at the future Electron-Ion Collider (EIC). The ePIC experiment's luminosity monitor uses the

Bethe-Heitler bremsstrahlung process e+p→e-γp,where the emitted photon converts into an e+e- pair. These charged particles are separated by a dipole magnetic field and detected using segmented electromagnetic calorimeters (ECALs) based on the Beam Pipe Calorimeter design.
This research employs full GEANT4 simulations to optimize the pair spectrometer's detection efficiency and energy resolution. Current efforts include mapping ECAL acceptance versus photon energy ($E\gamma$) and testing magnetic field configurations to maximize pair separation and tracking precision. The goal is to identify the optimal geometry and magnetic settings that improve detector performance and reduce systematic errors. Future work will integrate machine learning for tracking and benchmark simulations with experimental data to refine the final luminosity detector design.

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**Kate Rickels**

Furman University


*Characterizing the Dynamics of Select Eclipsing CV Binary Systems*


Co-Authors: Joshua Begelman, Mridul Agrawal, Valeria Garcia Lopez and David Moffett; Furman University Department of Physics


Poster Number: 173


In this project, we continued to work on building code to determine/verify the period of ~50 eclipsing cataclysmic variables and detect changes in observed period using O-C (observed minus calculated) diagrams. We wrote Python script to access the Transiting Exoplanet Satellite Survey's 2-min photometric cadence data from the Mikulski Archive for Space Telescopes. Additionally, we processed data from the American Association of Variable Star Observers and eclipse times we find in existing literature. We used a periodogram to determine the initial orbital period of the system, then fit an inverse Gaussian function to each eclipse in the light curve to find the observed eclipse time values. Then, we calculated the predicted eclipse times and constructed an O-C diagram for the eclipsing CV in question. The O-C diagram allows us to calculate $\dot{P}$ (derivative of the period with respect to time) to better understand orbital evolution in these binary systems.


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**Tristan Rieman**

Ohio University

*Handheld Hyperspectral Sensing with STELLA: Educational Applications and Plant Stress Assessment*

Co-Authors: Jared L; DeForest, Ohio University Department of Environmental and Plant Biology

Poster Number: 193

In recent decades spectroscopic data has been increasingly used to monitor the processes that occur in Earth's environment. NASA's LandSat Science program developed satellites that monitor photosynthetic rates, carbon sequestration, and other conditions on a global scale. However, this is costly and inaccessible as a means for research in smaller scale ecosystems. The STELLA device was developed as an inexpensive and open-source way for anyone to do science. At Ohio University the prototype device was built for proof of concept in plant stress assessment. A second, more advanced STELLA 1.2 has been developed to increase the types of sensors available for measurements. An initial test was set up with Japanese indigo in three categories (High P, High K, and control) of soil nutrient availability to measure the light reflected by the chloroplasts using STELLA. This will evaluate the effectiveness of the devices in finding nutrient stress in plants.

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**Arianna Rodríguez-Ortiz**

University of Puerto Rico-Mayagüez

*Spectral Radio Analysis of CH in the Molecular Clouds M17 and W51*

Co-Authors: Allison Smith - University of Puerto Rico-Mayagüez, Emmanuel Morales - University of Puerto Rico-Utuado

Poster Number: 90

Through spectroscopic analysis, one of three hyperfine transition lines of methylidine (CH) in the W51 molecular cloud region of the interstellar medium (ISM) was observed at 3.3 GHz with the Arecibo Observatory 12-meter radio telescope. The interstellar medium (ISM) drives the stellar-feedback mechanism for the development of the Milky Way Galaxy (MWG) and its star-forming processes. The molecular clouds M17 and W51 are found in the plane of the Milky Way Galaxy (MWG) and analyzed at the University of Puerto Rico-Mayagüez, under PI Allison Smith, to create a survey of the Milky Way Galaxy galactic plane using CH as a molecular tracer for diatomic Hydrogen (H2) while

observing the low-density ISM regions. There are also detections of Hydrogen Radio Recombination lines (H RRLs) at 3,326.987 MHz and 3,248.707 MHz. The radial velocity and H2 column density estimates are based on detections of CH. Estimates for H2 column densities based on carbon monoxide open-source data were also obtained. A statistical analysis of the retrieved parameters followed. These results are consistent with the behavior of massive star-forming regions and motivate further exploration of M17 and W51 and validation of results by studying CO data profiles. These results are consistent with the behavior of massive star-forming regions and motivate further exploration of M17 and W51 and validation of results by studying CO data profiles.

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**Tyler Rogers**

High Point University

*Toward Nanowire Devices: Patterning and Characterizing Buried Graphene Substrates*

Co-Authors: Dr; Sean Johnson, Morgan Abrams, Vovi Lagutin, Sara Hamidpour

Poster Number: 355

Graphene, a two-dimensional nanomaterial with exceptionally high thermal and electrical conductivity, presents promising opportunities for nanowire fabrication in flexible electronics, photodetectors, and other semiconductor devices. We evaluated thin-film deposition and analysis techniques for their effectiveness in achieving precise control of thickness, surface uniformity, and adhesion to graphene substrates with the goal of burying a layer of graphene under an SiO2 dielectric layer. A theoretical comparison considered radio frequency (RF) sputtering and electron-beam evaporation as candidate physical vapor deposition methods for graphene. For patterning and selective exposure of the buried graphene, photolithography, electron beam lithography, reactive ion etching (RIE), and hydrofluoric acid etching were examined. Characterization techniques such as ellipsometry, Raman spectroscopy, scanning electron microscopy (SEM), and atomic force microscopy (AFM) were assessed for their applicability in graphene analysis. Experimentally, we demonstrate that a process including RF sputtering, photolithography, and RIE — analyzed by AFM and ellipsometry — successfully produces the first patterned, buried graphene substrates.

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**Ethan Ropp**

Furman University

*Wave Lab Design for Undergrads with a Focus on Comparing Light and Sound*

Co-Authors: Courtney J Kucera and Jeremy Gulley; Furman University Department of Physics

Poster Number: 167

In this project we created labs designed to demonstrate the physics of waves and the parallel nature of light and sound. The first lab is a wave interference demo that uses a double slit along with two speakers, allowing students to both see and hear wave interference. Some aspects of waves, like harmonics, are not yet possible to demonstrate with light in an undergraduate lab. So, for the harmonics lab, students use an FFT to record pitches of different timbres, observe the harmonics, and analyze the data. For the resonance lab, we use a PASCO string vibrator and resonance tube. With the string vibrator students adjust frequency of the vibrator to find the resonant frequencies at different lengths, while with the tube they adjust length in order to find the frequencies of mystery tuning forks. Then, to demonstrate atomic resonance with light, we follow up with a diffraction grating spectrometer.

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**Liam Royle-Grimes**

University of Wyoming

*Reverberation Mapping of the Quasar PG 1302-102 Falsifies Doppler Boosting Binary Hypothesis*

Co-Authors: Michael Brotherton, Kaiwen Zhang, Jacob McLane, Theodora Zastrocky (Wyoming), Yan-Rong Li, Pu Du, Dong-Wei Bao, Feng-Na Fang, Chen Hu, Ming Xiao, Jian-Min Wang (IHEP, Beijing)

Poster Number: 291

The quasar PG3102-102 is a binary black hole candidate based on its light curve, which shows a period of 1,884 ± 88 years. There are several theoretical explanations for how close binary black holes might cause such a periodic signature. We executed a multiyear spectroscopic monitoring campaign using the Wyoming Infrared Observatory 2.3 meter telescope(WIRO). This data set can be used to test one leading hypothesis, doppler boosting by orbital motion. Our observations show that the broad Hß light curve lags that of the continuum by 196 ± 6.5 days in the observed frame.

This result falsifies the doppler boosting hypothesis. The Hß redshift does not undergo periodic changes indicating a circumbinary broad line region. Under the doppler boosting hypothesis, the Hß signal would not be expected to follow the boosted portion of the continuum.
Further, the clear reverberation we observe is consistent with a single SMBH model.

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**Paul Saja**

Austin Peay State University

*Fostering Scientific Curiosity: A Model for Undergraduate-Led Physics Outreach*

Co-Authors: Paul Saja, William Keener, Calleway Schmidt, Keira Scott, Thomas Champagna, Finch Middleton, Zoe Wolf, Brian Gaither, Eugene Donev; Department of Physics, Engineering, and Astronomy, Austin Peay State University

Poster Number: 20

To the public, and especially to young children, physics can feel distant and inaccessible. As undergraduates, we have a unique opportunity to change that perception. The Del Square Psi SPS chapter at Austin Peay State University addresses this through a continuous outreach initiative designed to inspire. While we do engage with our on-campus community, our primary focus is to bring the beauty and wonder of physics to children in grades K-5. By utilizing hands-on science demonstrations, we create early exposure to complex topics by meeting children where they are and fostering an environment for them to engage with science. This poster showcases our methods for sparking this curiosity and presents the key lessons we've learned in effective science communication. Providing this early access creates a desire for comprehension that has value beyond measure, both for the community we serve and for the development of our undergraduate members as science communicators.

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**Phoenix-Avery Sarían**

The Ohio State University

*A Statistical Approach to Isolating the CMB from Secondary Anisotropies*

Co-Authors: William Coulton

Poster Number: 126

The Cosmic Microwave Background (CMB) provides a snapshot of the early universe, but measurements are contaminated by the kinetic Sunyaev-Zel'dovich (kSZ) effect, which occurs when CMB photons scatter off free electrons in moving galaxy clusters. Unlike other foregrounds, kSZ shares the CMB's blackbody spectrum, making standard cleaning methods ineffective.

I investigated methods to separate CMB from kSZ by exploiting spatial structure differences. As a baseline, I implemented Fourier filtering to isolate small scales where kSZ dominates. I then explored Wavelet Phase Harmonics (WPH), which utilizes differences in scale and statistical properties. CMB maps exhibit strong WPH structure with nontrivial phase correlations, while kSZ maps remain nearly flat. By comparing observed map statistics to Gaussian CMB simulations, the CMB contribution can be subtracted, isolating kSZ.

This methodology is tailored for the Simons Observatory. Once validated on simulations, this approach will enable kSZ extraction to trace cosmic structure growth, constrain neutrino masses, and illuminate reionization processes.

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**Jake Scheer**

Texas Lutheran University

*SPS TLU's Family Physics Night*

Co-Authors: Jake Scheer and Colin Halady

Poster Number: 18

Since 2012, Texas Lutheran University has hosted its own Family Physics Night science museum annually. This has been an event for people of all ages to enjoy, from elementary kids to teachers and adults. Starting out 13 years ago, Family Physics Night has been focused on connecting with our community. And because of how much the science fair has grown, we have been able to focus more on choosing interactive activities that everyday people can take home and learn from. Thanks to the support of our community, we get to take the opportunity every November to set up and prepare demonstrations of the subjects we are learning in class. This helps us as physics students learn, not only the material, but also how to effectively communicate complex ideas to people of all ages.

In our presentation, we discuss the different benefits of having a community driven event on campus that the students get to direct, as well as the benefits to the community that such an event provides.

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**Blake Schuetz**

Embry-Riddle Aeronautical University - Prescott

*Applications of Cosmic Watch Detectors in Cosmic Ray Experimentation*

Co-Authors: Gary Wiens (ERAU Electrical, Computer, and Software Engineering Department) and Dr; Darrel Smith (ERAU Physics and Astronomy Department)

Poster Number: 54

Particle detectors like the Coherent CAPTAIN-Mills detector (CCM) at Los Alamos National Laboratory are setting new limits to the mass and variety of dark matter searches. Our project involves assembling 4 Cosmic Watch Detectors (CWDs), designed by MIT students. These will be positioned above Embry-Riddle Aeronautical University's 5-gallon scintillator detector to determine energy calibrations and event triggers to advance CCM research. Triggering events, specifically in the middle of one of the scintillator detector's vertical columns, will guarantee event locations where Michel electrons produce light completely inside the scintillator detector. The project outcome will be to measure the kinetic energy distribution of cosmic Michel electrons, determined by the amount of their light output, and compare it to the theoretical distribution to determine the upper limit of the energy scale. This will allow the scintillator detector to act as a model for other universities pursuing cosmic ray detection and dark matter searches.

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**Jacob Schwartz**

The George Washington University

*Nucleon Polarizabilities and Elastic Compton Scattering on 4He at HIγS*

Co-Authors: Gerald Feldman, Mitchell Lewis, Department of Physics The George Washington University, Triangle Universities Nuclear Laboratory

Poster Number: 116

The electric and magnetic scalar polarizabilities (E1 and M1) of the nucleon are fundamental structure constants that describe its response to external electromagnetic fields. Neutron polarizabilities have relatively larger uncertainties compared to those of the proton. Chiral Effective Field Theory (χEFT) is used to calculate the angular distributions of the Compton differential cross section for light nuclei which provides a way to extract neutron polarizabilities from elastic Compton scattering measurements. The High Intensity Gamma-Ray Source (HIγS) at Duke University delivers a monoenergetic photon beam that provides the external electromagnetic field to low-Z nuclear targets. Utilizing the unique capabilities of HIγS, we measured the angular distribution of the Compton scattering cross section on 4He at 100 MeV in the summer of 2025. Our experimental set-up and data analysis procedures will be described, and preliminary spectra will be presented in order to show the quality of our data.

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**Keira Scott**

Austin Peay State University

*Comparing Five Methods for Determining the Refractive Index of a Glass Prism Using a Multi-Wavelength Laser and a Versatile Optical Setup*

Co-Authors: Thomas Campagna, Keira Scott, Jair Martinez, Michael Graff, and Eugenii U; Donev (Affiliations: Department of Physics, Engineering, and Astronomy, Austin Peay State University)

Poster Number: 309

We present an update on our research’s progress to include measurements and fits of rotating analyzer ellipsometry (RAE) to compare with previous methods for determining a glass prism's refractive index dispersion, focusing on their accuracy and pedagogical value for undergraduate physics. Methods include minimum deviation, Fresnel reflectance, fitting to the minimum deviation curve, and Brewster’s angle. The angle of minimum deviation was the most accurate (≤0.03% error), while the Fresnel method showed the largest inconsistency (0.05%−1.54% error). The minimum deviation fitting results are consistently lower due to an unknown systematic error, while the Brewster’s angle results can be made to match by mixing in fractions of s-polarization. Future steps involve total internal reflection and further research into RAE. RAE appears to be a viable, but less accurate method. This method has proven to be very sensitive, where contaminants and minor human errors can introduce considerable errors in our results.

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**Jacob Shafer**

South Dakota School of Mines & Technology

*Stellar Body Evolutions and Analysis of Stable Carbon Burning in MESA*

Co-Authors: Christopher Butsavage

Poster Number: 327

The primary goal of our research is to determine the lower stellar mass limit for stable carbon burning in massive stars, depending on the carbon fusion nuclear cross-section. This information carries profound consequences concerning how a star will evolve once it runs out of fuel. Despite tremendous experimental efforts, it is challenging to study processes that occur in the cores of stars. For this project, the open-source computational software known as Modules for Experiments in Stellar Astrophysics (MESA) is utilized. MESA simulates stellar evolution by taking in several adjustable parameters given by the user, such as the mass of the star, composition, and more. The program allows us to save the results graphically at set intervals. Moving forward, we would like to study the lifecycles of stars formed in the early universe and compare these to stars of the modern age.

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**Shoshana Shapiro**

SUNY New Paltz

*Finding Active Galaxies in a JWST Calibration field*

Co-Authors: Marcio Melendez, Space Telescope Science Institute; Travis Fischer, Space Telescope Science Institute

Poster Number: 337

We developed an unprecedented pipeline for identifying Active Galactic Nuclei (AGN) candidates using only JWST NIRCam wide-band photometry, a method designed to maximize the scientific return from archival data.
We applied this method to a JWST calibration field (PID 1160 Obs, 22) imaged with eight NIRCam filters. Focusing on four wide-band filters (F115W, F200W, F356W, and

F44W), we performed aperture photometry including PSF subtraction and manual verification, which yielded a catalog of 1781 previously unrecorded galaxies. Our core methodology calculates flux ratios to position sources on a color-color diagram, using our pipeline to isolate AGN candidates within a specific region. This application greatly expanded the scientific field: from only 10 previously known galaxies, we identified 202 promising AGN candidates. This widely applicable method demonstrates a promising approach for discovering AGN populations in other JWST fields, laying the groundwork for a deeper understanding of galaxy evolution.

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**Wee Keat Siaw**

Brigham Young University - Idaho

*Method Development and Validation for Microscopic Measurement of the Fluorescence Color of Sedimentary Organic Matter in Geologic Samples*

Co-Authors: Paul C; Hackley; United States Geological Survey

Poster Number: 189

The goal of this study was to develop and validate a standard operating procedure for measuring the fluorescence emission of sedimentary organic matter (SOM), a proxy used to assess thermal maturity conditions in petroliferous basins. We tested the performance of a spectrometer integrated with a Zeiss Axio lmager M2m microscope, and evaluated instrument calibration, dark-current correction, time duration for instrument stabilization, light delivery optimization, and the number of measurements necessary to optimize measurement precision. These tests were used to guide instrument operation, ensure measurement accuracy, and to characterize performance limitations of the system as SOM transitions to higher thermal maturity with accompanying signal deterioration. Adhering to thereby established guidelines enhances the reliability of fluorescence spectroscopy data for evaluating the thermal maturity of SOM. This work reaches toward the overall objective of standardizing spectral fluorescence measurements of SOM.

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**John Sibley**

Louisiana Tech University

*Photophysical Studies of Molecular Ce3+ Complexes for Next-Generation Scintillators*

Co-Authors: Elisabeth Fatila, Louisiana Tech University

Poster Number: 151

Scintillators are vital for radiation detection in fields such as high-energy physics, security screening, and medical imaging. Inorganic crystals offer high light output but are moisture-sensitive and often exhibit slower scintillation, while organic scintillators provide fast response but are brittle and difficult to machine. Polymer-based scintillators address these issues through durable, moldable hosts like polymethylmethacrylate or polyvinyltoluene but still lack the performance of inorganic systems.

This project aims to combine the advantages of both material types by incorporating molecular $Ce^{3+}$ complexes into polymer hosts to achieve fast luminescence and high light output. The photophysical properties of these complexes will be characterized using UV–vis absorption, steady-state fluorescence, and time-resolved luminescence spectroscopy to probe excited-state dynamics, emission lifetimes, and quantum yield. The resulting materials are expected to enhance energy resolution and detection speed for applications in particle physics and medical imaging.

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**Sirray Smith**

Morgan State University

*Constraining Geothermal Flux In Antarctica Using An Ice-and-Heat Flow Model*

Co-Authors: T; J; Fudge, University of Washington

Poster Number: 22

The geothermal flux, the flow of heat from the earth, is an important boundary condition for ice sheet models that predict future sea level because it plays a critical role in determining if the ice sheet is frozen to or sliding over the bed. The values for geothermal flux are uncertain in Antarctica due to limited measurements. Boreholes through the ice permit direct measurements of geothermal flux, but are sparse because of the effort required. Thermal modeling of the ice sheet is an indirect way to estimate the maximum geothermal flux where the bed is known to be frozen and the ice flow is straightforward. Raymond arches, a distinctive upwarping of internal layers beneath an ice divide, are an indication that the ice sheet is frozen to the bed. We use a 1-D ice-and-heat flow model to find the maximum geothermal flux before the ice would be melting at the bed. The model uses the ice rise characteristics, such as ice thickness, surface temperature, and accumulation rate to calculate the maximum geothermal flux constraint. We compare our constraints to Antarctic-wide estimates of Martos et al. (2017). Our results show that the geothermal flux at Berkner Island is below that estimated by Martos et al. (2017). In future work, we will identify site characteristics for more ice rises with Raymond Arches to find constraints on the maximum geothermal flux. Our results will be used to assess the accuracy of existing maps of geothermal flux (e.g. Martos et al., 2017).

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**Gabriel Sojka**

Western Illinois University

*Short Term Variability of a Methanol Maser in the Orion Nebula*

Co-Authors: Esteban Araya, Western Illinois University and New Mexico Tech

Poster Number: 183

The Orion Nebula is our nearest site of high-mass star formation, which makes it a unique region to study the type of environments where our own Solar System may have formed. This region is currently being observed as part of the VLA Orion-A Large Survey (VOLS) project (P.I.s G. Busquet and J. Girart) using the Very Large Array telescope in New Mexico. VOLS is conducting radio continuum and spectral line observations, including of the 6.67 GHz methanol (CH3OH) line. In this work we discuss preliminary results on short term variability (within a few weeks) of a CH3OH maser in Orion, as well as variability of a continuum source located near the maser. We discuss different scenarios that could explain the data, including the possibility that changes in the maser may be related to a magnetic reconnection event responsible for the continuum variability.

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**Casia Steinhaus**

University of North Dakota

*Comparing Similarities of Machine Learning Models*

Co-Authors: Malte Grunert, Institute of Physics, Technische Universität Ilmenau; Dr; Erich Runge, Institute of Physics, Technische Universität Ilmenau

Poster Number: 92

Predicting optical properties of materials is essential for technological applications. Machine learning optimizes algorithms on a set of data to predict the correct response, which can be used to predict properties of materials such as optical spectra, energy above hull, and direct bandgap. We aim to determine whether machine learning models reconstruct a similar internal structure during the training process, and whether such a similar internal structure is linked to the efficacy of transfer learning.

Similarities between models are analyzed using state-of-the-art methods allowing us to compare the activations of two models. High similarity between models trained on different properties allows us to conclude the models reconstruct a similar internal structure.

We find that retraining on a new property increases the model's similarity to the original target property and to the new property the model was retrained on. This suggests that models do reconstruct a similar internal structure.

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**Anish Suresh**

Rutgers University

*Analytical Investigation on Effects of Anisotropies in Loop Quantum Cosmology*

Co-Authors: Parampreet Singh, Louisiana State University

Poster Number: 165

Cosmological models of classical General Relativity predict that the universe began at the Big Bang singularity, a point in space-time where all geodesics end. General Relativity alone cannot accurately describe dynamics near such points, so the inclusion of Quantum Mechanics is necessary. Loop Quantum Cosmology (LQC), a theory of quantum gravity, successfully incorporates both to resolve the Big Bang singularity. This effect is analytically encoded in the Modified Friedmann Equation for an isotropic (symmetric) universe. However, anisotropies are possible in the early universe and affect dynamics significantly, so obtaining an equation that also captures anisotropic effects is important. In this project, we derive three relevant Modified Friedmann Equations for the vacuum,

anisotropic model called Bianchi-I LRS. Through the evolution of the physical parameters of the system, we analytically prove that the universe's behavior follows one of two paths depending on the initial conditions. One path directly corresponds to the classical solution, while the other requires coupling two separate solutions. Physically, we find that the need for multiple solutions comes from the strength of the anisotropies.

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**John Taylor**

Furman University

*pH Optimization of RE-doped Chelate and Nanoparticle Film Coatings*

Co-Authors: Phansit Nimsrinuan and Courtney J Kucera; Furman University Department of Physics

Poster Number: 169

Rare-earth-doped chelate and nanoparticle synthesis will be examined for the incorporation of the particles into a variety of matrix materials for identification purposes discussed later. The main focus of this work is to analyze the effect of varying pH in order to optimize the synthesis of chelates and nanoparticles. These chelates and nanoparticles will be examined using x-ray diffraction (XRD), ultraviolet-visible (UVVIS) spectroscopy and photoluminescence (PL) for structure analysis and rare earth incorporation into each system. Each system includes examination of the dried chelates or nanoparticles, along with the original supernatant from processing. Once optimization has been completed, these systems will be combined in a polymer matrix to be used for coating. These coatings will be used in real world applications such as rescue missions and evidence of tampering.

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**Truc Anh Tran Nguyen**

Davidson College

*DEVELOPING A FITTING TOOL FOR EXTRACTING CROSS-SECTIONS OF NEUTRON-INDUCED REACTIONS ON CARBON-12*

Co-Authors: Anthony Kuchera, Cyrus Boothby, Seoyoon Song, Andrew Wantz

Poster Number: 106

This work develops a fitting program that is used to extract neutron induced nuclear reaction cross sections from the Los Alamos Neutron Science Center. Measurements are used to benchmark and improve simulation of experiments that require neutron detection. Experimental Q-value spectra were measured from the incoming neutron energy and the energy detected of the outgoing particles in a diamond detector. The number of counts in each peak of the Q-value spectrum is determined to extract the count for calculating cross sections of reactions, which is done by fitting the data with a Gaussian and linear background model. The challenges encountered with the current program, HDTV, is its inability to extract covariance data and constrain various fit parameters. Obtaining a covariance matrix is critical for evaluating how errors interact and preventing cases of under- or overestimation of uncertainty in the final results, which would support the work with result validation in the long run. The issues are addressed through a code developed with the LMFit Python Library, which has the ability to extract covariance matrices and manual fit features that allows users to constrain parameters for better fit. With improvements, LMFit may eventually replace HDTV as the primary fitting program.

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**Ajla Trumic**

University of California, Berkeley

*Modeling Radiative Muon Capture using Bayesian Analysis Techniques*

Co-Authors: Ajla Trumic, Dr; Yury Kolomensky, Department of Physics, University of California, Berkeley

Poster Number: 104

One of the most prominent background sources in muon to positron conversion studied in the Mu2e experiment comes from radiative muon capture (RMC). Modeling this spectrum is a challenge since the unknown endpoint (kmax) and difficult to predict neutron knockout process for RMC imposes theoretical uncertainties. We seek to find a model that describes existing data that can be used to quantify this background for the Mu2e experiment. As of now, this research uses two models to describe RMC: the closure approximation and a nucleon knockout model. We use a Bayesian approach with Monte Carlo Markov Chain in Julia for parameter estimation for kmax and normalization constants in an attempt to reanalyze TRIUMF data from Armstrong et al. for Al27.

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**Libby Turner**

Florida State University

*Characterization of the Magnetic Anisotropy in a Mn3+ Spin-Crossover Complex*

Co-Authors: Brittany Grimm (Florida State University, National High Magnetic Field Laboratory), Irina Kühne (University College Dublin), Conor Kelly (University College Dublin), Mihail Atanasov (Max-Planck Institut für Kohlenforschung), Frank Neese (Max-Planck Institut für Kohlenforschung), Mykhaylo Ozerov (National High Magnetic Field Laboratory), Andrew Ozarowski (National High Magnetic Field Laboratory), Grace Morgan (University College Dublin), Stephen Hill (Florida State University, National High Magnetic Field Laboratory)

Poster Number: 241

Several molecular systems with 3d4 transition metal centers exhibit spin-crossover (SCO) behavior, wherein the system transitions between spin-triplet (S=1) and spin-quintet (S=2) states under external stimuli such as temperature. The complex [MnIII(3-OMe-5-NO2-Sal2323)]PF6 undergoes a sharp, first-order phase transition from a high-spin (HS, S=2) to a low-spin (LS, S=1) state at 51 K. This work characterizes the magnetic anisotropy of the LS state using Far Infrared Magnetospectroscopy (FIRMS) on a single crystal. Zero-field splitting (ZFS) parameters are directly extracted from the zero-field frequency-swept spectra. Numerical solutions of the effective spin Hamiltonian, using fixed axial (D) and rhombic (E) ZFS terms, allow Zeeman anisotropy, represented by the principal components of the g-tensor, and the molecular orientation to be determined through a least-squares fitting. We conclude that stabilization of the LS state is achieved from an unusual ligand-driven axial compression within the molecular structure which destabilizes the dx2−y2 orbital state.

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**Madalyn Twichell**

Grove City College

*Grove City College SPS Local Outreach*

Co-Authors: Grove City College

Poster Number: 16

On April 1, 2025, the Grove City College Sigma Pi Sigma (SPS) chapter hosted three local schools for Physics Day: an educative outreach event focused on interactively engaging the young minds of over 40 elementary-aged students with the wonders of physical phenomena. The station rotations included an egg drop challenge; smashing flowers dipped in liquid nitrogen; exhibiting vortices via a demonstration; simulating dragonfly flight with paper airplanes; analyzing the relationship between light and electromagnetic waves with UV beads; and highlighting notable past and present physicists. Elements of the 2024-2025 Science Outreach Catalyst Kit (SOCK), provided by the SPS National office, were utilized to integrate fun and learning in a meaningful way through the exploration of dragonfly mechanics. The students departed not only with physical mementos of their learning experience, but also with newfound appreciation for the discipline of physics.

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**Khanh Vu**

Mount Holyoke College

*Electromagnetic Shower Reconstruction for Dark Matter Searches at SBND*

Co-Authors: Supraja Balasubramanian, Mount Holyoke College, SBND, Fermilab

Poster Number: 323

The Short-Baseline Near Detector (SBND) is a Liquid Argon Time Projection Chamber (LArTPC) neutrino detector located on the Booster Neutrino Beam (BNB) at Fermilab. SBND is the near detector of Fermilab's Short-Baseline Neutrino program, and will precisely constrain the flux and neutrino-argon interaction systematic uncertainties for a world-leading search of eV-scale sterile neutrino oscillations. In addition, SBND's proximity to the beam target allows it to conduct a rich program of neutrino interaction measurements as well as novel searches for physics beyond the Standard Model of particle physics (BSM). There are several theories that suggest that dark matter candidates can be produced in the BNB. In this poster, I present a study of electromagnetic "shower"-like signatures of dark matter interactions in SBND.

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**Aarnav Vyas**

University of Illinois at Urbana-Champaign

*Detector Masses for Spin-Dependent Fifth Force Search*

Co-Authors: Josh Long

Poster Number: 345

We aim to detect a spin-dependent macroscopic force that would signify physics beyond electromagnetism. Such exotic interactions, predicted by Moody and Wilczek, could provide experimental evidence for the axion, a leading dark-matter candidate. Our experiment employs a torsion oscillator system in which a driven source mass modulates a nearby detector mass to search for spin-dependent interactions. The detector and source masses are thin silicon plates coated with ferrimagnetic dysprosium iron garnet (Dy3Fe5O12), chosen for its tunable magnetic compensation temperature that suppresses net magnetization while retaining orbital spin excess.

Finite-element simulations guided the design of anti-symmetric torsional test masses with minimized mechanical loss and resonance near 1 kHz, where vibration isolation is most effective. A co-precipitation synthesis method is used to fabricate rare-earth magnetic samples, later pressed into a custom mounting geometry that enhances the detector area by a factor of five over previous designs. This work advances the development of highly sensitive spin-polarized test masses, paving the way for next-generation searches for axion-mediated fifth forces.

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**Joshua Wager**

Old Dominion University

*Enhancing Ion-Trap Loading Efficiency  Through Laser Ablation*

Co-Authors: Dr; Matt Grau

Poster Number: 120

Ion traps are crucial tools in physics and chemistry that use electric fields to confine charged
particles. However, a key step in the operation of an ion trap is creating the ionized particle and then loading it into the trap. The goal of this research project is to develop a new ablation-based ion-loading source for our lab’s ion trap and categorize various compounds of barium to determine their effectiveness as ion-loading sources. Ablation is the process of removing material from a target when a high-energy laser pulse concentrates on a tiny point, creating a microscopic explosion that vaporizes matter into a

cloud of neutral and ionized atoms. A charged plate is then used to filter out ions, ensuring only neutral atoms reach the trap center. These atoms are then photoionized, allowing us to selectively ionize the particular isotope of barium that we wish to trap.

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**Naomi Wagner**

Oglethorpe University

*Spy Themed Science Outreach Catalyst Kit*

Poster Number: 12

The Next Generation Science Standards offer many ways to introduce science to K-5 students. A common way they introduce Science is through observation. Although idle observation is an effective tool to understand the world, observation through direct interaction, or physical demonstrations, provides a way for students to ask deeper questions about why things work the way they do. In fact, many students are first introduced to science through physical demonstrations. My project aims to provide physics-based demonstrations to help students and learners of all ages ask bigger critical questions about physics. When people begin to ask the right questions about physics, they learn to understand and trust it more. With the Society of Physics Students I designed the Science Outreach Catalyst Kit, which offers 5 spy-themed physics demonstrations with short, thought-provoking explanations. These demonstrations are geared towards learners of all ages and have tailored explanation sheets to cater to different age groups. These hands-on physics outreach demonstrations invite learners into the conversation about how the physical world works.

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**Kevin Wagoner**

Nebraska Wesleyan University

*Accurate Positioning of the Magnetopause*

Co-Authors: Richard Bonde, Texas Christian University

Poster Number: 311

The magnetopause is the boundary between Earth's magnetosphere and the solar wind. This barrier surrounds the Earth, and its location is highly relevant to certain atmospheric instruments, some of which can be damaged by interactions with the solar wind if they cross beyond the magnetopause. Using data from NASA's THEMIS mission and other satellites, we have assessed the accuracy of three predictive models of magnetopause location under enhanced solar wind conditions associated with solar storms. We find that during certain intense solar wind conditions, these models tend to overestimate the magnetopause distance by 0.5 – 3.3 Earth radii.

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**Kylea Watson**

University of North Florida


*From Sound to Sentiment: Wave Physics as a Tool for Understanding Athletes*


Co-Authors: Chris Kelso: University of North Florida, Professor


Poster Number: 64


Can measurable features of music provide a framework for representing emotional states in athletic environments? This project investigates this question by examining how sound frequencies can reflect athletes' emotions observed during football practices and games with Edward Waters University. Athletes' behaviors and emotional responses are observed and documented in real time. Based on these observations, music such as Agape by Nicholas Britell is selected to represent the emotions displayed. Using Logger Pro, waveform properties including frequency, amplitude, and temporal patterns are extracted and analyzed as a form of "sheet music" for the players' emotional states. To validate this representation, athletes provide handwritten reflections describing what the selected music conveys to them and whether it aligns with their emotional experiences. By using waveform analysis, observation, and athlete perspectives, this research investigates if wave physics can provide insight into the dynamics of complex human behavior, offering an interdisciplinary framework for connecting sound, emotion, and performance.


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**Madison Wilson**

Berea College

*Using MPPCs to Measure the Zenith Angle Dependence of Cosmic Ray Muons*

Poster Number: 147

A cosmic ray muon detector was designed and assembled using plastic scintillators coupled with Multi-Pixel Photon Counters. Our design incorporated custom-built electronics and shielding to optimize signal detection. This setup was used to investigate the angular distribution of atmospheric muons as a function of zenith angle. The measured distribution closely followed the theoretical cos^2(θ) dependence, confirming both the expected trend and the effectiveness of the detector.

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**Jason Withers**

Lamar University

*Dependence of the Refractive Index for Flint Glass to an Energy Background*

Co-Authors: Jason Withers, Christopher Lowe and Dr; Cristian Bahrim

Poster Number: 32

We study the dependence of the refractive index, n, for flint glass with the change of energy background. An increase in the energy background increases the vibrational frequency of the electric dipole constituents. For low energies the vibrations are quasi-linear and the interaction between light and matter is described by Lorentz's oscillatory model, where n depends on the Cauchy parameter, C. We assess the changes of index n for flint glass by measuring changes of C when the background energy set up across the glass is below the first excitation threshold of 131.33nm.

When we measure the change in n using the reflection of a 650 nm laser beam near the Brewster angle assisted by a low voltage between 0 and 2.4volts, we observe that the C value remains practically the same, of 11254. So, we decided that we need to add more voltage. However, for assisting energies larger than 2.4eV, the surface dipoles vibrate nonlinearly. Therefore, we changed our focus of study from the reflection of light at surface to the transmission of light throughout glass, using the vibrations of bulk dipoles. Using the minimum deviation method, we observe a measurable change in C close to 9.5volts, where C becomes 11280. This result proves that an additional energy background can induce a measurable change in the refractive index of glass. We acknowledge The Office of Undergraduate Research's URG program for funding this research project.

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**Noah Wyatt**

The University of Tennessee at Chattanooga

*Comparative Study of SeGA and DeGAi High-Purity Germanium Detector Arrays for Decay Spectroscopy at FRIB*

Co-Authors: Ruchi Mahajan, University of Kentucky

Poster Number: 125

The Gaseous Detector with Germanium Tagging (GADGET II) is an advanced detection system at the Facility for Rare Isotope Beams (FRIB), designed to study charged particles and coincident γ-rays from exotic nuclear decays. It consists of a Time Projection Chamber (TPC) for charged-particle tracking, surrounded by a High-Purity Germanium (HPGe) array for high-resolution γ-ray detection. GADGET II is being used to study the βpα decay of 20Mg to populate the 4.03 MeV resonance in 19Ne, which dominates the 15O(α,γ)19Ne reaction rate, an astrophysically important reaction for modeling Type I X-ray bursts emitted from accreting neutron stars. Two HPGe arrays have been employed in this setup: the Segmented Germanium Array (SeGA), which consists of sixteen coaxial detectors arranged in two rings, and the Decay Germanium Array Initiator (DeGAi), composed of twenty-four clover detectors equipped with bismuth germanate (BGO) Compton-suppression shields arranged in a 4π configuration. To evaluate and compare the performance of SeGA and DeGAi, detailed GEANT4 simulations were performed using the ATTPCROOT framework with standard γ-ray sources (137Cs, 22Na, and 60Co). The resulting photopeak efficiency curves highlight DeGAi's improved performance at higher energies, supporting its use in the upcoming 2025 experimental campaign at FRIB.

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**Hakan Bora Yavuzkara**

Davidson College

*Track Completion in TPCs using Transformers*

Co-Authors: Hakan Bora Yavuzkara 1, B; Wagner 1, M; P; Kuchera 1, R; Ramanujan 1, C; Hallinan 1, Yassid Ayyad 2, Daniel Bazin 2 (Davidson College 1, Michigan State University 2)

Poster Number: 84

The Active-Target Time Project Chamber (AT-TPC) is a charged particle detector used at various facilities around the world, including the Facility for Rare Isotope Beams (FRIB). A gas fills the volume of the detector and serves as both the detection medium and as the target for nuclear collisions. The AT-TPC produces “images” of nuclear reactions, recording the trajectories of particles within the chamber as a series of points. These point clouds often have “broken” regions in tracks due to experimental conditions such as missing sensor pads, or over-biased pad regions.

We train a point-cloud based transformer to reconstruct broken tracks from the 16O+α and 22Mg+α experiments conducted at FRIB in 2021 and 2020 respectively. To achieve this, we simulated 16O+α and 22Mg+α tracks that were then artificially broken by removing 25% of the original points either from the center of the event, from a randomly chosen region of the event, or from throughout the event. We compared the AdaPoinTr and SnowflakeNet point cloud transformer architectures, with our best results generating 94.7% of points within 1% of their original, known location for simulated 16O+α data, and 87.3% for simulated 22Mg+α data.

This work was partially supported by NSF grants PHY-2012865, OAC-2311263, and the Davidson Research In Science Experience (RISE)

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**Jahel Leonardo Yucra**

Weber State University

*Real-Time Control System for Hybrid Rocket Performance Analysis*

Co-Authors: Leonardo Yucra, Taylor Trujillo, Morgan Britton, Ben Albert, Steven DiPani, David Lunde; Affiliations: Miller Advanced Research and Solutions Center

Poster Number: 317

A closed-loop throttle controller for a laboratory-scale hybrid rocket is presented. Stability in oxidizer mass flow, and chamber pressure was achieved using a PID controller to command a servo actuator adapted for testing. A series of open-loop and closed-loop tests were performed to achieve repeatable steady-state conditions.

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**Barbara Zboichyk**

Appalachian State University

*Creating a Ruby Laser for Instruction and Demonstration*

Poster Number: 161

The intensity of an input power source is imperative to creating and sustaining a laser. To find out whether our proposed input source can create a needed intensity within our ruby laser cavity, we must find two properties of the pump laser: its beam propagation factor and the beam overlap between the input beam and the laser mode. In our experiment, an Ophir Spiricon beam profiler is used to measure the radius and intensity of our pump laser beam. From this data, the beam propagation factor and beam overlap of our pump laser are calculated and compared to theoretical values.

Acknowledgements: This work was supported by internal grants of Appalachian State University, the United States Department of Energy under Grant No. DE-SC0025444 and the National Science Foundation under Grant No. PHY-2510502.

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**Amilia price**

East Carolina University

*Investigation Proton Absorption using Simulations*

Poster Number: 213

This project aims to show how to modify Gafchromic film to get accurate dosimetry measurements with proton beams in the 2-4 MeV range. By simulating different thicknesses of a chosen material, a correlation between the energy of the proton beam and how much of said material is needed to stop it can be observed. Different materials are shown to have different resolutions, meaning that the number of energies that the material

can account for depends on the material that you choose, with thinner, less dense materials being preferred to thicker, denser materials.