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

Friday 31 October 2025 - Saturday 1 November 2025

North Lakhimpur University

Book of Abstracts

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

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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.

2

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

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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.

3

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

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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.

4

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

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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.

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Neutrino mass genesis in Scoto-Inverse Seesaw with Modular A_4

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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.

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Neutrino Mass Matrix with unique Correlations

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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.

9

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

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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.

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

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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.

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

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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.

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Leptogenesis in Alternative Left Right Symmetric Model

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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.

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Propagation of nonlinear waves in molecular clouds

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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 astromedia of these fluctuations are also enlighted.