Texas Sec American Physical Society / Texas Sec American Assoc of Physics Teachers / Society of Physics Students Zone 13 Joint Spring Meeting

University of Houston, Houston TX 77204
April 3-5 2025

Welcome

Welcome to the 2025 Spring Meeting of the Texas Section of the American Physical Society (TSAPS), the Texas Section of the American Association of Physics Teachers (TSAAPT), and the Society of Physics Students Zone 13! This event will occur at the University of Houston's (UH's) Main Campus, April 3-5.

Wi-fi: The wireless network 'UH-Guest' can be joined and does not require a password. eduroam is also available on the UH campus.

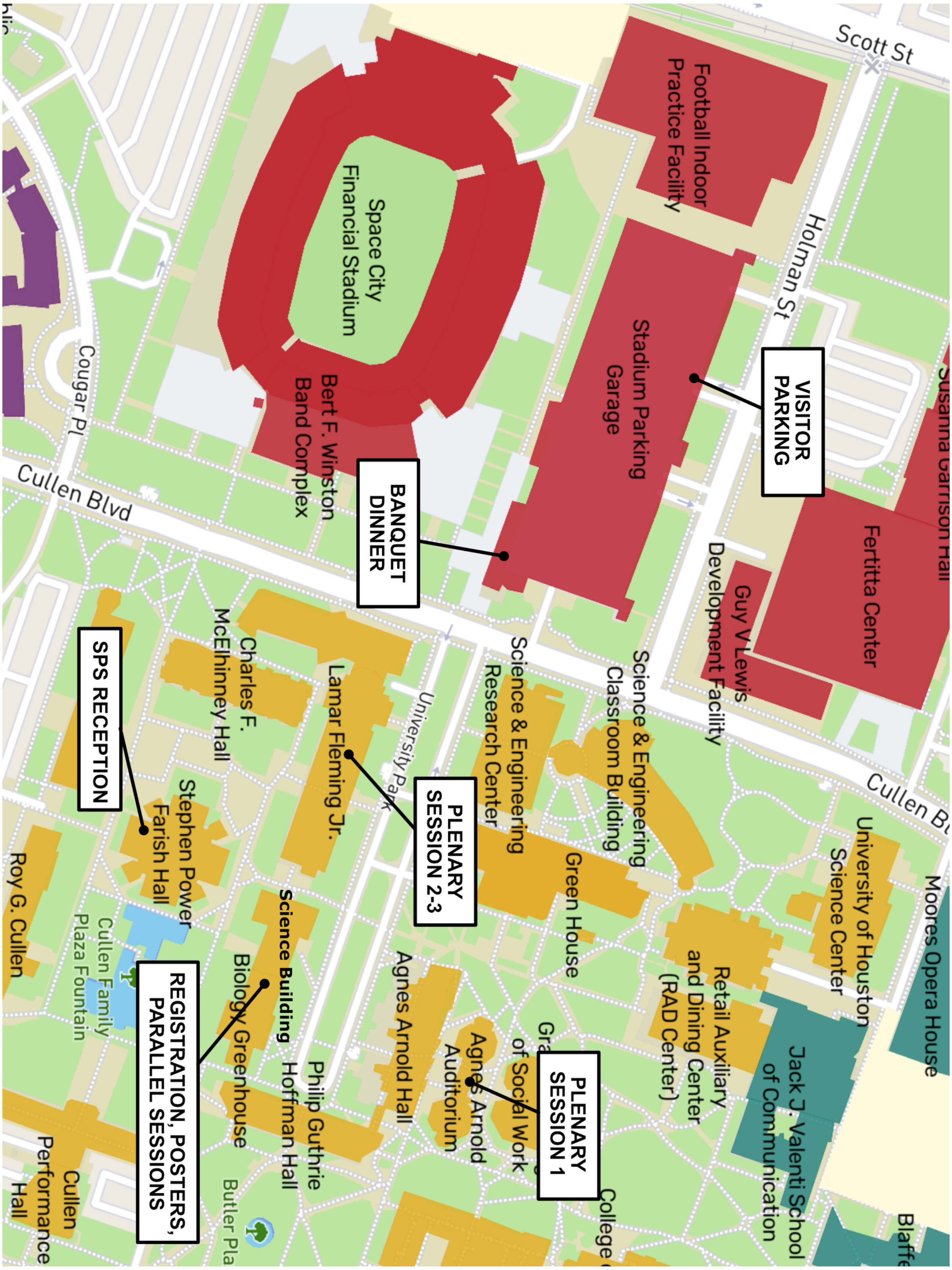
Parking: You should plan to park in the stadium garage visitor lot, near the intersection of Scott St and Holman St. If you prepaid for parking vouchers, you will recieve them at registration.

Structure of the conference: The meeting will involve three Plenary sessions, three Parallel sessions, two Poster sessions, and one Teaching Workshop session. Please see the detailed schedule for times and locations of these sessions!

- Plenary sessions: Plenary speakers will have 20 minutes to present their research to all conference attendees, with 5 additional minutes for questions.
- Parallel Sessions: Four sessions of talks will occur simultaneously (on different topics). Each presenter will have 10 minutes to speak, with an additional two minutes for questions.
- Poster Sessions: Attendees will have the opportunity to visit posters they are interested in and hear from the presenter. While there is no strict time limit, it is generally best for a poster presentation to take around 6-7 minutes.
- Teaching Workshops: Teachers can gain new skills and understanding about pedagogy in these sessions, which can run one or two hours.

Food and Refreshments Friday and Saturday: Coffee, tea, and water will be available throughout the day, with light refreshments in the morning and afternoon. Lunches will be provided for all attendees. A banquet dinner will be held Friday at 6:30pm (pre-paid attendees only).

Code of Conduct: Treat each other with respect, please see our code of conduct (on the website) for details of what constitutes harassment. If you feel that you are being harassed at any point during the meeting, you can contact the organizers (gcmorrison@uh.edu), and/or submit a Title IX complaint by filling out the form at https://www.uh.edu/eos-forms. All attendees are covered by the anti-harassment and anti-discrimination policies, you do not need to be a UH student to make a complaint to the organizers or to submit the Title IX form.

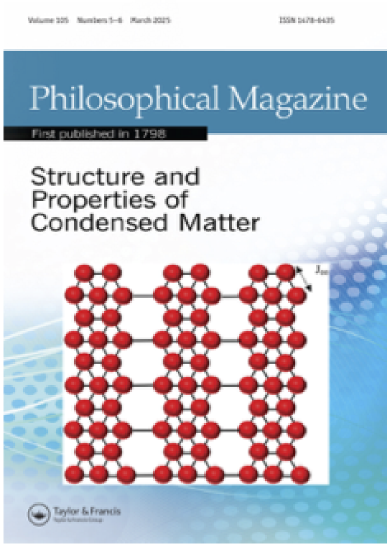


Scott St
Football Indoor Practice Facility
Holman St
Space City Financial Stadium
Stadium Parking Garage
VISITOR PARKING
Susanna Garrison Hall
Fertitta Center
Guy V Lewis Development Facility
Bert F. Winston Band Complex
BANQUET DINNER
Cougar Pl
Cullen Blvd
Science & Engineering Classroom Building
Science & Engineering Research Center
Charles F. McElhinney Hall
Lamar Fleming Jr.
University Park
PLENARY SESSION 2-3
SPS RECEPTION
Stephen Power Farish Hall
Green House
University of Houston Science Center
Moores Opera House
Retail Auxiliary and Dining Center (RAD Center)
Jack J. Valenti School of Communication
Science Building
Biology Greenhouse
Agnes Arnold Hall
Agnes Arnold Auditorium
PLENARY SESSION 1
Roy G. Cullen
Cullen Family Plaza Fountain
REGISTRATION, POSTERS, PARALLEL SESSIONS
Philip Guthrie Hoffman Hall
Cullen Performance Hall
Butler Pla

Sponsors of the meeting

We are happy to acknowledge our sponsors and exhibitors for their generous financial support

- University of Houston College of Natural Sciences and Mathematics
- University of Houston Dept of Physics
- Phil. Mag. C, Quantum Materials and Devices
- MD Anderson UT Health Medical Physics Graduate Program



Organization of the meeting

The overall timeline of the meeting is below. All poster sessions are on Friday. All teaching workshops are on Saturday. Plenary and parallel talks are on both Friday and Saturday.

Thursday April 3		
5-8pm	Science Bldg	Registration
5-8pm	Farish 101	Welcome and SPS reception
7-8pm	Science Bldg	TSAPS / TSAAPT Exec Board meetings

Friday April 4		
8-10:15	Science Bldg	Registration
8:45-9:00	Agnes Arnold Aud1	Welcome
9-10:15am	Agnes Arnold Aud1	Plenary 1
10:15-12	Science Bldg	Poster session 1
12-1:30	Science Bldg	Parallel sessions 1
1:30-2:00	Science Bldg	Lunch + Member Business Meeting
2:00-3:30	Science Bldg	Parallel sessions 2
3:30-5:00	Science Bldg	Poster session 2
5:00-6:15	Fleming 160	Plenary 2
6:30-8:30	WhatItDoBBQ	Banquet dinner

Saturday April 5		
9-10:30	Science Bldg	Parallel Sessions 3
8:30-10:30	Science/Fleming	Workshops
10:30-11:30	Fleming 160	Plenary 3
11:30-12:30	Fleming 160	Lunch and Student Awards

All poster sessions will be held in the hallways of the Science building, and posters do not have a specific location. Poster presenters, please put your poster on an available board and easel before the session begins.

The locations and subject matter of the parallel sessions are listed below

Parallel Session	Day/Time	Room
High Energy 1 (theory)	Friday 12-1:30	S116
High Energy 2	Friday 2-3:30	S116
High Energy 3	Saturday 9-10:30	S116
Condensed Matter 1	Friday 12-1:30	S114
Condensed Matter 2	Friday 2-3:30	S114
Condensed matter 3	Saturday 9-10:30	S114
Physics Education 1	Friday 12-1:30	S202
Physics Education 2	Friday 2-3:30	S202
Quantum Theory	Friday 12-1:30	S102
SPS / Undergraduate	Friday 2-3:30	S102
Astronomy / Astropysics	Saturday 9-10:30	S102
Biophysics / Medical Phys	Saturday 9-10:30	S115

The locations and topics of the teaching workshops are listed below

Teaching Workshops	Day/Time	Room
Diversity, Equity, and Inclusion in Physics: Hard Conversations in an Anti-DEI Climate	Saturday 8:30-9:30	S119
Exoplanets and Citizen Science Astronomy in the Classroom	Saturday 8:30-9:30	F232
Training Young Scientists and Engineers: Integrating Technology and Computational Thinking into Science Courses	Saturday 9:30-10:30	F231
Exploring Gravitational Waves with VIGOR (Virtual Interaction with Gravitational waves to Observe Relativity)	Saturday 9:30-10:30	F232

Business meetings for TSAPS / TSAAPT are listed below. All TSAPS/TSAAPT members are encouraged to attend the business meeting!

Other Events	Day/Time	Room
TSAPS Board Meeting	Thursday 7-8pm	S119
TSAAPT Board Meeting	Thursday 7-8pm	S115
Joint TSAPS / TSAAPT Member Business meeting	Friday 1:30-2:00	S116

Plenary 1: April 4 9-10:15 in Ag Arnold Aud 1

9:00-9:25
Paige Evans, Clinical Full Professor University of Houston Dept of Mathematics, and Co-Director of the *teach*HOUSTON program.

Strengthening Physics Education: Preparing, Supporting, and Retaining Outstanding Teachers

9:25-9:50
Evelyn Tang, Assistant Professor Rice University Dept of Physics, and Senior Investigator at the Center for Theoretical Biological Physics

Robust Emergent Function in Living Systems

9:50-10:15
Tatiana Erukhimova, Instructional Professor and Marsha L. '69 and Ralph F. Schilling '68 Chair for Physics Outreach, Texas A&M University

Making Physics Viral

Plenary 2: April 4 5-6:15, Fleming 160

5:00-5:25
Zhifeng Ren, Paul C. W. Chu and May P. Chern Endowed Chair in Condensed Matter Physics at the University of Houston, and Director of the Texas Center for Superconductivity

Hydrogen Production Storage and Transport

5:25-5:50
Thomas Halsey, Professor in the Practice, Chemical and Biomolecular Engineering at Rice University, former Chief Computational Scientist at ExxonMobil in Spring TX

How to find, and succeed in, an industrial job

5:50-6:15
Louis E Strigari, Professor and Mitchell/Heep/Munnerlyn Endowed Chair in Observational Astronomy at Texas A&M University

Galactic searches for dark matter

Banquet Speaker: April 4 6:30-8:30pm, WhatItDoBBQ

Talk beginning around 6:45pm
Daniel Newmeyer, Vice President of Education, Space Center Houston Manned Space Flight Education Foundation

Curiosity Launched: Inspiring Students through Physics and Space Exploration

Plenary 3: April 5, 10:30-11:20, Fleming 160

10:30-10:55
Kaden Hazzard: Associate Professor of Physics and Astronomy at Rice University

A strange exchange: paraparticles and where to find them

10:55-11:20
Rene Bellwied: M.D. Anderson Chair Professor University of Houston Dept of Physics.

The Creation of Matter: After 25 years at RHIC and LHC, what have we learned?

Contents

Poster Session 1: April 4 10:30-12:00

Three-Dimensional Granular Dynamics: An Investigation of Methodology

April 4 10:30-12:00 Science Bldg.

Andrew Long (presenter)

Angelo State University Department of Physics and Geosciences

CoAuthors: Michael C. Holcomb (Angelo State University)

This research explores the viability of using birefringent spheres to model granular systems and force chains, as a means of verifying the force chain model in a three-dimensional system. Fabrication of the birefringent spheres is based on the work of Li, W et al. (2021) and the method they proposed therein. We use acrylic plexiglass sheets to make troughs of varying widths to test different system depths. This materials lack of notable stresses allows us to evaluate whether we can capture coherent records of the cross polarized spheres that would be suitable for further analysis.

Funding acknowledgment: Angelo State University Faculty Mentor Research Grant

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Broadband Light Detection with 2D Bi_2O_2Se Nanosheets-Quantum Dots Hybrid

April 4 10:30-12:00 Science Bldg.

David Black (presenter)

Department of Physical and Applied Sciences, University of Houston-clear Lake, Houston, TX, 77058, USA

CoAuthors: David Black,1 Jittin Thomas,1 Whitney Jones,1 Mackenzie Songsart-Power,1 Amit Shringi,2 Fei Yan,2 Tej B. Limbu11Department of Physical and Applied Sciences, University of Houston-clear Lake, Houston, TX, 77058, USA2Department of Chemistry and Biochemistry, North Carolina Central University, NC, 27707, USA

Zipper two-dimensional (2D) materials, such as Bi_2O_2Se, have emerged as promising alternatives to van der Waals 2D materials for high-performance optoelectronic applications. However, the relatively narrow bandgap (1.5 eV) of Bi_2O_2Se restricts its photodetection capability to the near-infrared (IR) region. In this study, we present the synthesis of 2D Bi_2O_2Se quantum dots (QDs) and their application in broadband light detection. The QDs were produced by ultrasonication of 2D Bi_2O_2Se nanosheets in N-methyl-2-pyrrolidone using a tip sonicator, followed by centrifugation. The ultrasonication process is expected to fragment the Bi_2O_2Se nanosheets into QDs. The synthesized material was characterized using scanning electron microscopy, energy dispersive spectroscopy, atomic force microscopy, and UV-visible spectroscopy. Additionally, the photodetection properties of the fabricated devices will be discussed.

Chemical Vapor Deposition of Randomly Oriented 2D MoS2 Sheets

April 4
10:30-
12:00
Science
Bldg.

Miguel Montes (presenter)

University of Houston - Clear Lake, Physics Department

CoAuthors: Miguel A. Montes,1 Jittin M. Thomas,1 Mackenzie Songsart-Power,1 Chetan Dhital,2 Tej B. Limbu (Professor)

Two-dimensional (2D) transition metal dichalcogenides (TMDs), particularly molybdenum disulfide (MoS_2), have attracted significant attention for their unique electronic and optoelectronic properties. Chemical vapor deposition (CVD) is a promising technique for synthesizing high-quality and large area 2D MoS_2 films with controlled morphology and layer thickness. In this study, we report the CVD growth of MoS_2 films on SiO_2/Si substrates, where the resulting film consists of randomly oriented MoS_2 sheets. The synthesis was carried out using MoO_3 and sulfur precursors with argon gas a carrier gas under optimized growth conditions to achieve uniform coverage and high crystallinity. Structural and morphological characterization of the synthesized material were performed using Raman spectroscopy, atomic force microscopy (AFM), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS). The findings provide insight into the growth dynamics of CVD-synthesized MoS_2 and its potential for scalable integration into electronic and photonic devices. The electrical and optoelectronic properties of the as-grown films will also be discussed.

Neutrino-Nucleon Scattering

April 4
10:30-
12:00
Science
Bldg.

Karim Hassinin (presenter)

University Of Houston Department Of Physics

CoAuthors: Daniel Cherdack

Neutrino-nucleon scattering is a fundamental weak interaction process. Knowledge of the the cross sections in the few hundred MeV to several GeV range is essential for long-baseline neutrino oscillation experiments, where uncertainties on interaction processes propagate to measurements of neutrino oscillation parameters. Neutrino-nucleon interactions are grounded in electroweak theory and shaped by quark interactions and nucleon structure. Experiments utilize bound nucleon targets within active detector volumes, requiring careful modeling of binding energies, multi-nucleon correlations, and final-state interactions. In this poster I will present an overview neutrino nucleon interaction models, and their predictions of final state kinematics.

Funding acknowledgment: DOE Grant DE-SC0021407

Design of the Guided Parachute Recovery System for Small High Altitude Balloon Payloads

April 4
10:30-
12:00
Science
Bldg.

Megan Cowan (presenter)

University of Houston, College of Natural Science and Mathematics, Department of Computer Science

CoAuthors: C'lette Coronado (University of Houston, College of Engineering, Department of Mechanical Engineering)Christal Biney(University of Houston, College of Engineering, Department of Mechanical Engineering)Travis Provence(University of Houston, College of Natural Science and Mathematics, Department of Computer Science)Igor Lucic(University of Houston, College of Business, Department of Marketing Entrepreneurship)

When conducting experiments with high-altitude balloons, one of the biggest challenges is the recovery of the scientific payload. Despite having reliable tracking methods during flight and knowing the landing location of the balloon payloads, these payloads have a high probability of landing in inaccessible locations that inhibit timely recovery. Therefore, the goal of the Guided Parachute Recovery system is to be a reliable method for guiding a descending, high-altitude payload to at least one preselected location for recovery. The overall system will consist of four subsystems; parachute and deployment (PDS), flight control actuators (FCA), flight sensor processing (FSP), and flight guidance (FGS) that will perform a recovery operation.

A Comparison of Neutrino Monte Carlo Generator Models

April 4
10:30-
12:00
Science
Bldg.

Kristen Dobbs (presenter)

University of Houston

CoAuthors: Lars Walker, Travis Olson, Lisa Koerner, Daniel Cherdack

Neutrinos are elementary particles with no charge and a very small mass that interact rarely with matter. Experiments designed specifically for neutrino detection study the fundamental properties of these particles. Physicists apply detector reconstruction methods to monte carlo (MC) generated events to determine what percent of true neutrino events would be correctly identified in a detector.NOvA and T2K are two neutrino experiments that each use different technology to detect and reconstruct neutrino events. The NOvA experiment uses PVC cells filled with liquid scintillator that detect the moving charged particles produced by interacting neutrinos, and is designed to find neutrinos peaked in the 2.0 GeV range. T2K uses densely instrumented water cherenkov detectors to find neutrinos peaked in the 0.6 GeV range. Each experiment also uses different methods of monte carlo generation to determine detector efficiency. The purpose of this study is to compare the different MC generation methods, to gain a sense of similarities, differences, strengths and weaknesses that can then be leveraged to enhance NOvA-T2K joint analyses.

Funding acknowledgment: DOE Grant DE-SC0021407

Dual-Phase TPC Extraction Grid Development and Production in Darkside-20k Prototypes

April 4
10:30-
12:00
Science
Bldg.

Daniel Huff (presenter)

University of Houston

CoAuthors: The DarkSide-20k Collaboration

A number of physics collaborations around the world today employ time projectionchambers (TPCs) in highly sensitive detectors to search for evidence of rare particles. The dual-phase TPC detector concept relies on two unique (but related) event signals, S1 and S2, to increase a detectors effectiveness against backgrounds. The Darkside-20k (DS-20k) experiment applies this idea to dark matter detection. In its detectors, DS-20k utilizes an S1 signal from recoil-induced photon emissions in liquid Argon, and an S2 signal from induced collisions between ionization electrons and the second phase gas pocket of the TPC. A uniform electric drift field is applied to the lower liquid volume to direct ejected electrons towards an extraction grid; there a second, stronger field accelerates them into the gas region. The extraction grids for the DS-20k prototypes Proto-0 and Mockup were carefully designed and constructed to ensure field uniformity and resistance to destructive forces from their

detectors. A wound-pin technique was used to produce replaceable grid wire units from stainless steel which can maintain this function.

Funding acknowledgment: The National Science Foundation

Characterization of the Surface Properties of a-GaOOH Microparticles as a Means to Investigate Antibacterial Mechanisms

April 4
10:30-
12:00
Science
Bldg.

Devansh Matham (presenter)

Texas Christian University - Department of Physics and Astronomy

CoAuthors: D.K. Matham - Texas Christian UniversityT.Y. McHenry - Texas Christian UniversityM.M. Smit - Texas Christian UniversityP. Ahluwalia - Wayne State UniversityZ. Rabine - Harmony School of InnovationD.A. Johnson - Texas Christian UniversityJ.H. Brannon - Texas Christian UniversityY.M. Strzhemechny - Texas Christian University

β-Ga2O3 is of great interest for researchers due to a multitude of potential applications in photovoltaic devices, high frequency electronics, biological therapeutics, and more. In our research group, β-Ga2O3 microcrystals are synthesized through a simple bottom-up hydrothermal method. First, we produce an α-GaOOH precursor that undergoes subsequent calcination to yield the desired product. While the antibacterial properties of β-Ga2O3 have been brought to light recently, none were addressed for α-GaOOH, providing us a motive to investigate further. During the synthesis of α-GaOOH microparticles using our hydrothermal growth method, the pH conditions are varied to produce crystals with different morphologies. Various characterization techniques are then used to verify the quality, and investigate the crystallinity and any defective properties of the material. Antibacterial assays are used with S.aureus and E.coli bacteria to determine the materials cytotoxicity. Through this experimentation method, we have concluded that higher pH growth conditions yield elongated formed crystals, and subsequently provide better effectiveness against gram-negative bacteria.

Neutrino-Water Cross Section Analysis at T2K

April 4
10:30-
12:00
Science
Bldg.

Donnie Munford (presenter)

University of Houston Department of Physics

CoAuthors: Dr. Daniel Cherdack

Neutrinos are a light, neutral fundamental particle that exhibit a strange behavior; they oscillate between different flavor (interaction) states as they travel through space, producing different particles when they interact. To study these oscillations, experiments such as T2K were built to observe the interactions and attempt to understand the process of oscillations. This is done through a system of dual detectors, a near detector that is used to observe neutrino interactions from un-oscillated neutrinos, and a far detector that observes neutrinos after some have oscillated into other flavor states. Due to the nature of the neutrinos neutral charge, they can only be observed through the daughter particles produced after an interaction occurs. My research focuses on determining the cross section (a measure of interaction probabilities) of neutrino interactions on water that produce a single muon and a single pion as daughter particles. The extraction process for this specific cross-section measurement is presented.

Funding acknowledgment: DOE Grant DE-SC0021407

The Tilting Motion of the Central Core Reveals the Transport Mechanism of the Sarco/Endoplasmic Reticulum Ca^{2+}-ATPase.

April 4
10:30-
12:00
Science
Bldg.

Rulong Ma (presenter)

University of Houston, deparment of Physics

CoAuthors: Rulong Ma, James M Briggs

The sarco/endoplasmic reticulum Ca2+-ATPase (SERCA) transports two Ca2+ ions per ATP hydrolyzed from the cytoplasm to the lumen. However, how the ATP hydrolysis remotely drives the Ca2+ transport is unclear. In the SERCA1a crystal structures, the ATP hydrolysis is accompanied by the notably increasing tilting angle of the central core (CC) and the Ca2+ transport, and the CC tilting angle dramatically decreases in the E2 to E1 transition. We demonstrated that the significantly increasing tilting motion of the CC drove the Ca2+ release in the molecular dynamics simulation of the R836A variant, and the dramatic spontaneous decrease in the CC tilting angle of the E2 state drives the transition from E2 to E1 states. The repulsion between the phosphorylated D351 and the phosphate groups in ADP triggers the release of ADP from the SERCA1a headpiece. We proposed a novel SERCA transport mechanism in which ATP hydrolysis drives a significant tilting motion of the CC, which drives Ca2+ transport and the A domain rotational motion

in the E1P-ADP-2Ca2+ to E2P transition. The dramatic spontaneous decrease in the CC tilting angle of the E2 state drives the restart of the transport cycle.

Funding acknowledgment: No Funding support

Novel Techniques for Visualizing Infrared Light

April 4 10:30-12:00 Science Bldg.

Jack Lee (presenter)

Rice University

CoAuthors: Christopher Marble, Vladislav Yakovlev

Our work combines a smartphone augmented reality system with an inexpensive web camera to project the invisible infrared laser as a false color image. A laser operator can visualize the laser and environment simultaneously using a VR-headset which covers the eyes preventing exposure to the laser while in use. Remote viewing using a camera on the headset allows an operator to visualize the laser from the operators point of view unlike other camera alignment systems. This technology represents the first-ever documented demonstration of augmented-reality aided 360 degree remote viewing applied to laser physics and engineering. This technique represent new resource-inexpensive, scalable methods to more efficiently realign complex optical systems.

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Applications of Mathematical Models of Virus to Mpox

April 4 10:30-12:00 Science Bldg.

Gabriel McCarthy (presenter)

Texas Christian University Department of Physics and Astronomy

CoAuthors: Hana Dobrovolny

Mpox virus is a type of virus similar to smallpox that can cause diseases in humans. Several experiments have been done to collect data on how mpox evolves within an infected host. This data can be analyzed within the context of mathematical models to determine important characteristics of mpox. From this analysis, we can estimate the growth rate, reproduction number, and infecting time of mpox. We can also construct confidence intervals to estimate the error in our predictions using bootstrapping. Bootstrapping allows us to analyze parameter correlations within mpox data to understand how parameter values within the model affect each other in our model. From these values and confidence intervals, we can learn about how mpox evolves within the body over time. This information, in turn, may allow us to make predictions on how mpox evolves within people during infection that could inform future treatment regimens.

Funding acknowledgment: I received support from TCU's Research and Creative Activities Fund

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Nanocomposite Materials for Improved Radiation Shielding in Spacecrafts

April 4 10:30-12:00 Science Bldg.

Arielle Slaten (presenter)

University of Houston-Clear Lake Department of Physical and Applied Sciences

CoAuthors: Arielle Slaten (University of Houston-Clear Lake), Dr. Serkan Caliskan (University of Houston-Clear Lake), Dr. Hakduran Koc (University of Houston-Clear Lake)

Employing both molecular dynamics (MD) and density functional theory (DFT) simulations, we explore the enhancement of nanocomposites for radiation shielding in spacecraft applications. Our study focuses on integration of aluminum metal matrices (Al MM) with carbon nanotubes (CNTs) and silicon carbide (SiC) to optimize mechanical, electronic, and thermal properties under space conditions. We systematically analyze how these nanofillers interact with the metal matrix to improve performance. Our findings reveal that SiC significantly enhances thermal stability and hardness, while CNTs improve mechanical strength and resistance to high-temperature deformation. The combined incorporation of SiC and CNTs into the Al MM is promising for developing advanced nanocomposites with optimal radiation shielding and durability for aerospace environments.

Funding acknowledgment: This research is supported by the University of Houston-Clear Lake and NASA

DarkSide-20k: Advancing Direct Detection Techniques in the Search for Dark Matter

April 4
10:30-
12:00
Science
Bldg.

Sanjay Sharma Poudel (presenter)

University of Houston, Department of Physics

CoAuthors: DarkSide Collaboration

DarkSide-20k is a next-generation dark matter detector based on a dual-phase liquid argon time projection chamber (LAr TPC), designed to explore weakly interacting massive particles (WIMPs) with unprecedented sensitivity. It is a crucial part of the Global Argon Dark Matter Collaboration's (GADMC) plan to probe the dark matter parameter space down to and into the neutrino fog. The detector, hosted at the Gran Sasso National Laboratory (LNGS), utilizes low-radioactivity underground argon (UAr) to suppress intrinsic backgrounds and employs an innovative methods of background rejection. The experiment is optimized for ultra-low background conditions, leveraging advanced techniques to mitigate radiogenic and cosmogenic backgrounds while maintaining high detection efficiency. DarkSide-20k aims to push the limits of direct dark matter detection and pave the way for future multi-ton-scale experiments. We will discuss the design, background mitigation techniques and current status of Darkside-20k.

Funding acknowledgment: Support from the National Science Foundation

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Prospects for possibly measuring time variation signals from neutrino and other sources at dark matter detectors

April 4
10:30-
12:00
Science
Bldg.

Yi Zhuang (presenter)

Texas AM University Department of Physics and Astronomy, Mitchell Institute for Fundamental Physics and Astronomy

CoAuthors: Louis E. Strigari (Department of Physics and Astronomy, Mitchell Institute for Fundamental Physics and Astronomy, Texas AM University), Lei Jin (Department of Mathematics and Statistics, Texas AM University-Corpus Christi), Samiran Sinha (Department of Statistics, Texas AM University)

We study the prospects for measuring the time variation of solar and atmospheric neutrino fluxes at future large-scale Xenon and Argon dark matter detectors. Our rigorous calculations focus primarily on periodicities of one year, one day, and eleven years. Identifying the time variation of the neutrino fluxes will be important for

distinguishing neutrinos from dark matter signals and other detector-related backgrounds, and extracting properties of neutrinos that can be uniquely studied in dark matter experiments. We also discuss the potential to extract WIMP information from time-series data in dark matter experiments through signal superposition. When multiple sources are involved, additional statistical methods may be needed to search for possible periodic signals in experimental data, especially when scanning a wide range of frequencies.

NUMI Flux Systematic Uncertainties

April 4
10:30-
12:00
Science
Bldg.

Fatima Abd Alrahman (presenter)

University of Houston

CoAuthors: Anthony Wood , Daniel Cherdack , Karim Hassinin

The Imaging Cosmic And Rare Underground Signals (ICARUS) detector is a 476 t active liquid argon time projection chamber neutrino detector at Fermilab. ICARUS lies 795 m downstream and 5.75° off-axis from the Neutrinos at the Main Injector (NuMI) beam. To create a neutrino beam NuMI directs a pulsed beam of 120 GeV protons onto a graphite target to create hadrons, which are then focused by magnetic horns and allowed to decay into neutrinos. At the ICARUS off-axis angle the neutrino flux originates from the decays of unfocused/antifocused pions decays and from high-transverse momentum kaon decays. These contributions allow ICARUS to observe a significant flux of (anti-)electron and (anti-)muon neutrinos in a kinematic region relevant to the upcoming DUNE experiment. These factors also introduce various model uncertainties that have not been studied in detail by existing on-axis experiments. This poster will explore the systematic uncertainties in the NuMI flux at ICARUS that arise from uncertainties on hadron interaction cross sections and beamline operation conditions.

Funding acknowledgment: DOE Grant DE-SC0021407

Parallel Sessions 1 April 4 12:00-1:30

High Energy 1 (theory), S116

1: Determining the Neutron Skin of Pb-208 at ALICE

April 4
12:00 -
12:12
S116

Sabrina Hernandez (presenter)

University of Houston, Department of Physics

The study of heavy-ion collisions reveals the properties of nuclear matter under extreme conditions and the quark gluon plasma (QGP). The ALICE experiment conducted at the Large Hadron Collider (LHC) allows for the study of these interactions through lead-lead (Pb-Pb) collisions on the scale of femtometers, at extremely high collision energies of 5.36 TeV. This presentation focuses on the neutron skin effect, a phenomenon in which there exists an excess of neutrons, extending beyond the proton distribution in the nuclei, forming a neutron ,*Shell*. By analyzing ultra-central collisions of Pb nuclei and utilizing the zero degree calorimeter (ZDC), we extract the proton and neutron yields to study the nuclear geometry. Experimental results can be compared to the theoretical framework Trajectum, a hydrodynamic model that simulates QGP evolution. These studies allow us to understand the structure of neutron-rich nuclei and matter, such as in neutron stars.

2: Probing QGP via net charge fluctuations in heavy-ion collisions

April 4
12:12 -
12:24
S116

Roman Poberezhniuk (presenter)

University of Houston, Physics Department

CoAuthors: Roman Poberezhniuk (Physics Department, University of Houston), Jonathan Parra (Physics Department, University of Houston), Claudia Ratti (Physics Department, University of Houston), Volodymyr Vovchenko (Physics Department, University of Houston), Volker Koch (Nuclear Science Division, Lawrence Berkeley National Laboratory)

The D-measure of the event-by-event net charge fluctuations was introduced over 20 years ago as a potential signal of quark-gluon plasma (QGP) in heavy-ion collisions, based on the fractional charges of quarks leading to suppression of fluctuations relative to hadron gas baseline. Measurements have been performed at RHIC and LHC, but in the absence of quantitative calculations for both scenarios, the conclusion has been elusive. Here, we employ a recently developed formalism of density correlations to incorporate the effects of resonance decays, local charge conservation, and experimental kinematical cuts to perform quantitative calculations of charge fluctuations in central Pb-Pb collisions at LHC energies. We find that the hadron gas scenario is in fair agreement with the experimental data of the ALICE Collaboration only when a very short rapidity range of local charge conservation is enforced. On the other hand, the QGP scenario predictions show small sensitivity to the range of local charge conservation and yield excellent agreement with experimental data. We present predictions for LHC Run 2 as a precision test of the two scenarios.

3: Probing nucleis neutron skins with the longitudinal dynamics of conserved charges in relativistic heavy-ion collisions.

April 4
12:24 -
12:36
S116

Gregoire Pihan (presenter)

University of Houston

CoAuthors: Akihiko Monnai (Osaka Institute of Technology), Bjoern Schenke (Brookhaven National Laboratory), Chun Shen (Wayne State University)

The rapidity distributions of conserved charges, namely net baryons, electric charges, and strangeness, in relativistic heavy-ion collisions carry valuable information about initial-state stopping, the identities of charge carriers such as string junctions, and the nuclear structure of colliding nuclei. We develop a (3+1)D hydrodynamics + hadronic transport framework to simulate the event-by-event dynamics of conserved charges (B, Q, S). Applying this framework to the RHIC isobar collisions, we find that the net electric charge to baryon ratio difference between the two systems is a sensitive probe for the neutron skin difference between the isobar species [1]. We expand our phenomenological studies and propose to explore constraints on the neutron skin of ^{208}Pb via proton-lead (p+Pb) collisions at LHC energies. Our approach predicts a 20% difference in net electric charges to baryon ratio between peripheral and central p+Pb collisions. Because this observable is sensitive to electric and baryon charges of the Pb nucleus, it offers a direct probe of the lead's neutron skin. Future measurements in both collider and fixed-target modes in the SMOG2 at LHCb can provide complementary constraints on nuclei's neutron skins from high-energy experiments.

4: Measuring the speed of sound from transverse momentum in heavy-ion collisions at the Relativistic Heavy-Ion Collider

April 4
12:36 -
12:48
S116

Caleb Broodo (presenter)

University of Houston, Dept. of Physics

The speed of sound in a medium represents the stiffness of it's equation of state. If measurable, this quantity offers a window into interesting phenomena involved in heavy-ion physics, such as phase transitions, thermalization, and the bulk behavior of hadronic gas or quark gluon plasma. In this study, we use similar techniques performed at CERN to extract the speed of sound at various collision energies in the STAR detector at Brookhaven National Laboratory's Relativistic Heavy-Ion Collider located in Long Island, NY.

Funding acknowledgment: U.S. Department of Energy Office of Science

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5: Measurment of $\Xi(1820)$ in ALICE p-p at $\sqrt(s) = 13$ TeV

April 4
12:48 -
13:00
S116

Adel Bensaoula (presenter)

University of Houston

CoAuthors: Rene Bellwied (University of Houston)

We present an experimental study of the doubly strange baryon resonance $\Xi{*}{*}(1820)$ (dss) in the $\Xi^- \rightarrow K^-\Lambda$ decay channel in the ALICE experiment from the RUN2 data taking period produced in p-p collisions at $\sqrt(s) = 13TeV$ at the LHC. We describe the measurement technique for event classes corresponding to different charged-particle multiplicity densities, $< dNch/d\eta_{lab} >$ and report measurements with systematic and statistical errors of the mass, width and yield, along with first measurement of its transverse-momentum spectra and yields. Our measurement of the mass and width are within the reported values by the Particle Data Group. These results will bring much needed understanding of the internal structure and mass spectrum of excited baryon resonances and would serve as a baseline for future studies of signatures of in-medium modifications to these observables in extreme conditions.

6: Study of Central Exclusive Production in Proton-Proton Collisions at $\sqrt{s} = 510$ GeV with the STAR Experiment

April 4
13:00 -
13:12
S116

Aranya Giri (presenter)

University of Houston, Department of Physics

Central Exclusive Production (CEP) in proton-proton collisions provides a controlled environment for studying hadron spectroscopy, where two protons remain intact after interacting via an exchanged gluonic system, producing an exclusive final state. This study utilizes data from Run 17 of the STAR experiment at RHIC, focusing on CEP at $\sqrt{s} = 510$ GeV. Scattered protons are detected with Roman Pots along the beamline, while rapidity gaps-crucial for exclusive productionare ensured using vetos in the Zero Degree Calorimeter (ZDC) and Beam-Beam Counters (BBCs). The analysis examines 2-, 4-, and 6-prong decay channels involving pions, kaons, and protons, reconstructed with the Time Projection Chamber (TPC) and Time of Flight (TOF) detectors in the central region. The published results for the 2-prong decay channel have been successfully reproduced, while the 4- and 6-prong channels pose additional challenges due to overlapping resonances and background contributions. Ongoing studies involve detailed modeling to disentangle these effects and refine the interpretation of the multi-particle final states.

Funding acknowledgment: Department of Energy

Condensed Matter 1, S114

1: Advancing Breast Cancer Diagnosis: Nanomaterials-based Gas Sensors for Non-Invasive Detection

April 4
12:00 -
12:12
S114

DAVID WALIGO (presenter)

University of Houston, Department of Physics

CoAuthors: Maggie Paulose, Oomman K. Varghese

Gas sensors have become essential tools for environmental monitoring, industrial safety, and medical diagnosis. Among these devices, metal oxide semiconductor sensors are particularly promising for various applications due to their ability to detect trace levels of gases by reversibly changing the electrical conductivity. They are known for their affordability, compatibility with microelectronics, ease of fabrication and scalability. Recent studies are focused on leveraging the potential of these sensors to detect volatile organic compounds (VOCs) linked to diseases, especially cancer. However, challenges such as sensitivity and selectivity have hindered their clinical reliability. In this presentation, we discuss a novel nanomaterial-based sensor array designed to improve the detection accuracy of breast cancer related biomarkers, offering a non-invasive and cost-effective alternative for early stage cancer detection.

2: Singular values statistics of finite-temperature determinant quantum Monte Carlo simulations

April 4
12:12 - 12:24
S114

Wen Chen (presenter)

University of Houston, Department of Physics

CoAuthors: Wen Chen, Rubem Mondaini (University of Houston)

Introducing the auxiliary bosonic field, the partition function can be converted to a determinant of M matrix which is not positive definite in the finite-temperature determinant quantum Monte Carlo simulations. Thats why sign problems occur and become a limitation for challenging the strongly correlated fermions in high dimensional systems. Under the polar decomposition, the M matrix can be considered as a factorization of a unitary matrix U which includes the information of the sign and a positive semi-definite matrix$(M^\dagger M)^{1/2}$In this work, we use singular values statistics of M matrix, i.e., eigenvalues statistics of $(M^\dagger M)^{1/2}$to investigate the phase transitions of two kinds of Hubbard-like model on honeycomb lattice. With the interaction strength increases, on the one hand, auxiliary fields as random variables break the symmetric structure of matrices and make the singular values uncorrelated, on the other hand, unlike the completely random fields, the typical fields in the simulations of Mott insulator phase induce the level repulsion. Compared with results of random fields, the level statistics of typical fields are truly different, and the information of phase transition can be extracted.

3: AI-Driven Particle Detection in CR-39 Nuclear Track Detector

April 4
12:24 - 12:36
S114

Noah D'Amico (presenter)

Texas Tech University, Center for Emerging Energy Sciences (CEES), Department of Physics and Astronomy

CoAuthors: Sandeep Puri, Ian Jones, Dr. Cuikun Lin, Dr. Andrew Gillespie, Dr. Robert Duncan (all affiliations are Texas Tech University, Center for Emerging Energy Sciences (CEES), Department of Physics and Astronomy)

Plastic Nuclear Track Detectors (PNTDs) provide a cost-effective method for nuclear radiation analysis, but manual track counting can take months. We implemented a machine learning object detection model in MATLAB, reducing analysis time to hours with over 90

Funding acknowledgment: Department of Energy award No. DE-AR0001736 , Texas Research Incentive Program and 2025 Research Assistance Program by Texas Tech University

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4: Temperature-Dependent Dynamics and Hysteresis in Polymer Brushes grafted onto nanoparticles

April 4
12:36 -
12:48
S114

Hala Farghaly (presenter)

University of houston

CoAuthors: Aman Agrawal (University Of Chicago),Ahmed Elzatahry (University of Houston),Jack Douglas (National Institute of Standards and Technology (NIST), Karim Alamgir (University of houston)

Polymer-grafted nanoparticles (PGNs) represent a promising frontier in materials science. Significant efforts have been made to understand the dynamics of polymer brushes grafted onto nanoparticles. Due to the system complexity and different parameters that affect the PGNPs system behavior, among them the grafting density, polymer molecular weight, solvent quality, and nanoparticle size. Therefore, despite these efforts, numerous questions remain unanswered, highlighting the ongoing complexity surrounding this area. This study investigates the dynamics of polystyrene grafted on silicon dioxide nanoparticles ($Ps - g - SiO_2$) in a cyclohexane solvent, theta solvent for polystyrene. Using dynamic light scattering (DLS), we investigate the effect of temperature on the system energy and hydrodynamics radius. Our results disclose that hysteresis primarily arises from the claustration of polymer brushes. Initially, PGNPs are in metastable phase, where the energy gain from core attraction is higher than entropy loss, leading to particles self-assembly into spherical clusters, hence hysteresis occurs. As the system relaxes overtime, the particles rearrange themselves, maximizing their free energy, and moving toward new equilibrium state, where entropy balance the enthalpy.

5: Disordered Hyperuniformity in Thin Films of Polymer-Grafted Nanoparticles with Hard and Soft Cores

April 4
12:48 -
13:00
S114

Akhtar Gul (presenter)

University of Houston

CoAuthors: Alamgir Karim (Department of Chemical and Biomolecular Engineering, University of Houston), Michael Bockstaller (Department of Materials Science and Engineering, Carnegie Mellon University), Krzysztof Matyjaszewski (Department of Chemistry, Carnegie Mellon University), Jack Douglas (National Institute of Standards and Technology (NIST), Gaithersburg, MD 20878).

Polymer-grafted nanoparticles (PGNPs) inherently adjust their packing to maximize configurational entropy, resulting in unique interaction-driven structures. This study investigates how these systems display disordered hyperuniformity by examining single-particle nanocomposites made from hard inorganic (SiO_2) and soft organic (organonanoparticle, oNP) cores, all grafted with polymethyl methacrylate (PMMA). Thin films of these nanocomposites were prepared using solution flow coating at two distinct thicknesses: 150 nm and 50 nm, followed by various annealing treatments. Atomic force microscopy (AFM), two-dimensional Fourier transform (2D-FFT), and radial profile analysis demonstrated that a sequence of thermal annealing (TA) followed by solvent vapor annealing (SVA) fosters hyperuniform structures in both hard and soft core nanoparticle systems. Particularly, the 50 (SiO_2) -based films exhibited significant hyperuniformity, with structural order beginning to form even during the film casting process. These findings underscore the tunability of nanoscale order in PGNP systems as influenced by film thickness and processing conditions.

Funding acknowledgment: Department of Energy (DOE)

Physics Education Research 1, S202

1: Using Optical Illusions to teach Quantum Mechanics

April 4
12:00 - 12:12
S202

Richard Kriske (presenter)

MIT

Optical illusions resemble the issues of QM. These characteristics reveal the mechanism of the Visual Cortex. Different illusions demonstrate different properties of Quantum Mechanics. One is the "Rabbit/Duck" illusion. First it is the Rabbit/Duck superposition. Suddenly either the Rabbit or the Duck appears, which is the Eigenstate Rabbit, or Eigenstate Duck. The student see that at least in visual systems Eigenstates "real". Once this goal is met to show how superpositions turn into "real" images, "real" eigenstates, then the instructor can demonstrate how persistent eigenstates are. Next it can be shown that the Eigenstate can disappear and go back to the Superposition, and the other Eigenstate can appear. Other mathematical properties can be demonstrated such as the combination of Eigenstates. In some optical illusions, one part of the superposition with collapse into a real image, then another part will collapse, demonstrating that Eigenstates, can be added. Lastly the course will be to show that there is a connection between protein Eigenstates and visual Eigenstates. Unfortunately not enough is known to map which proteins are in combination with which visual Eigenstate, but some of the students will be fascinated with the "magic".

Funding acknowledgment: None

2: Exploring Methods to Increase Student Engagement in Physics Bottleneck Courses

April 4
12:12 -
12:24
S202

Aaron Modic (presenter)

Texas A&M International University, Department of Mathematics and Physics

An introduction to the Academic Recovery and Data Analysis (ARDA) program at Texas A&M International University followed by preliminary discussions and effectiveness of several teaching methods to enhance student engagement and to reduce the D/F/W rate of students in bottleneck physics courses. These topics include increased student assessment, extra student tutoring, and skeletal note outlines.

Funding acknowledgment: U.S. Department of Education

3: Optimization of student learning of approximate functions

April 4
12:24 -
12:36
S202

Hunter Close (presenter)

Texas State University Dept of Physics

CoAuthors: Hunter G. Close (Texas State University), Samuel F. Zamora (Texas State University)

The undergraduate physics major at Texas State includes a standard middle-level introduction to mathematical methods. In this course, we delved deeply into student learning of approximations to learn what instructional support was needed for students to develop a reliable, functional ability to use and interpret approximations. Over seven semesters, we iteratively refined a three-week instructional sequence that centers on electrostatic potential energy of a series of progressively more complicated charge configurations, culminating in analysis of the stability of a test charge near the origin between two identical, evenly spaced, coaxial, uniformly charged rings. Ongoing real-time observation of student's in-class conversations was the main source for our reflection on and improvement of the instructional documents. Our observations basically indicated that we had far underestimated the many difficult aspects of this topic for beginners. The result of our work is an instructional document that guides students efficiently to a correct understanding of how approximations are used by practicing physicists and that has all the "wrinkles ironed out". The instruction will be summarized and offered freely for use at other institutions.

Quantum Theory, S102

1: Path integral derivation of the thermofield double state in causal diamonds

April 4
12:00 -
12:12
S102

Gustavo C Valdivia-Mera (presenter)

University of Houston

CoAuthors: Carlos Ordoez (University of Houston), Abhijit Chakraborty (University of Waterloo)

In this article, we adopt the framework developed by R. Laflamme in *Physica A*, **158**, pp. 58-63 (1989) to analyze the path integral of a massless – conformally invariant – scalar field defined on a causal diamond of size 2α in 1+1 dimensions. By examining the Euclidean geometry of the causal diamond, we establish that its structure is conformally related to the cylinder $S^1_\beta \otimes R$, where the Euclidean time coordinate τ has a periodicity of β. This property, along with the conformal symmetry of the fields, allows us to identify the connection between the thermofield double (TFD) state of causal diamonds and the Euclidean path integral defined on the two disconnected manifolds of the cylinder. Furthermore, we demonstrate that the temperature of the TFD state, derived from the conditions in the Euclidean geometry and analytically calculated, coincides with the temperature of the causal diamond known in the literature. This derivation highlights the universality of the connection between the Euclidean path integral formalism and the TFD state of the causal diamond, as well as it further establishes causal diamonds as a model that exhibits all desired properties of a system exhibiting the Unruh effect.

Funding acknowledgment: Army Research Office

2: Quantum supremacy and hybrid boson sampling

April 4
12:12 -
12:24
S102

Vitaly Kocharovsky (presenter)

Texas AM University, Department of Physics and Astronomy

CoAuthors: Vitaly Kocharovsky

We reveal the nature of quantum supremacy and P-hard complexity of many-body systems. It originates from the interference of eigen-squeeze modes and eigen-energy quasiparticles. As a result, quantum systems naturally evaluate Fourier-series coefficients whose calculation is P-hard for classical computers. Applying the newly found hafnian master theorem and referring to the Todas theorem on a P-complete oracle, we show that such nature of quantum supremacy is universal. We suggest hybrid boson sampling from a system of coupled photons and BoseEinstein condensed atoms placed inside a multi-mode cavity as a simulation process testing quantum supremacy. An atomphoton scattering and interatomic collisions create quasiparticles and atom-photon eigen-squeezed modes. We calculated them via BlochMessiah reduction and find a joint probability distribution of atom and photon numbers

within a quasi-equilibrium model via a hafnian of an extended covariance matrix. It shows a sampling statistics that is P-hard for computing, even if only photon numbers are sampled. Merging cavity-QED and quantum-gas technologies has a potential to overcome the limitations of separate, photon or atom, sampling schemes. We propose pioneering proof-of-principle experiments on hybrid boson sampling.

3: Noise-induced synchronization in coupled quantum oscillators

April 4
12:24 -
12:36
S102

Bhavay Tyagi (presenter)

University of Houston, Department of Physics

CoAuthors: Eric R. Bittner (Department of Physics, University of Houston)

We consider the quantum dynamics of a pair of coupled quantum oscillators coupled to a common correlated dissipative environment. The resulting equations of motion for both the operator moments and covariances can be integrated analytically using the Lyapunov equations. We find that for fully correlated and fully anti-correlated environments, the oscillators relax into a phase-synchronized state that persists for long-times when the two oscillators are nearly resonant and (essentially) forever if the two oscillators are in resonance. We identify an exceptional point that indicates the onset of broken symmetry between an unsynchronized and synchronized dynamical phase of the system as correlations within the environment are increased. We also show that the environmental noise correlation leads to quantum entanglement, and all the correlations between the two oscillators are purely quantum mechanical in origin. This work provides a robust mathematical foundation for understanding how long-lived exciton coherences can be linked to vibronic correlation effects.

Funding acknowledgment: This work was funded by the National Science Foundation (Grant No. CHE-2404788) and the Robert A. Welch Foundation (Grant No. E-1337). The authors acknowledge discussions with Professor Carlos Silva (U. Montreal) and Andrei Piryatinski (LANL), which led to the development of this model and series of calculations.

4: Entangled Photons as a probe in quantum spectroscopy

April 4
12:36 -
12:48
S102

Sameer Dambal (presenter)

University of Houston, Physics Department

Recent advances in quantum light spectroscopy have highlighted the potential of using light entanglement as a sensitive probe for many-body dynamics and material correlations. However, a comprehensive theory to explain experimental results remains elusive, primarily due to the complexity of the Hilbert space and the intricate interactions and nonlinearities inherent in material systems. The exponential growth of the Hilbert space further complicates numerical simulations. To address these challenges, we propose a novel approach by reformulating the problem in terms of a finite-sized correlation matrix, assuming a Hamiltonian described by bilinear boson operators. This framework enables efficient numerical simulations using finite matrix theory. We apply this method to predict the output joint spectral intensity (JSI) of frequency-entangled biphotons and calculate the von Neumann entropy. Our results demonstrate an agreement with previous experimental observations in empty microcavities and underscore the potential of photon entanglement as a powerful tool for probing many-body dynamics and correlations in material systems.

5: The Atomistic Mechanism of Si (111)-77 Surface Reconstruction Revealed Using a Machine-Learning Force Field

April 4
12:48 -
13:00
S102

Yidi Shen (presenter)

California Institute of Technology + Materials and Process Simulation Center

CoAuthors: Qi An (Iowa State University), William A. Goddard III (California Institute of Technology)

While the formation of$Si(111) - 7 \times 7$ Surface upon annealing is well known, the mechanism underlying this surface reconstruction remains elusive. We employ molecular dynamics simulations based on a machine-learning force field to unravel the atomistic mechanism. Our simulations reveal two possible pathways. The first pathway involves the growth of a stacking fault from a metastable 55 structure to the stable 77 reconstruction. The second pathway shows the direct formation of the 77 structure. Both mechanisms involve key steps including creation of dimers and five-member rings, stabilization of the triangular halves, and the formation of corner hole by joining of several five-member rings. Adatoms and dumbbell configuration are formed from extra atom diffusion or rearrangement during the evolution of triangular halves and dimer formation. Our findings offer some insights into surface reconstruction in semiconductor materials.

Funding acknowledgment: YS and QA were supported by NSF (CMMI-2019459). WAG thanks the Hong Kong Quantum AI Lab, AIR@InnoHK of Hong Kong Government for support.

6: Quantum Memory: Exact Emergent Hamiltonians in 1D and 2D Lattice Systems

April 4
13:00 - 13:12
S102

Anubhab Sur (presenter)

Department of Physics, University of Houston

CoAuthors: Rubem Mondaini (Department of Physics, University of Houston)

With the advent of exquisite quantum emulators, storing highly entangled many-body states becomes essential. While entanglement typically builds over time after initializing a quantum system with a product state, freezing that information at any given instant requires quenching to a Hamiltonian with the time-evolved state as an eigenstate, which we achieve via the Emergent Hamiltonian framework introduced by Vidmar et al., Phys. Rev. X7, 021012 (2017) in a quantum system of hard-core bosons. While the Emergent Hamiltonian is generically non-local and may lack a closed form, in our case it is exact and capable of pausing dynamics indefinitely with perfect precision, thus opening a new frontier in quantum memory applications. Unlike other phenomena such as many-body localization, our method preserves both local and global properties of the quantum state. In particular, we demonstrate that this formalism is exact for 1D hardcore bosons at any filling and for single-particles in any dimension. A complete spectral characterization of the original and emergent Hamiltonians at various times is carried out . Additionally, we explore the duality between the many-body dynamics of spin-1/2 particles on a 2D lattice and the dynamics of two interacting large spins within this framework.

Funding acknowledgment: R.M. acknowledges support from the TcSUH Welch Professorship Award; calculations used resources from the Research Computing Data Core at the University of Houston and through allocation PHY240046 from the Advanced Cyberinfrastructure Coordination Ecosystem: Services Support (ACCESS) program, which is supported by U.S. National Science Foundation grants 2138259, 2138286, 2138307, 2137603, and 2138296.

7: On the Origin of Classicality: Quantum Darwinism in Superconducting Circuits

April 4
13:12 -
13:24
S102

Kiera Salice (presenter)

University of Houston

CoAuthors: Kiera Salice (Department of Physics, University of Houston), Zitian Zhu (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China) , Akram Touil (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico), Zehang Bao (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China), Zixuan Song (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China), Pengfei Zhang (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China),Hekang Li (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China), Zhen Wang (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China), Chao Song (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China), Qiujiang Guo(School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China), H. Wang (School of Physics, ZJU-Hangzhou Global Scientific and Technological Innovation Center,and Zhejiang Key Laboratory of Micro-nano Quantum Chips and Quantum Control, Zhejiang University, Hangzhou, China)(State Key Laboratory for Extreme Photonics and Instrumentation, Zhejiang University, Hangzhou, China), and Rubem Mondaini (Department of Physics, University of Houston)(Texas Center for Superconductivity, University of Houston, Houston)

The transition from quantum to classical behavior is a central question in modern physics. How can we rationalize everyday classical observations from an inherently quantum world? Quantum Darwinism offers a compelling framework to explain this emergence of classicality by proposing that the environment redundantly encodes information about a quantum system, leading to the objective reality we perceive. Here, by leveraging superconducting quantum circuits, we observe the highly structured branching quantum states that support classicality and the saturation of quantum mutual information, establishing a robust verification of the

foundational framework of quantum Darwinism and the accompanying geometric structure of quantum states. Additionally, we propose a class of observables that can be used as a separate quantifier for classicality, originating a computationally and experimentally inexpensive method to probe quantum-to-classical transitions. Our investigation delves into how the quantum effects are inaccessible to observers, allowing only classical properties to be detected. It experimentally demonstrates the physical framework through which everyday classical observations emerge from underlying quantum principles and paves the way to settling the measurement problem.

Funding acknowledgment: The experimentation team acknowledges the support from the National Natural Science Foundation of China (Grant Nos. 12274368, 12174342, 12274367, 12322414, 12404570, 12404574, U20A2076), the Zhejiang Provincial Natural Science Foundation of China (Grant Nos. LR24A040002 and LDQ23A040001). A.T. acknowl- edges support from the U.S. DOE under the LDRD pro- gram at Los Alamos. R.M. acknowledges support from the TcSUH Welch Professorship Award.

Parallel Sessions 2: April 4 2-3:30

High Energy 2, S116

1: Using deep learning techniques to investigate phase transitions in physics

April 4
03:00 -
03:12
S116

Ahmed Abuali (presenter)

University of Houston, Department of Physics

CoAuthors: David A. Clarke (2Department of Physics and Astronomy, University of Utah, Salt Lake City, Utah 84112, USA), Morten Hjorth-Jensen (Department of Physics and Astronomy and Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan 48824, USA and Department of Physics and Center for Computing in Science Education, University of Oslo, N-0316 Oslo, Norway), Ioannis Konstantinidis (Computer Science Department, University of Houston, Houston, Texas 77204, USA), Claudia Ratti (Physics Department, University of Houston, Houston, Texas 77204, USA), Jianyi Yang (Computer Science Department, University of Houston, Houston, Texas 77204, USA)

Deep learning techniques, particularly neural networks, are powerful tools for pattern recognition, often uncovering hidden patterns. It is well known they are effective for recognizing phase transitions, even for systems without an explicit order parameter. Conventionally, training is performed in the vicinity of the critical region. In this talk, I will consider 2D Ising, 3D Ising and Heisenberg models. Neural networks are trained on lattice configurations for these systems at extreme temperatures far from the critical point, specifically at T=0 and T=. Once trained, these ML models are tested on the models' configurations over a broad range of temperatures, generated through MCMC simulations. By treating the average predictions from the output layer as an effective order parameter, we can accurately locate the critical temperature. Furthermore, we apply histogram reweighting techniques to the neural network predictions to help extract critical exponents associated with these phase transitions.

2: Cosmic Trajectories. From the Quark to the Hadronic Phase

April 4
03:12 -
03:24
S116

Lorenzo Formaggio (presenter)

University of Houston

CoAuthors: Dr. Claudia Ratti (University of Houston)

One of the most intriguing open questions in understanding the evolution of the early universe is the nature of the Quantum Chromodynamics (QCD) phase transition. Was it a crossover, a first-order, or a second-order phase transition? To address this fundamental question, we delve into the QCD phase diagram, calculating how the chemical potentials evolve with temperature (Cosmic Trajectory). The trajectorys position and shape provide crucial insights into the transitions nature. Our approach involves numerically solving a system of five conservation equations, including baryon number, lepton number, universe charge neutrality, and beta chemical equilibrium conditions. We specifically calculated trajectories for a free quantum gas model of the Quark Gluon Plasma (QGP) and compared them to the interacting QGP case, obtained using a lattice QCD equation of state based on a fourth-order chemical potential Taylor expansion. The primary findings of this work are: how the cosmic trajectories depend on lepton asymmetries, how the lattice QCD EOS influences the trajectories, and the conditions under which a crossover is more likely to occur instead of a first-order phase transition.

3: Strange and non-strange quark stars from resummed QCD

April 4
03:24 -
03:36
S116

Tulio Eduardo Restrepo Medina (presenter)

University of Houston, Physics department

CoAuthors: Tulio E Restrepo (Department of Physics, University of Houston, TX 77204, USA), Jean Loc Kneur (Laboratoire Charles Coulomb (L2C), UMR 5221 CNRS-Universit Montpellier, 34095 Montpellier, France), Constana Providncia (CFisUC, Department of Physics, University of Coimbra, 3004-516 Coimbra, Portugal), Marcus Benghi Pinto (Departamento de Fsica, Universidade Federal de Santa Catarina, 88040-900 Florianpolis, SC, Brazil)

We use the recently developed resummation technique known as renormalization group optimized perturbation theory (RGOPT) to evaluate the equation of state (EoS) describing cold and dense quark matter at next-to-leading order (NLO). The technique is applied to non-strange quark matter as well as strange quark matter, while ensuring thermodynamic consistency in both cases. The resulting mass-radius relations are compared with those from NNLO perturbative QCD (pQCD). We find that the RGOPT considerably reduces the renormalization scale dependence relative

to that produced by pQCD. Moreover, for the same value of the renormalization scale, the RGOPT yields lower maximum star masses than those furnished by pQCD. Furthermore, when the renormalization scale is adjusted to produce maximum star masses in the range of 2-2.6 solar masses, the RGOPT results align well with recent observational data.

4: Machine Learning for the QCD Equation of State

April 4
03:36 -
03:48
S116

Justin Laberge (presenter)

University of Texas at El Paso, Physics Department

CoAuthors: Ahmed Abuali (Univ. Houston), Micheal Kahangirwe (Univ. Houston), Jorge Munoz (UTEP), Claudia Ratti (Univ. Houston).

Under the hot, dense conditions of the early universe, and possibly within neutron stars, matter is theorized to exist as deconfined quark-matter. The transition between ordinary matter and deconfined quarks, dubbed the quark-gluon plasma, is central to the study of Quantum Chromodynamics (QCD). In high-energy particle collision experiments, the conditions for this primordial state of matter are reproduced, allowing the phase transition to occur on very short time scales. To more extensively study this phase transition, hydrodynamic simulations are used, recreating the fireball produced in high-energy collisions. These simulations require accurate equations of state, relating state variables of the system such as pressure and temperature. Generation schemes of such equations of state typically involve the heavy computation of thermodynamics, and can describe unphysical or acausal behaviors. In this work, we first construct many possible QCD equations of state, then apply machine learning using a kNN algorithm to classify equations describing unphysical, or physical behaviors without heavy computation. The parameter space used to construct equation of states is explored to discover valid and invalid regions for future application in hydrodynamic simulation

Funding acknowledgment: U.S. Department of Energy, Office of Science, Reaching a New Energy Sciences Workforce Program, Award Number DE-SC-0021994

5: Optimization of Multipolynomial Monte Carlo for Trace Estimation in LQCD

April 4
03:48 -
04:00
S116

Sudip Shiwakoti (presenter)

Baylor University, Physics Department

Our objective is to calculate disconnected quark diagram in lattice QCD from the trace of inverse of a matrix. We proposed Multipolynomial Monte Carlo algorithm for this calculation and trying to optimize it. We are using partially quenched Wilson- Dirac fermion matrices A evaluated at the physical pion mass of 135 MeV. We have developed the polynomials from the polynomial preconditioned GMRES method to approximate A-1. Also, we used eigenvalue deflation method to reduce the variance. We have used lattice size of 163 x 48 and 243 x 64. This optimized Multipolynomial Monte Carlo method has speed up the trace calculation significantly compared to standard Hutchinson method.

6: A Review on Conformal Symmetries

April 4
04:00 -
04:12
S116

Nada Eissa (presenter)

University of Houston, Physics Department

A conformal field theory (CFT) is generally characterized by scale invariance. However, a proper definition of conformal invariance extends to include a broader set of transformations: Poincar, scale, and special conformal transformations. This group of conformal symmetries is particularly significant not only because of its rigorous mathematical foundation but also because it imposes strong constraints on measurable quantities.In this talk, I will define the conformal symmetry group in d-dimensions and explain how its constraints determine the general form of n-point correlation functions. I will then construct the simplest example of a conformally invariant theory in 1D, known as conformal quantum mechanics (CQM). By analyzing a Coulomb-like potential, I will demonstrate how conformal transformations govern the time evolution of the state vector and constrain the coupling constants of the theory.Since many physical systems exhibit conformal invariance under specific conditions, I will focus on applying CQM to the study of the thermodynamic properties of a Schwarzschild black hole in the near-horizon approximation.

Funding acknowledgment: Army Research Office

Condensed Matter 2, S114

1: Enhancement of Photocurrent and Photoresponsivity in Gold Nanoparticle/2D BiOSe Hybrid Material

April 4
03:00 -
03:12
S114

Jittin Thomas (presenter)

Department of Physical and Applied Sciences, University of Houston-clear Lake, Houston, TX

CoAuthors: Jittin Thomas(1), Whitney Jones(1), Mackenzie Songsart-Power(1), David Black(1), Amit Shringi(2), Fei Yan(2), Tej B. Limbu(1)1 Department of Physical and Applied Sciences, University of Houston-clear Lake, Houston, TX, 77058, USA2 Department of Chemistry and Biochemistry, North Carolina Central University, NC, 27707, USA

Zipper two-dimensional (2D) materials such as Bi2O2Se have emerged as promising alternatives to van der Waals 2D materials for high-performance optoelectronic applications. However, the relatively low bandgap (1.5 eV) of Bi2O2Se limits its photodetection capability to the near-infrared (IR) region. In this study, we report enhanced photoconductivity and photoresponsivity in a micro-sized photodetection device fabricated using a hybrid material composed of Bi2O2Se nanosheets and gold (Au) nanoparticles, under visible light illumination. The electrical conductivity of the Au nanoparticles/Bi2O2Se film in the photodetection device was measured to be 1x10-3 S/m, an order of magnitude higher than that of the pure Bi2O2Se film. The device made with the Bi2O2Se film exhibited a photoresponsivity of 2 x10-4 A/W under green and red laser illumination, which increased by roughly three times to 7 x10-4 A/W for the device fabricated with the Au nanoparticles/Bi2O2Se hybrid material. This enhancement in photoresponsivity is attributed to the excitation of surface plasmons on Au nanoparticles and the increased number of photons interacting with the material. This approach paves the way for developing cost-effective and efficient photodetection devices for future applications.

Funding acknowledgment: FRSF

2: Photo-induced Charge Transfer Properties of 2D Nb2CTX MXene for Molecule Detection

April 4
03:12 -
03:24
S114

Mackenzie Songsart-Power (presenter)

University of Houston - Clear Lake

CoAuthors: Brady Wilson, Joseph W. Phalen, Chetan Dhital, Tej B. Limbu

MXenes have garnered significant attention for surface-enhanced Raman scattering (SERS) applications due to their exceptional electronic properties and remarkable hydrophilicity. However, niobium carbide (Nb_2C_{TX}), a notable member of the MXene family, has been underexplored for SERS applications. In this work, we present a comprehensive investigation of the SERS properties of $Nb_2C_{T_x}$ nanosheets, using

methylene blue (MB) and crystal violet (CV) as probe molecules under laser excitations at 532 nm and 488 nm. The results revealed that the Raman enhancement of dye molecules on the $Nb_2C_{T_x}$-based SERS substrate was determined by the interplay between laser energy and the probe molecule. The two orders of magnitude higher EF for MB (2.12×10^6) compared to CV (2.65×10^4) obtained using 532 nm laser excitation was attributed to a light-induced resonance charge transfer transition within the MB-Nb_2C_{TX} system. The distinctly different EF values for MB and CV suggest that SERS technology based on chemical mechanisms could enable selective molecular detection. Our results provide valuable insights into the SERS mechanism and contribute to the development of cost-effective and 2D MXene-based selective SERS substrates for molecular sensing applications.

3: Enhancing Activity and Stability of NiFe LDH with Ce Cations for High Current Density Oxygen Evolution Reaction in Alkaline Water via a One-Step Hydrothermal Method

April 4
03:24 -
03:36
S114

Paul Byaruhanga (presenter)

University of Houston, Department of Physics and Texas Center for Superconductivity

CoAuthors: Shuo Chen(Department of Physics, and Texas Center for Superconductivity at the University of Houston (TcSUH), University of Houston, Houston, Texas 77204, USA)

Pursuing hydrogen fuel via water electrolysis has gained attention to address fossil fuel depletion and environmental issues. The efficiency of water electrolysis depends on overcoming the sluggish oxygen evolution reaction (OER) kinetics. Developing active, durable, and cost-effective OER electrocatalysts is crucial, especially in alkaline environments. NiFe-layered double hydroxides (LDH) are among the most active OER electrocatalysts but require enhanced activity and stability. Here, we synthesized cerium-doped NiFe-LDH nanosheets via a single-step hydrothermal method. Cerium incorporation boosts catalytic efficiency and increases active sites. The optimized Ce-doped NiFe-LDH/NF catalyst showed outstanding OER performance, requiring low overpotentials of 252 mV and 307 mV at 100 and 1000 mA cm^{-}2 in 1 M KOH. It maintained 1 A cm^{-}2 for 300 h and exhibited superior stability for 100 h under industrial conditions, surpassing prior Ce-doped catalysts

Funding acknowledgment: Department of Physics, and Texas Center for Superconductivity at the University of Houston (TcSUH), University of Houston, Houston, Texas 77204, USA

4: Phase segregation in high Mn-doped Mg3SbBi based thermoelectric materials

April 4
03:36 -
03:48
S114

Muhammad Haroon Khan (presenter)

University of Houston Department of Physics Texas Center for Superconductivity

CoAuthors: Rui Shu (University of Houston), Shuo Chen (Univeristy of Houston), Paul Byaruhanga (Univeristy of Houston) , Shaowei Song (Univeristy of Houston), Dezhi Wang (Univeristy of Houston), Zhifeng Ren (Univeristy of Houston)

N-type Mg3Sb2-based thermoelectrics exhibit exceptionally high thermoelectric performance and superior mechanical stability. However, their performance is severely restricted by a high density of Mg vacancies and complex microstructure defects. In this work, we experimentally investigated the phase structure and thermoelectric performance of Mn-doped Mg3SbBi compound. At low Mn doping level of 1

Funding acknowledgment: Texas Center for Superconductivity

5: Effect of Chemical and Physical Pressure on the Ti-Doped CsV3Sb5 Superconductor

April 4
03:48 -
04:00
S114

Keshav Shrestha (presenter)

Department of Chemistry and Physics, West Texas AM University

CoAuthors: Keshav Shrestha (Department of Chemistry and Physics, West Texas A M University, Canyon, TX 79016, USA), Kyryl Shtefiienko (Department of Chemistry and Physics, West Texas A M University, Canyon, TX 79016, USA), Cole Phillips (Department of Chemistry and Physics, West Texas A M University, Canyon, TX 79016, USA), Matthew J. Stitz Perry College of Mathematics, Computing, and Sciences, University of West Georgia, Carrollton, GA 30118, USA), Ganesh Pokharel (Perry College of Mathematics, Computing, and Sciences, University of West Georgia, Carrollton, GA 30118, USA), Stephen D. Wilson (Materials Department, University of California, Santa Barbara, California 93106, USA), David E. Graf (National High Magnetic Field Laboratory, Tallahassee, Florida 32310, USA andDepartment of Physics, Florida State University, Tallahassee, Florida, 32306, USA)

Kagome materials have recently garnered enormous interest due to their exhibition of multiple electronic orders, such as charge density wave (CDW), nontrivial topology, and superconductivity. This talk focuses on the evolution of the electronic properties of CsV3Sb5 under both chemical and physical pressure. The parent compound, CsV3Sb5, exhibits a CDW phase below T* = 94 K and a superconducting phase below Tc = 2.5 K. Titanium doping, which acts as chemical pressure by substituting vanadium atoms, suppresses the CDW phase to 78 K and enhances Tc to 3.25 K at 0.1

Funding acknowledgment: Work at the West Texas AM University is supported by the KRC Student Research Grants, the Welch Foundation (AE-0025), NSF (2336011) and NSF CC* GROWTH 2018841. G.P. gratefully acknowledges the support of the University of West Georgia. S.W.D. gratefully acknowledge support via the UC Santa Barbara NSF Quantum Foundry funded via the Q-AMASE-i program under award DMR-1906325. Work at the National High Magnetic Field Laboratory is supported by NSF (DMR-2128556) and the State of Florida.

6: Highly Efficient And Stable Iron Molybdate Electrocatalyst Towards Oxygen Evolution Reaction Under Alkaline Conditions

April 4
04:00 -
04:12
S114

FNU Vidhi (presenter)

University of Houston

CoAuthors: Paul Byaruhanga*, Shuo Chen* (Department of Physics, and Texas center for Superconductivity at the University of Houston, University of Houston, Houston, Texas 77204, USA)*

Electrochemical water splitting is a key strategy for sustainable hydrogen production, with alkaline water electrolysis offering a direct route. However, the sluggish kinetics of the oxygen evolution reaction (OER) hinder efficiency, necessitating advanced electrocatalysts to lower overpotential. While RuO_2 and IrO_2 are highly active, their scarcity and cost limit widespread use. Here, $FeMoO_4$ supported on Nickel Foam (NF) was synthesized via a one-step hydrothermal method. Surface characterization revealed distorted cube-like nanostructures, providing a large surface area for OER. Raman analysis post-OER indicates alkaline leaching of $[MoO_4]^{2-}$, forming FeO(OH) as the active species. $FeMoO_4$ exhibits an overpotential of 295 mV at 500 mA/cm^2 in 1M KOH, outperforming IrO_2/NF (542 mV). It demonstrates exceptional durability, sustaining 900 hours at 1000 mA/cm^2 (313 mV) and 400 hours at 321 mV in freshwater and seawater, respectively, with minimal degradation. This catalyst exhibits the best OER performance among iron molybdate catalysts reported to date.

Funding acknowledgment: Texas Center for Superconductivity, University of Houston

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Physics Education Research 2, S202

1: THE IMPACT OF A STEAM PROJECT-BASED LEARNING COURSE ON TEACHING COMPETENCIES OF ELEMENTARY EDUCATION STUDENTS AT THE VNU UNIVERSITY OF EDUCATION,

April 4
03:00 -
03:12
S202

Dang Minh Tuan (presenter)

VNU University of Education, Department of childhood education and primary education

CoAuthors: Dang Minh Tuan, Quang Thi Quy

This study examines the impact of a STEAM project-based learning course on enhancing teaching competencies of elementary pre-service teachers, particularly their ability to integrate technology into instruction. The STEAM project-based course was designed following project-based learning principles, allowing students to actively engage with integrating Science, Technology, Engineering, Arts, and Mathematics into elementary education. Using a pre-post measurement design involving 245 undergraduate students majoring in Elementary Education, statistical analysis revealed significant improvement in students' understanding and STEAM teaching skills after the course compared to their baseline performance (p ¡ 0.001). Exploratory factor analysis identified three core competency areas improved through the course: (1) theoretical knowledge of STEAM, (2) skills in designing and implementing technology-integrated project-based lessons, and (3) attitudes and confidence towards STEAM education. These findings affirm the effectiveness of incorporating STEAM education into elementary teacher training programs and provide recommendations to enhance the quality of STEAM training in the future.

Funding acknowledgment: NA

2: Improving Student Computational Thinking Outcome Expectancy through Integrating Model-building in a Secondary Physics Course

April 4
03:12 -
03:24
S202

James Newland (presenter)

Texas Advanced Computing Center, UT Austin

The role of computation in physics is increasing in both a professional and educational context. High school physics pedagogy should incorporate computational thinking, data science, and computer science skills to bolster learning across these domains. The study described here shows that when students build physically meaningful models using computer programming in a physics course, their outcome expectancy is positively impacted. Outcome expectancy can predict students' future academic and professional choices. The STEMcoding platform asks students to construct models using Euler-Cromer step-wise modeling of physical phenomena, such as those described by the laws of motion. The study presented had students use

STEMcoding during the kinematics portion of Advanced Placement Physics 1 classes at a large, urban high school in southeast Texas. A moderate positive impact on outcome expectancy was found across various groups in the study population. Results show how computational essays can provide scaffolded learning while allowing students to use code to create interactive models, allowing knowledge construction in a domain-specific manner.

Funding acknowledgment: N/A

3: Barrier to Physics Accesibility for ALL

April 4
03:24 -
03:36
S202

Maqsuda Afroz (presenter)

Chavez High School

When we think Physics we think Newton, Einstein, Hawkings etc. All considered geniuses. I would like to discuss the fact having such renowned and famous names hampers physics accessibility for all as it creates an immediate sense of who should and can study physics. The talk will look at further barriers to physics accessibility also including but not limited to resources based on neighborhoods and preconceived notions about them.

4: A Newtonian Perspective on the Vibrational Spectrum of Diatomic Molecules

April 4
03:36 -
03:48
S202

James C. Espinosa (presenter)

Weatherford College

In modern physics courses, authors give a litany of failures of classical physics that convinces students for the need of the theory of relativity and quantum mechanics. One of the failures is the supposed inability of Newtonian physics to account for the existence of molecules and to explain their spectrum. We will show how the vibrational spectrum can be explained by using purely classical action at a distance electrodynamics.

5: LMS Based Team Problem Solving

April 4
03:48 -
04:00
S202

Evan Richards (presenter)

Lee College, Physics

I teach classes at both Lee College and University of Houston-Clear Lake (UHCL). While the labs at each campus have similarities (e.g., studio learning environment), they differ in key aspects. At Lee College, most walls are covered in dry erase boards for team-based problem-solving, while the UHCL lab lacks such boards and has double the capacity. I will discuss how I have adapted these activities for the UHCL laboratory using the LMS capabilities

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SPS & Undergraduate Research, S102

1: Discovering Immunogenic Neopeptides from Novel Chimeric RNA FGFR3-KHSRP to Develop Vaccines for Pancreatic Cancer

April 4
03:00 -
03:12
S102

Maggie Fuller (presenter)

University of Houston Physics department

CoAuthors: Brandon Than (UH Biology and Biochemistry), Dr. Preethi Gunaratne (UH Biology and Biochemistry), Dr. Greg Morrison (UH Physics)

Pancreatic cancer is among the most lethal malignancies due to its aggressive nature and limited treatment options. Chimeric RNAs, often dysregulated in cancer, are promising biomarkers and therapeutic targets. This study investigates the FGFR3-KHSRP chimeric RNA, identified in pancreatic cancer patient-derived xenograft (PDX) models, for mRNA vaccine development. We characterized the fusion by identifying exon boundaries, reconstructing its sequence, and validating it via RT-PCR and Sanger sequencing. Immunogenic neopeptides were predicted from the fusion protein junction using NetMHCPan, MixMHCPred, and BigMHC, prioritizing strong-binding candidates. Structural modeling with AlphaFold and ApeGen provided insight into protein stability and HLA binding. Our findings suggest FGFR3-KHSRP-derived neopeptides exhibit strong MHC class I binding affinity, supporting their potential to elicit an anti-tumor immune response. Future work includes docking simulations with ApeGen and experimental validation via flow cytometry, advancing a precision oncology approach for pancreatic cancer immunotherapy.

2: Investigating the QCD Critical Point at finite strangeness chemical potential

April 4
03:12 -
03:24
S102

Anabella Leon (presenter)

University of Houston

CoAuthors: Hitansh Shah, Claudia Ratti, Volodymyr Vovchenko

The search for the QCD critical point remains a fundamental challenge in understanding the phase structure of strongly interacting matter. A recent approach suggests identifying the critical point by examining entropy density contours in the $T - \mu_B$ plane, extrapolated from first-principles lattice QCD calculations at zero chemical potential μ_B. In this work, we extend this approach to the $T - \mu_S$ plane and identify a first-order phase transition. This provides new insights into the equation of state in the strangeness direction, helping to characterize the role of strange degrees of freedom at high densities. Our results have important implications for the behavior of QCD matter in both heavy-ion collisions and neutron stars.

3: Changing the Index of Refraction of Silica Glasses

April 4
03:24 -
03:36
S102

Jason Withers (presenter)

Lamar Univerisity Physics Department

CoAuthors: Jason Withers (student), Dr. Cristian Bahrim (Professor)

The index of refraction is a measure of the optical response of a transparent material. It is explained by understanding light matter interaction (LMI). One way of understanding it is considering the harmonic oscillations of dipoles that form bulk matter to the E-field of the incident light. Changing the environment surrounding a material can effectively modify its index, such as changing the environmental temperature. This shifts the wavelength by an amount which is approximated by $hc/\lambda' = hc/ + kT$ (h=Plancks constant, c=speed of light in vacuum, k is Boltzmann constant). This happens in Earths atmosphere and leads to interesting optical phenomena. The physics of LMI between EM waves and our atmosphere elegantly explain these optical occurrences. Experiments using the fundamentals of LMI were done in our Optics Lab. Our experiments of dispersion of light use Cauchy Lorentz model for harmonic oscillatory dipoles. Experiments using tape, crown/ flint prisms and H / He discharge tubes to model sunlight are reported. We simulate the change in temperature with an applied voltage set up across a silica prism, and measure changes in refractive index due to an isotropic increase in the energy environment, equivalent to the equation for the conservation of energy $hc/\lambda' = hc/ + eV$.

Funding acknowledgment: Lamar University Office of Undergraduate Research and Creativity

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4: Characterization of a Nonthermal Atmospheric Pressure Plasma Jet Generated via Dielectric Barrier Discharge

April 4
03:36 -
03:48
S102

Matthew Barton (presenter)

Angelo State University, Department of Physics and Geosciences

A plasma is a body of mobile charges, governed by statistical mechanics and typically dominated by electric and magnetic forces. Usually, plasmas exist at high temperatures and low pressures as this allows self-sustained ionization and minimal neutralizing collisions. However, through dielectric barrier discharge (DBD), electrons in the system can be preferentially heated, leaving the far more massive ions at a cooler temperature. DBD occurs when the voltage across 2 electrodes is sufficiently high to eject electrons from the surface, while not generating an arc discharge. These electrons then collide with atoms from an input gas, ionizing it without producing a high current through the plasma. This results in a weakly coupled plasma where the bulk temperature is as low as room temperature. In addition, this can be achieved at atmospheric pressure, although the plasma is not in thermodynamic equilibrium and quickly neutralizes. In this research, a nonthermal atmospheric pressure plasma jet was produced, and characteristics of the plasma were investigated via BOLSIG, a numerical solver for the boltzmann equation for low-temperature plasmas. Additionally, the effects of varying power input, gas flow rate, and anode placement on the jet characteristics were investigated.

Funding acknowledgment: Angelo State University Faculty-Mentored Undergraduate Research Grant

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5: Solid State Quantum Tunneling

April 4
03:48 -
04:00
S102

Caeden Moody (presenter)

Angelo State University

CoAuthors: Dr. Eddie Holik III

Quantum Tunneling Composites (QTC), often referred to as QTC pills, are small, semiconductive sensors which, when one applies pressure onto them, can facilitate quantum tunneling. These pills suspend a conductive metal otherwise too dispersed to conduct electricity; however, when pressure is applied, the conductive component of the pill becomes compressed enough to allow an incident electron to tunnel through. These composites see frequent use in technologies employing pressure-dependent systems like impact sensors or blood-pressure cuffs. I propose to mathematically model and then experimentally measure the efficiency of various QTC pills. To take such measurements, the time-independent Schrdinger Equation can be solved for a wave function $\psi(x)$ in terms of the incident and transmission amplitudes of the electrons, T. Using the uniaxial strain tensor, ε, and the height of the QTC, it will be possible to parameterize the resultant transmission amplitude as a

function of force applied to the cross-sectional area of the QTC pill. The experiment will be constructed from a set of these composites connected in series with a direct current (DC) power source.

Funding acknowledgment: I would like to thank the wonderful donors at Angelo State University for allowing me to pursue this area of study under Angelo State University's Faculty Mentored Research Grant Program and I would like to thank the University of Houston for allowing me to speak at their institution.

6: Extracting Observables from Trajectum, a Heavy-Ion Collision Model

April 4
04:00 -
04:12
S102

Christian Schmidt (presenter)

University of Houston College of Natural Sciences and Mathematics, Dept. of Physics

CoAuthors: Caleb Broodo (UH Dept. of Physics)

Trajectum is a state-of-the-art heavy-ion collision model which simulates the evolution of high-energy collisions of atomic nuclei, known as events, allowing users to extract dynamical characteristics of the high-temperature, high-density nuclear medium created in such collisions. Such a model can be used to investigate the evolution of the nuclear medium in different spaces of the QCD phase diagram. In this study, we use Trajectum to investigate Au+Au $\sqrt{s_{NN}} = 200$ GeV collisions, a collision system studied at the Relativistic Heavy-Ion Collider at Brookhaven National Laboratory. From this model, we determined the speed of sound and the effective temperature. These observables provide information about the relationship between thermodynamic state variables (pressure, temperature, and energy density) in the nuclear medium.

Poster Session 2: April 4 3:30-5

Observing Short-Term Atmospheric Conductivity Variations Using a Balloon-Borne Payload

April 4
3:30-5:00
Science
Bldg.

Mohamed Meziou (presenter)

UH Department of Computer Science

CoAuthors: Nathan Herrada (Dept. of Physics), June Nguyen (Dept. of Physics), Eduardo Ceja (Dept. of Mechanical Engineering), Marco O'Malley (Dept. of Computer Engineering), Dr. Andrew Renshaw (Dept. of Physics), Dr. Edgar A. Bering (Dept. of Physics)

As part of the Undergraduate Student Instrument Project (USIP) at the University of Houston, our team has redesigned an experiment previously attempted in the program to observe atmospheric conductivity. Atmospheric conductivity is defined as how easily ions move in the atmosphere and is proportional to their mobility and concentration (i.e., how quickly ions move and interact with one another in a given space, and how many there are in that space). The causes of short-term variations - variations in the space of minutes to hours - in this conductivity are still poorly understood. We have designed a balloon-borne payload experiment that will measure atmospheric conductivity while collecting meteorological and environmental data so the two can be compared alongside one another, and the influence of potential variables can be determined. Our design fits strict weight (<6 lbs.) and budget (<$3000) requirements. This serves the dual purpose of making our experiment compatible with our own constraints and making it a design that is replicable for others with strict requirements and limited finances.

Nuclear Pasta Under Magnetic Fields

April 4
3:30-5:00
Science
Bldg.

Alejandro Pinero (presenter)

UTRGV, Physics

CoAuthors: Nicholas Dimakis (UTRGV), Andrea Pelayo (UTRGV)

Nuclear pasta is a theoretical state of matter found in the inner crust of neutron stars. It is composed of protons and neutrons under extreme densities. The goal of the project is too investigate the effect of magnetic fields on the nuclear pasta of neutron stars. The group uses LAMMPS for the molecular simulations and looks for the evolution of said pasta under different variables including density, temperature, and ratio of protons to neutrons. Work from author Daniela Ramirez is referenced for her work on the subject, with the project specifically expanding on the effect of magnetic fields on the pasta. A different evolution of clusters is found when these magnetic fields are present, due to the Zeeman effect. Pictures of the simulations will be shown to emphasize the differences in evolution of the matter.

Funding acknowledgment: NuSTEAM

Developing an Advanced Radiation Detection Laboratory at UTEP Using Geiger-Muller Counters

April 4
3:30-5:00
Science
Bldg.

Andres Salazar (presenter)

The University of Texas at El Paso, Physics

CoAuthors: Balam Sotelo (The University of Texas at El Paso, Physics)Rene Bellweid (University of Houston, Physics)Jorge Munoz (The University of Texas at El Paso, Physics)

We are developing an advanced laboratory manual for senior undergraduate students focused on radiation and nuclear physics. The manual will provide a structured learning experience, beginning with fundamental concepts such as background radiation and radiation statistics, and progressing toward more complex topics like absorption of gamma rays or half-life determination of Ba-137m.To date, we have successfully conducted and adapted four key experiments:1.Geiger-Müller Plateau - Determining the plateau region and optimal operating voltage of a Geiger-Müller counter.2.Statistics of Counting - Investigating the statistical nature of radiation measurements, comparing Poisson and Gaussian distributions.3.Background Radiation - Measuring and analyzing background radiation to understand its influence on experiments.4.Resolving Time - Determining the resolving time of a GM counter to account for dead time effects in radiation detection.This project will serve as a valuable resource for students, enhancing their practical understanding of radiation physics through hands-on experimentation and data analysis.

Funding acknowledgment: This material is based upon work supported by the U.S. Department of Energy, Office of Science, Reaching a New Energy Sciences Workforce (RENEW) program award numbers DE-SC-0021994 and CW46261.

Pair Spectrometer Luminosity Detector for EPIC at the EIC

April 4
3:30-5:00
Science Bldg.

Philip Cole (presenter)

Lamar University

CoAuthors: Christopher Ezike (Lamar University), Jaden Mensah-Kennedy (Lamar University), Chase T Whisenhant (Lamar University), Arana Giri (University of Houston), Philip Cole (Lamar University)

In collaboration with the University of Houston and York University, the Lamar NuSTEAM team will help design the luminosity monitor for EPIC. The proposed luminosity monitor will form an essential component for the EPIC experiment and will be based upon the Bethe-Heitler process ep ep. The bremsstrahlung photon will then impinge upon a converter and will pair produce, i.e. ee. The resulting collinear eepair will then enter the field of a magnetic dipole causing these oppositely charged relativistic leptons to separate through being swept out in oppositely curved trajectories and exit into straight-line path directed onto highly segmented stacked arrays of ECALs for measuring the energy of each of these pair-produced leptons. The design of the ECAL is based on the Beam Pipe Calorimeter detailed in unpublished thesis of Bernd Surrow (DESY,1998). We will present the ideas behind mapping out the acceptance of the calorimeters as a function of E. We will discuss the simulations used to adjust the magnetic fields to optimize the acceptance of the pair-produced ee, by accurately reconstructing the parent bremsstrahlung photons energy and thereby directly measuring the overall pair-production rate for precisely ascertaining the EIC electron beam flux.

Funding acknowledgment: DE-SC0024354

Effects of Electrons on the Speed of Sound in a Proton-Electron Magnetized Neutral System

April 4
3:30-5:00
Science
Bldg.

Cesar H. Morales Alba (presenter)

University of Texas Rio Grande Valley + Department of Astronomy Physics

CoAuthors: Dr. Efrain J. Ferrer

We take into consideration a proton-electron neutral system in the presence of a moderate magnetic field. The speed of sound (SoS) in such a system is calculated considering that the electron chemical potential depends on the baryonic chemical potential through the neutrality condition. It is shown that the square of the SoS in such a system is one order larger than the square of the SoS in a system only formed by protons at the same density. This result is of interest for the astrophysics of neutron stars, as a large SoS will indicate how stiff the equation of state of the system is and therefore how big the mass of the star can potentially be.

Funding acknowledgment: National Science Foundation Grant No. PHY-2013222 and De- partment of Energy Grant No. DE-SC0022023

Oxidization Conditions Determination of Additively-Manufactured Inconel 718 Samples

April 4
3:30-5:00
Science
Bldg.

Analisa Mayo-Ramos (presenter)

University of Texas at San Antonio , Physics Department

CoAuthors: Dr. Elizabeth Sooby (University of Texas at San Antonio, Department of Physics Astronomy), Dr. Patrick Warren (University of Texas at San Antonio, Department of Physics Astronomy)

Additively manufactured metal alloys are a proposed alternative to joints, fasteners, and other complex geometry parts within nuclear reactors. Currently, oxidization behavior of AM materials as print conditions vary is not well understood, and the corresponding mechanical performance requires further investigation. The main objective of the research presented is to choose an optimal temperature to perform air oxidization of Inconel 718 samples to further elucidate oxidative difference in varied build/print parameters. High-temperature exposures were performed via a Netzsch simultaneous thermal analyzer (STA) over a temperature range of 800°C to 1000°C and a 4 hour isothermal hold under 200 ml/min of N2/O2 and 20 ml/min of Ar. Five Inconel 718 samples, printed with standard parameters as selected by Oak Ridge National Laboratory, were exposed. Subsequently ex-situ characterization was performed with the Hitachi FlexSEM 100 Scanning Electron Microscope and Oxford Instruments energy dispersive x-ray spectroscopy. SEM images of the top surface and the cross-section of the Inconel 718 samples, the 900°C to 1000°C oxidization

range, is too aggressive due to the presence of large nucleated oxide grains, failing oxide layers, and large blister.

Funding acknowledgment: CONsortium of Nuclear sECurity Technologies (CONNECT), National Nuclear Security Administration Minority Serving Institution Partnership Program (NNSA MMSIPP), Department of Energy (DOE)

Atmospheric Neutrino Non-standrad Interaction Search in NOvA and DUNE Experiment

April 4
3:30-5:00
Science Bldg.

Muyuan He (presenter)

University of Houston, department of physics

Neutrino oscillation experiments have reached an era of high precision, where all oscillation parameters except for the cp-violation phase δ_{CP}, are now measured within 5

Creating a Catalog of Fully Characterized TESS Detached Eclipsing Binaries

April 4
3:30-5:00
Science Bldg.

Kaloyan Penev (presenter)

University of Texas at Dallas

CoAuthors: Joshua Schussler (University of Texas at Dallas)

We are in the process of conducting a detailed homogeneous Bayesian analysis of TESS eclipsing binary lightcurves and spectral energy distributions to extract the physical properties of these systems, along with detailed information about the associated, often non-Gaussian and highly correlated, uncertainty distributions. I will present the methodology and early results of this effort.

Funding acknowledgment: NASA grant 80NSSC23K1486

Computational Analysis of Microthruster Array for Minimum Thruster Size Validation

April 4
3:30-5:00
Science
Bldg.

Karen S Martirosyan (presenter)

University of Texas Rio Grande Valley

CoAuthors: Samuel Gauna, and Maxim Zyskin

The design of microthruster arrays for space propulsion require a detailed understanding of plume-plume and plume-wall interactions to ensure efficient operation, prevent unplanned ignition, and minimize material degradation. This study employs computational simulations to determine the minimum feasible thruster size in an array while mitigating neighbor interference effects. The combustion process of nanoenergetic fuel is modeled on a millisecond timescale with an ignition temperature threshold set at 0.5 (normalized scale), evaluating thrust efficiency and structural integrity under varying operational conditions. Additionally, additive printing technologies have been used for the rapid prototyping and volumetric printing of individual microthrusters and thruster arrays, enabling precise control over chamber and nozzle geometries for optimized performance. The study explores how these advanced fabrication techniques can be leveraged to produce thrusters with minimized interference effects, ensuring that size constraints do not compromise thrust generation, thermal stability, or material durability. The study provides critical insights into microthruster array optimization, offering a pathway for enhanced scalability and reliability in next-generation space propulsion systems.

Funding acknowledgment: NASA MPLAN Award

Capturing Cellular Dynamics: A Force Center Model Inspired by the Game of Life

April 4
3:30-5:00
Science
Bldg.

YooJin Choi (presenter)

Angelo State University

CoAuthors: Michael C. Holcomb

Force center models have been used to analyze large-scale tissue rearrangements during embryonic development. These studies have identified possible intercellular coordination via mechanical stress feedback. Here, we present a force center model that implements principles from Conways Game of Life. Our approach aims to explore aspects of proliferation dynamics and potential apoptosis triggers of cancer cells. Through development of a mechanical stress responsive cellular automata, we demonstrate that mechanical stress feedback may play a role in these dynamic cellular behaviors.

Funding acknowledgment: Angelo State University Undergraduate Faculty Mentored Research Grant

Scattering kinematics in Neutrino Generators

April 4
3:30-5:00
Science
Bldg.

Lars Walker (presenter)

UH

CoAuthors: Daniel Cherdack(UH) , Kristen Dobbs(UH)

Neutrinos are fundamental fermions with no electric or color charge and relatively small masses. Neutrinos cannot be directly observed and their properties must be inferred from their interaction products. Neutrinos are studied using active detectors, where the nuclear target material also serves as the outgoing particle detector. The observed properties of the interaction products can be used to characterize the incoming neutrinos as well as the physics of the interaction process, e.g. the Weak Charge (Weak Isospin) distribution within a nucleon. Neutrino generators are collections of neutrino interaction models that make predictions of outgoing particle kinematics for a variety of interaction processes. In one such process, known as two-particle, two-hole (2p2h), neutrinos interact with an interacting pair of nucleons within a nucleus. In this poster I will describe basic scattering theory and show how the predicted interaction kinematics and final state observables are connected for this 2p2h process. I will compare this 2p2h process to a similar process, one-particle, one-hole (1p1h), to demonstrate how the predicted kinematics differ.

Solution Processed Sb2S3 Thin Film Solar Cells

April 4
3:30-5:00
Science
Bldg.

suresh Nonis (presenter)

University of Houston , Department of Physics

CoAuthors: Suresh Nonis, Maggie Paulose, and Oomman K. Varghese*1Nanomaterials and Devices Laboratory, Department of Physics, University of Houston, Houston, Texas 77204, USA 2Texas Center for Superconductivity, University of Houston, Houston, Texas 77204, USA*Corresponding author email: okvarghese@uh.edu

Sustainability demands environmentally benign, low cost, plentiful materials for solar cell application. Antimony sulfide (Sb_2S_3) is such a semiconductor with optoelectronic characteristics highly suitable for photovoltaics. It is a member of the chalcogenide family with a direct bandgap of ∼1.7 eV and a high absorption coefficient (¿10^5 cm^{-1}). We explored the structural, optical, and electrical properties of Sb_2S_3 thin films fabricated using hydrothermal and solution processing. Devices were fabricated on fluorine doped tin oxide glass with TiO2 as the electron transport layer, CdS as the buffer layer, Sb2S3 as the absorber, and P3HT as the hole transport layer. The device characterization revealed the effects of deposition conditions and post-fabrication treatments in enhancing the performance. This presentation provides the details of the work.

Funding acknowledgment: Department of Physics, University of Houston. Texas Center for Superconductivity, University of Houston.

Reducing Cognitive Load: Creating Educational Physics Lecture Videos

April 4
3:30-5:00
Science Bldg.

Antonio Cascio (presenter)

East Texas AM University - Department of Physics and Astronomy

CoAuthors: Kitty Todd (East Texas AM University - Department of Physics and Astronomy)

Online educational videos serve as key instructional tools for students and supplement in-class learning. However, their presentation may either aid or hinder information retention. This study utilizes Cognitive Load Theory and prior multimedia learning research to design videos that minimize cognitive load and enhance comprehension. The aim is to evaluate the effectiveness of high-quality, research-based videos in introductory physics classes and optimize their potential benefits, such as improving students' understanding outside of class, enabling more in-class problem-solving practice, and aiding teachers in explaining complex concepts. The videos are created using Python's Manim library and incorporate multimedia principles to systematically reduce cognitive load. To achieve this, feedback from undergraduate and graduate students will be collected via post-surveys. These surveys measure cognitive load while viewing videos on challenging physics concepts. Analyzing survey responses will assess the effectiveness of the video lessons and compare them to lecture-based videos. The findings aim to emphasize the importance of reducing cognitive load in and out of the classroom, ultimately improving material retention.

Numerical Calculations of the Energies and the Decay Energy Spectra of Quantum Mechanical Resonances

April 4
3:30-5:00
Science Bldg.

Caleb Gregory (presenter)

Lamar University SPS President Physics Department

CoAuthors: Daniel Figueroa, Dr. Rafael de la Madrid.

In quantum mechanics, unstable states (called resonances) decay spontaneously. Such decays are characterized by their energies and spectra. In this project we intended to develop a numerical procedure to calculate the energies and the decay spectra of quantum mechanical resonances. Using Fortran and Mathematica I was able to build a program that could find the resonances of Oxygen.

Funding acknowledgment: SURF (Surf Undergraduate Research Fellowship) Lamar UNiversity Physics Departmetn, Lamar Undergraduate Research Assocaition

A low-cost Raman spectrometer for liquid sample analysis

April 4
3:30-5:00
Science
Bldg.

Phil Alcorn (presenter)

Tarleton State University, Department of Chemisty, Geoscience, and Physics

CoAuthors: Ryan Adkins (Tarleton), Asher Boniol (Tarleton), Fabian Gonzalez (Tarleton), Dr. Christopher B. Marble (Tarleton)

Raman spectroscopy is a powerful tool for analyzing liquid samples, offering molecular fingerprinting capabilities for detecting and identifying contaminants. We constructed a Raman spectrometer for liquid sample analysis for under $3,000. We utilized 3D-printed part designs from OpenRaman.org to minimize the price of the spectrometer. The spectrometer was calibrated using a neon discharge lamp, achieving a full width at half maximum (FWHM) resolution of 0.5 nm (15 cm^{-1}). To validate its performance, we recorded the Raman spectra of isopropyl alcohol, detecting the characteristic C-C and C-H stretch vibrations. Our results demonstrate the feasibility of an affordable, customizable Raman spectrometer for liquid analysis, with potential applications in environmental monitoring, chemical identification, and contamination detection.

Funding acknowledgment: Student research funded by Tarleton State University

Parallel Sessions 3, April 5 9-10:30

High Energy 3, S116

1: Quarkyonic Matter at Finite Temperature Nonzero Isospin Asymmetry

April 5
09:00 -
09:12
S116

Tripp Moss (presenter)

University of Houston

CoAuthors: Volodymyr Vovchenko, Roman Poberezhniuk

We extend the recently developed quantum van der Waals quarkyonic matter to nonzero isospin asymmetries by utilizing the two-component van der Waals equation with a generalized excluded volume prescription. We find that the speed of sound peaks well above the conformal limit for all values of the asymmetry parameter, signifying a transition from hadronic to quarkyonic matter. We also incorporate leptonic degrees of freedom and explore the neutron star equation of state, calculating mass-radius relations and tidal properties of neutron stars. Finally, we extend our analysis from T=0 to finite T, probing the temperature dependence of the quarkyonic transition.

2: QCD equation of State from Black Hole and Hadronic Physics

April 5
09:12 -
09:24
S116

Prachi Garella (presenter)

University of Houston

CoAuthors: Musa R. Khan, Claudia Ratti, Jorge Leite Noronha, Joaquin Grefa, Rmulo Rougemont, Mauricio Hippert, Yumu Yang

We present a new equation of state for hot and dense matter with a broad coverage in density and temperature, obtained by merging a Hadron Gas Model with van der

Waals interactions with a deconfined medium described through holography. A family of 5-dimensional holographic black holes, constrained to mimic the lattice QCD equation of state at zero density, is used to investigate the temperature and baryon chemical potential dependence of the equation of state around and above the QCD phase transition. The model correctly reproduces lattice QCD thermodynamics, but it does not provide a proper description of the hadronic phase. For this reason, we merge the holographic equation of state with the hadronic one at temperatures below the phase transition. This new equation of state, that contains a first order phase transition at high chemical potential and a critical point at $T = 103$ MeV and $\mu_B = 597$ MeV, covers a large range in temperature and chemical potential, thus providing a useful tool for hydrodynamic simulations of heavy-ion collisions.

Funding acknowledgment: Department of Energy, Office of Science, Office of Nuclear Physics, National Aeronautics and Space Agency (NASA)

3: A new 4D lattice QCD equation of state: extended density coverage from a generalized T-expansion

April 5
09:24 -
09:36
S116

Johannes Jahan (presenter)

University of Houston - Department of Physics

CoAuthors: Ahmed Abuali (University of Houston), Szabolcs Borsanyi (Wuppertal University), Micheal Kahangirwe (University of Houston), Paolo Parotto (Universit di Torino), Attila Pasztor (ELTE Etvs Lornd University), Claudia Ratti (University of Houston), Hitansh Shah (University of Houston), Seth Trabulsi (Rice University)

Although calculations of QCD thermodynamics from first-principle lattice simulations are limited to zero net-density due to the fermion sign problem, it is possible to extend the equation of state (EoS) to finite values of the B, Q and S chemical potentials via expansions around zero chemical potentials. Taylor expansion around zero chemical potentials enables to cover with confidence the region up to $\mu/T < 2.5$, and is usually limited at 450 MeV in any chemical potential. Thanks to a new method based on a T'-expansion scheme, it was however possible to extend the reach of the extrapolation in the (T, μ_B) plane, up to a baryo-chemical potential around $\mu_B/T = 3.5$. We present here a generalization of this scheme in which all three chemical potentials can be varied independently. We base our construction on continuum-estimated susceptibilities, obtained with the 4stout action on lattices with up to $N_\tau = 16$, 20 and 24 time slices, depending on the quantity considered. As a result, we are able to offer a substantially larger coverage of the four-dimensional QCD phase diagram, compared to extrapolations based on the Taylor expansion.

Funding acknowledgment: This material is based upon work supported in part by the National Science Foundation within the framework of the MUSES collaboration, under grant number No. OAC-2103680, as well as under grants No. PHY-2208724, PHY-1748958 and PHY-2116686, in part by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Award Number DE-SC0022023, as well as by the National Aeronautics and Space Agency (NASA) under Award Number 80NSSC24K0767.

4: Jet quenching parameter within a baryon-dense quark-gluon plasma from holographic black holes

April 5
09:36 -
09:48
S116

Musa Rahim Khan (presenter)

University of Houston

CoAuthors: Ayrton Da Cruz Pereira do Nascimento (Instituto de Fsica da Universidade Federal do Rio de Janeiro), Joaquin Grefa (Kent State University), Maurcio Hippert (Rio de Janeiro State University), Claudia Ratti (University of Houston), Jorge Noronha (University of Illinois at Urbana-Champaign), Romulo Rougemont (Universidade Federal de Goias), Raghav Kunnawalkam Elayavalli (Vanderbilt University)

We investigate the properties of hot and strongly coupled quark-gluon plasma using an Einstein-Maxwell-dilaton model, which is based on the gravity/gauge duality framework. Our approach employs a five-dimensional holographic black hole model, calibrated to match the lattice QCD equation of state at zero chemical potential. The model, with updated parametrization, exhibits a line of first-order phase transition at high chemical potential, with a critical point located at $T = 103.5$MeV and $\mu_B = 597.5$ MeV. Here we focus on studying the jet quenching parameter in a baryon-rich quark-gluon plasma, particularly along the line of first-order phase transition and in the vicinity of the critical point. Additionally, we show how Bjorken flow can be applied to derive a time-dependent holographic jet quenching parameter, which plays a crucial role in understanding jet energy loss for both modeling and phenomenological applications.

Funding acknowledgment: MUSES , NSF

5: Lattice QCD-Based 3D-Ising Equation of State: Universal Behaviors Near the Critical Point

April 5
09:48 -
10:00
S116

Micheal Kahangirwe (presenter)

University of Houston, Physics Department

CoAuthors: Claudia Ratti (University of Houston), Maneesha Pradeep (University of Maryland)

I present a novel construction of the quantum chromodynamics (QCD) equation of state (EoS) incorporating a 3D-Ising critical point at finite baryon density. This approach extends the density coverage beyond previous lattice Taylor expansions

around $\mu_B = 0$ by employing the T'-expansion scheme, which performs particularly well near the transition line where the scaling relation $(\partial/\partial T)_{\mu_B} = (\partial^2/\partial\mu_B^2)_T$ dominates. The position, shape, and strength of the critical point can be tuned within a range accessible to beam-energy scan heavy-ion collision experiments. Using thermodynamic principles, I analyze the universal behavior of the specific entropy per baryon along the first-order transition (coexistence) line, revealing potential non-monotonic features that could impact hydrodynamic trajectories. These findings have phenomenological implications for the study of heavy-ion collisions and neutron star mergers, offering new insights into the QCD phase structure at finite density.

Funding acknowledgment: This material is based upon work supported by the National Science Foundation under grants No. PHY2208724, PHY-1654219 and PHY-2116686, and within the framework of the MUSES collaboration, under grant number No. OAC-2103680. This material is also based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Award Number DE-SC0022023 and by the National Aeronautics and Space Agency (NASA) under Award Number 80NSSC24K0767.

6: Thermodynamics of 3-Flavor NJL Model with Quark-dependent Vector Coupling

April 5
10:00 -
10:12
S116

Jonathan Gonzales (presenter)

University of Houston, Physics

CoAuthors: Claudia Ratti, Tulio Restrepo

The Nambu-Jona-Lasinio (NJL) model serves as a chiral-symmetric effective model for describing Quantum Chromodynamics (QCD), that contains a critical point on the phase diagram. In the application to dense stars, the NJL model requires a vector-repulsion term to obtain large enough star masses, consistent with experimental observations. In this presentation, we will explore the thermodynamic properties of the NJL model for 2 + 1 flavours, and focus on the vector-repulsion term with a condensate-dependent coupling, implemented to improve the thermodynamic behavior at high temperature.

Condensed Matter 3, S114

1: Stability analysis of doped carbon nanotubes (CNTs)

April 5
09:00 - 09:12
S114

Huma Nawaz (presenter)

University of Houston, Department of Physics

CoAuthors: Huma Nawaz, Chunhua Li, and Chin Sen Ting

In this study, we investigated the electronic band structure and stability of doped (5, 0), (5,5), and (7, 0) CNTs. Dynamical stability was studied through phonon dispersion and ab initiomolecular dynamics calculations (AIMD) as implemented in the Quantum-espresso suite1. Doping of the groups 13, 14, and 15 elements was studied. We also studied the dependence of stability on doping concentrations. Due to the one-dimensional (1D) nature of the systems, while all our proposed pristine CNTs are stable, many of the CNTs with dopants produce unstable structures. We analyzed the bonding and vibration modes around the dopant atoms to elucidate the underlying cause of instability. The electron-phonon interaction and superconducting transition temperature (Tc) were also calculated for stable pristine and doped CNTs. It was seen that (5,0) Si CNT exhibited a maximum value of Tc.

Funding acknowledgment: Not applicable

2: Elastic Properties of Electron-Irradiated Graphene Drums.

April 5
09:12 - 09:24
S114

Anil Pudasaini (presenter)

Department of Physics, University of North Texas

CoAuthors: Franklin Talbert, Thineth Bandara Jayamaha Hitihamilage, Jacob Hardin, Mahendra Subedi, Jingbiao Cui, Jose Perez (Physics Department, University of North Texas)

In this study, we aim to investigate the mechanical behavior of graphene drums subjected to electron irradiation. Electron irradiation in the energy range of 5-30 keV is commonly used for characterizing and modifying graphene, as well as for fabricating devices through e-beam lithography. To date, the effects of such electron irradiation on graphene have not been well understood. Irradiation was carried out using a scanning electron microscope, with dosages ranging from 110^{15} e/cm to 110^{16} e/cm. This irradiation is believed to induce hydrogenation. Nanoindentation measurements were performed before and after irradiation, and the experimental data were fitted to theoretical models to determine the elastic modulus. Fluctuations in the elastic modulus were observed, which are attributed to the formation of a carbonaceous film and hydrogenation during the irradiation process. To mitigate this, further irradiations will be conducted in ultrahigh vacuum (UHV) conditions. This behavior is consistent with previously reported data, which show an increase in the elastic modulus for low defect densities due to the suppression of long-wavelength phonon modes

Funding acknowledgment: This research work is supported by the National Science Foundation (NSF) DMR-2312436.

3: Modeling the effects of electron irradiation on graphene drums using the local activation model

April 5
09:24 -
09:36
S114

Thineth Bandara Jayamaha (presenter)

Department of Physics, University of North Texas

CoAuthors: Ibikunle Ojo, Jacob Hardin, Anil Pudasaini, Roberto Gonzalez, Jiang Yan, Jingbiao Cui, and Jose Perez (Department of Physics, University of North Texas)

We investigate the effects of electron irradiation on suspended graphene monolayers and graphene supported on SiO_2 substrates within the electron dose range of 5.0×10^{15} to 4.3×10^{17} electrons/cm^2. The suspended graphene monolayers are mechanically exfoliated onto SiO_2 substrates with micrometer-sized holes, ensuring that the graphene completely covers the holes. Irradiation was performed using a scanning electron microscope at 2025 keV electron energy. Our observations reveal a two-stage behavior in the ratios of the Raman peaks: I_D/I_G, $I_{D'}/I_G$, and $I_D/I_{D'}$ as a function of the average distance between defects, L_D, where I_D, I_G, and $I_{D'}$ correspond to the intensities of the D, G, and D' peaks, respectively. We obtain excellent fits to the dependence of these ratios on L_D using the local activation model equation. Additionally, we conducted annealing studies on samples irradiated to the first stage and used an Arrhenius plot to measure activation energies for defect healing (E_a). For the graphene drums, we obtained $E_a = 0.90$ eV, which is consistent with the presence of hydroxyl groups, while for supported graphene, $E_a = 0.36$ eV, corresponding to hydrogen adsorbates. Our results demonstrate that the local activation model is an effective tool for characterizing defects in graphene drums.

Funding acknowledgment: National Science Fundation (DMR-2312436)

4: Effects of Incident Electron Energy on Electron-Irradiated Graphene

April 5
09:36 -
09:48
S114

Mahendra Subedi (presenter)

University of North Texas

CoAuthors: Thineth B Jayamaha, Sabin Gautam, Yamnath Poudel, Anil Pudasaini, Dr. Jose Perez, Dr. Dr. Jingbiao Cui

In this paper, we systematically explore the consequences of electron irradiation on mechanically exfoliated graphene through scanning electron microscopy (SEM) at electron energies of 1 KeV, 2 KeV, 4 KeV, 8 KeV, 16 KeV, and 30 KeV. We use Raman spectroscopy as our preliminary characterization technique to evaluate the formation of defects by examining the I_D/I_G and $I_{D'}/I_G$ ratio and determining the energy-dependent evolution of defects. Our observations show a clear trend in generating defects in graphene: lower electron energies produce more defects than higher electron energies. Our results can be explained by the interaction of low-energy electrons with the graphene lattices atomic structure; lower-energy irradiations result in more bond-breaking and defect build-up through localized energy deposition. Higher electron energies reduce the likelihood of defects forming due to a reduced inelastic scattering cross-section and increased penetration depth, reducing the energy delivered directly to the graphene lattice. Additionally, our work suggests the possibility of hydrogenation occurring because of irradiation, which may influence defect formation and graphenes electronic properties.

Funding acknowledgment: This work was supported by the National Science Foundation under Award Number DMR-2312436.

5: Hydrogenation of Graphene Using Electron Irradiation in Ultra-High Vacuum Studied Using X-Ray Photoelectron Spectroscopy

April 5
09:48 -
10:00
S114

Jacob Hardin (presenter)

University of North Texas, Department of Physics

CoAuthors: Thineth Jayamaha (University of North Texas), Anil Pudasaini (University of North Texas), Roberto Gonzalez Rodriguez (University of North Texas), Jingbiao Cui (University of North Texas), Jose Perez (University of North Texas)

There have been numerous reports on the hydrogenation of graphene using electron irradiation in the 1020 keV electron energy range. Most of these studies have relied on Raman spectroscopy for characterization, which is not an element-specific technique. We have used X-Ray photoelectron spectroscopy (XPS) for this study, which is a more element-sensitive technique. Chemical vapor deposition grown graphene samples were irradiated to a dosage of 1×10^{17} electrons/cm^2 with a beam energy of

1.5 keV in an ultra-high vacuum (UHV) chamber at a base pressure of 3×10^{-10} torr. After irradiation, the samples were removed from the UHV chamber and placed in a different chamber for XPS studies. The C1s XPS peak showed that before irradiation, the sample mostly showed sp^2 type carbon and hydroxyl (C-OH). After irradiation, we found that the XPS spectra corresponded to a higher proportion of sp^3 carbon due to C-H$_2$ than sp^2 carbon. After annealing, we placed the same sample back in the UHV system and irradiated it under similar conditions as before. We then did XPS again and observed the same effect that after irradiation, the mostly sp^2 carbon and C-OH changed to mostly sp^3 carbon associated with C-H$_2$. We attribute hydrogenation to the electron-induced dissociation of adsorbed water or the C-OH.

Funding acknowledgment: The research was funded by NSF grant DMR-2312436

6: Kondo effect in strained kagome systems

April 5
10:00 -
10:12
S114

Patricia de Assis Almeida (presenter)

Universidade Federal de Uberlandia

CoAuthors: George martins and Sergio Ulloa

Kagome systems have recently received significant attention due to the discovery of kagome metals, such as alkali-based AV3Sb5 [1]. A prominent feature of the kagome lattice is the appearance of both dispersive bands with graphene-like Dirac points and van Hove singularities, as well as a flatband with highly degenerate states. This makes it an ideal system for studying topology and correlation effects. Here, we focus on the latter by analyzing the characteristics of the Kondo effect for a magnetic impurity in kagome systems under the influence of homogeneous strain. We analyze the system using the single impurity Anderson model (SIAM) and the numerical renormalization group (NRG). We find that the presence of singularities in the density of states of the nanoribbon and their strong sensitivity to applied strain allows for the enhancement and/or suppression of the Kondo effect in the impurity-plus-kagome system. This control affects the Kondo temperature and associated features, such as the spectral function. We present results for different impurity bonding geometries and chemical potentials to assess the effect of various features on spin screening.

Funding acknowledgment: CAPES-print

Astronomy / Astrophysics, S102

1: Constraining Tidal Dissipation for Kepler Binaries

April 5
09:00 -
09:12
S102

Joshua Schussler (presenter)

University of Texas at Dallas

CoAuthors: Torsha Majumder (University of Lethbridge), Kaloyan Penev (University of Texas at Dallas)

Tidal dissipation plays an important role in the evolution of stellar systems, but more data is needed to test models against. Our group uses a computational approach to constrain the amount of tidal dissipation in a system based on its circularization. We are applying this approach to binaries from the Kepler space telescope. Here, I present our first results.

Funding acknowledgment: NASA grant 80NSSC23K1486

2: Maximum entropy estimates of Hubble constant from Planck measurements

April 5
09:12 -
09:24
S102

David Knobles (presenter)

The Platt Institute of Cosmology and Nuclear Physics

CoAuthors: David Knobles (The Platt Institute) and Mark Westling (Meta)

Maximum entropy (ME) is used as a method to infer the Hubble constant from the anisotropies in the cosmic microwave background (CMB) measurements made by the Planck satellite. A simple cosmological model provides physical insight into parameter sensitivities and affords a robust statistical sampling of a parameter space. The parameter space includes the spectral tilt and amplitude of adiabatic density fluctuations of the early universe and the present-day ratio of dark energy density to the critical mass density, and terms involving the ratios of matter and baryonic densities and the Hubble constant. A statistical temperature is estimated by applying the equipartition theorem which uniquely specifies a posterior probability distribution. The ME analysis implicitly infers a mean value of the Hubble constant to be about 67.5 km/sec/Mpc with a standard deviation of about 2.5 km/sec/Mpc. The Planck collaboration result is 67.4 km/sec/Mpc with a standard deviation of 0.5 km/sec/Mpc. The upper limit of the ME value for the Hubble constant of about 70 km/sec/Mpc lies in the middle of the set of estimates from the Chicago Carnegie Hubble Program using data collected from the James Webb Space Telescope (JWST).

Funding acknowledgment: The Platt Institute

3: An Industrial Application of Auroral Acceleration Processes

April 5
09:24 -
09:36
S102

Edgar Andrew Bering, III (presenter)

University of Houston, Physics and ECE

What is the practical application of this work? is a question that all of us have confronted many times throughout our careers. Wave-particle interactions found in the aurora may be used in the design of electric propulsion systems for spacecraft. RF power has been used or proposed in electric propulsion systems to ionize, to heat, and to accelerate the propellant. The VAriable Specific Impulse Magnetoplasma Rocket (VASIMR®) is a high-power electric spacecraft propulsion system, capable of Isp/thrust modulation at constant power. The VASIMR® uses a helicon discharge to generate plasma. The plasma is leaked through a strong magnetic mirror to the second stage. In this stage, this plasma is energized by an RF booster stage that uses left-hand polarized slow mode waves launched from the high field side of the ion cyclotron resonance. The single-pass ion cyclotron heating (ICH) produces a substantial increase in ion velocity in the resonance region. This perpendicular velocity is converted to axial flow velocity through the conservation of the first adiabatic invariant as the magnetic field decreases in the exhaust region.

Funding acknowledgment: Funding for this work was provided by the AdAstra Rocket Company.

4: Constraining Neutron Star EoS Using Machine Learning and the CompOSE Database

April 5
09:36 -
09:48
S102

Josiah Daniel Baker (presenter)

East Texas AM, Department of Physics and Astronomy

CoAuthors: Dr. Ronaldo V. Lobato (Universidade de So Paulo (UNICID), So Paulo, Brazil), Dr. Carlos Bertulani (East Texas AM, Commerce Tx, Department of Physics and Astronomy)

Astronomical data collected so far have not been sufficient todetermine the internal structure of neutron stars (NSs). One of themain telltales of the internal structure of a NS is its equation ofstate (EoS), i.e., the relation between its internal pressure anddensity. The NS EoS has been studied theoretically using numerousphenomenological and microscopic nuclear models. Many of these EoShave very different underlying assumptions. Comparison of such modelswith observations have not been able to provide a compelling evidencesfar of the best theoretical model found in the literature. As aresult, there are many different EoS that reproduce astronomicalobservations equally. To further constrain and find the most suitableEoS one has increasingly adopted Bayesian analysis techniques. Thismethod been used by many authors to probe the impact ofphenomenological and microscopic EoS on known data, including recentobservations from NICER and LIGO. We are currently working with thismethod using applications of Machine Learning (ML) to improve theconstraints placed on the several EoS, comparing them withastronomical observations and with available nuclear reaction data. Weextend our group previous works on ML by including numerous EoScompiled by the CompOSE task force.

Funding acknowledgment: This work was partially supported by a DOE-Pantex grant to East Texas AM University

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5: Induced Magnetic Moment of Neutrinos in High Magnetic Fields

April 5
09:48 - 10:00
S102

Jean Guma De la Vega (presenter)

University of Houston-Clear Lake

CoAuthors: Namratha Gopanaboyina, Samina S. Masood

In a statistical background, the electromagnetic properties of particles are known to change, with the electric charge and mass of particles being modified at finite temperature and density (FTD). The massless gauge bosons also acquired dynamically generated mass due to the plasma screening effect. As such, the magnetic moment is expressible as a function of temperature and chemical potential. In addition, very high magnetic fields can affect the mass of electrons. Modifications to the properties of particles occur within the high temperature and density environment and high magnetic fields of Neutron Stars. Using hot and dense fermion propagators and modified electron mass, we can calculate the magnetic moment of Dirac neutrinos inside the extreme environments of Neutron Stars.

6: Measurement of double differential charged current muon neutrino scattering in three-momentum transfer and available energy using the NOvA Near Detector

April 5
10:00 - 10:12
S102

Travis Olson (presenter)

University of Houston

CoAuthors: Travis Olson (University of Houston, for the NOvA collaboration

This talk presents results of inclusive charged-current muon-neutrino-nucleus scattering results in three-momentum transfer and available energy. The measurements are based on an estimated 995,760 Nu-Mu CC interactions in the scintillator medium of the NOvA Near Detector. The subdomain populated by 2-particle-2-hole is by the cross-section excess relative to predictions for numu-nucleus scattering that are constrained by a data control sample, and the full domain and restricted domain

measured inclusive cross sections are compared to various models for the 2-particle-2-hole process.

Funding acknowledgment: Department of Energy

7: Propagation of Electromagnetic Waves in Hot and Dense Media

April 5
10:12 -
10:24
S102

Namratha Chander Gopanaboyina (presenter)

University of Houston- Clearlake, Department of Physical and Applied Sciences

CoAuthors: Jean Guma De la Vega (University of Houston Clearlake), Dr. Samina Masood (University of Houston Clearlake)

In extreme astrophysical environments such as neutron stars, ultra-high tem-peratures and densities significantly alter electromagnetic wave propagation.This study examines Quantum Electrodynamics (QED) in hot and dense me-dia by evaluating renormalization constants for electromagnetic interactions atfinite temperature and chemical potential. These modifications affect key pho-ton properties, including dispersion, polarization, and absorption, which play acrucial role in high-energy astrophysical processes.Using Masoods ABC functions within the real-time formalism of QED, wecompute finite-temperature and density corrections to the renormalized charge,wavefunction, and electron self-mass. The variations in the renormalized cou-pling constant and radiative self-mass corrections provide insight into how electroweak interactions influence photon behavior in extreme conditions. A keyresult is the emergence of a non-zero photon mass, leading to modifications inpolarization states, electric permittivity, and magnetic permeability, ultimatelyaffecting light refraction in compact objects.

Biophysics / Medical Physics, S115

1: Comparison of Effects of Propofol, Sevoflurane and Isoflurane on DPPC Lipid Membrane Fluidity at Clinical Concentrations

April 5
09:00 -
09:12
S115

Muhammad Bilal Siddique (presenter)

Department of Physics and Astronomy, Texas Tech University Lubbock

CoAuthors: Juyang Huang, Department of Physics and Astronomy, Lubbock

In this study, the effects of anesthetic drugs propofol and sevoflurane on lipid membrane fluidity are compared with isoflurane. To get a basic picture, the simplest lipid membrane of DPPC was chosen. Lipid membranes were labeled with dipyrene-PC

fluorescent probe, whose excimer/monomer (E/M) fluorescence peak ratio showed an immediate increase after adding the drugs, indicating a sharp increase of membrane fluidity. We studied clinical concentrations of 10 M propofol, 0.5 mM sevoflurane and 1 mM isoflurane. The fluidity increases at these concentrations on DPPC lipid bilayer are comparable, and all drugs are quite effective to loosen up the highly ordered lipid domains of saturated lipids, and significantly and rapidly increase membrane fluidity.

2: The role of mechanical stress in cephalic furrow formation in the Drosophila embryo

April 5
09:12 -
09:24
S115

Michael C. Holcomb (presenter)

Angelo State University Department of Physics and Geosciences

CoAuthors: Redowan A. Niloy (Texas Tech University Department of Mechanical Engineering), Guo-Jie J. Gao (Shizuoka University Department of Mathematical and Systems Engineering), Jeffrey H. Thomas (Texas Tech University Health Science Center Department of Cell Biology and Biochemistry), Jerzy Blawzdziewicz (Texas Tech University Department of Mechanical Engineering)

Cephalic furrow (CF) is an epithelial invagination that forms during gastrulation in the Drosophila melanogaster embryo. We present an analysis of how local forces associated with cell-membrane tensions and cell pressures interact with the long-range tensile stress along the invaginating furrow during the initial stages of cephalic furrow formation (CFF). We propose two numerical models which capture different aspects of CFF. The first is a force-center model that shows how the spatiotemporal heterogeneity of initiator-cell activation observed in vivo is likely a result of tensile-stress-feedback-based intercellular coordination. The second is a multi-node lateral vertex model that allows us to quantify the balance between cortical membrane tension forces, cellular pressures, and the inward force produced by the tension along the curved apical surface of the anteroposterior cross-section of the developing CF. Comparing our simulations to experimental results, we find that a tension-induced inward force plays a crucial and indispensable role during the initial stages of CFF. We argue that this inward force is necessary for the initial descent of the initiator cells during early CFF.

3: Developing an Adaptive Head and Neck Phantom

April 5
09:24 -
09:36
S115

Diana Carrasco (presenter)

The University of Texas MD Anderson Cancer Center, Department of Radiation Physics

CoAuthors: Paige Taylor (MD Anderson Cancer Center)

Adaptive radiation therapy (ART) adjusts radiation plans based on changes in a patient's anatomy over time, enhancing precision and minimizing exposure to healthy tissues. Despite its potential, ART's clinical effectiveness remains limited due to the lack of standardized tools to simulate changes. We address this gap by developing an adaptive head and neck phantom capable of mimicking anatomical changes during radiotherapy. Current efforts focus on quantifying anatomical changes and evaluating materials for tissue equivalence in different treatment modalities. Eight phantom materials were tested for tissue equivalence in proton therapy by comparing the measured and treatment planning system relative linear stopping powers (RLSP). Materials were considered tissue equivalent if the difference was less than 5

4: Microbial Growth in Various Environments

April 5
09:36 -
09:48
S115

Samina Masood (presenter)

Department of Physical and Applied Science, University of Houston Clear Lake

We study the impact of various environmental conditions on the growth rate of microbes. We mainly focus on bacterial growth in the presence of weak magnetic field, nanostructure or a comparative study of various surfaces. It has been found that the growth rate is significantly affected by the various types of magnetic fields or nanoripple structures. We have some preliminary results so far and investigate the theoretical reasons for the change of this behavior as well.

Funding acknowledgment: N/A

5: Characterization of the relative sensitivity of lymphocytes and their subtypes as a function of proton dose and LET

April 5
09:48 -
10:00
S115

Madison Grayson (presenter)

MD Anderson Cancer Center Graduate School of Biological Sciences, Medical Physics Department

CoAuthors: Madison Grayson (MD Anderson), Fada Guan (MD Anderson), Yuting Li (MD Anderson), Lawrence Bronk (MD Anderson), and Radhe Mohan (MD Anderson)

Radiation-induced lymphopenia (RIL) is a common adverse effect of radiation therapy and has a significant detrimental association with overall survival. Recent studies have demonstrated that proton therapy, presumably because of its smaller dose bath, mitigates the severity and incidence of RIL. However, protons have variable linear energy transfer (LET), which is currently not accounted for in RIL risk modeling. To incorporate LET into risk models, it is important to characterize the sensitivity of lymphocytes as a function of proton dose and LET. We have developed a specialized Lucite irradiation device (*jig*) to expose lymphocytes to a range of LETs. The jig is designed to fit into the snout of the proton treatment head, with a well plate positioned on top. The dose and LET distributions for this device have been determined using optimization techniques and calculated using a Monte Carlo simulation. Once irradiated, the lymphocytes are analyzed using flow cytometry. The jig was validated using Markus chamber measurements and EBT3 film. This preliminary work demonstrates the potential to characterize the dose and LET sensitivity of lymphocytes using this setup. Future studies will expose lymphocytes to a wider range of doses and LETs to fully characterize their sensitivity.

Teaching Workshopsf

Diversity, Equity, and Inclusion in Physics: Hard Conversations in an Anti-DEI Climate

April 5
08:30 - 09:30
S119

Jennifer Parsons

Tyler Jr. College, Engineering and Physical Sciences

DEI can affect our physics, and we need to figure out how to address it with regard to student success and promoting objectivity in science. STEM fields, while inherently objective, can be influenced by human biases and ignorance that create barriers to objectivity, participation and success. This session explores the critical need to address bias and awareness through STEM education and provides practical strategies for having caring and authentic course-relevant conversations in the classroom.

Exoplanets and Citizen Science Astronomy in the Classroom

April 5
08:30 - 09:30
F232

Mary Urquhart

University of Texas at Dallas, Department of Science/Mathematics Education and Department of Physics

Come learn about more about exoplanets, how the properties of exoplanets and their host stars are tied to the physics of astronomy, and how exoplanets are found. This workshop will also introduce exoplanet citizen science projects using data ranging from space-based missions to equipment as simple as a small robotic telescope or a color digital camera. Researchers at the University of Texas at Dallas, funded by the National Science Foundation, are developing free and open-source software and a web interface for extracting high precision brightness measurements of stars from citizen scientist observations with the PANOPTES, Exoplanet Watch, and the Unistellar network projects. In this session explore activities, demos, online resources, data, and opportunities for doing authentic science with students!

Teacher-participants will also be encouraged to apply for a paid Research Experience for Teachers taking place this summer at the University of Texas at Dallas. We acknowledge support from National Science Foundation Grant No. 2311527 for

Elements: Enabling High Precision Citizen Science Photometry from Wide Field Color Images.

Training Young Scientists and Engineers: Integrating Technology and Computational Thinking into Science Courses

April 5
09:30 -
10:30
F231

Michael C. Holcomb

Angelo State University Department of Physics and Geosciences

The evolving job market requires educators to adapt to changing needs and requirements in order to provide students with the necessary skills to be successful. The demand for computational skills has spread into almost every industry. Incorporating computational thinking skills into STEM curricula is therefore necessary to prepare today'ss learners for quality careers.

We will introduce activities and ideas that educators can incorporate into their classrooms. These have been used in, and adapted to, learners from middle school all the way through lower-level undergraduate physics and physical science courses. These activities incorporate electronic devices such as cell phones and Arduinos, allowing students to take real-time data and draw real-world context through directed inquiry-based exploration.

We will also demonstrate the Learning by Making platform, which has been successfully implemented into 9th grade classrooms in CA and is currently being implemented in 8th grade classrooms in both TX and CA as part of the STEMACES program (Science, Technology, Engineering, Mathematics, and Computing Educational Success; funded by US DoEd grant S411B230042). The implementation of coding and sensors in this manner has been shown to increase student learning in science and mathematics.

Exploring Gravitational Waves with VIGOR (Virtual Interaction with Gravitational waves to Observe Relativity)

April 5
09:30 -
10:30
F232

Mary Urquhart

University of Texas at Dallas, Department of Science/Mathematics Education and Department of Physics

The famous 2015 discovery of the first gravitational waves observed by the Laser Interferometer Gravitational-Wave Observatory (LIGO) ushered in a new frontier in astrophysics and brought gravitational waves into the public imagination. The power to virtually engage with gravitational waves is now at your fingertips. Bring your laptop or tablet with you to join us in an exploration of gravitational waves using a preview of our latest version of a free web-based VIGOR interactive. VIGOR is designed to go beyond rubber sheet and 'ripples in space time' analogies to build an intuitive understanding of a complex topic. Our approach uses engaging animations, approximations of accurate physics, and carefully designed user options for system properties and information displayed. Intended for use by a wide audience including novices and advanced students, the goal is to develop intuition about the tensorial nature of gravitational waves and how they are affected by the properties of binary black systems that emit them. One or more members of our multidisciplinary VIGOR team at the University of Texas at Dallas will be your guide(s). Questions and participant suggestions are welcome!

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