SPARK 2025 (Symposium on Physics: Advances in Research and Knowledge)

Report of Contributions

https://indico.global/e/spark2025

Contribution ID: **1** Type: **Oral**

Reconstruction of f(R) Gravity in Kaniadakis Holographic Dark Energy Model

Saturday, November 1, 2025 4:51 PM (13 minutes)

Kaniadakis Holographic Dark Energy extends the standard holographic dark energy (HDE) model by integrating Kaniadakis entropy, a generalization of the classical Bekenstien-Hawking entropy. Kaniadakis entropy incorporates relativistic statistical mechanics into standard HDE model and is characterized by a deformation parameter K. This study aims to construct a new form of f(R) gravity theory by inserting the Kaniadakis holographic dark energy within the framework of the FLRW metric. The proposed model is then evaluated for its effectiveness in explaining the phenomenon of late-time cosmic acceleration. The viability of the model is assessed through several key criteria: the positivity of the effective gravitational coupling to avoid ghost instabilities; stability under cosmological perturbations and positivity of the scalar mode to preclude tachyonic behavior; consistency with the ΛCDM limit in the high-curvature regime; the emergence of a stable de Sitter phase at late times; and compatibility with local gravity tests via a chameleon mechanism. This work collectively tries to test and ensure the theoretical soundness and observational relevance of the reconstructed f(R) framework.

Author: MALAKAR, Kalyan (Dibrugarh University, Dibrugarh, Assam. PIN: 786004)

Co-authors: Prof. BHUYAN, Kalyan (Dibrugarh University); Dr GOHAIN, Mrinnoy (Dibrugarh University); Mr MAZUMDAR, Rajdeep (Dibrugarh University)

Presenter: MALAKAR, Kalyan (Dibrugarh University, Dibrugarh, Assam. PIN: 786004)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **2** Type: **Oral**

Tuning the Neel Temperature of Antiferromagnetic Film: Thickness and Stoichiometry Dependence

Saturday, November 1, 2025 2:15 PM (15 minutes)

Abstract: Tunability of the Ne´el temperatures (TN) in case of antiferromagnetic (AFM) materials has significanct importance in exchange bias studies, magnetic and spintronic device applications etc. Interestingly, AFM transition metal oxide thin films demonstrate TN dependance on film thickness and stoichiometry. This article reports the estimation of TN for AFM nickel oxide (NiO) ultrathin films and focuses on its systematic variation with film thickness and Ni:O stoichiometry. Bulk NiO, with TN=523 K, is a type-II insulating AFM at room temperature. At reduced dimesion, e.g. ultrathin films, TN decreases from its bulk value. The exchange scattered low energy electrons from the (001) AFM NiO surface produce additional p(2x2) fractional order magnetic spots in a Low Energy Electron Diffraction (LEED) pattern owing to the exchange interaction. Intensity of the fractional order spots drops down with raising sample temperature until the magnetic LEED spots vanish at TN.
NiO ultrathin films were deposited on Ag(001) substrate using standard in-situ molecular beam epitaial (MBE) technique [1]. The thicknesses of the films were estimated using a pre-calibrated quartz microbalance. Stoichiometric variations were created at the film surface by different dosages Ar+ ion bombardment. Measurement of film thickness and quantification of relative elemental compositions were characterized by X-ray photoemission spectroscopy (XPS).
Fig. (a) shows the LEED of 15 ML (monolayer) NiO/Ag(001) film at 300 K for the incident beam energy of 30 eV. The fractional ordered (1/2,0) spots of magnetic origin have intensity 2-4% of the integer order spots (beyond the field-of-view of LEED screen at this low beam energy). Fig. (b), on the other hand, shows the LEED pattern of 15 ML NiO film at

T=525 K (>TN), where the fractional order spots disappear. Intensity decrements of these p(2x2) spots against sample temperatures are plotted in figs. (c) and (d) at various film thicknesses. While fig. (c) focuses on the submonolayer thickness range, 0.5 to 2 ML; fig. (d) demonstrates the temperature dependent plots for the cases of thicker films, 2, 6, 10 and 15 ML. The values of TN corresponding to various thicknesses are provided in table 1.

Table:1
Thickness (in ML) 0.5 0.75 1 1.5 2 6 10 15
TN (in K) 260 260 260 360 410 450 475 510

TN decrement as a result of finite size effects could be observed with the lowering of film thickness. Interestingly, at the submonolayer range, no significant change of TN could be noted while the average spot intensities decrease with coverage. This could be attributed to the formation of nano-sized domains with smaller areas at lower coverages.
Fig. (e) shows a systematic variation of TN with the stoichiometric modifications at a 20 ML film surface. Oxygen deficiencies were produced via mild Ar+ ion sputtering (400 eV, 5 min) cycles followed by vacuum annealing at 473 K. Elemental quantifications, estimated using surface sensitive XPS at the grazing emission angle [2], indicate towards weaker surface AFM ordering upon oxygen reduction as shown in table 2.

Table 2:
O: Ni ratio 1 0.94 0.89 0.83 0.78
TN (in K) 510 473 448 418 353

References:

[1] J. Das, K. S.R. Menon, "A revisit to ultrathin NiO(001) film: LEED and valence band photoemission studies,"J. Electron Spectrosc. Relat. Phenom., vol. 203, pp. 71-74, 2015, doi: 10.1016/j.elspec.2015.06.006.

[2] J. Das, K. S.R. Menon, "Effects of surface non-stoichiometry on the electronic structure of ultrathin NiO(001) film,"Appl. Surf. Sci., vol. 359, pp. 61-67, 2015, doi: 10.1016/j.apsusc.2015.09.173.

Author: DAS, Jayanta (Department of Physics, Panchakot Mahavidyalaya, Sarbari, P.O: Neturia, Dist: Purulia, Pin: 723121, West Bengal, India)

Presenter: DAS, Jayanta (Department of Physics, Panchakot Mahavidyalaya, Sarbari, P.O: Neturia, Dist: Purulia, Pin: 723121, West Bengal, India)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **3** Type: **Oral**

Metal-Incorporated CdS Nanostructures for Improved UV Photodetection: A Study for Solar Energy Applications

Saturday, November 1, 2025 3:15 PM (15 minutes)

In this work, we have studied the used of a thin film-based metal-semiconductor junction to improve the optical absorption, scattering and field intensities of the electromagnetic spectrum in the ultra-violate (UV) region. Nanoparticles (Nps) of copper (Cu), silver (Ag) and gold (Au) with size 14nm are individually incorporated on 5nm thick CdS thin film. The finite difference time domain (FDTD) method was applied to simulate the optical cross-sections and field intensities of these metal-incorporated CdS nanostructures. Out of the three metals, Cu-incorporated CdS (Cu/CdS) and Au-incorporated CdS (Au/CdS) show enhanced optical absorption from 250nm to 400nm under the UV region compared to that of isolated Cu and Au Nps. In the ultraviolet spectrum, the combined Au/CdS nanostructure exhibits the highest absorption in comparison to the individual contributions of isolated CdS and Au Nps. Similarly, the individual absorption of isolated CdS and isolated Cu Nps contribute the highest absorption in the combined Cu/CdS nanostructure in the UV range. The scattering cross-sections of Cu/CdS and Au/CdS are also found to be enhanced in the UV region. In the case of Ag/CdS, no significant enhancement of absorption and scattering cross-section is found in the UV region. A study of electric field intensity shows that at the lowest wavelength (˜ 200nm) Cu/CdS shows the highest field intensity at around 38 (V/m)2. At 300nm Au/CdS shows the highest field intensity around 47.6 (V/m)2. However, in 400nm Ag/CdS shows the strongest field intensity value 9.3×103 (V/m)2 arises due to surface plasmon resonance excitation.

Author: SAIKIA, Dilip (Silapathar College, Silapathar, Dhemaji)

Co-authors: Dr ADHIKARY, Nirab C. (Physical Science Division, IASST, Guwahati); Dr THAKUR, Samir (Department of Applied Sciences, Gauhati University)

Presenter: SAIKIA, Dilip (Silapathar College, Silapathar, Dhemaji)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **4** Type: **Oral**

Self-organization of Multiple Double Layers in different Negative Differential Regimes

The ubiquitous development of multiple charged layers and their characteristics has been widely investigated in recent years under varied experimental conditions in hollow cathode discharges due to their wide variety of applications [1], [2]. However, no controlled plasma source could be developed during these earlier studies to investigate the underlying cause of formations of complex charged layers like multiple double layers (MDL) and anode spots. In the present experimental study, a controlled negatively biased grid acting as a secondary plasma source is positioned between a hollow cylindrical mesh cathode and a spherical anode in the vacuum chamber while a low magnetic field is present in it. The present study investigates the impact of the introduction of the biased grid that facilitates the nonlinear dissipation of trapped non-thermal electrons in the plasma column due to its repelling effect, leading to the formation of complex MDL near the anode during different Negative Differential Resistance (NDR) regimes in a DC glow discharge plasma [3]. The NDR typically develops after a controlling grid is introduced and arises when the discharge current shows abrupt jumps in the hysteresis traces [4]. The present study also provides insight into the reorganization of MDL near the anode and the associated sheath-plasma interaction triggering the phenomenon of self-organization during the discharge. The initial sheath formation near the anode occurs due to the insufficient supply of electrons by the negatively biased grid suggesting the entrapment of localized charged particles near the biased grid [1], [4]. This localization of charged particles due to the space charge effect also creates intricate structures near the grid. The initial sheath formations surrounding the anode progressively change into concentric bright spots on the anode when the applied voltage is raised beyond the barrier potential of the biased grid. The potential distribution governs the ongoing developments of many localized complex sheaths following the trapping of charged particles and the production of complex structures in the presence of a negatively biased grid [5]. A set of detailed nonlinear dynamical analyses are done to investigate and confirm the formation of the MDL through the interaction of low-frequency as well as high-frequency [6]. Thus, the resulting sheath dynamics and self-organized phenomenon through successive layer reduction promote the NDR zone in the plasma and its resistance to the associated sheath-plasma instabilities. These self-organized structures or MDL formation are essential for numerous kinds of plasma applications in medical and nanomaterial synthesis.

Author: DEBNATH, Arpan (National Institute of Technology Agartala)

Co-authors: Dr PAUL, Manash Kumar (National Institute of Technology Agartala); Mr DEBBARMA, Salswkang (National Institute of Technology Agartala); Dr MAROJU, Suman Kalyan (National Institute of Technology Agartala)

Presenter: DEBNATH, Arpan (National Institute of Technology Agartala)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **5** Type: **Oral**

Neutrino mass genesis in Scoto-Inverse Seesaw with Modular A_4

We propose a hybrid scotogenic inverse seesaw framework in which the Majorana mass term is generated at the one-loop level through the inclusion of a singlet fermion. This singlet Majorana fermion also serves as a viable thermal relic dark matter candidate due to its limited interactions with other fields. To construct the model, we adopt an
A_4 flavour symmetry in a modular framework, where the odd modular weight of the fields ensures their stability, and the specific modular weights of the couplings yield distinctive modular forms, leading to various phenomenological consequences. The explicit flavour structure of the mass matrices produces characteristic correlation patterns among the parameters. Furthermore, we examine several testable implications of the model, including neutrinoless double beta decay ($0\nu\beta\beta$), charged lepton flavour violation (cLFV), and direct detection prospects for the dark matter candidate. These features make our model highly testable in upcoming experiments.

Author: Dr DAS, Pritam (Salbari College)

Co-authors: Mr PATHAK, Gourab (tezpur University); Prof. DAS, Mrinal (Tezpur University)

Presenter: Dr DAS, Pritam (Salbari College)

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **8** Type: **Oral**

Neutrino Mass Matrix with unique Correlations

Saturday, November 1, 2025 2:15 PM (13 minutes)

A minimal and predictive Majorana neutrino mass matrix texture is proposed. The texture involves four parameters that reveal unique correlations and predict the three neutrino mass eigenvalues, while strictly ruling out the inverted hierarchy. Furthermore, it imposes constraints on the three CP-violating phases. Based on these predictions, we estimate both the effective Majorana neutrino mass and the CP asymmetry parameter. The proposed texture can be derived from a discrete symmetry within the framework of the seesaw mechanism.

Author: Mr CHAKRABORTY, Pralay (Gauhati University)

Co-author: Dr ROY, Subhankar (Gauhati University)

Presenter: Mr CHAKRABORTY, Pralay (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **9** Type: **Oral**

Performance Analysis of Satellite-Based Classical and Quantum Communication with Adaptive Optics

Saturday, November 1, 2025 2:15 PM (15 minutes)

Secure long-distance communication has become a fundamental requirement in modern information systems, particularly in satellite-based networks where the exchange of sensitive data across vast distances is often exposed to eavesdropping, signal degradation, and transmission errors. Classical communication systems, though widely deployed, face limitations in ensuring unconditional security due to their susceptibility to interception and computational attacks, while quantum communication systems based on principles such as quantum key distribution (QKD) offer theoretically unbreakable security but are highly vulnerable to photon loss, atmospheric turbulence, and channel noise [1-4]. The problem addressed in this study is the challenge of maintaining high fidelity in transmitted bits when signals traverse different satellite orbits—Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Earth Orbit (GEO)—where distance directly impacts photon loss, error rates, and the final usable key size. To mitigate these issues, we propose a comparative simulation model that evaluates the performance of both classical and quantum communication under varying satellite altitudes, incorporating photon loss, repeater effectiveness, and error correction efficiencies, with and without the inclusion of adaptive optics (AO). The methodology involves simulating the transmission of a fixed number of bits while applying altitude-dependent photon loss factors, signal amplification via repeaters, and system-specific error correction mechanisms, followed by the integration of adaptive optics to reduce atmospheric-induced photon scattering [5-7]. Results are visualized using tabular and graphical analyses that highlight the differences in post-correction matching bits across classical and quantum systems under LEO, MEO, and GEO conditions. The findings indicate that while both systems suffer severe degradation at GEO levels, adaptive optics significantly enhances performance in LEO and MEO by reducing effective photon loss, leading to higher matching bit counts after correction. Classical systems tend to retain slightly higher performance due to stronger error correction mechanisms, but quantum systems with AO demonstrate competitive outcomes, proving that physical-layer optimizations can partially compensate for quantum channel vulnerabilities[8][9]. In conclusion, this work demonstrates that integrating adaptive optics into satellite-based communication systems is a promising approach to mitigate photon loss, particularly for quantum systems aiming to scale toward global secure communication. The comparative analysis offers insight into the trade-offs between classical and quantum communication, reinforcing the necessity of hybrid solutions that combine physical channel enhancements with advanced error correction to achieve robust and secure satellite communication in future space-based networks.

Author: BARMAN, Moushumi (Assam Don Bosco University)

Co-author: Dr NANDI, Gypsy (Assam Don Bosco University)

Presenter: BARMAN, Moushumi (Assam Don Bosco University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied &

Engineering Physics

Contribution ID: **10** Type: **Oral**

SYNTHESIS AND CHARACTERIZATION OF OXIDE NANOPARTICLES FOR ITS APPLICATION IN MEMRISTIVE DEVICES

Abstract: The last few decades have been revolutionary for semiconductor processing and applications due to their extraordinary optical and electronic properties. In this paper, ZnO and PbO nanoparticles are prepared by chemical bath deposition technique. The structural morphologies of the prepared samples are verified with the help of XRD analysis and HRTEM technique. XRD analysis shows the hexagonal structure of ZnO nanoparticles and orthorhombic structure of PbO nanoparticles. The average particle size calculated from the XRD data are found be 28.934 nm for ZnO nanomaterials and 63.11 nm for PbO nanomaterials. HRTEM imaging technique further verifies the structural characterization of the prepared samples. The electrical study is done with the help of an electrometer. The I-V measurement curve shows a zero crossing pinched hysteresis loop. The presence of such a pinched hysteresis loop suggests the existence of memristive properties in the semiconductor nanomaterials. The primary goal of this research work is to synthesize ZnO and PbO semiconductor nanomaterials and analyze their various physical and electrical properties for their applications in memristive devices.
Keywords: ZnO, PbO nanoparticles, quantum confinement, optoelectronics, memristor, hysteresis loop.

Author: Mr ROY CHOUDHURY, JYOTI PRTASAD (ASSAM DON BOSCO UNIVERSITY, SONAPUR)

Presenter: Mr ROY CHOUDHURY, JYOTI PRTASAD (ASSAM DON BOSCO UNIVERSITY, SONAPUR)

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **11** Type: **Oral**

Realisation of Two-Zero Texture of Neutrino Mass Matrix Using Γ_3 Modular Group with Type II Seesaw Dominance in Left-Right Symmetric Model

Saturday, November 1, 2025 3:59 PM (13 minutes)

Assuming that neutrinos are Majorana particles, we have realized two-zero textures using the Γ_3 modular group. The Γ_3 modular group is a finite modular group isomorphic to the A_4 group. By assigning the matter fields of the model to irreducible representations of A_4 and choosing appropriate modular weights, we successfully construct two-zero textures of the neutrino mass matrix. The model is based on the Left-Right Symmetric Model (LRSM), where the active neutrino masses are generated via type II seesaw dominance. To achieve this dominance, the particle content of the LRSM is extended by introducing one sterile fermion per generation, and the scalar sector is augmented by adding scalar doublets (χ_L, χ_R). After constructing the two-zero textures, we compute the neutrino oscillation parameters and the baryon asymmetry of the universe (BAU) for each texture. We find that the textures can successfully reproduce the neutrino oscillation parameters and the effective Majorana mass. However, not all of the realized textures yield a satisfactory result in the calculation of BAU.

Author: KUMAR, Bhabana (Tezpur University)

Co-authors: Dr DUTTA, Debajyoti (Bhattadev University); Prof. DAS, Mrinal Kumar (TEZPUR UNIVERSITY)

Presenter: KUMAR, Bhabana (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **12** Type: **Oral**

Leptogenesis in Alternative Left Right Symmetric Model

We study the possibility of leptogenesis within the Alternative Left Right Model (ALRM). ALRM is a variant of the Left Right Symmetric Model. Unlike the usual Left Right Symmetric Model, it avoids the flavour changing neutral current. Type-I seesaw generates the majorana mass of the heavy RH neutrino (ν_R), which gives the lepton number violating decay. We find that even for a large value of the yukawa coupling, there is a possibility of leptogenesis within the ALRM below the Davidson Ibarara bound.

Author: DEKA, Hrishikesh (Indian Institute of Technology Guwahati)

Presenter: DEKA, Hrishikesh (Indian Institute of Technology Guwahati)

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **13** Type: **Poster**

Propagation of nonlinear waves in molecular clouds

Saturday, November 1, 2025 11:45 AM (1 hour)

A theoretical analysis is done to explore the dynamics of nonlinear gravito-electrostatic wave in the molecular clouds. It contains warm lighter electrons, ions and massive positively and negatively charged dust grains. The effects of multi-fluidic viscous drag forces, the gradient forces, naturalistic equilibrium inhomogeneities and nonlinear convective dynamics are also considered. A couple of inhomogeneous Korteweg de-Vries Burger (i-KdVB) equations are analytically derived using a multiscale approach [1-3]. To investigate the fluctuations dynamics of the gravito-electrostatic wave, a numerical method is carried out []. In the numerical treatment it is seen that the waves propagate as electrostatic rarefactive damped oscillatory shock-like structures and self-gravitational compressive damped oscillatory shock-like structures. The applications and implications in the diverse astro-media of these fluctuations are also enlighted.

Author: Dr HALOI, Archana

Presenter: Dr HALOI, Archana

Session Classification: Poster Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **14** Type: **Oral**

Calibration of Organic Liquid Scintillator EJ-315 and Unfolding of Gamma Spectra

Saturday, November 1, 2025 2:15 PM (20 minutes)

This work presents the methodology and results of calibrating an organic liquid scintillator (EJ-315) [1] for gamma-ray spectroscopy using standard gamma sources, followed by spectral unfolding using a pre-determined detector response matrix using GEANT4 [2]. Energy calibration was performed via identification of known gamma peaks, and their Compton edge positions from Ba-133, Co-60, Na-22, and Cs-137 sources. Mathematical modelling of the detector's linear light yield response was implemented. The calibrated spectra were unfolded using the GRAVEL [3] iterative technique to reconstruct the incident photon energy distribution.

References:
[1] C. C. Lawrence, A. Enqvist, M. Flaska, S. A. Pozzi, A. M. Howard, J. J. Kolata and F. D. Becchetti, Response characterization for an EJ315 deuterated organic-liquid scintillation detector for neutron spectroscopy, Nucl Instrum Methods Phys Res A 727, Elsevier, (2013) 21.
[2] J. Allison, K. Amako, J. Apostolakis, H. Araujo, P. A. Dubois, M. Asai, G. Barrand, R. Capra, S. Chauvie, et al., Geant4 developments and applications, IEEE Trans Nucl Sci 53, (2006) 270.
[3] H. Dombrowski 2023 JINST 18 P07005, doi:10.1088/1748-0221/18/07/P07005

Author: Mr SAIKIA, Trinayan (Rajiv Gandhi university)

Co-authors: Dr SINGH, Lakhwinder (Central University of South Bihar); Dr GUPTA, Sonika (Rajiv Gandhi Univeristy); Prof. SINGH, Venktesh (Central University of South Bihar)

Presenter: Mr SAIKIA, Trinayan (Rajiv Gandhi university)

Session Classification: Oral Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **15** Type: **Poster**

Spectroscopic and DFT insights of Ophthalmic Acid

Saturday, November 1, 2025 11:45 AM (1 hour)

Spectroscopic and DFT insights of Ophthalmic Acid

Primary author: Amar Jyoti Saikia*1,2
Co-author: Lakhi Nath Borah3, Bhargab Borah4
Presenter: Amar Jyoti Saikia
Track Classification: Track 03

1 Department of Physics, Dhemaji College, Dhemaji
2 Department of Physics, Madhabdev University
3 Department of Physics, Madhabdev University
4 Department of Physics, DDR College, Chabua

*Corresponding Author: amasaik@gmail.com

Abstract: The current study is aimed at elucidating the structural, quantum chemical, and vibrational properties of ophthalmic acid employing the B3LYP/6-311++G(d,p) level of theory under the framework of DFT. The optimization followed by frequency calculation of the entitled molecule is performed using ORCA 6.0. The dipole moment, HOMO-LUMO energy gap, electrophilicity index, electron affinity, and ionization potential of ophthalmic acid are reported for the first time. The computed vibrational frequencies, i.e., Raman and IR, indicate the stability of the molecule with a total energy of -6.56×10ˆ5 kcal/mol. The NH_2 and O-H wave wavenumbers are observed around 3000-3500 cm^{-1}, while the C=O stretching modes are assigned around 1700 cm^{-1} with a maximum PED distribution of 85%.

Keywords: Ophthalmic acid, DFT, HOMO–LUMO, IR, Raman

Author: SAIKIA, Amar Jyoti (1 Department of Physics, Dhemaji College 2 Department of Physics, Madhabdev University)

Presenter: SAIKIA, Amar Jyoti (1 Department of Physics, Dhemaji College 2 Department of Physics, Madhabdev University)

Session Classification: Poster Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **16** Type: **Oral**

A Minimal and Predictive Hybrid Seesaw Model for Majorana Neutrinos

Saturday, November 1, 2025 2:41 PM (13 minutes)

In the framework of the hybrid type-I + type-II seesaw mechanism, we propose a minimal and predictive texture for the Majorana neutrino mass matrix. The texture contains four free parameters that lead to intriguing correlations and yield several notable predictions, including the exclusion of the inverted hierarchy of neutrino masses, the determination of the octant of the atmospheric mixing angle, and constraints on the three CP-violating phases. Furthermore, the texture is embedded within the discrete symmetry group A_4, together with the Standard Model gauge groups.

Author: GOSWAMI, Sagar Tirtha (Gauhati University)

Co-authors: Mr CHAKRABORTY, Pralay (Gauhati University); Dr ROY, Subhankar (Gauhati University)

Presenter: GOSWAMI, Sagar Tirtha (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **18** Type: **Oral**

INDIA'S THREE-STAGE NUCLEAR POWER PROGRAMME: A BRIEF REVIEW IN 2025

Nuclear power provides a stable and reliable source of energy that can reduce dependence on fossil fuels. Nuclear power is capable of providing large scale base load electricity. India's Nuclear programme has led to the development of indigenous technologies and highly skilled manpower. It helps diversify India's energy mix, reducing vulnerability to international fuel price shocks. In this paper the author tries to give an up to date account of India's three stage Nuclear programme.

Author: KALITA, Pranjal (Madhab Choudhury college)

Presenter: KALITA, Pranjal (Madhab Choudhury college)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **19** Type: **Oral**

A modular symmetric approach to neutrino mixing with Froggatt-Nielsen mechanism

Saturday, November 1, 2025 4:12 PM (13 minutes)

One of the unsolved problems of the Standard Model (SM) is the flavor structure of the fermions. The hierarchy in the mixing angles and masses, both in the quark and lepton sectors, can only be explained by theories beyond the SM. The Froggatt-Nielsen (FN) mechanism is one of the elegant frameworks to explain the flavor structure of quarks and neutrinos. In general, the Froggatt-Neilsen mechanism needs additional horizontal symmetry $U(1)_{FN}$ to generate a mass hierarchy in the quark and neutrino sector. This symmetry is spontaneously broken at a high energy scale. In this work, we have implemented the FN mechanism in the modular symmetric framework. We do not need an extra $U(1)_{FN}$ symmetry because of the use of modular symmetry. The modular weights play the role of $U(1)_{FN}$ charge. We have developed a neutrino mass model to study neutrino oscillation parameters and Lepton Flavor violation using this mechanism.

Author: PATHAK, Gourab (Tezpur University)

Co-author: Prof. DAS, Mrinal Kumar (Tezpur University)

Presenter: PATHAK, Gourab (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **20** Type: **Oral**

Effect of Polyvinylpyrrolidone (PVP) concentration upon YBCO nanoparticles synthesized by sol-gel technique

Saturday, November 1, 2025 3:30 PM (15 minutes)

In this work, five (05) samples of YBCO have been synthesized via sol-gel technique. The samples were prepared by varying the concentrations of polyvinylpyrrolidone (PVP), keeping all other reaction parameters constant. The synthesized samples were then characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Energy Dispersive Analysis of X-rays (EDAX), Transmission Electron Microscopy (TEM/HRTEM) and Fourier Transform Infrared Spectroscopy (FTIR). From the XRD analysis, information regarding the crystallite structure of the samples has been obtained. From SEM analysis, information regarding the surface morphology, shape and size of the synthesized samples has been obtained and the elemental composition of the sample has been confirmed from the EDAX data. Using TEM analysis, the particle size of the YBCO nanoparticles were observed to be in the range 10 nm to 70 nm having mostly spherical shape. Formation of distinct rings, observed from the SAED pattern indicated the highly crystallite nature of the sample. From FTIR analysis, information regarding the functional groups of the synthesized samples has been obtained. From the XRD analysis, it has been confirmed that, changing the concentration of PVP, during the preparation of the samples, resulted in the formation of nanoparticles having varying crystalline sizes. The average crystalline size of YBCO nanoparticles decreased with increase in PVP concentration.
After successful synthesis of the 05 different YBCO nanocomposite samples as discussed above, we have attempted to study the variation in resistance of the samples, with variation in temperature, in a temperature range starting from 0 0 C to 75 0 C.

Author: SARMA, Manash Pratim (Gauhati University)

Co-author: Dr BHATTACHARJEE, Suparna (Gauhati University)

Presenter: Dr BHATTACHARJEE, Suparna (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **21** Type: **Oral**

Nucleus -Acoustic Waves In Degenerate ONe And CO White Dwarf Cores And Nearly Degenerate Envelopes

We present a theoretic investigation to analyze the low-frequency nucleus-acoustic waves excitable in the completely degenerate (CD) cores of ONe (oxygen-neon) and CO (carbon-oxygen) white dwarfs and their nearly degenerate (ND) envelopes. We use a quantum hydrodynamic formalism to model the complex system dynamics comprising of the electronic species, light nuclear species (LNS), and heavy nuclear species (HNS). The inner concentric layer-wise electronic pressures are judiciously modelled. The equation of state (EoS) for the electrons takes into account contribution due to the electronic pressure (degenerate Fermi pressure for the CD core and the ND pressure for the surrounding transition ambience around the core), pressure due to the interaction of the electrons with other electrons and surrounding nuclei, exchange interaction [1], and correlation interaction [1], explicitly. The constitutive LNS and HNS are governed classically by an appropriate EoS taking into account their thermal pressures. The electronic energy distribution, governed by the Fermi-Dirac thermostatistical distribution law, involves both the thermodynamical temperature and chemical potential. It emphasizes on the transition state between the thermodynamical temperature (classical) and the Fermi temperature (quantum) for the borderline regions of intermediate degeneracy [2] for the first time. The model closure is obtained with the help of the gravito-electrostatic Poisson formalism. A normal Fourier-centric spherical mode analysis procedurally yields a generalized linear dispersion relation (sextic in degree). A numerical illustrative platform is employed to highlight the nucleus-acoustic wave propagatory and dispersive features. It is demonstrated that the nucleus-acoustic wave in ONe (CO) white dwarfs exhibits sensible growth features in the transcritical (supercritical) wave space. Its temperature-sensitivity is more (less) prominent in ONe (CO) white dwarfs, and so forth. A full nucleus-acoustic wave dispersion portrayal is illustratively presented and interpreted. The astronomical circumstances sensible of presented study are finally outlined.

References:
[1] C. Li, Y. Zhan, B. Zhou, J. Zhang, S. Chen, "Electron exchange-correlation effects on dispersion properties of electrostatic waves in degenerate quantum plasmas", Chinese Journal of Physics, vol. 72, p 375-385 (2021).
DOI: https://doi.org/10.1016/j.cjph.2021.05.014
[2] Q. Haque, "Drift and ion acoustic waves in an inhomogeneous electron-positron-ion plasma with temperature degeneracy and exchange-correlation effects", Results in Physics, vol. 18, 103287, (2020).
DOI: https://doi.org/10.1016/j.rinp.2020.103287

Author: DASGUPTA, Dr. Sayanti (Department of Physics, Sadiya College)

Presenter: DASGUPTA, Dr. Sayanti (Department of Physics, Sadiya College)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **22** Type: **Poster**

Laser-Induced Fluorescence Spectroscopy based sensors for Environmental Monitoring: Applications in Water and Air Quality Assessment

Saturday, November 1, 2025 11:45 AM (1 hour)

Environmental contamination by heavy metals in water and Particulate matter (PM) in air poses severe risk to ecosystems and human health. Heavy Metals such as Arsenic (As), Lead (Pb) and Mercury (Hg) in drinking water are linked to cancers, neurological damage, and developmental disorders, while airborne Particulate Matter especially, $PM_{2.5}$ and PM_{10} contribute to respiratory and cardiovascular diseases. Laser-Induced Fluorescence (LIF) offers a sensitive, portable, and rapid choice for pollutant monitoring, making it highly relevant for environmental quality assessment. In this study we had developed LIF-based sensors which have enabled trace-level detection of As, Pb, and Hg in water and achieved WHO detection limits. Also in air quality monitoring, LIF has been employed for rapid characterization of particulate matter ($PM_{2.5}$ and PM_{10}). By detecting intrinsic fluorescence of organic compounds, LIF provides chemical fingerprints that support source identification and real-time pollution assessment. Overall, LIF demonstrates versatility as a cost-effective tool for environmental monitoring, combining sensitivity, selectivity, and portability to address critical challenges in both water and air quality assessment.
Keywords: Laser-Induced Fluorescence, Heavy Metal sensing, Atmospheric Particulate Matter, Environmental monitoring

Author: Ms KONWAR, Pragya Parmita (Gauhati University)

Co-authors: Dr HAZARIKA, Simanta (Gauhati University); Dr RADIUL, Seikh Mustafa (Gauhati University); Mr BHUYAN, Gautom (Gauhati University)

Presenter: Ms KONWAR, Pragya Parmita (Gauhati University)

Session Classification: Poster Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **23** Type: **Poster**

Hydrothermal synthesis of 1T´/2H MoS2 microspheres with incorporation of NH4+ ions for enhanced adsorption and photocatalytic degradation of water soluble organic dyes.

Abstract: This study reports the successful hydrothermal synthesis of high-quality 1T´/2H mixed phase molybdenum disulfide (MoS2) three-dimensional (3D) microspheres in a highly alkaline medium under optimized synthesis parameters. MoS2 nanostructures have gained significant interest due to their unique properties and potential applications in electronics, optoelectronics, environmental remediation and energy storage devices [1] [2]. The as-synthesized material demonstrates superior performance in the removal of water soluble organic dyes through adsorption and photodegradation under natural sunlight. The structural, optical and morphological features of 1T´/2H MoS2 microspheres were characterized by X-ray diffraction (XRD), Field-emission scanning electron microscopy (FESEM), Fourier transform Infrared spectroscopy (FTIR), photoluminescence (PL), UV-Visible spectroscopy and Raman spectroscopy. Batch adsorption studies and photocatalytic degradation of water soluble organic dyes using 1T´/2H MoS2 microspheres was carried out for both cationic and anionic organic dyes - methylene blue (MB) and methyl orange (MO). An adsorption capacity of up to 147.11 mg/g at a dye concentration (MB) 40 mg/L was achieved, with superior removal rate above 90% for all dye concentrations within 106 minutes. The adsorption kinetics study revealed that adsorption of methylene blue dye onto the MoS2 microspheres surface followed pseudo second order kinetics and the adsorption isotherm at equilibrium was described by both Langmuir and Freundlich models, suggesting that the 1T´/2H MoS2 microspheres surface consists of a combination of homogeneous and heterogeneous sites. The 1T´/2H MoS2 microspheres exhibited significant improvements in the photodegradation of both cationic and anionic dyes –methylene blue (MB) and Methyl orange (MO) dyes, achieving 96% and 90% degradation within 35 and 80 minutes. The excellent removal efficiency and superior photocatalytic degradation are attributed to the 1T´/2H mixed phase structure and the hierarchical MoS2 microsphere-like morphology.

Authors: Ms SULTANA, Najmin (Gauhati University, department of Physics); Dr DEB, Sulochana (Gauhati University, department of Physics)

Co-author: Mr GOGOI, Priyanku (Gauhati University, department of Physics)

Presenter: Ms SULTANA, Najmin (Gauhati University, department of Physics)

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **24** Type: **Poster**

Effect of deposition duration on the structural, optical, and electrical properties of chemically deposited Cd1-xMnxS thin films

Saturday, November 1, 2025 11:45 AM (1 hour)

Cd1-xMnxS thin films were successfully deposited onto soda–lime glass substrates via the cost-effective chemical bath deposition (CBD) technique at varying deposition durations. Structural characterization using XRD confirmed the formation of a polycrystalline cubic zinc blende structure. The enhanced intensity of the prominent (111) diffraction peak indicates improved crystallinity. Furthermore, an increase in crystallite size accompanied by a reduction in microstrain and dislocation density suggests the formation of high-quality films with reduced structural disorder as the deposition duration increases. SAED patterns obtained from HRTEM further verified the polycrystalline nature of the films, and the interplanar spacings were calculated from the high-resolution images. FESEM analysis revealed a decrease in grain size from 154.04 nm to 118.72 nm with increasing deposition duration, while cross-sectional FESEM images confirmed an increase in film thickness. EDX and XPS analyses validated the presence of the constituent elements Cd, Mn, and S, along with their respective oxidation states. UV–Vis spectroscopic analysis revealed an optical transmittance of 80–90%, confirming the high transparency of the Cd1-xMnxS thin films. The optical band gap was found to decrease from 2.875 eV to 2.737 eV with increasing deposition duration, indicating a tunable direct band gap. I–V measurements further verified that the films exhibit semiconducting behaviour. The combination of high optical transmittance, tunable band gap, and semiconducting conductivity demonstrates that Cd1-xMnxS thin films are promising candidates for optoelectronic device applications, particularly in photovoltaics, photodetectors, and other light-harvesting technologies.

Author: SHARMA PATHOK, HIMANSHU (Dibrugarh University)

Co-author: Prof. KUMAR SAIKIA, Prasanta (Dibrugarh University)

Presenter: SHARMA PATHOK, HIMANSHU (Dibrugarh University)

Session Classification: Poster Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **25** Type: **Poster**

Design and Development of a High Voltage Pulsed Power Driver for a Tubular Inertial Electrostatic Confinement Fusion Device

Saturday, November 1, 2025 11:45 AM (1 hour)

Artificial neutron sources are used in many research and industrial fields, and among them, Inertial Electrostatic Confinement (IEC) fusion devices are well known for their small size, flexible operation, and wide range of applications. These devices can produce neutrons in both continuous and pulsed modes, which makes them suitable for future space power systems, making medical isotopes, detecting landmines, treating cancer with boron neutron capture therapy, and creating plasma jets for spacecraft. In this work, a high-voltage Pulsed Power Driver (PPD) was developed at the Centre of Plasma Physics–Institute for Plasma Research (CPP-IPR) to generate pulsed neutrons from a tubular IEC fusion device. The system includes a 0.04 μF, 100 kV capacitor, a spark-gap high-voltage switch, a power supply, resistors, diodes, and a trigger unit. Experimental results recorded with high voltage and current probes demonstrated a peak current of approximately 23.5 A at -35 kV input voltage and a peak power dissipation of around 800 kW, marking significant progress in operating tubular IEC fusion devices in pulsed mode.

Author: KALITA, Sanjib (Department of Electronics and Communication Engineering, Assam Don Bosco University, Guwahati, Assam)

Co-authors: Mr BHARALI, Nishant (CPP-IPR); MOHANTY, Smruti Ranjan (Centre of Plasma Physics- Institute for Plasma Research, Sonapu)

Presenters: Mr BHARALI, Nishant (CPP-IPR); KALITA, Sanjib (Department of Electronics and Communication Engineering, Assam Don Bosco University, Guwahati, Assam)

Session Classification: Poster Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **26** Type: **Oral**

Thermodynamics of Flat 4D Einstein-Gauss-Bonnet Black Hole with Rényi Entropy: An RPST-like formalism

Saturday, November 1, 2025 4:25 PM (13 minutes)

We investigate the thermodynamics of asymptotically flat black holes in four-dimensional Einstein-Gauss-Bonnet (4D-EGB) gravity using Rényi entropy as a non-extensive generalization of the Bekenstein-Hawking entropy. The resulting thermodynamic structure, formulated within a restricted phase space-like (RPST-like) framework, reveals a striking resemblance to the thermodynamics of AdS black holes in the standard RPST formalism. In particular, we identify a thermodynamic duality between the Rényi deformation parameter β and a conjugate response potential ζ, analogous to the central charge and chemical potential in holographic theories. An extensive thermodynamic analysis in both fixed charge-($\tilde{Q}$) and fixed potential-($\tilde{\Phi}$) ensembles reveal Van der Waals-like first-order phase transitions which is an unexpected feature for asymptotically flat black holes. Furthermore, through the formalism of geometrothermodynamics (GTD) and thermodynamic topology, It is shown that the Rényi modified flat black hole mimics, in both its thermodynamic topology and geometry, the features of its counterparts in the 4D-EGB AdS black hole under RPST, reinforcing the structural similarity between these seemingly different systems. Our findings point to a deeper correspondence between non-extensive entropy and holographic thermodynamics, suggesting that Rényi entropy may serve as a natural bridge between flat-space black hole thermodynamics and AdS holography.

Author: Mr BHATTACHARJEE, Amijit (Dibrugarh University)

Presenter: Mr BHATTACHARJEE, Amijit (Dibrugarh University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **29** Type: **Oral**

Dark matter puzzle in the framework of f(R) gravity

The nature of dark matter remains one of the most compelling puzzles in modern cosmology and astrophysics. Different observational evidences on galactic and cosmological scales strongly indicate the presence of a non-luminous matter component
in the Universe, the existence of which is still a mystery. In this work, we consider a promising modified framework, the f(R) theory of gravity, as a suitable approach to study the dark matter problem on the galactic scale. The study examines how f(R)
gravity can account for the flatness behavior of galaxy rotation curves without requiring elusive dark matter within galaxies. We consider a specific form of an f(R) model that effectively mimics dark matter effects and highlight its theoretical consistency and
viability, and compare its predictions with astrophysical observations. Thus, a good agreement of theoretically predicted results with observations has been obtained. Our analysis sheds light on the potential of f(R) modified gravity as a compelling alternative to the elusive dark matter paradigm.

References:
[1] D. J. Gogoi and U. D. Goswami, "Cosmology with a new f(R) gravity model in Palatini formalism,"Int. J. Mod. Phys. D, vol. 31, no. 06, p. 2250048, 2022.
[2] T. P. Sotiriou and V. Faraoni, "f(R) theories of gravity,"Rev. Mod. Phys., vol. 82, no. 1, pp. 451–497, 2010.
[3] B. Li, G. B. Zhao, and K. Koyama, "Halos and voids in f(R) gravity,"Mon. Not. R. Astron. Soc., vol. 421, no. 4, pp. 3481–3487, 2012.
[4] B. Whitt, "Fourth order gravity as general relativity plus matter,"Phys. Lett. B, vol. 145, no. 3–4, pp. 176–178, 1984.
[5] J. Velásquez and L. Castañeda, "Equivalence between scalar-tensor theories and f(R)-gravity: From the action to cosmological perturbations,"J. Phys. Commun., vol. 4, no. 5, p. 055007, 2020.

Author: Mrs MOHAN, Gayatri (Sibsagar Girls' College, Sivasagar)

Presenter: Mrs MOHAN, Gayatri (Sibsagar Girls' College, Sivasagar)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **30** Type: **Oral**

Backaction-Free Weak Force Sensing in a Quantum-Well Equipped Optomechanical System Beyond the Standard Quantum Limit

Saturday, November 1, 2025 4:30 PM (15 minutes)

We present a theoretical investigation of back-action noise cancellation in a hybrid optomechanical cavity system, equipped with a quantum well (QW) [1] and supplemented with an optical parametric amplifier (OPA). In conventional optomechanical systems, quantum back-action noise arising from radiation-pressure fluctuations imposes the standard quantum limit (SQL) on force sensitivity [2,3], thereby restricting the detection of extremely weak forces. In our hybrid model, the exciton–photon interaction between the quantum well and the cavity field modifies the system response, opening auxiliary interference channels that can be exploited for noise suppression. By employing the scheme of coherent quantum noise cancellation (CQNC) [3,4], we establish the conditions under which destructive interference between the back-action force and the QW-induced auxiliary noise pathways results in complete elimination of measurement back-action. In addition, the inclusion of the OPA introduces a controllable nonlinearity into the cavity, which provides an effective means to reduce shot noise and enhance the tunability of the overall system dynamics. By gradually increasing the OPA pump gain, we demonstrate that back-action cancellation can be achieved at reduced driving laser power, while simultaneously enhancing the sensitivity of weak force detection [5]. This combined effect enables SQL-beating performance under realistic operating conditions. Our analysis, carried out within the Langevin equation framework, shows that appropriate tuning of the couplings and OPA gain allows the system to transition from SQL-limited operation to a back-action–free regime. These findings establish QW–cavity–optomechanical hybrid system as a promising platform for next-generation quantum sensing, precision metrology, and weak force detection beyond the reach of conventional back-action–limited systems.

Author: ROY, Alolika (IIT Guwahati, B. D. College)

Co-author: Prof. SARMA, Amarendra K. (IIT Guwahati)

Presenter: ROY, Alolika (IIT Guwahati, B. D. College)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **31** Type: **Oral**

Bifurcation and Critical Phenomena in Black Hole Thermodynamics

Saturday, November 1, 2025 2:54 PM (13 minutes)

In this work, we treat black holes as bifurcation points and explore their thermodynamic phase structure using the framework of bifurcation theory which is a commonly used method from non-linear dynamics. By constructing an appropriate bifurcating function, we analyze how black holes transition between different thermodynamic phases through changes in the number and stability of fixed points. Our study shows that stable fixed points correspond to thermodynamically stable black hole states, while unstable ones indicate instability and decay. The dynamical evolution of the system further supports this correspondence, with stable configurations approaching equilibrium and unstable ones diverging from it.

Authors: HAZARIKA, Bidyut (Research Scholar,Department of Physics,Dibrugarh University); Dr PHUKON, Prabwal (Dibrugarh University)

Presenter: HAZARIKA, Bidyut (Research Scholar,Department of Physics,Dibrugarh University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **32** Type: **Oral**

Lyapunov Exponents, Phase Transitions, and Chaos Bound of ModMax AdS Black Holes

Saturday, November 1, 2025 3:07 PM (13 minutes)

We study the thermodynamic phase transition of ModMax anti-de Sitter (AdS) black holes using Lyapunov exponents of massless and massive particles in unstable circular orbits. Our results demonstrate that the thermal profile of the Lyapunov exponent serves as an efficient probe of the black hole's phase structure. We calculate the discontinuity in the Lyapunov exponent across the transition and show that it acts as an order parameter, exhibiting a critical exponent $\delta = 1/2$ in the vicinity of the critical point. Furthermore, we explore the violation of the chaos bound, finding that the bound is violated when the horizon radius falls below a threshold value. We also examine how the ModMax parameter and the particle's angular momentum modify this threshold, revealing their role in controlling the onset of chaos bound violation.

Authors: AWAL, Mozib; Dr PHUKON, Prabwal (Dibrugarh University)

Presenter: AWAL, Mozib

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **33** Type: **Poster**

Dynamical Dark Energy parametrizations with the KiDS-1000 Observations

Saturday, November 1, 2025 11:45 AM (1 hour)

Recent results from the Dark Energy Spectroscopic Instrument (DESI) collaboration, based on Baryon Acoustic Oscillation (BAO) measurements, have provided intriguing evidence in favor of dynamical dark energy. In particular, DESI has released a dedicated analysis of dark energy parameterizations by combining their BAO DR2 observations with the Planck 2018 cosmic microwave background data and Type Ia supernovae constraints. Motivated by these developments, it is of considerable interest to further examine dynamical dark energy models using complementary low-redshift probes, especially weak gravitational lensing measurements from large-scale surveys such as KiDS-1000 and DES. In this work, we explore the dynamics of dark energy through three widely studied time-dependent parametrizations: the Chevallier–Polarski–Linder (CPL), Barboza–Alcaniz (BA), and Jassal–Bagla–Padmanabhan (JBP) models, using KiDS-1000 observations. Our analysis yields the following constraints on the dark energy equation of state parameters: for CPL, w0=−0.93−0.17+0.59, wa=−0.60−0.68+0.92; for BA, w0=−0.91−0.46+0.72, wa=−1.6−1.4+1.2; and for JBP, w0=−1.19±0.59, wa=−0.10±1.5. Notably, the CPL parametrization shows consistency with DESI's findings. We also obtain constraints on the clustering amplitude parameter S8: for CPL, S8=0.76±0.53; for BA, S8=0.73±0.38; and for JBP, S8=0.744−0.061+0.051. These results are consistent with the KiDS-1000 weak lensing measurements but remain in significant tension with the Planck 2018 constraint, S8=0.832±0.013. Our findings thus add the evidence supporting a possible departure from the cosmological constant and motivate continued investigation of evolving dark energy scenarios with upcoming high-precision cosmological data.

Author: Mr KUMAR, Dharmendra (Malaviya National Institute Of Technology Jaipur)

Presenter: Mr KUMAR, Dharmendra (Malaviya National Institute Of Technology Jaipur)

Session Classification: Poster Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **34** Type: **Poster**

Application of ST RADAR in the Study of Thunderstorms over Complex Terrain

Saturday, November 1, 2025 11:45 AM (1 hour)

Thunderstorms are among the most hazardous convective systems in the Indian subcontinent, and their occurrence is particularly frequent over the complex terrain of Northeast India. This study highlights the role of Very High Frequency (VHF) Stratosphere-Troposphere (ST) radar observations from Gauhati University in advancing the understanding of thunderstorm dynamics in Assam. A detailed analysis of the 20 April 2024 pre-monsoon thunderstorm is presented to illustrate the radar's capabilities in capturing fine-scale temporal and vertical convective processes.
Key parameters such as vertical velocity, horizontal wind components (U and V), signal-to-noise ratio (SNR), and backscatter power are examined to describe the storm's evolution The time-altitude evolution of vertical velocity indicates that prior to initiation, vertical air motions were weak, generally below ±1 m s^{-1} throughout the troposphere. During the convective phase, strong mid-tropospheric updrafts developed, accompanied by downdrafts reaching nearly -4 ms^{-1}, coinciding with the onset of surface precipitation. To validate radar-derived convective signatures, rain data from a collocated disdrometer is incorporated, which aligns well with the radar observations and confirms the brief, low-intensity rainfall associated with the event.
The combined observations reveal the progression of updrafts, downdrafts, turbulent mixing, and refractive index fluctuations associated with convective activity. These results underscore the utility of ST radar in resolving fine-scale storm evolution over complex terrain. Finally, the study emphasizes the importance of integrating ST radar and ground-based precipitation measurements with satellite and numerical modelling approaches to improve thunderstorm forecasting and disaster preparedness in Northeast India.

Author: MILI, Pankaj (Gauhati University)

Co-authors: Dr SAIKIA, Manoj (Gauhati University); Mr NATH, Nilotpal (Gauhati University)

Presenter: MILI, Pankaj (Gauhati University)

Session Classification: Poster Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **35** Type: **Poster**

Wavelength-Dependent SERS of Methyl Orange on Ag/ZnO/AZO Heterostructures Based on Analytical Enhancement Factor

Saturday, November 1, 2025 11:45 AM (1 hour)

Surface-enhanced Raman scattering (SERS) is a highly effective analytical technique for ultrasensitive detection of chemical and biological species. Hybrid plasmonic-semiconductor systems are particularly notable for their reproducibility and multifunctionality. Ag/ZnO/AZO heterostructures achieve enhancement factors (EFs) of about 10^7 and detection limits as low as 10^{-12} M [1]. Ag-decorated ZnO nanorods show EFs of 2.7×10^8 for Rhodamine 6G [2], while ZnO nanoplate-Ag hybrids enable low-concentration detection of indigo carmine, supported by charge-transfer mechanisms [3].
We conducted a study on the wavelength-dependent surface-enhanced Raman scattering (SERS) of Methyl Orange (MO) using Ag/ZnO/AZO heterostructures. Raman spectra at 488, 514, and 633 nm showed significant enhancement at shorter wavelengths, revealing strong vibrational features (ν(N=N), ν(C–C), δ(C–H)) and additional ZnO E2 and N/Ag modes, indicating plasmon–exciton coupling.
The analytical enhancement factor (AEF) ranged from 10^{12} to 10^{14}, aligned with high-performance Ag/ZnO composites that achieved approximately 10^{11}. This sensitivity enabled reliable detection of MO at very low concentrations. The enhancement is attributed to the combined electromagnetic effects of Ag plasmonic hot spots and chemical charge transfer from ZnO. These findings highlight Ag/ZnO/AZO heterostructures as wavelength-tunable SERS platforms, useful for detecting dyes, biomolecules, and environmental pollutants.

References:
[1] Samriti, Kumar, P., Kuznetsov, A. Y., Swart, H. C., & Prakash, J. (2024). Sensitive, stable, and recyclable ZnO/Ag nanohybrid substrates for surface-enhanced Raman scattering metrology. ACS Materials Au, 4(4), 413-423.
[2] Li, N., Xu, G., Yan, M., Chen, B., Yuan, Y., & Zhu, C. (2023). Fabrication of vertically aligned ZnO nanorods modified with dense silver nanoparticles as effective SERS substrates. Chemosensors, 11(4), 210.
[3] Pham, T. T. H., Lan, N. T., Trang, T. T., Dien, N. D., Vuong, T. X., Nguyen, T. T. T., & Vu, X. H. (2025). Facile synthesis of a ZnO nanoplate/Ag nanoparticle hybrid as a highly sensitive SERS substrate for indigo carmine detection. RSC advances, 15(17), 13095-13110.
[4] Sun, Z., Fang, X., Kang, C., Han, Y., Zha, L., & Zhang, X. (2022). Plasmonic Ag/ZnO nanoscale villi in microstructure fibers for sensitive and reusable surface-enhanced Raman scattering sensing. ACS Applied Nano Materials, 6(1), 714-719.
[5] Behera, R., & Nag, A. (2025). Semiconductor-Bimetallic Plasmonic Heterojunction ZnO– Ag–Cu as Reusable SERS Substrate with Attomolar Detection Limit. Chemistry–An Asian Journal, 20(9), e202401580.

Author: Dr RAJKUMAR, Pradhyut (Nabajyoti College, Kalgachia)

Co-author: Dr DAS, Apurba (Handique Girls' College)

Presenter: Dr RAJKUMAR, Pradhyut (Nabajyoti College, Kalgachia)

Session Classification: Poster Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **36** Type: **Oral**

Revolutionizing Aqueous Aluminum-Ion Batteries: Manganese Carbonate as a Cathode Material.

Saturday, November 1, 2025 4:30 PM (15 minutes)

The increasing demand for clean energy has led researchers to find alternatives for efficient energy storage solutions. While lithium-ion batteries (LIBs) are a promising technology, they face problems in terms of safety, availability, environmental impact and cost. Hence, aqueous metal ion batteries such as Na-ion, Zn-ion, Al- ion batteries are being explored. Aqueous Aluminum ion batteries (AAIBs) have gained interest in the recent years due to their muti electron redox reactions, abundance, safety and low cost. However, in the aqueous AIB systems, a major problem is the availability of suitable cathode materials, high overpotential and structural degradation of the electrode material. In order to overcome such challenges, we need to come up with electrode materials with high tunability, high theoretical capacity and environment friendliness [1]. Herein, a focus on MnCO3 as a potential cathode in aqueous aluminum ion battery is studied. Manganese, particularly, manganese oxides, are being explored as anode materials in lithium-ion batteries (LIBs) [2]. However, the preparation of manganese oxides requires high-temperature calcination treatment. Hence, MnCO3 is considered as an alternative to manganese oxides as its production does not require high-temperature processing, which reduces the cost and safety risks. MnCO3 has been investigated as anode material for LIBs [3]. However, there are issues such as low electron conductivity, which hinders its performance. These issues are being addressed by creating a composite material using highly conductive nanosheets [4]. Hence, in this work I have tried to investigate the electrochemical properties of MnCO3 in AAIB system due to its high natural abundance, low toxicity and low cost. The electrochemical activities of MnCO3 are investigated using cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) in a three-electrode glass cell set up with Pt and Ag/AgCl as counter and reference electrodes respectively. The voltage range is taken to be 0 V to 1.2 V. To investigate the Al+3 ion storage behavior in MnCO3; 1 M AlCl3, 0.5 M Al2(SO4)3, and 1 M Al(ClO4)3 electrolytes were employed. Further, the work is extended by making a composite of MnCO3 with graphene in order to enhance its electrochemical performance and provide a new framework towards stable energy storage systems.

Author: PRIYANKA, Padmini (Tezpur University)

Presenter: PRIYANKA, Padmini (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **37** Type: **Oral**

Neutrinoless double beta decay in the framework of D4 × Z2 Left-Right Symmetric Model

Saturday, November 1, 2025 3:20 PM (13 minutes)

With the advent of new physics scenarios in the neutrino sector, several models have been introduced to give an indepth view of the texture of the neutrino mass matrix. Here, we attempt to study the neutrino mass matrix considering the left-right symmetric model and its different phenomenological implications in the light of current neutrino oscillation data. The dihedral group D4 and cyclic group Z2 are implemented for the symmetry realization of the neutrino mass matrix. We here focus on the new physics contribution to neutrinoless double beta decay which is one of the most sensitive experiments that can confirm the intrinsic nature of the neutrinos, whether Dirac or Majorana besides providing insights into the scale of the absolute neutrino mass and the hidden mechanism of the neutrino mass generation. We consider both the mass ordering, normal and inverted for our study.

Author: Dr BORGOHAIN, Happy (Silapathar College)

Presenter: Dr BORGOHAIN, Happy (Silapathar College)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **38** Type: **Poster**

Development of an analysis algorithm for electrostatic probe characteristics in Scilab

Electrostatic probes are widely used in various ion sources to measure the plasma parameters. Such probes are cost effective, easy to construct in laboratory and one can easily analyse the current-voltage (I-V) characteristics of the probe to find out the local plasma conditions in an ion source. However, due to unfavourable alterations in plasma conditions, a random fluctuation is often observed to be integrated with the probe data. Therefore, to analyse such probe data, an algorithm has been developed in Scilab environment which can calculate plasma parameters for a given experimental condition. The experimental data are fitted with an empirical tangent hyperbolic function that contains four constants that controls the various plasma parameters.

Author: DAS, Bidyut Kumar (Department of Physics, Dakshin Kamrup College,)

Presenter: DAS, Bidyut Kumar (Department of Physics, Dakshin Kamrup College,)

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **39** Type: **Oral**

Optimizing circuit implementation and analyzing the parameter dependency for the FitzHugh-Nagumo model

Saturday, November 1, 2025 2:30 PM (15 minutes)

Neuron excitation and generation of action potential can be simplified by using the FitzHugh–Nagumo (FHN) model [1]. Such models are not only required for understanding complex neural activity but also to predict and replicate in software and hardware [2]. Hardware emulation is indispensable for building brain computing platforms inspired by brain, medical devices and analyzing real time performances [3]. In this work, the coupled differential equations for the membrane potential and recovery potential are solved using electronic components comprising of integrators, linear and nonlinear amplifiers, adders etc. To accurately replicate the model dynamics, the individual components are optimized and the efficiency found out in terms of correlation with the theoretical model. The suitability of the electronic model is also tested by varying the FHN parameters like the time scale of recovery variable, the external stimuli, etc. The results show that the optimized circuit faithfully reproduces the FHN dynamics and provides a method for neural signal simulation and hardware emulation in future.

Author: DEKA, Bandita (Gauhati University,)

Co-authors: TIRU, Banty (Gauhati University); Mr MEDHI, Kangkan (Gauhati University); Mr BAISHYA, Kankan (Gauhati University)

Presenter: DEKA, Bandita (Gauhati University,)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **40** Type: **Oral**

Analysis, Modeling and Hardware Emulation of Indoor Power Line Channels for Power Line Communication

Saturday, November 1, 2025 2:45 PM (15 minutes)

Abstract: Power Line Communication (PLC) utilizes the available power lines (PLs) for various utilities, such as smart metering, control, Internet of Things (IoT) etc. [1] in places where the implementation of new wires is impossible or costly, and the use of wireless is restricted. However, the cables offer a harsh environment for data transfer characterized by high attenuation, multi-path and non-Additive White Gaussian Noise [2]. Multipath occurring due to impedance mismatches give rise to deep notches and a prime concern of PLC implementation. The primary and foremost requirement for the development of PLC systems is thus, detailed analysis of PL channels [3] and the development of suitable emulated scenarios [4], where the former can be tested and optimized. The latter now is based on complex methodologies [4]. In this paper, an analysis is done for 33 practical indoor PL channels in the frequency range 2-30MHz suitable for broadband PLC (BPLC) in terms of general and notch characteristics by evaluating the S21 parameters. The notch analysis incorporates parameters like occurrences, frequency, depth, bandwidth, quality factor, etc., giving an insight into their performance as a communication channel. An assessment of the channel's capacity and OFDM performance is also carried out. To develop a hardware emulator for PL notches, a multi-notch channel is modelled using series LC circuits and dependencies analyzed. The efficiency of the method for notch and channel emulation is found in terms of correlation of the S21 parameters between observed, modelled, and emulated, as well as the performance of OFDM. Emulation of PL channels using equivalent LC circuits can be achieved using cost-effective hardware, as demonstrated by the work.

References:
[1] S. Ustun Ercan, "Power line Communication: Revolutionizing data transfer over electrical distribution networks,"Engineering Science and Technology, an International Journal, vol. 52, p. 101680, 2024, doi: https://doi.org/10.1016/j.jestch.2024.101680.
[2] E. Biglieri, "Coding and modulation for a horrible channel,"IEEE Communications Magazine, vol. 41, no. 5, pp. 92–98, 2003, doi: 10.1109/MCOM.2003.1200107.
[3] Q. Shang and Y. Zhang, "Research on Channel Modeling and Topology Performance Analysis of PLC Network,"in Proceedings of the 2023 International Conference on Power System Technology (POWERCON), IEEE, 2023.
[4] B. Han, V. Stoica, C. Kaiser, N. Otterbach, and K. Dostert, "Noise Characterization and Emulation for Low-Voltage Power Line Channels between 150 kHz and 10 MHz,"2016. doi: 10.5445/IR/1000056745.

Author: MEDHI, Kangkan (Gauhati University)

Co-authors: Ms DEKA, Bandita (Gauhati University, Pragjyotish College); Prof. TIRU, Banty (Gauhati University); Mr BAISHYA, Kankan (Gauhati University)

Presenter: MEDHI, Kangkan (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **41** Type: **Oral**

Generation of LG and HG beams using Computer Generated Hologram

The generation of higher-order optical modes has become an important area of research owing to their unique phase and intensity distributions, which enable advanced applications in optical trapping, high-capacity communication systems, and quantum information processing. Among these, Laguerre–Gaussian (LG) and Hermite–Gaussian (HG) beams represent two fundamental families of structured light, characterized by orbital angular momentum and Cartesian nodal line structures, respectively. The present work focuses on the design and implementation of Computer-Generated Holograms (CGHs) for the efficient generation of LG and HG beams.

The objective of this study is to demonstrate a cost-effective and flexible approach for producing such beams by encoding the required phase profiles onto digitally synthesized holograms. The methodology involves calculating the analytical phase functions corresponding to LG and HG modes and embedding them into hologram masks using Fourier optics principles. These holograms, when displayed on a spatial light modulator (SLM) or printed onto diffractive optical elements, are illuminated by a fundamental Gaussian laser beam. Upon diffraction, the encoded phase distribution reconstructs the targeted beam profile at the detector plane. The LG modes exhibit azimuthal phase variations with characteristic doughnut-shaped intensity distributions, while the HG modes display rectangular symmetry with well-defined nodal lines along orthogonal axes.

Simulation studies confirm that the CGH-based approach can accurately reproduce both the amplitude and phase characteristics of the desired modes. Numerical Fourier transforms of the designed holograms yield intensity profiles consistent with theoretical expectations for a wide range of LG indices (radial and azimuthal) and HG orders. Experimental verification further validates the approach: by projecting the CGHs onto a liquid crystal SLM and illuminating with a He–Ne laser beam, we successfully obtained high-quality LG and HG modes. The generated LG beams exhibited clear phase singularities and orbital angular momentum features, whereas the HG beams showed distinct orthogonal nodal structures. Minor discrepancies between simulation and experiment were attributed to pixel resolution limits and alignment errors, but overall beam quality and mode purity remained high.

The results demonstrate that CGHs provide a versatile platform for generating structured light modes without the need for complex optical arrangements such as mode converters or interferometric setups. Compared to conventional methods, this technique offers enhanced flexibility, scalability, and cost-effectiveness, as holograms for arbitrary modes can be designed computationally and rapidly reconfigured in real time using programmable SLMs.

In conclusion, this work establishes a simple yet powerful method for generating LG and HG beams using computer generated holography. The combination of numerical design and experimental realization highlights the robustness and practicality of the approach, making it a valuable tool for applications in modern optics, particularly in optical manipulation, laser mode engineering, optical communication, and quantum technologies.

Author: Dr KONWAR, Santanu (Abhayapuri College)

Co-author: Dr MALIK, Karuna Sindhu (Brainware University)

Presenter: Dr KONWAR, Santanu (Abhayapuri College)

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **42** Type: **Oral**

Excimer Fluorescence of Acriflavine Dye in Glycerol and Ethylene Glycol

Abstract
This study explores at the excimerization of acriflavine dye in ethylene glycol and glycerol solvents. Acriflavine, a member of the acridine dye family, is well-known for its distinctive fluorescence capabilities, which are used in cellular imaging, nucleic acid analysis, and dye laser active media. The study investigates the effect of solvent environment, dye concentration, and pH on acriflavine emission properties, focusing on excimer production and its implications for photonic applications. UV-visible absorption spectroscopy reveals concentration-dependent absorption characteristics represented by different monomer bands. Steady-state fluorescence studies demonstrate that at increasing concentrations in both solvents, red-shifted excimer bands appear. Temperature-dependent studies imply that excimer production is regulated by dynamic diffusion. Time-resolved fluorescence spectroscopy verifies the singlet character of both monomeric and excimeric states, offering mechanistic insights into the excimerization process. Critical concentrations are established, indicating the equilibrium between the monomer and excimer populations. Furthermore, pH-dependent spectrum changes demonstrate the importance of acidity in influencing fluorescence characteristics. Overall, this study gives a thorough knowledge of acriflavine excimerisation in viscous solvents, with the potential to increase its performance in dye laser technologies and other applications.

Authors: SWARGIARY, HIREN (EASTERN KARBI ANGLONG COLLEGE); Mr CORRESPONDING AUTHOR, Simanta Hazarika (Gauhati University)

Presenter: SWARGIARY, HIREN (EASTERN KARBI ANGLONG COLLEGE)

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **43** Type: **Oral**

Portable Low-Cost Smartphone Microspectrophotometer for Simultaneous Imaging and Spectral Analysis

Saturday, November 1, 2025 4:45 PM (15 minutes)

Microspectrophotometry (MSP), which integrates microscopic imaging with spectrophotometric analysis, is a powerful technique for concurrent morphological and spectral characterization of samples at the micron scale, supporting critical applications in biological sciences, forensic investigations, and materials research. However, the high cost and operational complexity of conventional MSP systems limit their accessibility, particularly in resource-limited environments. In this work, we present a fully standalone, user-friendly, and low-cost MSP system developed on a smartphone platform. The device uniquely leverages both the front and rear cameras of the smartphone, coupled with simple optical components, to simultaneously acquire microscopic images and spectroscopic data from the same sample region, without dependance on external microscopy or spectrometry modules. Compact, lightweight, and enclosed in a 3D-printed housing, the system is constructed entirely from off-the-shelf optoelectronic components. Its performance was validated through imaging and spectral analysis of biological samples, with results benchmarked against a standard laboratory-grade MSP instrument. This smartphone-based MSP system represents an affordable, robust, and practical alternative to conventional systems, expanding access to integrated morphological and spectroscopic analysis for diverse point-of-care and field applications.

Author: Mr CHETRY, Biprav (Tezpur University)

Co-authors: Mr DHAR, Pratik (Tezpur University); Prof. NATH, Pabitra (Tezpur University)

Presenter: Mr CHETRY, Biprav (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **44** Type: **Oral**

Convergence properties of Mellin moments under sine-cosine PDF parametrizations

Saturday, November 1, 2025 3:33 PM (13 minutes)

Abstract: We investigate the numerical convergence of Mellin moments of parton distribution functions (PDFs) when the conventional constant prefactor is replaced by sine-cosine expansions. Moments are computed for gluons and quarks using two theoretical parameter sets and compared with results from the standard parametrization. Our analysis demonstrates that trigonometric structures not only preserve the expected decrease of moments with increasing index but also improve numerical stability in small-x dominated integrals.

Keywords: Mellin moments, Parton Distribution functions, Trigonometric Parametrization, Quantum Chromodynamics, Small-x

Author: GYUTH, Gyati (NERIST)

Co-authors: Dr JAHAN, Akbari (NERIST); Ms ANTUN, Hiinyo (NERIST)

Presenter: GYUTH, Gyati (NERIST)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **45** Type: **Oral**

Comparative Mellin moment evaluation using exponential and generalized polynomial parametrizations

Saturday, November 1, 2025 3:46 PM (13 minutes)

We present a comparative analysis of Mellin moments of parton distribution functions (PDFs) using two parametrization strategies, viz. exponential-smooth polynomial weights and generalized polynomial expansions. Both approaches extend beyond the conventional constant-term model, introducing flexibility in modeling quark and gluon dynamics across the momentum fraction domain. Mellin moments are systematically computed for two parameter sets and analyzed across several indices. Together, these complementary parametrizations enrich the accuracy and stability of Mellin moment evaluations, offering new perspectives for Quantum Chromodynamics (QCD) phenomenology. This comparative framework provides a basis for optimizing functional forms in global parton distribution analyses.

Author: ANTUN, Hiinyo (North Eastern Regional Institute of Science and Technology)

Co-authors: Mr GYUTH, Gyati (North Eastern Regional Institute of Science and Technology); Dr JAHAN, Akbari (North Eastern Regional Institute of Science and Technology)

Presenter: ANTUN, Hiinyo (North Eastern Regional Institute of Science and Technology)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **46** Type: **Oral**

A Bio-inspired Dual-Parameter Sensor-Based Microstrip Patch Antenna for Soil Moisture and Salinity Detection

Saturday, November 1, 2025 3:00 PM (15 minutes)

Abstract: This paper presents a bio-inspired slotted microstrip patch antenna (MPA) designed as a dual-parameter sensor for monitoring soil moisture and water salinity. The antenna employs a radiating patch patterned with spider-web-like and circular cross-shaped slots, which enhances its sensitivity to variations in the dielectric properties of materials placed in its near field. To enable contactless and non-destructive measurements, a hollow polydimethylsiloxane (PDMS) block is integrated above the patch and functions as a microfluidic chamber for sample analysis. The antenna' s performance was investigated using full-wave electromagnetic simulations in Ansys HFSS under two sensing conditions. For soil moisture, dry soil samples were gradually added with fresh water, increasing the volumetric water content (VWC) from 0% to 80%. In the second case, fresh water was mixed with salt concentrations ranging from 0.5% to 10% (w/v) to evaluate salinity response. The simulation results demonstrated strong sensing capabilities in both scenarios. For soil moisture detection, the antenna exhibited a consistent downward shift in resonant frequency as VWC increased, moving from 5.6 GHz in dry soil (0% moisture content) to 5.19 GHz at the 80% moisture content. For salinity detection, the reflection coefficient (S11) showed clear dependence on ion concentration, with the magnitude increasing from −17.48 dB at low salinity (0.5%) to −16.79 dB at high salinity (10%). This trend was attributed to conductivity-driven impedance mismatching in the water-salt mixtures. By associating frequency changes with soil moisture and S11 variations with salinity, the proposed antenna offers a compact and non-invasive solution for dual-parameter environmental sensing. Its bio-inspired slot structure and microfluidic chamber integration help to ensure high sensitivity and practical use. This novel design demonstrates the antenna's promise for low-cost and efficient monitoring systems in agriculture, irrigation management, and water quality testing.

`Keywords: Bio-inspired, dual-parameter sensing, soil moisture and water salinity.`

Author: KULI, MUHIM (Gauhati University)

Co-authors: Mr BARO, Bidyut Kumar (Gauhati University); Dr SARMAH, Kumaresh (Gauhati University)

Presenter: KULI, MUHIM (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **47** Type: **Oral**

Photoluminescence in ZnO nanoparticles fabricated by pulsed laser ablation in water.

Zinc oxide (ZnO) nanoparticles (NPs) were prepared in distilled deionized water by pulsed laser ablation for various ablation durations (5, 10 and 15 mins) and pulse energies (30, 45, 60 mJ/pulse). All the samples possessed characteristic Raman peaks; E2 (low), E2 (high), A1 (TO), A1 (LO) etc. attributed to the wurtzite crystal structure of ZnO [1]. TEM and SAED results revealed nearly spherical nanocrystals depicting crystalline wurtzite ZnO phase with average size reducing from ˜15 nm at low fluence to ˜ 27 nm at high fluence, while distributions narrowing from 14 nm to 9 nm consistent with enhanced crystalline ordering. The size and shape of the nanoparticles were affected only slightly by the ablation time but more by laser energy. The size variation with time was explained with competition between crystalline growth and fragmentation [2]. UV–Vis absorption showed size-dependent shifts, while steady-state photoluminescence (PL) exhibited a clear transition from broad to sharp near-band-edge (NBE) ultraviolet emission, along with increasing less dominant defect level emissions (DLE) in visible spectral region, with increasing fluence. In addition to this, a, hardly effected by experimental conditions, were also observed [3]. Notably, time-resolved PL (TRPL) measurements yielded stable exciton lifetimes of ˜185–194 ps across all conditions, confirming radiative recombination dominance independent of size and defect variations. The results demonstrate that laser fluence provides effective control over ZnO NP size and optical emission, enabling size-dependent tunable PL for UV optoelectronic applications.

References:
1. K.A. Alim, V.A. Fonoberov, M. Shamsa, A.A. Balandin, "Micro-Raman investigation of optical phonons in ZnO nanocrystals", Journal of Applied Physics, vol. 97, pp. 124313, 2005.
2. G. Yang, Laser Ablation in Liquids: Principles and Applications in the Preparation of Nanomaterials, Pan Stanford, 2012.
3. Gyan Prakash Bharti and Alika Khare, "Quenching of visible photoluminescence and observation of two photon absorption-induced photoluminescence in pulsed laser deposited Zn1−xTixO (0.000 ☒ x ☒ 0.050) thin films", Journal of Physics D: Applied Physics vol. 52, pp. 015103 , 2019.

Author: DEY, Partha (Eastern Karbi Anglong College, Sarihajan)

Co-authors: Dr BHARTI, Gyan (Department of Applied Physics, Ashoka Institute of Technology & Management, Varanasi, India.); Dr KHARE, Alika (Department of Physics, Indian Institute of Technology Guwahati, Guwahati, India)

Presenter: DEY, Partha (Eastern Karbi Anglong College, Sarihajan)

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **48** Type: **Poster**

Controlling Magnetic Behavior of Nanowires Through Artificial Defects: A Micromagnetic Study.

Saturday, November 1, 2025 11:45 AM (1 hour)

Imperfections in magnetic nanowires can lead to significant changes in their magnetic behavior. Therefore, it is essential to study the effects such defects can have on their magnetic properties. In this work, we perform micromagnetic simulations of magnetic nanowires with artificial defects, and investigate how surface and internal defects influence their hysteresis loops and coercive fields. Our results demonstrate that the size, shape, and position of defects strongly affect the magnetic behavior of nanowires. In particular, artificial defects of identical size and shape but placed at different positions along the nanowire axis leads to notable differences in hysteresis loops and coercivity. The simulations also reveal how the defect's position governs the magnetization reversal process, offering insight into the underlying physics. The mechanisms of magnetization reversal, and their connection to variations in coercive fields, have been investigated by means of snapshots of the magnetization before and after reversal. These findings show that the magnetic response of nanowires can be deliberately tuned by introducing artificial defects, paving the way for device designs where performance can be controlled via engineered imperfections. All simulations were performed using the MuMax3 micromagnetic simulation package.

Author: SIVANANDA, Dr. Dibya Jyoti (Darrang College)

Presenter: SIVANANDA, Dr. Dibya Jyoti (Darrang College)

Session Classification: Poster Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **49** Type: **Poster**

Distinguishing CPT-Odd and CPT-Even Contributions of Lorentz Invariance Violation in Neutrino Oscillations

Saturday, November 1, 2025 11:45 AM (1 hour)

Abstract: Lorentz Invariance Violation (LIV) refers to the breaking of Lorentz symmetry, which ensures that the laws of nature remain identical for all inertial observers. If such violations exist, they could appear as intrinsic effects even in vacuum, independent of external influences. Studying how LIV modifies standard neutrino oscillation probabilities therefore provides a powerful tool to test this possibility. Since LIV effects are expected to be sub-dominant compared to the standard oscillation dynamics, they are typically treated as small perturbations to the standard matter Hamiltonian [1]. Within the theoretical framework of the Standard Model Extension (SME) [2], these perturbations can be consistently parameterized and analyzed.

In this study, we incorporate the effective LIV Hamiltonian into the GLoBES simulation package [3] to perform numerical analyses of oscillation probabilities in the presence of LIV. Both CPT-odd (a) and CPT-even (c) components of LIV are examined independently, allowing us to distinguish their respective roles in shaping oscillation phenomenology. The energy dependence of the CPT-even LIV component makes it particularly interesting and we explore how its contribution differs from the LIV CPT-odd component. Using the Deep Underground Neutrino Experiment (DUNE) as a representative long-baseline setup, we investigate how LIV effects alter oscillation patterns, with special emphasis on the emergence of parameter degeneracies between LIV contributions and the standard oscillation parameters. Such degeneracies may obscure or mimic genuine oscillation effects, thereby influencing the interpretation of experimental results. We further assess their implications for precision measurements, focusing in particular on the sensitivity to leptonic CP violation.

References:
[1] S. K. Agarwalla, S. Das, S. Sahoo, and P. Swain, "Constraining Lorentz invariance violation with next-generation long-baseline experiments,"JHEP, vol. 2023, no. 07, p. 216, 2023, doi: 10.1007/JHEP07(2023)216.

[2] A. Sarker, A. Medhi, and M. M. Devi, "Investigating the effects of Lorentz Invariance Violation on the CP-sensitivities of the Deep Underground Neutrino Experiment,"Eur. Phys. J. C, vol. 83, no. 7, p. 592, 2023, doi: 10.1140/epjc/s10052-023-11785-4.
[3] P. Huber, M. Lindner, and W. Winter, "Simulation of long-baseline neutrino oscillation experiments with GLoBES (General Long Baseline Experiment Simulator),"Comput. Phys. Commun., vol. 167, pp. 195–202, 2005, doi: 10.1016/j.cpc.2005.01.003.

Author: Mr DEKA, Priyankush (Tezpur University, India)

Co-authors: Mr SARKER, Arnab (Tezpur University, Assam, India); Dr DEVI, Moon Moon (Tezpur University, India)

Presenter: Mr DEKA, Priyankush (Tezpur University, India)

Session Classification: Poster Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **50** Type: **Poster**

Study of Gas Breakdown Characteristics in Air and in Argon Gas

In the present work, breakdown characteristics in air and in Argon gas are studied in a discharge tube. The experiment is performed in a glass tube with two circular electrodes. A dc voltage (˜ 300 –600 V) is applied between the electrodes to create the discharge. The breakdown voltage is measured for different gas pressures at a fixed electrode gap. The Paschen curve is then obtained at different electrode gaps for two cases 1) with air as background gas and 2) with Argon as background gas. The working pressure is maintained in the range ˜ 10-2 to 10-1 mbar and the electrode gap is varied in the range ˜ 4 to 10 cm. The experimental results are compared with the theoretical Paschen curve and it is found that at smaller electrode gaps the minimum breakdown voltage is very close to the theoretical result. However, at larger electrode gaps the experimental breakdown voltages are relatively higher than the theoretical values. This deviation can be attributed mainly to factors such as non-uniform electric fields, surface roughness or contamination on the electrodes, formation of anode spots and secondary electron emissions [1, 2].

References:
[1] P. Mathew, J. George, Sajith Mathews T., and P. J. Kurian, "Experimental verification of modified Paschen's law in dc glow discharge argon plasma,"AIP Advances, vol. 9, p. 025318, 2019.
[2] C Torres, P G Reyes, F Castillo and H Martínez "Paschen law for argon glow discharge,"in Journal of Physics: Conference Series, vol. 370, p. 012067, 2012.

Authors: NONGSIEJ, Pynshngainlang (Assam Don Bosco University); SHARMA, Sumita K (Assam Don Bosco University)

Presenter: NONGSIEJ, Pynshngainlang (Assam Don Bosco University)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **51** Type: **Poster**

Design and simulations of a “Monochromatic Neutron Source for precision measurements”

Saturday, November 1, 2025 11:45 AM (1 hour)

Precision and accurate measurements with neutron beams require a monochromatic, background-free, variable-energy neutron source. Also, the accuracy of absolute normalization of the neutron flux is essential. We are working towards developing a neutron source that meets these criteria. This is also in support of the mandates D1, D3 of the CUPAC-NE Collaboration[1]. In particular, IUAC-PAC has approved two precision measurements by our collaboration[2,3].
For example, Nuclear Astrophysics reactions have very low cross-sections. These reactions proceed through emissions of photons, neutrons and/or charged particles. These background radiations introduce uncertainties in reaction rate measurements. For photon detection, this is circumvented by constructing the accelerator and detector facility in deep underground environments (LUNA[4], JUNA[5]). The Indian Neutrino Observatory proposal is also towards this direction. However, this technique isn't optimum for neutron beam measurements, since alpha emitters like Th in surrounding rocks produce neutrons through (α,n) reactions. The accelerator itself also contributes background neutrons, and achieving “perfect neutron shielding”is highly challenging. Our efforts are aimed at mitigating these effects, and progress made towards this is reported.
Our background suppression method relies on a similar technique used in leading nuclear astrophysics facilities, like ERNA (Italy), St. George (USA), Dragon (Canada), etc. In these, an RMS is used in inverse kinematics and coincidence is imposed between signals in the detector and the recoils detected at the RMS focal plane. Our method will use the HIRA-RMS facility at IUAC in inverse kinematics[6].
Finally, the neutron beam production method is similar to “The Orsay neutron source”at IPN, France[7]. In this, p(^{7}Li,^{7}Be)n was used in inverse kinematics and kinematic focusing was used to get neutron flux as high as 10^7 n/s/sr (100nA beam-current). The main constraints according to the authors were: (i) Damage to the production target by incident beam, (ii)Compromise of the key monochromatic character of the neutron beam above E(^{7}Li)=16.513 MeV,and (iii)Impracticality of the technique for E(^{7}Li)>25.726 MeV. These pose serious limitations on the utility of the “neutron source”for fundamental research. We will use the 15-UD Pelletron accelerator at IUAC, identical to the one used at IPN-Orsay, but optimized to overcome the limitations stated by them. In addition, our method also addresses the issue of the “absolute normalization of neutron flux”.
A 4 MHz ^{7}Li pulsed beam from the IUAC 15-UD pelletron will be used for neutron production using p(^{7}Li,^{7}Be)n reaction in inverse kinematics. The available neutron beam energy range will be 300 keV-12 MeV with ΔE˜100 keV. The source of backgrounds, the scattered and/or secondary neutrons and photons, will be suppressed by demanding that the neutron and the ^{7}Be originate from the same event.

Indico rendering error

```
Could not include image: Cannot read image data. Maybe not an image file?
```

We have performed a preliminary ion optics simulation for HIRA RIB mode. Fig.(2) presents the simulation results for a 32 MeV ^{7}Li beam and 16.73 MeV ^{7}Be ions, after target loss. The results obtained matches closely with those documented during the commissioning of the RIB facility[8]. Table-1 lists the ion optical parameter from the simulation. This is a preliminary simulation up to first-order. Further optimization is required for better output.

Indico rendering error

```
Could not include image: Cannot read image data. Maybe not an image file?
```

Indico rendering error

```
Could not include image: Cannot read image data. Maybe not an image file?
```

Acknowledgement: We extend our heartfelt gratitude to Prof. G. C. Wary, Prof. M. Patgiri, Dr. V. M. Datar, HIRA group, Dr. S. Santra and Dr. P. C. Rout for their constant guidance and unwavering support.

References:

1 G. C. Wary et al., "Developing a Discovery Class Particle Accelerator Facility at Cotton University by CUPAC- North East Collaboration,"Proc. DAE SNP, 65, G4, 760 (2021).
2 J. J. Das et al., "Production and slowing down of fast neutron beam produced using 15-UD Pelletron accelerator and HIRA facility for AD-BNCT investigations at IUAC Delhi,"IUAC AUC-71368, 2021.
3 J. J. Das et al., "Measurement of s process neutron source strength in AGB stars by time reversal method,"AUC-75328, 2024.
[4] H Costantini et al.,"LUNA: a Laboratory for Underground Nuclear Astrophysics,"Rep. Prog. Phys. 72 086301, 2009, doi: 10.1088/0034-4885/72/8/086301
[5]Hao Ma et al., "Status and prospect of China Jinping Underground Laboratory", J. Phys.: Conf. Ser. 2156 012170, 2021, doi: 10.1088/1742-6596/2156/1/012170
[6] A. K. Sinha et al.,"Heavy ion reaction analyzer (HIRA): a recoil mass separator facility at NSC," NIM A 339 (1994) 543-549, https://doi.org/10.1016/0168-9002(94)90191-0
[7] M. Lebois et al., "Development of a kinematically focused neutron source with the p(^{7}Li,^{7}Be)n inverse reaction,"NIM A 735 (2014) 145-151, https://doi.org/10.1016/j.nima.2013.07.061
[8] J. J. Das et al., "Development of a radioactive ion beam facility using 15 UD tandem accelerator at NSC,"J. Phys. G: Nucl. Part. Phys. 24 (1998) 1371–1375, doi:10.1088/0954-3899/24/8/009
[9] https://web-docs.gsi.de/~weick/gicosy/

Authors: Dr BARTHAKUR, Abhijit (Cotton University); Mr BORUAH, Bhargab (Cotton University); Ms SAIKIA, Dimal (Cotton University, Department of Radiation Oncology, State Cancer Institute, Gauhati Medical College); Mr GOGOI, Hritik (Cotton University); Prof. DAS, Jiban Jyoti (Cotton University); Mr GOGOI, Monuj; Dr BARO, Mridula (Cotton University); Mr KALITA, Naba Kumar (Cotton University, Suren Das College (Autonomous)); Mr PANDIT, Nabajyoti (Cotton University); BARUAH, RASNA (COTTON UNIVERSITY)

Presenters: Mr GOGOI, Monuj; BARUAH, RASNA (COTTON UNIVERSITY)

Session Classification: Poster Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **52** Type: **Poster**

Mass spectrum of tetraquarks using WKB approximation

Saturday, November 1, 2025 11:45 AM (1 hour)

In this work, we extend the semiclassical WKB (Wentzel–Kramers–Brillouin) approximation method, previously applied with success to heavy quark–antiquark (meson) systems, to the more challenging and less understood domain of tetraquark states. Tetraquarks, exotic states composed of two quarks and two antiquarks, provide a unique window into the dynamics of multiquark interactions and the non-perturbative regime of Quantum Chromodynamics (QCD). Understanding their mass spectrum is crucial for both theoretical hadron spectroscopy and experimental searches for new states observed at facilities such as LHCb, Belle II, and BESIII. To make the problem tractable, we adopt the diquark–antidiquark picture. In this framework, the tetraquark is treated as two clusters—a diquark and an antidiquark bound together by an effective potential. This reduction simplifies the four-body system into a quasi-two-body problem, allowing us to apply powerful semiclassical techniques while still retaining essential features of multiquark dynamics. The interaction is described by a generalized Cornell potential that combines short-range coulombic and long-range confining terms. Applying the leading order WKB quantization condition to the effective radial Schrödinger equation yields approximate analytic expressions for ground and excited state masses. Near the classical turning points, we expand the potential around a suitable equilibrium point r0 using Taylor series expansion. This approximation makes it possible to reduce the radial Schrödinger equation into a form suitable for the application of the WKB quantization condition. By imposing the standard WKB quantization integral, we derive analytic expressions for the energy eigenvalues that correspond to the tetraquark mass spectrum. This work demonstrates that the WKB approach provides a practical semi-analytic framework for exploring exotic tetraquarks and guiding experimental searches

Author: DEV, Tanmay (Department of Physics, Gauhati University)

Co-author: Dr HAZARIKA, Bhaskar Jyoti

Presenter: DEV, Tanmay (Department of Physics, Gauhati University)

Session Classification: Poster Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **53** Type: **Oral**

Ag-Au bimetallic nanoparticles deposited on filter paper as a simple SERS substrate for the quantitative analysis of Carbofuran and 2,4-dinitrophenol

Saturday, November 1, 2025 3:45 PM (15 minutes)

Ag-Au bimetallic nanoparticles deposited on filter paper as a simple SERS substrate for the quantitative analysis of Carbofuran and 2,4-dinitrophenol

Primary author: Nituraj Changmai1,
Co-author: Dipjyoti Sarma2, Pabitra Nath1*
Presenter: Nituraj Changmai
1Department of Physics, Tezpur University
2Faculty of Science, Assam down town University

*Corresponding author: pnath07@gmail.com

Surface-enhanced Raman scattering (SERS) has emerged as a reliable molecular spectroscopic technique for its high sensitivity and label-free detection capabilities 1, 2, 3. Herein, we report Ag-Au bimetallic nanoparticles deposited on Whatman filter paper as a simple, highly effective, and flexible SERS substrate. The proposed SERS substrate has been developed through drop-casting silver and gold nanoparticles onto the Whatman filter paper. Prior to the experimental investigation, the Au-Ag bimetallic nanoparticles on the filter paper have been characterized by field emission scanning electron microscopy (FESEM), energy-dispersive X-ray (EDX), and X-ray diffraction (XRD). The initial performance of the substrate has been evaluated using two Raman-active dyes –namely, malachite green (MG) and rhodamine 6G(R6G) is reported. Upon noticing their reliable performance with the standard Raman active samples, the applicability of the substrate has been realized through the detection of Raman signals from two pesticides, namely, 2,4-dinitrophenol and Carbofuran in wastewater samples. During the presentation, details of the findings will be presented during the conference.

References:

1 X. Tian et al., "New Trends in SERS Substrates With Micro-and Nanostructures: Materials, Substrates, Preparation, and Applications,"Battery Energy, p. 70023, 2025.
2 N. Chamuah, A. Hazarika, D. Hatiboruah, and P. Nath, "SERS on paper: an extremely low cost technique to measure Raman signal,"Journal of Physics D: Applied Physics, vol. 50, no. 48, Art. no. 48, 2017.
3 D. Sarma, S. Biswas, D. Hatiboruah, N. Chamuah, and P. Nath, "100 GSM paper as an SERS substrate for trace detection of pharmaceutical drugs in an aqueous medium,"Journal of Physics D: Applied Physics, vol. 55, no. 38, Art. no. 38, 2022.

Author: CHANGMAI, Nituraj (Tezpur University)

Presenter: CHANGMAI, Nituraj (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **54** Type: **Poster**

Design, Simulation, and Offline Testing of a Fast Neutron Moderator for AD-BNCT

Saturday, November 1, 2025 11:45 AM (1 hour)

abstract: The Cotton University Particle Accelerator Centre and North East (CUPAC-NE)1 is developing the first particle accelerator facility in Northeast India, a region with the nation's highest cancer incidence. This work focuses on Accelerator-Driven Boron Neutron Capture Therapy (AD-BNCT), an emerging cancer treatment based on the ^{10}B(n,α)^{7}Li reaction that selectively destroys boron-loaded tumor cells. Clinical efficacy depends on neutron energy: thermal neutrons (0.025 eV) are suited for superficial tumors, while epithermal neutrons (1 eV - 10 keV) penetrate deeper tissues and subsequently thermalize. Optimized moderation is therefore critical to maximize epithermal flux while ensuring patient safety.

The p(^{7}Li,^{7}Be)n reaction2 at 28 MeV in inverse kinematics is employed at the HIRA facility (IUAC)3 as the neutron source. Geometric constraints restrict moderator placement to $33° – 50°$ and ≤ 200 mm to avoid overlap with the first quadrupole (Q1) as shown in Fig.1, thereby fixing the beam energy. The primary neutron branch (1 - 5 MeV) is kinematically correlated with a satellite ^{7}Be branch (17 - 19 MeV), detectable at HIRA.

As current GEANT4/TOPAS models are unreliable above 23 MeV in inverse kinematics, a transformation code was developed to convert direct to inverse kinematics at equal center-of-mass energy, validated against GEANT4 within its reliable range. Moderator optimization was conducted with CAD-integrated GEANT4 simulations. Conical moderators, commonly employed in AD-BNCT, were found to be inefficient. After several iterations, an optimized design with 14× higher efficiency was achieved as shown in Fig. 2. The system uses water as moderator, Teflon as cone material (chemically inert, providing additional fast-neutron absorption via ^{19}F(n,α)^{16}O and favorable scattering), and Bi as a gamma shield. Simulations predict $\sim 3 \times 10^4$ thermal neutrons per hour from a 28 MeV, 5 pnA ^{7}Li beam on a 20 μm polypropylene foil, further enhanced by a Pb collimator. The spectrum exhibits a thermal peak at ~ 48 meV with FWHM ~ 147 meV.

A scaled moderator prototype was 3D-printed in PLA (Polylactic Acid), with simulations indicating that a gypsum coating achieves efficiencies comparable to Teflon. A preliminary test is planned at the medical cyclotron of the State Cancer Institute, Guwahati. For thermal neutron detection, a novel and cost-effective method using LR115(II) solid-state nuclear track detectors is proposed. In this method, moderated thermal neutrons interact with ^{10}B compounds, producing α-particles that generate observable tracks under an optical microscope. The technique was validated using a ^{241}Am α-source, which produced well-defined tracks. Using this technique, the thermal neutron flux at the moderator exit can be determined. The medical cyclotron is also equipped with a BF_3 neutron detector, which allows evaluation of the moderator's efficiency by comparing the incident-to-exit flux ratio. Following optimization, the final experiment will be conducted at HIRA (IUAC, AUC:71368), where accelerator-driven monochromatic neutrons will be moderated to produce a well-characterized thermal neutron beam.

Acknowledgement: We extend our heartfelt gratitude to Prof. G. C. Wary, Prof. M. Patgiri, HIRA group, Dr. S. Santra, Dr. P. C. Rout, Jibon Sharma, Achuyt and Abhilash for their help and guidance.

References

1 G. C. Wary, et al., "Developing a Discovery Class Particle Accelerator Facility at Cotton University by CUPAC - North East Collaboration,"in Proc. DAE Symp. Nucl. Phys., vol. 65, pp. 5–14, 2021.
2 J. J. Das, et al., "Production of light radioactive ion beams (RIB) using inverse kinematics,"Nucl. Instrum. Methods Phys. Res. B, vol. 241, pp. 953–958, 2005.
3 A. K. Sinha, et al., "Heavy ion reaction analyzer (HIRA): a recoil mass separator facility at NSC,"

Nucl. Instrum. Methods Phys. Res. A, vol. 339, pp. 543–549, 1994.

Author: GOGOI, Monuj (Cotton University)

Co-authors: Ms SAIKIA, Dimpal (Cotton University); Mr GOGOI, Hritik (Cotton University); Ms BARUAH, Rasna (Cotton University); Mr BORUAH, Bhargab (Cotton University); Mr KUMAR KALITA, Naba (Cotton University); Mr PANDIT, Nabajyoti (Cotton University); Dr BARTHAKUR, A (Cotton University); Prof. DAS, J J (Cotton University); Dr BARO, M (Cotton University); Dr DEVI, M M (Tezpur University)

Presenter: GOGOI, Monuj (Cotton University)

Session Classification: Poster Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **55** Type: **Poster**

Energy loss and Quenching Factor studies for low-recoil collision cascades in Silicon using Molecular Dynamics simulations

Saturday, November 1, 2025 11:45 AM (1 hour)

The direct detection of dark-matter mainly relies on the nuclear recoil energy in detector materials, where only a fraction of the recoil energy contributes to measurable ionization or scintillation signals. This fraction is termed as the quenching factor (QF) and is an essential parameter to reconstruct the nuclear recoil energy accurately. Lindhard's model provides a theoretical framework to calculate the quenching factor and SRIM framework is used to simulate for the electronic and nuclear energy loss in the materials. However, both of these methods, suffer from growing uncertainties specially in the sub-keV regime, where the sensitivity of light Dark-Matter is the most critical [1,2].
In this work, we present a classical molecular dynamics based framework to investigate the recoil energy loss and quenching factor in Silicon. For this work,a simulation cell of (20x20x20) lattice units with periodic boundary conditions is created. We adpot here, a modified tersoff-potential which precisely incorporates the Many-Body effects 3. The preliminary results reveal systematic deviations from Lindhard's model and are closer to experimental data between 20 eV to 10 keV energy range. This is highlighting the capability of MD-framework to capture the underlying atomistic processes such as defect formation, phonon excitations and lattice binding effects.

Author: Mr MISHRA, Deepak (Department of Physics, Central University of South Bihar Gaya)

Co-authors: Dr SINGH, Lakhwinder (Department of Physics, Central University of South Bihar Gaya); Dr LIN, Shin-Ted (College of Physics, Sichuan University, China); Prof. TSZ-KING WONG, Henry (Institute of Physics, Academia Sinica, Taiwan); Prof. SINGH, Venktesh (Department of Physics, Central University of South Bihar Gaya)

Presenter: Mr MISHRA, Deepak (Department of Physics, Central University of South Bihar Gaya)

Session Classification: Poster Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **56** Type: **Oral**

Smartphone-Integrated Paper-based Fluorescence Optode for Point-of-Care Monitoring of Na+/K+ Ratio

Saturday, November 1, 2025 3:15 PM (15 minutes)

Abstract: The sodium-to-potassium (Na+/K+) ratio serves as an important biomarker with relevance to electrolyte balance, renal health, hypertension, and metabolic and inflammatory conditions. Non-invasive body fluids offer practical routes for assessing the Na^+/K^+ ratio in point-of-care applications. Traditional methods for measuring Na^+ and K^+ such as flame photometry, ion-selective electrodes, and ICP-based techniques, are costly and confined to laboratory settings, making them unsuitable for rapid and point-of-care testing. We present a portable, low-cost, smartphone-integrated paper-based ion-selective fluorescence optode for quantitative detection of the Na^+/K^+ ratio. The sensing platform utilizes BODIPY-based fluorescent paper strips with two spatially separated sensing zones exhibiting high selectivity for Na^+ and K^+. Fluorescence emissions from the two zones is recorded by a smartphone using a customized 3D-printed optical aseembly. Preliminary observations demonstrate the sensing system's high specificity for Na^+ and K^+ with rapid detection, providing an accessible, user-friendly platform for clinical monitoring.

Author: DUTTA, Chunuranjan (Applied Photonics and Nanophotonics Laboratory, Department of Physics, Tezpur University, Sonitpur, Assam, India-784028)

Co-authors: RABHA, Bikiran (Applied Photonics and Nanophotonics Laboratory, Department of Physics, Tezpur University, Sonitpur, Assam, India-784028); CHETRY, Arati (Department of Chemistry, Dibrugarh University, Dibrugarh 786004, Assam, India); KHAKHLARY, Prithiviraj (Department of Chemistry, Dibrugarh University, Dibrugarh 786004, Assam, India); NATH, Pabitra (Applied Photonics and Nanophotonics Laboratory, Department of Physics, Tezpur University, Sonitpur, Assam, India-784028)

Presenter: DUTTA, Chunuranjan (Applied Photonics and Nanophotonics Laboratory, Department of Physics, Tezpur University, Sonitpur, Assam, India-784028)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **57** Type: **Oral**

Astrofluidic disk instability in fourth order gravity

We investigate the local gravitational instability of self-gravitating, rotating thin astrofluidic disks within the fourth order gravity (FOG) framework 1, 2. The analysis is performed in the weak-field non-relativistic regime. This consideration is well motivated as the dynamical timescales associated with the disk instabilities are much longer than the relativistic ones. In this regime, the evolution of the structure formation mechanism is consistently captured by the hydrodynamic equations coupled and enclosed with the FOG-modified gravitational Poisson equation. By incorporating higher-order corrections to the self-gravitational potential, we derive a modified dispersion relation using the tight-winding (local) approximation. Consequently, we also obtain the associated generalized FOG-modified Toomre stability criterion for the astrofluidic disks. The resulting modified criterion reveals that the stability of the fluidic disk is significantly altered by the free length parameter (L), introduced by the FOG theory. It potentially shifts the threshold value of the Toomre parameter, leading to observable differences in triggering structure formation compared to the Newtonian predictions.

Author: Mr DAS, Mritunjoy (Tezpur University)

Co-author: Dr KARMAKAR, Pralay Kumar (Tezpur University)

Presenter: Mr DAS, Mritunjoy (Tezpur University)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **58** Type: **Oral**

An Integrated Modeling Framework for Ion Transport and Electrochemical Responses in Paper-Based Microfluidic Sensors

Saturday, November 1, 2025 3:30 PM (15 minutes)

Paper-based electrochemical biosensors are gaining an importance as disposable devices for ion detection in healthcare and environmental applications. Their performance depends on the combined effects of ion transport within the porous paper medium, receptor-ion interactions and electrochemical transduction at the electrode. While experimental studies provide valuable demonstrations, a clear quantitative understanding of how these processes interact is still developing. In this work, we present a modeling framework that connects ion transport, receptor binding and current generation in a unified manner. The ion transport through a paper strip was simulated using an advection-diffusion approach, yielding breakthrough curves and concentration distributions across the strip. These outlet concentrations were then applied to a receptor binding model described by association and dissociation rate constants (k_{on}, k_{off}). The comparison of target and interferent ions showed that the target achieved faster binding and earlier receptor saturation, confirming the role of binding kinetics in ensuring selectivity. The electrochemical readout was obtained by converting ion flux to current using Faraday's law. The resulting chronoamperometric-like responses displayed an initial rise, a peak and a gradual decay, reflecting diffusion limitation and receptor occupancy. To extract design insights, parametric studies were performed by varying the effective diffusion coefficient (D_{eff}), electrode area (A) and binding kinetics. Larger electrodes scaled the current linearly whereas higher diffusion coefficients produced smoother transients and stronger binding accelerated receptor occupancy. A two-dimensional heatmap of peak current as a function of diffusion coefficient and electrode area highlighted the combined effect of transport and geometry, offering practical guidelines for sensor design. This study shows that the transport, binding and transduction must be considered together to capture the sensing behavior of paper-based electrochemical biosensors. The framework provides predictive insights that complement experimental studies on binding kinetics 1, nanomaterial assisted electrochemical interface 2 and pre-equilibrium biosensing 3. The results demonstrate how computational modeling can guide the rational design of next-generation paper-based biosensors with improved selectivity and sensitivity.

Author: SHIBAM, Rimjim (Tezpur University)

Co-author: Prof. SAHU, Partha Pratim (Tezpur University)

Presenter: SHIBAM, Rimjim (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **59** Type: **Oral**

Nonlinear structures in a plasma with charged debris and nonthermal electrons

Saturday, November 1, 2025 2:35 PM (20 minutes)

In this work, we investigate the nonlinear structures excited by moving external charged debris in a collisionless, unmagnetized plasma with thermal ions and Cairns-distributed electrons. The results indicate that the interplay between the debris motion and the nonthermal electron population strongly influences the properties of such structures. Our findings provide new insights into debris-plasma interactions and demonstrate the importance of nonthermal electron distributions in shaping nonlinear wave dynamics, with relevance to both laboratory and space plasma environments.

Author: JOARDAR, Bikramjit (Department of Physics, Gauhati University, Guwahati - 781014, Assam, India)

Co-author: MADHURJYA P. BORA (Department of Physics, Gauhati University, Guwahati - 781014, Assam, India)

Presenter: JOARDAR, Bikramjit (Department of Physics, Gauhati University, Guwahati - 781014, Assam, India)

Session Classification: Oral Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **60** Type: **Oral**

Berry Curvature Driven Anomalous and Spin Hall Effect in Ferromagnetic Janus Material

Saturday, November 1, 2025 2:30 PM (15 minutes)

The ability to generate and control spin current efficiently is a central challenge for advancing next-generation spintronic technologies. While nonmagnetic materials typically host spin Hall conductivity (SHC) 1 and ferromagnets are studied for anomalous Hall conductivity (AHC) 2, realizing both effects within a single material system remains rare and highly desirable for multifunctional applications. In this work, we investigate a ferromagnetic Janus transition metal dichalcogenide (TMD) as a platform for coexisting AHC and SHC. The Berry curvature and the spin Berry curvatures are computed within the Kubo formalism to quantify the anomalous and spin Hall conductivities. The intrinsic structural asymmetry of Janus systems enhances spin-orbit coupling (SOC), while ferromagnetic ordering breaks spin degeneracy in the Janus system. Our results reveal an intrinsic AHC driven by magnetization and a finite SHC arising from the redistribution of spin Berry curvature, highlighting promising opportunities for designing low-power, next-generation spintronic devices.

Author: ROY, Deepshekhar (Tezpur University)

Co-author: Prof. DEB, Pritam (Tezpur University)

Presenter: ROY, Deepshekhar (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **61** Type: **Oral**

Ultra Thin Polarization Insensitive Band-Pass Frequency Selective Surface For Ku Band Applications

Saturday, November 1, 2025 3:45 PM (15 minutes)

A frequency selective surface (FSS) is a thin, repetitive surface designed to reflect, transmit or absorb electromagnetic fields based on the frequency of the incoming radiation and resonant frequency of the elements. By altering the electromagnetic waves that strikes them, the frequency produce dispersive transmitted and/or reflected attributes. The desired characteristics of FSS include a low profile, decreased periodicity, dual polarization, angular stability and ease of manufacturing. Unlike idealized FSS models, real-world designs incorporate factors such as material imperfections, fabrication tolerances, and environmental influences, which can affect performance and necessitate careful optimization. According to the filtering characteristics the FSS can be divided into four types: low pass, high pass, passband and band stop. In wireless communication, FSS are implemented to reduce electromagnetic interference (EMI) and enhance signal clarity by filtering certain frequency bands. They are also used in stealth technology and reducing RCS [1, 2].
The objective is to develop a wideband FSS that operates at Ku band frequency range (12-18 GHz) for potential applications in satellite communication, radar, and stealth technologies. This paper presents the design and fabrication of a wideband band-pass FSS incorporating periodic structures based on square unit cell with interconnecting double hexagonal loop resonator at the center surrounded by a square ring resonator at the edges. The simulation process was conducted using CST software. FR4 was selected for substrate and copper was used as conductive layer to make patterns on the substrate. The dimension of the substrate is 6 mm×6 mm with a thickness of 0.4 mm. The thickness of the copper layer is 0.035 mm. The structure was optimized for minimal insertion loss in the passband and high rejection outside it. Simulation results demonstrated a clear band-pass response centered around 15.04 GHz with a bandwidth of 5.26 GHz. The designed unit cell was then simulated for a FSS of 22×22 unit cells and fabricated. The simulated and experimented results are found to be comparable.

Author: DAS, DEBASISH (Tezpur University)

Co-authors: Mr DAS, Hirak Jyoti (Tezpur University); Dr BHATTACHARYA, Nidhi (Tezpur University)

Presenter: DAS, DEBASISH (Tezpur University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **62** Type: **Oral**

Estimation of refractivity turbulence structure constant (Cn2) and atmospheric boundary layer height through ST Radar of Gauhati University

Saturday, November 1, 2025 2:55 PM (20 minutes)

Abstract: Atmospheric turbulence significantly influences the dynamics of the surface, lower, and upper troposphere. The refractivity turbulence structure constant (Cn2) serving as a crucial indicator for parameters such as kinetic energy dissipation rate and eddy diffusivity. In this study, continuous wind data from the Stratosphere Troposphere (ST) Radar system of Gauhati University (26.10N, 91.70E; 50 m above MSL) is utilized for Cn2 estimation. Using radar data at the various seasons of the year we have calculated Cn2 and are compared with GPS radiosonde results provided by RMC (IMD) Guwahati. The analysis shows that Cn2 decreases with height, ranging from 10−14 to 10−18 m−2/3, showing a reasonable agreement with the radiosonde results. Turbulence parameters critically shape boundary layer behaviour by driving vertical exchanges of momentum, heat, moisture, and other meteorologically relevant variables. High turbulence intensities cause the boundary layer to thicken, produce chaotic flow patterns, and significantly increase mixing rates, which enhances transport between the surface and free atmosphere.

These results demonstrate the effectiveness of Gauhati University ST radar system for analysing various turbulence parameters and boundary layer processes helping the understanding of vertical transport and turbulent mixing in the lower atmosphere. The agreement between radar and radiosonde-based measurements reinforces the credibility of remote sensing methods in continuous turbulent parameter characterization in atmospheric science.

Authors: NATH, Nilotpal (Gauhati University); MILI, Pankaj (Gauhati University); Dr SAIKIA, Manoj (Gauhati University)

Presenters: NATH, Nilotpal (Gauhati University); MILI, Pankaj (Gauhati University)

Session Classification: Oral Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **63** Type: **Oral**

Statistical Characterization of Flux Variability in X-ray Binaries

Saturday, November 1, 2025 3:15 PM (20 minutes)

X-ray binaries provide a powerful framework for studying accretion processes and compact objects such as neutron stars and black holes. Their flux variability, spanning time scales from milliseconds to years, reflects the complex interplay of mass transfer, disk instabilities, and emission mechanisms. We present a statistical characterization of flux variability using probability distribution functions. We demonstrated that statistical characterization serves as a reliable indicator of additive versus multiplicative processes and reveals differences between neutron star and black hole systems. As a future direction, we propose applying machine learning methods to classify variability patterns across large datasets, enabling automated mapping between statistical signatures and accretion states. This study highlights the importance of advanced statistical tools, coupled with data-driven techniques, in uncovering the physical processes driving variability in X-ray binaries.

Author: Dr DEKA, Kabita (Cotton University)

Co-author: Prof. AHMED, Gazi Ameen (Tezpur University)

Presenter: Dr DEKA, Kabita (Cotton University)

Session Classification: Oral Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **64** Type: **Oral**

Time delayed analysis of a firefly flash model

Saturday, November 1, 2025 3:35 PM (20 minutes)

This study presents a time-delayed analysis of a firefly flash model derived from the bioluminescent mechanism of fireflies1. The model is formulated on the basis of the well-established enzymatic reactions responsible for light emission. Numerical findings are validated against experimentally reported results. Additionally, multiple peak pulses at low temperatures, including double peak pulses that appear through period-doubling bifurcation, are satisfactorily explained by the time-delayed firefly model.

Reference:
1 D. Saikia and M. P. Bora, “Nonlinear model of the firefly flash”, Nonlinear Dynamics, vol. 101, no. 2, pp. 1301-1315, 2020.

Author: Dr SAIKIA, Debashis (Department of Physics, Nabajyoti College)

Presenter: Dr SAIKIA, Debashis (Department of Physics, Nabajyoti College)

Session Classification: Oral Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **65** Type: **Oral**

Design of a Compact UWB Microstrip Patch Antenna for Wireless Application

Design of a Compact UWB Microstrip Patch Antenna for Wireless Application

Primary author: Debajit Patir
Track Classification: Track 02
Department of Physics, Silapathar Science College
Dibrugarh University
*debajit.patir@gmail.com

Abstract: In this paper, a novel configuration of microstrip line fed ultra wide band (UWB) patch antenna using a defected ground plane structure is proposed for wireless application. The patch antenna is extended by etching slots in the patch and ground plane to achieve the operating bandwidth from 2.63 GHz to 6.81 GHz (VSWR ≤ 2). The proposed patch antenna has promising performance with UWB impedance matching, good radiation pattern and stable gain. Ansoft HFSS software is used to simulate the patch antenna installed on FR-4 substrate with dimension (25x38x1.6) mm3, having relative dielectric constant of 4.4 and loss tangent of 0.02.

Keywords: Microstrip line fed, Patch Antenna, Defected Ground Structure, Ansoft HFSS, VSWR, UWB

References:

1 Lingsheng Y. and Yoshitomi K., "A Compact Circular Corner Monopole Antenna for UWB Application", Microwave and Optical Technology Letters, Vol. 54, No. 1, January 2012.

2 D. Patir and Dipak Kr. Neog, "A Compact Ultra Wideband Metamaterial Based Octagonal Shape Patch Antenna for Band Notch Performance", Advanced Research in Electrical and Electronic Engineering (AREEE), vol. 2, Issue 13, pp. 6-8, Oct-Dec2015.

3 B. Ramesh, K. P. Vinay, L. B. Prasad, K. S. Ravi Kumar and D. V. Rama Koti Reddy, "Novel Bludgeon-shaped Microstrip Antenna with DGS for UWB Applications with Notch Band Characteristics", Innovation in Electrical Power Engineering Communication and Computing Technology, pp.61-69, 2020

[4] S. S. Al-Bawri, H. H. Goh, Md. S. Islam, H. Y. Wong, M. F. Jamios, A. Narbudowicz, M. Jusoh, T. Sabapathy, R. Khan, M. T. Islam, "Compact Ultra-wideband Monopole Antenna Loaded with Metamaterial", Sensors, vol. 20, issue 3, 2020.

[5] R. Kumar and D. C. Dhubkarya, "UWB Compact Microstrip Patch Antenna with High Directivity Using Novel Star-Shaped Frequency Selective Surface", Progress In Electromagnetics Research C, Vol. 119, pp. 255–273, 2022.

[6] Lak H. J., Ghobadi C. and Nourinia J., "A Novel Ultra-Wideband Monopole Antenna with Band-Stop Characteristic", Wireless Engg. and Tech., Vol.2, pp.235-239, 2012.

[7] D. K. Neog, S. S. Pattnaik, M. Dutta, D. C. Panda, S. Devi and B. Khuntia, "A novel patch antenna for wide band generation", Proceeding of international conference on antenna technologies, pp. 345-348, 2005.

[8] H. S. Singh, S. Kalraiya, M. K. Meshram and R. Shubair, "Metamaterial Inspired CPW-fed Compact Antenna for Ultra-wideband Applications", International Journal of RF and Microwave Computer-aided Engineering, May 2019.

……………………………………………

Author: PATIR, Debajit (Silapathar Science College, Dibrugarh University)

Presenter: PATIR, Debajit (Silapathar Science College, Dibrugarh University)

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **67** Type: **Oral**

Momentum-Resolved Spin Splitting in 3D Altermagnets: Interplay of Ferromagnetic and Antiferromagnetic orders

Saturday, November 1, 2025 2:45 PM (15 minutes)

Momentum-Resolved Spin Splitting in 3D Altermagnets: Interplay of Ferromagnetic and Antiferromagnetic orders

Primary author: Rotish Sarkar1
Co-author: Dr. Nimisha Raghuvanshi*1
Presenter: Rotish Sarkar
Track Classification: Track 03

1 Department of Engineering Sciences, Assam Energy Institute (RGIPT), Assam

*Corresponding Author: rotishs23ea@rgipt.ac.in

Abstract: This work synthesizes theoretical advances in Altermagnetism, a third type of collinear magnetism Similar to standard Antiferromagnetic (zero net magnetisation) and Ferromagnetic (spin splitting in band structure), aming to validate Altermagnetic band splitting in a real material and to propose a new correlation-driven mechanism. Chromium antimonide (CrSb) is demonstrated as a metallic altermagnet, exhibiting large, momentum-dependent spin splitting without net magnetization in the band structure. We developed a minimal two–orbital tight-binding model for the NiAs–type hexagonal lattice of CrSb. The theoretical model is a two-band Hubbard-like Hamiltonian solved at mean-field level , orbitals on a hexagonal lattice incorporating intra- and inter-orbital hopping up to third-nearest neighbors on the d_{xy} and d_{xˆ2-yˆ2} orbitals. By fitting hopping parameters (t_1=t_2=1.75, t_3=t_4=0.85, r=-1.95, s=-0.65, s_h=-0.05) in energy units along the high-symmetry M–\mathrm{\Gamma}–M path. It is analysed for coexisting Neel antiferromagnetic (AFM) and staggered orbital order (OO), the model reproduces the nonmagnetic band dispersion neglecting the interaction terms i.e. AFM and OO interaction and quantitatively captures key features of angle-resolved photoemission spectroscopy (ARPES) data near the Fermi level. Direct ARPES measurements reveal an anisotropic band splitting of approximately 0.6 eV linked to the d_{xˆ2-yˆ2} orbital character, confirming exchange-induced altermagnetic order above 700 K. Our results establish CrSb's simple orbital framework as an ideal platform for theoretical studies and practical spintronic applications, where field-free, spin-polarized transport and anomalous Hall phenomena arise from intrinsic momentum-space spin polarization
The orbital-order and Antiferromagnetic-order model demonstrates a new design principle: electronic correlations and orbital ordering and antiferromagnetic ordering can induce altermagnetism in lattices without considering relativistic spin-splitting. This expands the search space for altermagnets to correlated oxides and other systems. In both cases, the large momentum-dependent spin polarization and associated transverse spin currents point toward device concepts combining ferromagnet-like spin polarization with antiferromagnetic robustness. These advances inform material design strategies (e.g. engineering Cr–Sb hopping paths or orbital occupations) and point to novel spintronic applications leveraging altermagnetism

Author: SARKAR, ROTISH (RGIPT)

Presenter: SARKAR, ROTISH (RGIPT)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **69** Type: **Oral**

Common Origin of Asymmetric Self-interacting Dark Matter and Dirac Leptogenesis

Saturday, November 1, 2025 4:38 PM (13 minutes)

Assuming dark matter to be asymmetric as well as self-interacting and neutrinos to be Dirac fermions, we propose a framework to address the observed baryon imbalance of the universe. We add three right-handed neutrinos ν_{R_i}, $i = 1, 2, 3$, one singlet fermion χ, a doublet fermion ψ, and heavy scalar doublets η_i, $i = 1, 2$ to the Standard Model. Both χ and ψ are fermions with non-zero charge under an extended $U(1)_{B-L} \times U(1)_D$ symmetry. Additionally, a $\mathcal{Z}_2$ symmetry is imposed, where the singlets χ, ν_R, and η are negative and the doublet ψ is positive. Given the assumption that neutrinos are Dirac particles, $B - L$ turns into an exact symmetry of the universe. The CP-violating out-of-equilibrium decay of heavy scalar η generates an equal and opposite $B-L$ asymmetry among the left-handed (ν_L) and right-handed (ν_R) neutrinos. The $\nu_L - \nu_R$ equilibration process does not take place until below the Electroweak phase transition scale because of tiny Yukawa couplings. During this time, Sphaleron processes, which are active at temperatures higher than 100 GeV, transform a portion of the $B - L$ asymmetry stored in left-handed neutrinos into baryon asymmetry. MeV scale gauge boson Z' of $U(1)_D$ sector mediates both annihilation of symmetric dark matter component and self-interaction among dark matter particles. Moreover, Z' mixes with the Standard Model Z-boson and facilitates dark matter direct detection.

Authors: Dr DUTTA, Manoranjan (North Lakhimpur University); Dr NARENDRA, Nimmala (PES Institute of Technology & Management)

Presenter: Dr DUTTA, Manoranjan (North Lakhimpur University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **71** Type: **Poster**

Toward Affordable Multispectral Methods for Optical Glucose Detection Using Sugar Solutions and Blood-Like Tissue Phantoms

Saturday, November 1, 2025 11:45 AM (1 hour)

Accurately measuring blood glucose levels without drawing blood remains difficult because glucose has weak optical absorption and biological tissue introduces strong background interference. In this work, we explore whether a compact, low-cost multispectral sensor (SparkFun Triad AS7265x, 410–940 nm) can detect glucose-related optical changes. Sugar solutions ranging from 5–35% w/v were measured at several sensor–sample distances, with an 8 mm spacing yielding the most consistent spectral data. After normalization, Partial Least Squares (PLS) regression produced excellent calibration performance ($R^2 \approx 1.00$; RMSE ≈ 0.10%), demonstrating sensitivity to concentration-dependent changes stemming from scattering and refractive index variations. To better mimic physiological conditions, glucose was added to tissue-like optical phantoms composed of Intralipid and India ink. Preliminary measurements show subtle yet detectable spectral trends in the visible to near-infrared region. Overall, these results suggest that pairing low-cost multispectral sensing with multivariate analysis can provide coarse glucose estimates and represents a promising step toward portable, non-invasive monitoring technologies.

Authors: Dr CHETIA, Dipankar (North Lakhimpur University); Mr BORAH, Nikunja Ranjan (North Lakhimpur University)

Presenters: Dr CHETIA, Dipankar (North Lakhimpur University); Mr BORAH, Nikunja Ranjan (North Lakhimpur University)

Session Classification: Poster Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **72** Type: **Poster**

Green Synthesis and Characterisation of Silver Nanoparticles Using Leaf Extract of Houttuynia cordata (Mosondori) from Assam

Saturday, November 1, 2025 11:45 AM (1 hour)

The eco-friendly biosynthesis of silver nanoparticles (AgNPs) using plant leaf extract offers a cost-effective and sustainable route to value-added nanomaterials using plant metabolites as both reductants and capping agents. In this study, silver nanoparticles were synthesised using a green method that employed the leaf extract of Houttuynia cordata (Mosondori), an indigenous medicinal plant found in Assam. The phytochemical test reveals the bioactive compounds found in the plant extract are actively participate as both reducing and capping agents, thereby eliminating the need for hazardous chemicals. The formation of AgNPs by green synthesis was confirmed by a characteristic colour change and further validated by using characterisation techniques, UV-Vis spectroscopy, X-ray diffraction (XRD), and energy-dispersive spectroscopy (EDS). The characterised results show their crystalline nature and confirm elemental compositions, and the calculated average particle size of synthesised silver nanoparticles. Phytochemical test further indicated the involvement of bioactive compounds in nanoparticle stabilisation. As the AgNPs show a significant antibacterial activity, thus suggests potential applications in the field of environmental and healthcare sectors. This work demonstrated the cost-effective, biocompatible, and sustainable way of using locally available medicinal plants for the green synthesis of nanomaterials, and supporting the development of eco-friendly nanotechnology and rural biotechnology initiatives in Assam.

Author: ROBIDAS, Dipika (Dr)

Co-authors: BHUYAN, Kakali (North Lakhimpur College (Autonomous)); Ms MEHERAYAN, Spondita

Presenters: ROBIDAS, Dipika (Dr); BHUYAN, Kakali (North Lakhimpur College (Autonomous)); Ms MEHERAYAN, Spondita

Session Classification: Poster Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **73** Type: **Oral**

A DFT Study on influence of solvent media on electronic, optical and vibrational properties of TiO2 Nanoparticle

Saturday, November 1, 2025 4:00 PM (15 minutes)

Density Functional Theory (DFT) is used to investigate the optical, electrical and vibrational properties of titanium dioxide nanoparticles (TiO_2 NPs) by altering the solvent conditions from DI water to ethanol. From the theoretical calculations, it was observed that their HOMO-LOMO energy gaps are comparable with the experimental results. To study the electronic properties in detail, Koopmans' formulas are utilised to determine the binding energy per atom, energy gap, chemical potential, ionization potential, electron affinity, hardness and electrophilicity index. These parameters were calculated at the level of B3LYP with the LANL2DZ basis set using Gaussian 09 software. The IR and Ramman spectra for the proposed nanoparticles in different solvent conditions show the absorption and vibrational modes present in the system. This provides a clear indication of the solvent's effect on the physical and chemical properties of the TiO_2 NPs.

Author: NANDI, PRAKASH (TEZPUR UNIVERSITY)

Co-authors: Dr BISWAS, RAJIB (TEZPUR UNIVERSITY); DEKA, BEDANTA KUMAR (TEZPUR UNIVERSITY)

Presenter: NANDI, PRAKASH (TEZPUR UNIVERSITY)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **74** Type: **Oral**

An Analysis of Performance for n-Type Polycrystalline Silicon Cantilever-based Piezoresistive Pressure Sensors with Different Doping Concentrations

Saturday, November 1, 2025 3:00 PM (15 minutes)

Abstract: The performance of silicon semiconductor based piezoresistive pressure sensors is depends on mechanical properties and electrical properties of the material, structural configuration, and doping concentration. Among different materials, polycrystalline silicon (poly-Si) has gained significant attention due to its compatibility with standard microfabrication processes, cost-effectiveness, and suitability for microelectromechanical system (MEMS) applications. This study is to investigate the performance of n-type polycrystalline silicon cantilever-based piezoresistive pressure sensors with varying doping concentrations range from 1x10ˆ17 cm-3 to 1x10ˆ22 cm-3. This work is mainly focuses on change in conductivity of electron, which is the major charge carrier in the n-type polysilicon semiconductor. This change in conductivity highly influenced on the performance of pressure sensor. To analyses the performance of n-type Polycrystalline Silicon Cantilever-based Piezoresistive Pressure Sensors, The COMSOL Multiphysics Simulator is use to simulated the designed sensor with different doping concentration for the applied pressure for 0 kPa to 100 kPa. The main performance parameters for this study are stress distribution on the surface, voltage gradient distribution, linearity, conductance and resistance of the sensor. From the simulations results, it is observed that the stress distribution and the voltage gradient on the surface of the sensor are equal for all the simulated model sensors. It is also observed that the output of the conductance and resistance are highly linear with the applied pressure. The conductance value of the sensor is increase with increase in doping concentration and it also increase with increase in applied pressure. While the resistance of the senor is decrease with increase in doping concentration and also decrease with increase in applied pressure. Further it is also observed that the span or change in resistance due to change in the applied pressure is decrease with increase in doping concentration.
In conclusion, the increasing in the doping concentration increase in the conductivity which lead to the decrease in sensitivity of the n-Type Polycrystalline Silicon Cantilever-based Piezoresistive Pressure Sensors. The sensor is highly linear with the applied pressure with negative slope.

Author: Mr BOBINSON SINGHA, Lukram (Rajiv Gandhi University)

Co-author: MEETEI, Maibam Sanju (Rajiv Gandhi University)

Presenter: Mr BOBINSON SINGHA, Lukram (Rajiv Gandhi University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **75** Type: **Oral**

A Comparative Study of Hidden Layer Configurations in Multi-Layer Perceptrons (MLP) for Liver Cirrhosis Prediction

Saturday, November 1, 2025 4:15 PM (15 minutes)

Abstract: This study presents the design and simulation of a Multilayer Perceptron (MLP)-based Artificial Neural Network for predicting stages of liver cirrhosis using the Cirrhosis Prediction Dataset from Kaggle. The dataset includes medical and demographic records of 418 individuals, with 20 attributes such as age, sex, treatment type, and clinical conditions (ascites, edema, hepatomegaly), as well as biochemical test results (bilirubin, cholesterol, albumin, copper, alkaline phosphatase, SGOT, triglycerides, platelet count, and prothrombin time). The target variable is patient status (alive, transplant, or deceased), while the "stage"variable indicates histological severity from 1 to 4. After preprocessing, 15 features were selected for model input, including categorical encoding and normalization of numerical data. The dataset was split into training (70%), validation (15%), and testing (15%) subsets using stratified sampling to maintain class balance. Random shuffling minimized ordering bias, and validation data was employed to tune hyperparameters such as learning rate, activation functions, and hidden layer sizes, while early stopping was used to reduce overfitting. Two MLP architectures were implemented: a two-hidden-layer network and a three-hidden-layer network. For the two-layer model, a configuration of 60 neurons in the first layer and 30 in the second was simulated with sigmoid activation in hidden layers and softmax in the output layer. The best validation performance (0.25544 at epoch 22) achieved an overall accuracy of 52.9%, with training, testing, and validation accuracies of 54.1%, 58.7%, and 41.3%, respectively. Varying neurons between 10 and 100 in hidden layers showed no consistent trend but indicated that configurations between 60–100 neurons provided relatively stable performance. The highest overall accuracy in this set was 55.5% with 100 neurons. For the three-layer MLP, the first and second hidden layers were fixed at 100 and 60 neurons, while the third layer varied. The best performance was achieved with 80 neurons, reaching 55.3% overall accuracy and 63.5% validation accuracy. However, extreme configurations with very low or very high neurons showed reduced performance, highlighting a trade-off between model complexity and generalization.
In conclusion, MLP-based models demonstrate potential in non-invasive cirrhosis stage prediction using routine clinical and laboratory data. Results show that moderate network sizes (60–80 neurons per hidden layer) yield the most reliable accuracy. While deeper architectures can capture complex nonlinear patterns, careful tuning is required to avoid underfitting or overfitting. This work provides a foundation for further refinement of AI-based tools for liver disease prediction, supporting early diagnosis and clinical decision-making.

Author: Mr NYAYU, Nyakum (Rajiv Gandhi University)

Co-author: MEETEI, Maibam Sanju (Rajiv Gandhi University)

Presenter: Mr NYAYU, Nyakum (Rajiv Gandhi University)

Session Classification: Oral Presentations

Track Classification: Track 02: Electronics & Photonics, Computational Physics, Applied & Engineering Physics

Contribution ID: **76** Type: **Poster**

Impact of Magnetic Field-Modified Ion Streaming on Shear Viscosity and Conductivity in Strongly Coupled Dusty Plasma

The core objective of this study was to quantitatively determine the shear viscosity and thermal conductivity the key transport properties of strongly coupled dusty plasma when subjected to both ion streaming and an external magnetic field. Using Langevin dynamics simulations, we modeled the complexities introduced by the ion stream (typically from sheath electric fields) and its subsequent modification by the magnetic field. By applying the Green-Kubo integral formulae, we successfully computed these transport coefficients across a broad parameter space, encompassing variations in the Coulomb coupling (Γ), Screening parameter (κ), Mach number (M), Neutral pressure (Nn), and Magnetic field strength (B). The findings elucidate the critical role of inter-particle interactions in mediating the transport behavior under these combined external influences.

Author: Dr BEGUM, Mahmuda (Department of physics, Lakhimpur Girls' College, North Lakhimpur, Assam-787031, India)

Presenter: Dr BEGUM, Mahmuda (Department of physics, Lakhimpur Girls' College, North Lakhimpur, Assam-787031, India)

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **77** Type: **Oral**

Effect of Inner Horizon in Hawking Temperature of 5D Myers Perry Black Hole

Saturday, November 1, 2025 2:28 PM (13 minutes)

We investigate Hawking radiation of spin-1/2 particles from a five-dimensional Myers-Perry black hole with two independent rotation parameters. Using the semiclassical WKB approximation applied to the covariant Dirac equation, we compute the fermionic tunneling probability and recover the standard Hawking temperature at the outer horizon. Extending the analysis to include the inner horizon, we obtain a correlated Hawking temperature that encodes quantum interactions between horizons. This leads to modifications of the thermal spectrum and new insights into horizon dynamics, particularly near extremality where the horizons coincide. Analytical calculations and computational analysis illustrate the dependence of the correlated temperature on various parameters, emphasizing the inner horizon's significant role in Hawking temperature.

Author: UPADHYAYA, Sraban Kumar (Rajiv Gandhi University)

Co-author: Dr SINGH, Heisnam Shanjit (Rajiv Gandhi University)

Presenter: UPADHYAYA, Sraban Kumar (Rajiv Gandhi University)

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **78** Type: **Oral**

Enhanced Blue Luminescence in Y_2O_3:Ce^{3+}, Eu^{2+} Phosphor Mediated by Ce^{3+}→Eu^{2+} Energy Transfer

Saturday, November 1, 2025 4:00 PM (15 minutes)

Blue-emitting phosphors hold significant potential for applications in solid-state lighting. We synthesised Y_2O_3 phosphors co-doped with 1 mol% Ce^{3+} and varying concentrations (1, 2, 3, and 4 mol%) of Eu^{2+} using the solution combustion method. Structural, compositional, optical absorption, and emission properties were investigated. X-ray diffraction analysis confirmed the formation of a cubic phase with the Ia-3 (206) space group, and the incorporation of dopants did not alter the host crystal structure. The Ce^{3+} doped sample exhibited a strong absorption band around 206 nm, which was observed to red-shift upon Eu^{2+} co-doping. Under 300 nm UV excitation, the Ce^{3+}–Eu^{2+} co-doped samples displayed prominent blue emission, originating from the 5d → 4f transitions of Ce^{3+} (2F7/2, 2F5/2) and the allowed $4f^6 5d^1 \rightarrow 4f^7$ transition of Eu^{2+}. Photoluminescence spectra, excitation profiles, decay dynamics, and energy transfer efficiency analyses confirmed an efficient $Ce^{3+} \rightarrow Eu^{2+}$ energy transfer mechanism. The critical distance between Ce^{3+} and Eu^{2+} ions was calculated to be 4.56 Å, indicating exchange interaction as the dominant energy transfer pathway. These findings demonstrate that Y_2O_3:Ce^{3+}, Eu^{2+} phosphors are promising candidates for use as blue light-emitting components in solid-state white lighting applications.
Keywords: Y2O3:Ce, Eu nanophosphor; Optical band gap; Photoluminescence; Energy transfer; Luminescence lifetime; Quenching

Author: DUTTA, Manashree (Cotton University)

Presenter: DUTTA, Manashree (Cotton University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics

Contribution ID: **79** Type: **Oral**

Quantum Particle in a Parallelogram: Energy Spectrum and Eigenfunctions

Saturday, November 1, 2025 5:04 PM (11 minutes)

We study a quantum particle confined to a two-dimensional parallelogram with infinite potential walls. By employing a suitable non-orthogonal coordinate system, we derive exact expressions for the energy eigenvalues and eigenfunctions. The results generalize the rectangular case and reveal how skewing the domain modifies both the spectrum and the wave functions.

Author: DAS, Abinash (North Lakhimpur College(Autonomous))

Presenter: DAS, Abinash (North Lakhimpur College(Autonomous))

Session Classification: Oral Presentations

Track Classification: Track 01: High Energy Physics, Gravitation and Cosmology

Contribution ID: **80** Type: **Oral**

Evidence for collective radial flow in high-multiplicity pp collisions via long-range transverse momentum correlation at Run 3 LHC energy

Saturday, November 1, 2025 3:55 PM (20 minutes)

The observation of collective phenomena, a hallmark of the quark-gluon plasma (QGP) formed in heavy-ion collisions, in small systems like proton-proton (pp) collisions, remains a topic of intense debate. This study presents the first investigation of radial flow in high-multiplicity (HM) pp collisions using the novel transverse momentum correlation observable, $v_0[p_\mathrm{T}]$. Analogous to anisotropic flow coefficients, the $v_0[p_\mathrm{T}]$ probes event-by-event fluctuations of the mean transverse momentum and is sensitive to the isotropic, collective expansion of the system 1. Our analysis is performed using PYTHIA8 (v8.315) simulated events at Run 3 LHC energy ($\sqrt{s}$ = 13.6 TeV). We measure $v_0[p_\mathrm{T}]$ for inclusive charged and identified particles ($p/\overline{p}, \pi^{\pm}, K^{\pm}$). To suppress non-flow correlations from jets and resonance decays, we employ a pseudorapidity gap (η_gap) technique and extend it to include additional azimuthal gaps. The robustness of the signal is verified using two independent centrality estimators: charged particle multiplicity at mid-rapidity and the FT0 amplitude. The results reveal two key signatures of hydrodynamic collectivity: (i) A distinct mass ordering at low-p_T ($p_\mathrm{T} \leq 1.5$ GeV/c), where $v_0[p_\mathrm{T}]$ is largest for pions and smallest for protons. A characteristic baryon-meson splitting at intermediate p_T, with protons exhibiting a larger $v_0[p_\mathrm{T}]$ than mesons. Furthermore, the magnitude of $v_0[p_\mathrm{T}]$ shows a clear multiplicity dependence, with the largest magnitude observed for low-multiplicity (LM) (60-70\%) class, gradually following a decreasing trend for HM classes (30-40\% and 10-20\%). The persistence of these signals after applying stringent η_gap and azimuthal gaps strongly suggests a collective origin. These findings, extracted for the first time using the $v_0[p_\mathrm{T}]$ observable, provide compelling evidence that radial flow can be generated in HM pp collisions, challenging the traditional paradigm that collective effects are exclusive to larger collision systems.

References:

1 B. Schenke, C. Shen, and D. Teaney, "Transverse momentum fluctuations and their correlation with elliptic flow in nuclear collisions,"Physical Review. C, vol. 102, no. 3, Sep. 2020, doi: https://doi.org/10.1103/physrevc.102.034905.

Author: Mr AGARWALA, Rohit (Department of Physics, Bodoland University)

Co-author: Dr DEY, Kalyan (Department of Physics, Bodoland University)

Presenter: Mr AGARWALA, Rohit (Department of Physics, Bodoland University)

Session Classification: Oral Presentations

Track Classification: Track 04: Astronomy & Astrophysics, Space & Atmospheric Physics, Plasma Physics, Nuclear Physics and Non-linear Dynamics

Contribution ID: **81** Type: **Oral**

Green Chemistry Principle Mediated Synthesis of Biocompatible ZnS Quantum Dots: Potential Antibacterial Agent and Photo Catalyst

Saturday, November 1, 2025 4:15 PM (15 minutes)

Quantum Dots (QDs) are elite class of semiconductor nanoparticles which have potential applications in optoelectronics, photocatalytic activity and biomedical sector as they possess high fluorescent nature as well as high surface-to-volume ratio due to their atom like behaviour [1-3]. Despite having such promising ability, synthesis of these QDs adopting eco-friendly pathway is still a challenging one 3. Moreover, efforts are also made to utilize these metamaterials in biomedical domain too which is again a challenging task do to their inherent toxicity comes with their tiny size. Keeping in view, the present work demonstrates the Green Chemistry Principle mediated synthesis of Zinc Sulfide (ZnS) QDs, an important semiconductor from Group IIB-VIA. The primary characterization with Powder X-ray Diffraction Transmission, Electron Microscope (TEM) and UV-Visible spectra reveals the generation of quantum confined ZnS nanoparticles and FT-IR spectra admit the encapsulation of ZnS QDs with D-Fructose successively. The biological activity analysis demonstrates the cytofriendlyness of these ZnS QDs with high antibacterial efficiency. Moreover, both these dots are found to be highly eligible photocatalytic agents towards methylene blue (MB). Concisely, the present work demonstrate the multitasking nature of ZnS QDs which shows promising ability towards both biomedical domain as well as photocatalysis.

Author: Dr BARUAH, Jejiron Maheswari (Department of Chemistry, North Lakhimpur University)

Co-authors: KALITA, Diganta (Department of Chemistry, North Lakhimpur University); HAZARIKA, Himanka (Department of Chemistry, North Lakhimpur University); KALITA, Sanjeeb (Translational Biotechnology Research Laboratory, DBT-APSCS&T CoE for Bioresources and Sustainable Development, Kimin, Arunachal Pradesh, India)

Presenter: Dr BARUAH, Jejiron Maheswari (Department of Chemistry, North Lakhimpur University)

Session Classification: Oral Presentations

Track Classification: Track 03: Material Science & Nano-science, Quantum Thermodynamics & Statistical Physics